Cal Poly Pomona - Human Research Protections Program
Institutional Review Board (IRB)
Protocol Application (version: January 31, 2011)

IRB principles: respect for persons, beneficence, justice

Cal Poly Pomona (CPP) is committed both to research in advancement of teaching and science and to the protection of the individuals involved. As part of the assurance filed with regulatory agencies including the federal Dept. of Health and Human Services and policies from others like the State of California, the University has designated a human subjects' committee, called the Institutional Review Board or IRB, to review proposals for research involving living persons. This application, when submitted to the IRB, will be evaluated in terms of its compliance with ethical standards regarding the treatment of subjects (participants). The type of review – full, expedited, or exempt – will be determined by the IRB. While individual researchers are ultimately responsible for their practices, the IRB's review is designed to provide objective input as additional protection for the subjects. Further, it is of benefit to those who could be held accountable for the research practices, i.e., the researchers and the University. All research conducted by students, faculty, and sponsored individuals must have prior IRB approval.

Hints and help:

- Complete all sections in yellow about your research proposal. Incomplete protocols will be returned. There are blue highlighted links to additional information. Look at the helpful hints as indicated in *italics* with each question of the protocol. It is highly recommended to have someone not involved in the writing of the protocol look it over for clarity and typographical errors.
- More information about the IRB at Cal Poly Pomona is available at the Research web page, http://www.csupomona.edu/~research/irb/. There are sample protocols and consent forms, links to training materials, policies and procedures, etc.
- Submit your completed protocol application to the IRB office within the Office of Research (Research). E-mail it and any attachments such as surveys, informed consent forms, and recruiting flyers to bkennedy@csupomona.edu, the IRB administrator. To facilitate tracking, please include in the file name 1) your last name and 2) one or two key words describing its subject.
- Also, print off, sign, and bring or mail this front page as hard copy to the IRB office at Research, Building 1, room 229. You -- and all co-PIs -- must sign the "Declaration by all Investigators" before the review will begin.
- Training in the conduct of human subject research is critical and investigators must demonstrate their knowledge and awareness through the completion of appropriate coursework. In 2007, the IRB adopted the CITI "Course in The Protection of Human Research Subjects" (https://www.citiprogram.org) as the primary means of training and as a requirement of protocol approval. Please provide documentation of your training with this application; you may be asked to pursue additional training appropriate to your study.
- For other assistance, contact the Compliance Associate within Research, Bruce W. Kennedy MS RLATG CMAR CPIA, at 909-869-4215 and bkennedy@csupomona.edu.

Investigator information	Primary investigator (faculty, student, etc.)	Others (your faculty advisor, co-PIs, facilitator, sponsor, collaborators, etc.)
Name:	Nicholas Aguilera	Homeyra Sadaghiani
Affiliation (college/dept):	Department of Physics	Department of Physics
Phone contact (office or cell):		(909) 869-5194
Email contact:		hrsadaghiani@csupomona.edu
Title of this IRB protocol: Mathematical vs. Conceptual Understanding: Where do we draw the line?		
Date submitted:	_X_new ___amendment ___renewal; previous number:	
Any vulnerable subjects (risks)?: _X_minors ___pregnant women ___medically sensitive ___other:		

DECLARATION BY ALL INVESTIGATORS: This proposal is guided by the ethical principles regarding research involving human subjects as set forth in the Belmont Report. I/We agree to abide by the policies and procedures of the IRB at CPP, including obtaining appropriate training in human subject research for myself and those involved in its conduct. I/We will not initiate any research associated with this proposal on or off campus until authorized by the IRB. I/We will inform the IRB of any adverse events that occur or of a need to modify the study design. I/We understand that approval, when granted, is valid for up to one year and will submit a renewal for its continuation if needed.

(send this signed page to the IRB office)	Signature, certifying the above	Date
primary investigator:		
all others, including advisors:		

IRB office use	review type: full IRB (risk involved)	expedited/designated review (minimum risk/harm)	exempt PEIP NA
date rc'd: revised	assigned to:	training: PI others	approval date:
protocol #:			renewal date:
copies: chair file	final: signed ICF approval-memo authorizations e-mailed		
This protocol has been reviewed and approved for conduct by the IRB, California State Polytechnic University, Pomona.			
Jeffery S. Mio PhD, Chair, IRB		Date	

I. DESCRIPTION OF THE RESEARCH PROJECT

Research is defined as "a systematic investigation including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge." (45 CFR 46.102(d))

A. Purpose of this project – What hypothesis are you testing? Why are you conducting this study; explain the rationale? What are the objective(s) and goal(s)? *Provide enough detail such that a) the IRB member(s) reviewing your protocol will understand your research plan and b) to support a judgment of the risks and benefits in order to approve the "use" of the research participants.*

This project is intended to help us understand how students can best learn introductory physics at its most fundamental level, in a high school classroom. While similar studies are often conducted in introductory college-level undergraduate classes, there has not been much research done at the high school level. I believe that this study would be beneficial and informative because, while the prior mathematical experience of students in an introductory college-level physics class could range anywhere from algebra through differential equations, that of a high school classroom would be much less varied, creating significantly fewer variables in a study dealing with conceptual versus mathematical learning processes. Also, a significant number of introductory college physics students have already taken physics in high school, while a significant number have also never had a physics class prior to the one in question. The vast majority of high-school physics students have little to no prior experience in learning physics, thus eliminating another variable to be considered in such a study. The study will address a number of issues:

1. Determining whether a conceptually or mathematically-inclined method of instruction is more easily grasped by high school students.
2. How well students perform when quizzed on the material learned throughout the course of the study.
3. How the method of teaching affects the responses given by students on a post test at the end of the study.
4. Implementation/development of new teaching strategies using the results of the study.

This project is part of the PI's senior project for graduation and also serves as part of the co-PI's scholarly activities as a Physics Education Researcher. Furthermore, it has potential implications for the broad community of physics educators of all levels.

B. Relevance – State specifically the relationship of your proposed research to other, previous scientific and/or scholarly investigations in the field. Provide full citations (APA or MLA reference styles are good). *What literature is related to your research? What are you doing that builds on that information?*

Much prior research has been done on related topics to the one I am studying, but most of this research is done at the introductory college level. One study that I have focused on in my preliminary research suggest that introductory physics students often have preconceived notions about the basic physical laws of the universe that are often incorrect, and that the best way to approach instruction of these students is to apply more emphasis on fundamental, conceptual principles to attempt to dispel these misconceptions (1), another study concludes that prior mathematical experience has a significant effect on an introductory physics student's ability to learn in most physics classes (3), and another concludes that, overall, students learn best through the use of "interactive-engagement methods", where they are actively involved in solving problems, rather than through traditional lectures (2).

My goal in conducting this study is to use interactive-engagement teaching methods with students at the high school level, where less research has been conducted, in order to determine whether conceptually or mathematically-based instruction is more effective in enhancing students' knowledge. As mentioned in the previous question, another advantage to using high school students in the study, as opposed to college students, is that is range of mathematical background knowledge will be much less varied. Similarly, the vast majority of introductory high school physics students have never taken a physics class before, while many introductory college students have already taken one in high school or earlier in college, while many others have not. I foresee far fewer variables in analyzing data due to these reasons.

References

(1) Clement, J.; "Students' Preconceptions in Introductory Mechanics", *American Journal of Physics* **1981**, Jan. 1982, 66-71

(2) Hake, R. R.; "Interactive Engagement versus Traditional Methods: A six-thousand-student survey of mechanics test data for introductory physics courses", *American Journal of Physics* **1997**, Jan. 1998, 64-74

(3) Meltzer, D. E.; "A Relationship between Mathematics Preparation and Conceptual Learning Gains in Physics: A possible "hidden variable" in diagnostic pretest scores", *American Journal of Physics* **2002**, Dec. 2002, 1259-1268

C. Methods – Summarize the design (independent variables, interventions, treatments, etc.) of your proposed study. What are your expected outcomes? Describe <u>in detail</u> all procedures to be done with human subjects. <u>What</u> types of test(s) will be performed on or with the subjects? <u>How</u> will you carry them out and with <u>what</u> data gathering instruments and apparatus? <u>When</u> do you plan for the research to occur? <u>Where</u> will the research be held (and is authorization or permission needed there)? <u>Who</u> will conduct the research besides yourself? *Define terms, abbreviations, and procedures that may be specific to your discipline for the understanding of the IRB reviewer. By authorization, it is meant for example, a company's permission to use worker's time or a school principal's acknowledgement – if so, provide documentation to the IRB. Don't assume that the IRB reviewer will intuitively know the steps and logistics of your methods and process.*

Along with the co-PI, I will be aided in conducting this study by Mr. Kent Purser, physics teacher at Granite Hills High School in Apple Valley, CA, in the fact that has agreed to allow me to serve as a guest instructor and collect data from pre/post tests given in two of his physics classes over a one-week period during the fall quarter of 2011 during their regularly-scheduled class periods. It is important to note that while, as the students' regular physics teacher, he will be present as an observer during the instruction phase of the study and may offer assistance as needed, he will not have access to any data collected from the study.

As I will be working with minors in these classes, I will distribute and collect the appropriate parent permission forms from each student in his classes prior to beginning the study (see form attached at the end of this application). Participation in this study will be completely voluntary and non-participation in the study will have no ill-effects on the student's grade. Should a student or his/her parents not wish to participate, then an alternative learning activity will be assigned for that student by Mr. Purser that will have no connection to the study and no data will be collected from that student.

The pre/posttests mentioned above will be given in a confidential manner and will cover the topics discussed throughout the period of instruction. Students will not be asked to provide their names or any other self-identifying information on the tests, but will be asked for information regarding their mathematical and scientific backgrounds, for statistical purposes. Should a student not wish to answer any of the mathematical/scientific background information questions, he/she may select an option that says "Prefer not to say". Only a unique alphanumeric ID will be used identify student results. This ID will only be used to match student results from the pre/posttests, and to calculate students' learning gains throughout the laboratory activities. Student names and any other identifiers will be stripped from the data for all analysis.

Instruction during the course of the study will cover the topics of Newton's laws, gravity, and conservation of momentum and energy, as they relate to such scenarios as the motions of falling bodies and projectiles and elastic and inelastic collisions, among others. Both classes will be introduced to the conceptual principles and the mathematical equations and processes related to these topics, but one class will be taught with a strong emphasis on conceptual understanding on the physical laws and principles, while the other will be taught with an emphasis on applying a mathematical process to understand the material. They will be conducted in established or commonly accepted educational settings, involving normal educational practices, such as, research on regular and special educational strategies, research on the effectiveness of instructional techniques and curricula, and research on student specific difficulties with the topics discussed.

The co-PI, Homeyra Sadaghiani, will assist and advise the PI, Nicholas Aguilera, in conducting this research. While the study itself will be conducted at Granite Hills High School, in Apple Valley, CA, anonymous results will be brought back to the Cal Poly Pomona physics department for analysis to be carried out throughout the 2011-2012 school year.

II. AFFILIATIONS

These questions ask about how you are related to the institution and subjects where the research project is to be conducted. As examples: you are a teacher using your students in a classroom setting as your subjects, or you work for the company where a marketing survey is to be conducted, or you have a financial interest in a product being tested, or you are working with a colleague in another country.

A. Are you collaborating with another group such as a school, community association, government agency, etc.? Is IRB approval necessary, or being obtained, elsewhere (domestically or

internationally)? Is the project being sponsored or supported through a grant, contract, or other financial arrangement? Does the funding agency require IRB approval? Describe as appropriate. *The IRB is required to collect such data for OHRP (Office for Human Research Protections) on studies funded by DHHS (NIH, FDA, etc.).*

This study will be performed in collaboration with Granite Hills High School (GHHS) in Apple Valley, CA. Mr. Kent Purser, physics teacher at GHHS will be assisting as needed, as I conduct the study with two of his introductory physics classes. The study is not being sponsored or funded by any kind of financial arrangement.

B. Personal gain – Do you, as an investigator involved with the project, or any family member (spouse, child, etc.) have a financial or other "self" interest in this study? If yes, describe. *For example: an MBA student may conduct a consumer survey about establishing a business (restaurant) she herself wants to open. In this case, there could be a need for disclosure of the fact in the informed consent form.*

No

C. Are you a student? Is this project part of a classroom experience or a graduate program? Has your advisor/mentor reviewed your IRB application? Describe as appropriate. *Student protocols cannot be reviewed by the IRB until there is evidence of the advisor's contribution and approval including his/her signature on the front page of this application.*

The co-PI, Dr. Sadaghiani, is a physics faculty member who will be advising and mentoring me as a senior physics student who is participating in this project as part of a graduation requirement (PHY 461- PHY 462).

D. Do you have any pre-existing relationships of any kind with the subjects (participants) or institutions involved in conducting this study? If so, please describe them. *If you work for a company and need to keep its identity confidential, note that here.*

I have worked for this school district as an athletic coach and as a tutor since 2006, so it is possible that I may be acquainted with some of the students that will be participating in the study, but this will have no effect of how the study is conducted or analyzed.

E. If you are not affiliated with Cal Poly Pomona, who is your co-PI or facilitator on campus? *A co-PI applies when there is a collaborative research project being proposed in this protocol. A facilitator applies when there is a need for logistical support to conduct your study at Cal Poly Pomona. Not all studies need a facilitator, but the IRB may, upon review of your protocol, make it a condition for approval. See section 14.14 of the IRB policies and procedures. Obtaining a facilitator is the responsibility of the PI(s). Describe as appropriate. Specify the name, email address, and phone number of either your co-PI(s) or facilitator.*

Not applicable.

F. Though there may not be one, could there be the perception of a conflict of interest for either you, as the investigator, or for the subjects in this study? If so, how will you manage that? *See* ***http://www.csupomona.edu/~policies/Administrative/conflict_of_interest_and_financial_disclosure.html.***

The primary goal of this research is investigation of student specific difficulties in learning introductory physics topics and developing methods, curriculum materials, and techniques to help students to overcome these difficulties. Thus, this will benefit students in the long run and by no means will affect their course grades. The goals and objectives of all investigators and parties involved are aligned with this project and its potential outcome, thus there is no conflict of interest.

III. DATA COLLECTION

Collection methodologies include, but are not limited to: surveys, interviews, focus groups, oral histories, participant observation, observations of public behavior, research in public schools, and the analysis of existing data. Data include: survey sheets and questionnaires, biological samples, audio and video tapes, transcripts of verbal communication, photographs, paper and electronic records, previously collected (existing) information, etc. Personal and private data deemed by the IRB to be a risk to subjects if revealed can include gender, income, number of children, age, religion, ethnicity, e-mail addresses, and more. Even when labeled as demographic data, it is still personal and private and could potentially identify an individual. This is not to say such data should not be collected, but mechanisms must be described in this protocol to protect the interests of the subjects should they be (somehow) identified.

The HIPAA Privacy Rule regulations [45 CFR 164.514(b)] list specific elements that are considered to be personal identifiers. These include: name and initials; street address, city, county, precinct, zip code, or equivalent geocodes; elements of dates (except year) directly related to an individual (date of birth, admission date, discharge date, date of

death); elements of date including year for persons 90 or older; telephone and/or fax number; e-mail address; social security number; medical record or health plan identification number; account number; certificate and license number; vehicle identifier and serial number including license plate number; device identifier and serial number; web address (URL), internet IP address; biometric identifier including finger and voice print, full face photographic image and comparable image; other unique identifying number, characteristic, or code.

A. What data about the subjects will be collected? In what format (see above)? How will it be coded or identified? Will social security numbers be used? What will become of the data at the end of the study (returned, destroyed, archived)? *If data like audio and video tapes are kept, the subject must be told of the purpose (e.g., conference presentations) and for how long, as part of the informed consent process. The subject has the option, after the study is over, to contact the researcher to withdraw permission for continued use.*

As mentioned in section I-B, no personal data, names, student ID's, social security numbers, or demographics will be collected or used in any part of the study and the results will be presented anonymously with no identifiers linking any individual student to the study. Other than pre/posttest questions related specifically to material covered through in-class instruction, students will be asked about their mathematical and scientific backgrounds prior to taking part in the study. This is purely for statistical data and providing answers to these questions will be strictly voluntary. All data will be presented and discussed in a collective manner (e.g., percentage of correct responses on different questions, etc.) and will not single out any specific student's responses.

The pre/posttest and background information will be obtained in such a manner that human subject cannot be identified either directly or indirectly. All data obtained will be entered into a password-protected computer and backed up onto a disc that will be stored in a secure location. After transferring all data into an electronic format, the hard copies of the pre/posttests will be destroyed so that all data can only be accessed by the investigators*.

The physics senior project requires students to present a poster on their project. I anticipate that the data obtained during this study will appear on this poster as well as local or national meetings. Depending on our findings, it could potentially publish on an article in Physics education research related conferences and/or journals. As mentioned above, there will be no identifiers in any form of presentation that would directly or indirectly violate the anonymity of the survey.

*Parent permission forms will be kept as hard copies in a secure location, under lock and key, in order to preserve all original signatures.

B. If applicable, have you submitted a copy of the survey or questionnaire to the IRB? *(If using a published survey, do you need and have you provided permission to use it?)* **Provide the URL for electronic surveys.** *(It will be tested during IRB review; discard those data before 'going live.')*

____ yes ___X___ in development (only finalized surveys can be approved) comment below:

Questions asked to students in the pre/posttest would be typical physics subject-related questions and a few optional questions on the mathematical and scientific backgrounds of the students, to be used only for statistical data. Some example questions can be found attached at the end of this application.

C. Who will have access to and use the data? How will the raw data be kept protected and secure? How will the data, results, and conclusions be utilized (e.g., presentations, publications, or other)? *(per California law, CC 1798.24, the researcher must provide a plan sufficient to protect personal information from improper use and disclosures, including sufficient administrative, physical, and technical safeguards to protect personal information from reasonable anticipated threats to the security or confidentiality of the information.)*

The PI AND Co-PI are the only people who would have access to the data. All data will be password protected.

D. Does the research project have provisions or plans for the ongoing monitoring of data collection to ensure safety of subjects? If so, describe the plan. *This generally applies to longitudinal studies, meaning long-term interaction with the subjects. For example: a dietary study of a novel food product looking at physiological responses, or a repeated measures study where information is provided by subjects for many weeks, or studies involving data collection for months and different research assistants would be contacting subjects, or a behavioral study that might have lasting (mental) impressions.*

As mentioned above, all data will be kept in a password-protected manner and any codes that can connect the subjects to the data will be kept separately from the data and eventually be destroyed.

E. For studies involving medical records, explain compliance with the HIPAA privacy rule (Health Insurance Portability and Accountability Act) and disclosure of protected health information (PHI).

(see http://www.csupomona.edu/~research/irb/Hints_help_examples.shtml for the "Experimental subject's bill of rights – Medical research" consent form if invasive procedures are to be performed)

__X__ not applicable comment: .

IV. SUBJECTS

A human subject is a "living individual about whom an investigator (whether professional or student) conducting research obtains data through intervention or interaction with the individual or identifiable private information." (Dept. of Health and Human Services)

A. How many subjects (or participants) will be involved in the research project? What is the statistical validation for that number? *It is acceptable to have a range, but it must be a close approximation. For projects with surveys (e.g., electronic, phone, written, door-to-door canvassing), indicate the number to be recruited, the anticipated response rate, and thus the final number of actual participants.*

The subjects will be two groups of 30-40 introductory high school physics students, corresponding to the average yearly number of students taking high school physics at GHHS. It is anticipated that nearly all students in the classes will respond and participate in the study. (N=60-80)

B. Briefly describe the subject group(s), that is their characteristics -- for example age groups, gender, students, faculty members. *What are you looking for in your subjects?. See as well the section on recruitment of subjects.*

The subjects are introductory high school physics students at GHHS and can range in age from 15 to 18 years old.

C. What are the benefits, if any, to the subjects from their participation in the study? *Will they personally gain something through the research by being a subject? This information – summarized – must be included in the consent (and/or assent) form as well. If there is no direct benefit, then state that.*

Students will not be compensated in any way from this study, but they may benefit from the knowledge gained from the instruction process and may also benefit from the results of the study, should findings on more effective teaching methods be applied in the future.

D. Will the subjects be compensated? Will they be given something? If yes, in what way (token of appreciation, money, gift, cash card, course credit, etc.)? *This information – summarized – must be included in the consent (and/or assent) form as well. If there is no compensation, then state that.*

No compensation.

E. Describe the control and/or comparison group(s), as applicable.

Both groups are made up of introductory high school physics students and will be taught about Newton's laws and gravity as they relate to falling bodies and projectile motion. One group will be taught with an emphasis on conceptual understanding, while the other will be taught with an emphasis on mathematical comprehension.

V. VULNERABLE SUBJECTS

When a subject has limitations, is coerced or manipulated, there is a loss of capability to volunteer, and the subject may be vulnerable. The IRB considers the possibility that, for example, bosses can coerce at the workplace and teachers can manipulate in the classroom. Research conducted with vulnerable subjects requires demonstration of training with that specific population.

A. Minors – Will children, minors, or wards be recruited for this research? If so, explain in what way. How will their assent to participate be obtained? *Children in most circumstances are those less than 18 years of age. Research with children involving no greater than minimal risk requires the permission of one parent and the assent of the child (45 CFR 46.404).*

This study will involve the participation of minors. A permission form must be signed by both the parent and the student prior to that student's taking part in the study. This study involves no greater than minimal risk to all participants.

B. Others – Explain research involving other vulnerable subjects such as prisoners, pregnant women, or culturally or medically vulnerable groups? *Consider the circumstances. For example, a pregnant woman answering a survey about being a teacher may not be vulnerable, but she could be if it's a study about baby furniture.*

Not applicable.

VI. POTENTIAL RISKS AND THEIR ASSESSMENT

Definition of risk: A potential harm, discomfort, or inconvenience associated with your research that a reasonable volunteer would be likely to consider significant in deciding whether or not to participate. Risks include legal, social, emotional, or psychological issues, physical or biological hazards, revealing an identity, damage to reputation, exposure of behavior or medical character, illness, injury, side effects of applied or consumed products, revealing or loss of private information, etc. Risk comes at various orders of magnitude, ranging from mere inconvenience to perceptible bodily pain.

A. What are the risks? Describe any potential harm, discomfort, or inconvenience, however minimal, as you would explain them to the subjects. *This information – summarized – must be included in the consent form as well.*

The nature of this research has the minimum risk possible and by keeping all the research data safe and confidential one can ensure that there will be no social, emotional, or psychological damages to the subjects.

B. Describe your procedures for protecting against or minimizing the potential risks. *Is a debriefing statement needed? A brochure from the Counseling and Psychological Services might be necessary. Do you procedures and contacts with medical emergency services for treadmill exercises or phlebotomy? Could someone else obtain personal and private data? Should an adverse event occur – something you don't anticipate or didn't plan on – the IRB web site has a reporting form for this purpose.*

We will ensure confidentiality of the data and will not present any personal data in this research. The faculty and students who will be involved in the research would not be identifiable in any ways. We will not analyze any data before the grade due dates for each quarter to ensure that student refusal to participate in research project will not affect student grades in any manner.

C. Explain why these risks should be determined as reasonable in relation to the anticipated benefits, if any, while conducting research with the subjects. Include in your response the importance of the expected gain in generalizable knowledge, when evaluated against the risks.

As mentioned above all the data will be confidential and participation will be voluntary. The anticipated benefit can impact students' ability in learning physics and improve teaching and learning in general.

D. Is the study anonymous or confidential? Describe in detail your procedures meant to assure the protection of subjects' information, sensitive data, and privacy. *(See the CPP IRB web page for a discussion of what is confidential and what is anonymous. There are processes to de-identify data as well.)*

We will secure the data in a password-protected manner and separate from the data files to which the investigators will be the only people who would have access. In addition, we will inform the subjects of the voluntary and confidential nature of the research data in a written consent form (an example is enclosed). In addition to this experience, all the investigators have completed online training courses to ensure this research would not harm students and would not put them in any social, emotional, or psychological risk.

VII. RECRUITMENT

As applicable, attach copies of flyers, e-mail or blog text, advertisements, etc., to be used for the recruitment of subjects. Review by the IRB is ncessary for approval of your protocol. Include the statement as follows: The Cal Poly Pomona Institutional Review Board has reviewed and approved for conduct this research involving human subjects under protocol YY - ### (meaning year and sequence number).

A. How will you approach your subjects to potentially participate in the study? Where will you recruit them? Will translation of materials be necessary to other languages or to a different reading and comprehension level for recruiting purposes? *Consider that children often need simplified language. And studies show that the average adult reads at a 5th to 8th grade level.*

Students to be recruited will be informed about the study and will thus be recruited for it in their classroom at the start of the fall quarter. As the language of instruction in the class is English, I do not anticipate a need for language translation to the students themselves, but should they or their parents require any assistance with language or comprehension, there will be contact information given on the permission form.

B. Describe the criteria you will apply when selecting and enrolling subjects into the study. *Inclusion criteria are those characteristics on which you will be recruiting and accepting subjects. Exclusion criteria are characteristics on which subjects will be screened and potentially excluded from participating.*

All students taking introductory physics at GHHS with parent/guardian permission to take part in the study and have also provided assent, shall be selected and enrolled into the study. No other criteria shall be used.

C. Describe your procedures for the recruitment of a representative sample of the population based upon race, ethnicity, gender, health status, or other characteristic. If this is not the case, discuss the reasons for not having such a balanced sample (such as, the research is focused on a certain subject group).

The students we are studying are, by definition, enrolled in introductory physics GHHS. Therefore, we are not able to specifically recruit an ethnically or gender balanced population.

VIII. TRAINING

Formal training and practical experience in research with human subjects are critical for the protection of the participants and minimization of risk that might be associated with the conduct of the study. Federal regulations require that investigators possess training. The Cal Poly IRB adopted in 2006 the on-line CITI program as required training in human subjects research. All investigators submitting applications to the IRB after January 1, 2007, must complete appropriate modules of CITI as a condition of approval of a protocol. Other formal training will be considered by the IRB on an individual basis.

A. Describe the training possessed by you. Include when it was obtained and the CITI completion report number. Will you obtain any additional training related to this proposal? *If you are a student, your advisor (faculty mentor) must possess training as well, which you are to describe in the next section (VIII.B.).*

PI, Nicholas Aguilera, is a physics student who is involved in this study as part of his senior project. He has completed CITI training for Cal Poly Pomona, with the specific emphasis on research with minors. Training was completed on 7/26/11. His certificate number is 6363784.

B. Describe the training possessed by others including your co-investigators, collaborators, students, staff, faculty members, a student's mentor or advisor, etc., from Cal Poly or elsewhere, working on this study. Include when it was obtained and the CITI completion report number.

Co-PI Sadaghiani has been conducting research in physics education research since 2002 at The Ohio State University (as a graduate student) and at University of Washington (as a Research Assistant), and has published a number of articles in this field. Dr. Sadaghiani has completed CITI training in three different institutes. Her certificate number is 1218841.

IX. INFORMED CONSENT

The informed consent form (ICF) is the means by which you as the PI convey the principles of human subjects protections to your subjects: respect, beneficence, and justice*. There are examples on the IRB website. Complete the accompanying consent form(s) below. Include it as part of the URL in electronic surveys. Include it when submitting this protocol application for review. Include the assigned IRB protocol number in your ICFs.*

A. How will you obtain and document informed consent (for adults) or assent (for children)? Which study personnel will be involved in obtaining consent and/or assent? *For certain types of research methods, like on-line surveys, it is possible to obtain a waiver of consent (implied or passive) from the subjects. Contact the IRB for a determination and the requirements. A justification must be provided to obtain the waiver.*

The consent form for participating in the study is attached. Both a parent/guardian and a student signature are required in order to participate in the study.

B. Will there be recruitment of subjects who cannot themselves provide informed consent? If so, how will informed consent be documented for this population?

Consent must be provided by the parents/guardians of all minors participating in the study.

C. Describe how you will maintain the consent forms received from the subjects? *Where (location) will they be kept? For how long/until when? Will they be kept separate from subject data and specimens?*

We will keep scanned copies separate from data in a password-protected file and hard copies locked in a secure file cabinet in Dr. Sadaghiani's office in order to preserve original signatures.

X. CONSENT FORM

The IRB requests the following header be included in the ICF(s) of all Cal Poly Pomona approved protocols. It is reproduced on the next page followed by a write-in block for your Informed Consent Form to be completed. Alternatively, you can send it as an attachment, but it must have the informational header below.

California State Polytechnic University, Pomona
Informed Consent Form for Research Involving Human Subjects

You are being invited to participate in a research study, which the Cal Poly Pomona Institutional Review Board (IRB) has reviewed and approved for conduct by the investigators named here. This form is designed to provide you - as a human subject - with information about this study. The Investigator or his/her representative will describe this study to you and answer any of your questions. You are entitled to an Experimental Research Subject's Bill of Rights and a copy of this form. If you have any questions about your rights as a subject, complaints about the informed consent process of this research study, or experience an adverse event (something goes wrong), please contact the Compliance Office within Cal Poly Pomona's Office of Research at (909) 869-4215. More information is available at the IRB website, www.csupomona.edu/research/irb.

Below is this header in Spanish:

Forma de Consentimiento Informada para Investigación que Implica Sujetos Humanos

Usted está invitado a participar en un estudio de investigación que el Comité Examinador Institucional (CEI) de Cal Poly Pomona ha revisado y aprobado para ser conducido por los investigadores nombrados aquí. Esta forma está diseñada para proporcionarle información acerca de este estudio en su calidad de sujeto humano. El investigador o su representante le describirán este estudio y le contestarán cualquier pregunta que tenga. Usted tiene derecho a la Declaración de Derechos del Sujeto que participe en una Investigación Experimental y a recibir una copia de este documento. Si tiene alguna pregunta o quejas acerca del proceso descrito en dicho documento, por favor llame a la Oficina de la Conformidad que forma parte de la Oficina de Investigación de la Universidad de Cal Poly Pomona al (909) 869-4215. Más información esa disponible en sitio web de el CEI en el www.csupomona.edu/research/irb.

A properly written Informed Consent Form (ICF) will include the following elements. You, as the Principal Investigator, are responsible for addressing each when writing your consent and/or assent form. Both federal and California regulations require the inclusion of these elements to adequately inform subjects when participating in research. You may wish to use this page as a checklist. Incomplete forms will be returned to you for revision. See the IRB website for examples.

- A telephone number and/or e-mail address of all primary investigator(s) of this proposal, including faculty members and graduate students, who would be the point(s) of contact for the subjects
- Affiliations (professional and institution) of the contacts and investigators; use full names, thus don't write Cal Poly Pomona - use California State Polytechnic University, Pomona
- Clarification of the contacts in research projects which involve multiple sites (there can be multiple offices of research for example)
- Title of the protocol (same as on the front page of this application)
- Protocol number as assigned by the IRB (it will be provided after the protocol is submitted to the IRB administrator); it must appear distinctly (e.g., bolded, its own line)
- A statement that the study you are conducting involves research
- An explanation of the purpose(s) of the research, why it's being conducted by you
- A description of what the subject must do as part of the research, what data will be collected, what will happen to the data after the "active" phase of interaction with the subject is completed. (It has been found useful to include blocks in the ICF for subjects to initial when audio or video taping, so as to further document that these methods will be conducted.)
- The expected duration of the subject's participation on the study (e.g., 50 mins in one day, four visits between May 1 and June 30)
- The information about the procedures must be presented in layman's terms (at the 5th grade reading level); it must fully explain to the subjects what they are expected to do
- The entire consent and/or assent form may need to be translated into the subject's language of fluency
- Identification of any procedures or methods which are experimental
- A description of any reasonable and foreseeable risks or discomforts to the subject
- Changes of pronoun as appropriate to the subjects (e.g., you will be asked …; your child will do …)
- A description of any benefits to the subject or others which may reasonably be expected (or not) from the research
- A disclosure of appropriate alternative procedures or courses of treatment, if any, that might be advantageous to the subject

- For research involving more than minimal risk, an explanation as to whether any compensation and an explanation as to whether any medical treatments would be available if injury occurs and, if so, what that would consist of and where further information may be obtained
- California law, under Health & Safety Code Section 24172, requires that any person asked to take part as a subject in research involving a medical experiment, or any person asked to consent to such participation on behalf of another, is entitled to receive the **Experimental Research Subject's Bill of Rights** written in the language in which the person is fluent.
- An explanation of whom to contact for answers to pertinent questions about the research and research subject's rights, and whom to contact in the case of a research-related injury to the subject
- A statement that participation is voluntary, that declining to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled, and that the subject may discontinue participation at any time without penalty or loss of benefits, to which the subject is otherwise entitled
- Printed name and signature lines for the subject and the date signed
- Printed name and signature lines for the principal investigators (e.g., faculty member or the graduate student conducting the research) and perhaps research associates; and the date signed
- A statement that the subject is entitled to receive a copy of the completed informed consent form

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Parent/Guardian Informed Consent and Student Assent for a Research Study

Your child is being asked to take part in a research study on "**Mathematical versus Conceptual Learning in Introductory High School Physics Classes."** The study is being done by senior undergraduate physics major, Nicholas Aguilera, along with Dr. Homeyra Sadaghiani, who is a professor at California State Polytechnic University, Pomona. This study is being done to gain insights to how the educational community as a whole can enhance the learning experiences of introductory physics students at the most fundamental level.

Your child will be asked to take a pretest to gauge his/her understanding of relevant physics course-related material as well as determine his/her background experience in dealing with the mathematical and scientific concepts involved in the study. He/she will then take part in a series of physics lectures and activities given over the course of one week by Nicholas Aguilera during his/her regularly-scheduled physics class this fall quarter. Mr. Kent Purser, your child's current physics teacher at Granite Hills High School, will assist and supervise during this in-class instruction. At the conclusion of that week, your child will then be asked to take a posttest to gauge how much he/she learned over the course of the study.

It is important to note that participation in this study is completely confidential and your child's grade in the course will not be affected should he/she not participate in the study. No information that can specifically identify you or your child will be collected or released.

By signing below, you acknowledge that your child is participating in this research project voluntarily and that you, as his/her parent/guardian give your informed consent of his/her participation. All data collected during the study will be kept confidential and will only be used for the purpose of this research and improving student experience and learning in fundamental physics courses. Neither your child's name nor information identifying him/her as an individual will be disclosed to anyone. We appreciate your participation and time in advance. There is no compensation to you, but we hope the results of this study can improve student learning in introductory physics courses.

If you have any questions you can contact Nicholas Aguilera or Dr. Sadaghiani, given the following contact information:

Nicholas Aguilera- Primary Investigator
Senior Undergraduate Physics Student
California State Polytechnic University, Pomona
Physics Department
naaguilera@csupomona.edu

Homeyra Sadaghiani- Co-Primary Investigator
Assistant Professor of Physics
Room 8-227
(909)869-5194
California State Polytechnic University, Pomona
Physics Department
hrsadaghiani@csupomona.edu

Parent/Guardian signature: _____ Date: _____

Student signature: _____ Date: _____

Example Questions

These are the type of background and subject-related questions that will be given on the pre/posttest.

Background:

1) What is the highest-level mathematics course that you have completed?

a. Algebra I b. Algebra II/Geometry c. Trigonometry d. Pre-Calculus e. Calculus or above f. Prefer not to say

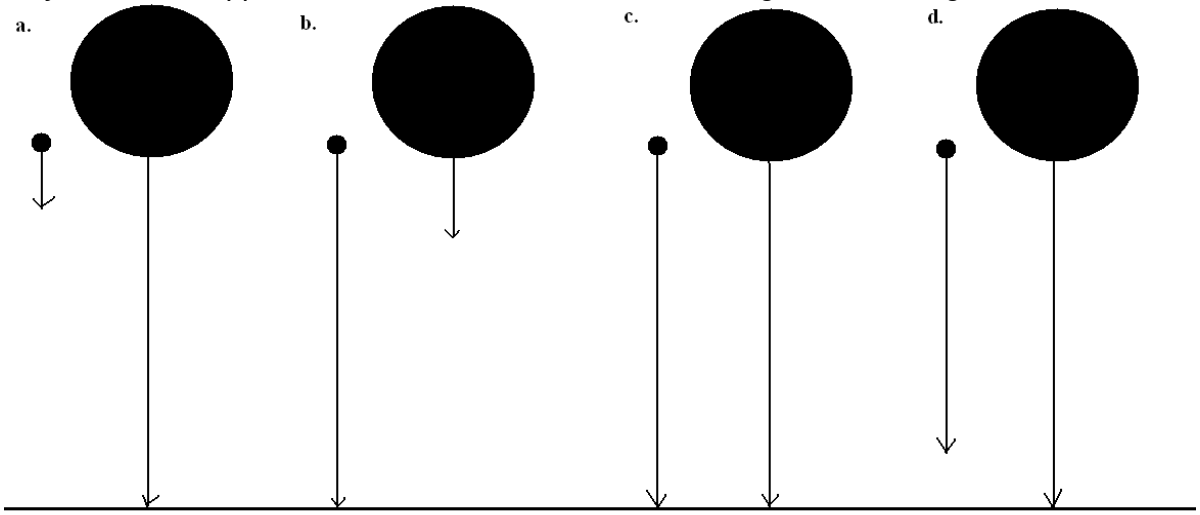
2) Have you ever taken an introductory physics course before? (Circle one)

Yes No Prefer not to say

If yes, did you pass that course? Yes No N/A Prefer not to say

Subject-related:

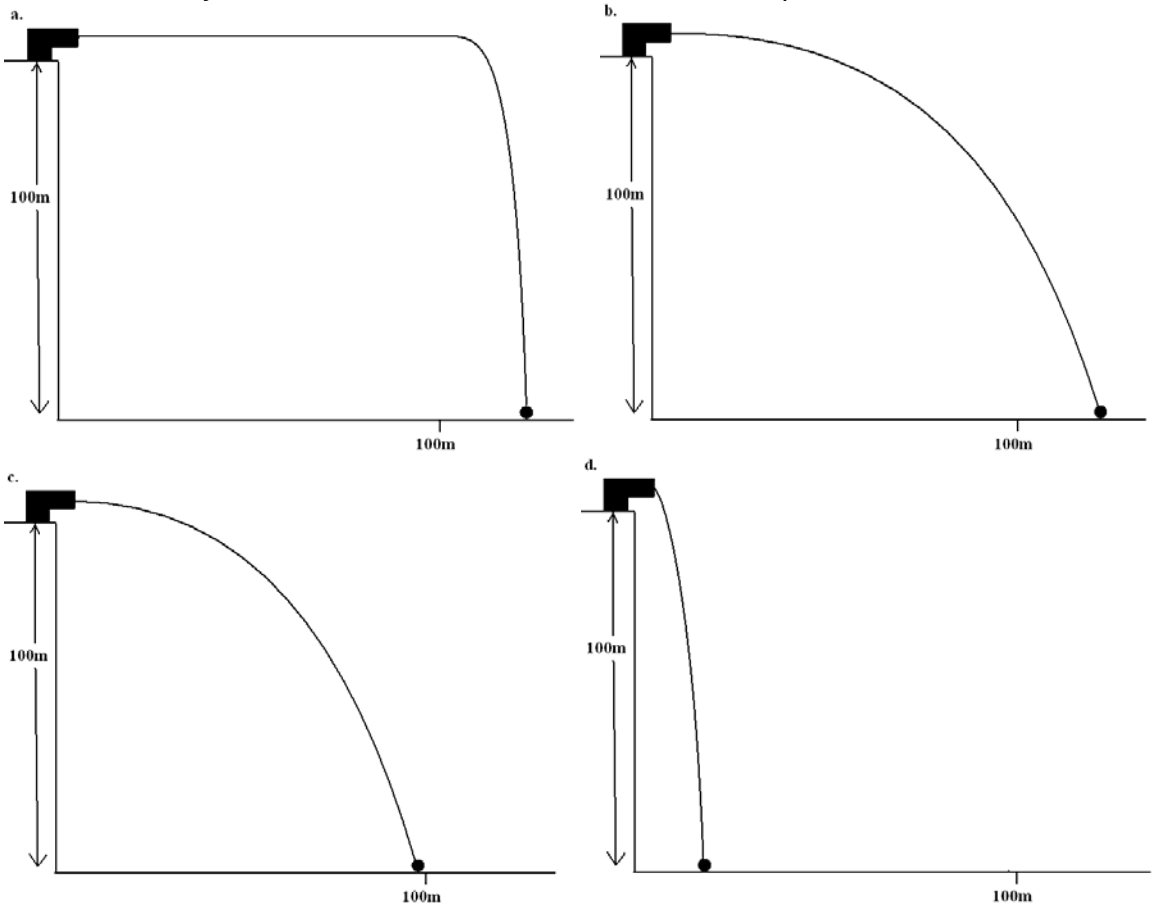
1) The two objects shown below are solid and made of the same material. Which picture best illustrates the position of the smaller object with respect to the bigger object as it hits the ground, if they are both dropped at the same time from the same height above the ground.



e. Unsure/Don't know

Explain your reasoning.

2) A cannon ball is launched horizontally off of a steep cliff into a level valley, as shown below, with an initial velocity of 30m/s. Which choice best illustrates the path of the cannon ball?



e. Unsure/Don't know

Explain your reasoning.