Please complete the following questions:

Proposal Title: Implementing Learner-Centered Strategies in Introductory Astronomy Courses: A Case Study of a New Professor

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College: Education

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Total Grant Amount Requested (not to exceed $15,000): $14,324

Compliance Information (check all that apply)

Note: No proposed research/creativity activity can go forward nor can funding be released until all of the following research compliance activities checked below have been addressed/resolved.

✓ Human Subjects  □ Vertebrate Animals  □ Infectious Agents  □ Lasers
   □ Radioactive Materials  □ Recombinant DNA  □ Other Hazardous Materials

Principal Investigators and Co-Principal Investigators: By submitting this form, I certify to the best of my knowledge, the information provided here is correct. I further certify that I, my spouse, and/or dependent children do not have any significant financial interests that would reasonably appear to be affected by the proposed funding. If, however, the above statements are not true, I will provide a written explanation detailing the said circumstances to Robin Toles prior to the initiation of the grant.
Implementing Learner-Centered Strategies in Introductory Astronomy Courses: 
A Case Study of a New Professor

PROPOSAL DESCRIPTION

Background

In education, the theory of constructivism has increasingly been used to explain the process of learning. Summarized by Bodner, constructivism is simply where “knowledge is constructed in the mind of the learner” (1986, p. 873). The idea is that people acquire new knowledge not in isolation, but rather through new information integrated into their mental landscapes – which have been formed by previous learning experiences. During the 1980’s, constructivism became the dominant theory of educational research in science and mathematics (Osborne, 1993). Although constructivism and its variants are not universally accepted by all researchers, it has proven to be a useful theoretical basis for the study of students’ understanding.

The instructional strategies required under the philosophy of constructivism are quite different from what has been observed in a traditional classroom. Teacher-centered methods that emphasize the transmission of knowledge from an “expert” (the instructor) to the “novice” (the student) do not take this preexisting mental landscape into account, and as such, are seen as ineffective – or in some cases even counter-productive – at helping students achieve deep conceptual understanding.

Physics education research has, in some respects, led the way in the development, implementation, and evaluation of “learner-centered” curricula and teaching strategies, and this agenda has now been embraced by astronomy education researchers as well. Curricula such as Tutorials in Introductory Physics (McDermott & Shaffer, 1998) and Lecture-Tutorials in Introductory Astronomy (Adams, Prather, & Slater, 2005) have been developed in order to consider the research on students’ pre-instructional ideas and use it in a way that allows students to actively engage with the content in a way that is not required in a traditional lecture. Studies large and small have shown that these and other, similar strategies are much more effective in helping students achieve large learning gains over the course of instruction (e.g., Hake, 1998; Prather et al., 2004).

If these strategies are significantly better at helping students learn, why aren’t more instructors using them? How does an instructor become a member of a “community of practice” that uses such strategies (Macklin, in press)? Understanding the decision-making of course design and implementation, the incentives and obstacles of implementing new instructional strategies, and the reactions to this process is critical to helping more instructors adopt learner-centered methods in their courses.

Description of the Project

This project is focused on understanding one instructor’s transition into a learner-centered community of practice. Research about this transition process will be conducted by two new faculty members, one from the College of Education and the other from the College of Sciences.
There are two parts to the project, creating an intersection of research and teaching. As Co-PI Nagamine receives training in and later implements learner-centered strategies in an introductory astronomy course for non-science majors (AST 104, Stars and Galaxies), PI Bailey will conduct a case study that tracks Nagamine’s progress in the process of employing these strategies.

Training for Co-PI Nagamine will come primarily through his participation in a Teaching Excellence Workshop, offered by the Center for Astronomy Education (CAE). This NASA-funded Center has become well-known within the astronomy education community. Workshops, frequently 6-9 per year, are held in a variety of locations and are run by a team of nationally-recognized astronomy educators (Ed Prather, Tim Slater, and Gina Brissenden, of the Conceptual Astronomy and Physics Education Research [CAPER] Team at the University of Arizona’s Steward Observatory). A secondary training opportunity will come through Nagamine’s attendance at the Cosmos in the Classroom symposium, sponsored by the Astronomical Society of the Pacific. Both the workshop and the symposium will take place during the summer of 2007.

PI Bailey, who has experience using such strategies from previous work with the CAPER Team, will assist Nagamine in re-developing the Fall 2007 AST 104 course. She will also collect a variety of data in order to document Nagamine’s transition into the community of practice of astronomy instructors using learner-centered strategies.

Several different types of data will be collected to document the instructor’s reasons for and reactions to changes in the AST 104 course after participation in the CAE workshop. These data will include, for example:

♦ *artifacts*, such as course syllabi and planning documents from course offerings both prior to and after the CAE workshop;

♦ approximately 5-7 *interviews* of Co-PI Nagamine conducted by PI Bailey over the duration of the study, including interviews prior to and after the CAE workshop as well as during and after the AST 104 course;

♦ *journals* written by Co-PI Nagamine regarding the implementation of the strategies learned; and

♦ *observations* of the AST 104 course by PI Bailey in order to monitor the implementation of changes.

The data collected from these different sources will be compared to ensure that interpretations made are consistent and valid.

In addition to the comprehensive data that will be collected for the case study of Co-PI Nagamine, PI Bailey will gather data to investigate student learning in the course. The *Light and Spectroscopy Concept Inventory* (LSCI; Bardar, 2006) and the *Star Properties Concept Inventory* (SPCI; Bailey, 2006), both of which are validated instruments designed for use in introductory astronomy courses, will be given to the students as pre/posttests. The topics of light and stars make up a significant portion of the AST 104 course, and student gains on these instruments are representative of their learning in the respective areas. Student performance on related exam questions will also be examined and compared to the LSCI and SPCI results.
Research Merit
Although previous studies have investigated the transition of science students from “novice” to “expert,” the transition of instructor from using teacher-centered to learner-centered strategies has not been explored. Research in communities of practice has not yet included astronomy education. This project, then, would provide a critical first-step to introducing this idea to the astronomy education community as well as to bring a new instructional area into the communities of practice literature.

Anticipated Long-Term Impact
Three significant long-term impacts are expected as a result of this investigation. The first is the impact of the implementation of learner-centered strategies on student engagement and student understanding. When implementing such strategies in introductory astronomy courses for nonscience majors, studies have shown that more than 80% of students indicated that they felt these strategies helped them learn (e.g., Hudgins, Prather, Grayson, & Smits, 2006) and that learning gains increased compared to traditional lecture-based courses (Hake, 1998; Hudgins, Prather, Grayson, & Smits, 2006; Prather et al., 2004).

The second anticipated impact of this project is that the strategies will be adopted by other faculty members for similar courses. Faculty members are sometimes reluctant to adopt practices that deviate from the traditional lecture, in part because of a lack of training and experience in their own education (T. Slater, personal communication). By demonstrating best-practices within their own department and having colleagues with whom they can discuss the process, it is believed that more faculty will be willing to implement such strategies.

Finally, by systematically investigating the issues involved with implementing such strategies, we can provide more information for instructors nationwide who are considering the creation of a more learner-centered classroom. The removal of isolation and description of an instructor’s integration into a community of practice will benefit others through the astronomy education community.

Support of University Macrothemes
This project supports a number of goals and macrothemes identified by the University of Nevada, Las Vegas. First and foremost, this interdisciplinary research project will be conducted by PI Bailey from the College of Education and Co-PI Nagamine from the College of Sciences. The partnership between the two faculty members will serve to enhance the increasingly strong relations between these Colleges and is supported by the Center for Mathematics and Science Education. The project also directly supports the following goals (UNLV Planning Council, 2002).

♦ UNLV Goal #1 – “Create and Sustain a Student-Centered Learning Environment”: By training Co-PI Nagamine in the use of learner-centered teaching strategies in introductory astronomy courses for nonscience majors, this project directly supports this goal. Furthermore, it is hoped that Co-PI Nagamine’s reformed course will become an example for other instructors in the Department of Physics, and eventually campus-wide.

♦ UNLV Research Macrotheme VII – “School Improvement, Assessment of Learning, and Educational Research”: The movement from a teacher-centered to a learner-centered course has been shown to improve student learning (e.g., Hudgins, Prather, Grayson, & Smits, 2006;
Prather et al., 2004). Furthermore, research on the implementation process, including determining an instructor’s incentives and obstacles to change, will serve the astronomy education community.  

• Regents’ Goal #2 – “Quality Education”: The goal of “quality education” as defined by the Regents of the University and Community College System of Nevada requires the provision of excellent learning experiences for its students. The learner-centered strategies to be implemented through this project will model such experiences.

**Tasks, Deliverables, and Outcomes Timeline**

It is anticipated that this project will have a number of outcomes and deliverables. Foremost is the movement of the Co-PI’s introductory astronomy course toward a more learner-centered environment. Future research efforts could focus on the effect of this environment on student learning or on disseminating the instructional strategies to other interested astronomy instructors.

Although increasingly more astronomy instructors have expressed interest in using learner-centered strategies, as evidenced by high attendance at the CAE’s national workshops (G. Brissenden, personal communication), there has not yet been any research on the process of implementing such strategies. This research into the instructor’s perceptions of the strengths, weaknesses, obstacles, and incentives is expected to be the first of its kind in astronomy education. As such, presentations and papers resulting from this research are important contributions to the astronomy education community. Deliverables include presentations submitted to the American Astronomical Society, American Association of Physics Teachers, and National Association for Research in Science Teaching national meetings, as well as one or more articles submitted to journals such as *Astronomy Education Review*, the *Journal of the Learning Sciences*, or the *Journal of College Science Teaching*.

The proposed timeline for this project is as follows.

<table>
<thead>
<tr>
<th>Time</th>
<th>Tasks and/or Milestones</th>
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<tbody>
<tr>
<td>Spring 2007 semester</td>
<td>Interview #1 of Co-PI Nagamine</td>
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<tr>
<td>May 2007</td>
<td>CAE Teaching Excellence Workshop</td>
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<tr>
<td>June-July 2007</td>
<td>Interview #2 of Co-PI Nagamine</td>
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<td>Planning for Fall 2007 course</td>
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<td>August 2007</td>
<td>ASP Cosmos in the Classroom Symposium</td>
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<td>Submission of abstract for NARST Spring 2008 conference</td>
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<td>Fall 2007 semester</td>
<td>Implementation of learner-centered strategies in AST 104</td>
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<td></td>
<td>Interviews #3-5 (approx.) of Co-PI Nagamine (distributed throughout semester)</td>
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<td>Spring 2008 semester</td>
<td>Interview #6 of Co-PI Nagamine</td>
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<td></td>
<td>Submission of abstracts for AAPT, AAS Summer 2008 conferences</td>
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<tr>
<td>Summer 2008</td>
<td>Writing and submission of article(s)</td>
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References


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<tr>
<th>Item</th>
<th>Requested Amount</th>
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<td>Salary &amp; Wages</td>
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<td>Fringe Benefits</td>
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<tr>
<td>Tuition &amp; Fees</td>
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<tr>
<td>Travel (CAE, ASP, AAS, and AAPT for both PI Bailey and Co-PI Nagamine; NARST for PI Bailey only)</td>
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<td>CAE Workshop &amp; AAS Meeting, Honolulu, HI (May 2007)</td>
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<td>ASP Cosmos in the Classroom, Claremont, CA (Aug 2007)</td>
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<td>Other Costs</td>
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<td><strong>Total Amount Requested</strong></td>
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BUDGET JUSTIFICATION NARRATIVE

A total of $14,324 is requested to support this project. The budget request is based upon the following items.

Salary & Wages – The PI will conduct 5-7 interviews with the Co-PI, which will then be transcribed by a student for hire at a rate of $12/hour. The amount requested for this project includes up to 100 hours worth of transcription services, totaling $1200.

Fringe Benefits – The current rate of fringe benefits for a student working less than 20 hours per week is 2%; for the wages requested, the fringe benefits total $24. The student hired for transcription services will be held to less than 20 hours per week.

Tuition & Fees – No money is required for tuition or fees.

Travel – The amount requested for travel includes several trips. The first is to the Center for Astronomy Education (CAE) Teaching Excellence Workshop, offered in conjunction with the American Astronomical Society’s (AAS) summer meeting in Honolulu, HI. Both the PI and Co-PI will attend this workshop to learn about learner-centered teaching strategies that will be implemented in the Co-PI’s introductory astronomy courses in Fall 2007. The PI will attend the workshop in order to (a) observe the learning environment and curriculum encountered by the Co-PI and (b) later help the Co-PI plan for the Fall 2007 course. The amount requested for this trip is $2,800. The CAE offers several workshops over the course of the year, but the offerings in the continental U.S. either have a different content focus or are Tier 2 (advanced) workshops.

The second trip is to the Astronomical Society of the Pacific (ASP)’s Cosmos in the Classroom symposium in early August 2007 in the greater Los Angeles area. This meeting is dedicated to the teaching of astronomy to non-science majors, and includes a variety of workshops and demonstrations on effective curricula and teaching strategies. As before, both the Co-PI and PI will attend this meeting. The amount requested for this trip is $2,000.

The travel budget also includes trips to a later AAS meeting and American Association of Physics Teachers (AAPT) meeting for both the PI and Co-PI, as well as a trip to the National Association for Research in Science Teaching (NARST) meeting for the PI. Results of this study will be submitted for presentation at all of these national conferences. The amount requested for these trips totals $7,200.

Equipment & Supplies – The requested budget includes $1,100 for equipment and supplies, including a digital video recorder and a digital voice recorder. These will be used by the PI to interview the Co-PI about his experiences during the case study and to record observations about the course upon its implementation.

Other Costs – No money is requested for other costs.