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Application Summary

Competition Details

Competition Title:	Textbook Transformation Grants, Round Twelve (Fall 2018-2019)
Category:	University System of Georgia
Award Cycle:	Round 12
Submission Deadline:	09/13/2018 at 11:59 PM

Application Information

Submitted By:	William Baird
Appplication ID:	2580
Application Title:	382
Date Submitted:	09/11/2018 at 8:26 AM

Personal Details

Institution Name(s):	Georgia Southern University - Armstrong Campus
Applicant First Name:	William
Applicant Last Name:	Baird
Applicant Email Address:	wbaird@georgiasouthern.edu
Applicant Phone Number:	912-344-2708
Primary Appointment Title:	Professor of Physics
Submitter First Name:	William
Submitter Last Name:	Baird
Submitter Email Address:	wbaird@georgiasouthern.edu
Submitter Phone Number:	912-344-2708
Submitter Title:	Professor of Physics

Application Details

Proposal Title
382

Final Semester of Project
Summer 2019

Requested Amount of Funding
$10,800

Type of Grant

No-or-Low-Cost-to-Students Learning Materials

Course Title(s)
Principles of Physics II

Course Number(s)
PHYS 2212K

Team Member 1 Name
William Baird

Team Member 1 Email
wbaird@georgiasouthern.edu

Team Member 2 Name
Jeffery Secrest

Team Member 2 Email
jsecrest@georgiasouthern.edu

Team Member 3 Name

Team Member 3 Email

Team Member 4 Name

Team Member 4 Email

Additional Team Members (Name and email address for each)

Sponsor Name
Delana Nivens

Sponsor Title
Dean, College of Science and Technology

Sponsor Department
College of Science and Technology

Original Required Commercial Materials (title, author, price)
Halliday & Resnick, Fundamentals of Physics 9th ed., Vol. 2 ($60-$265), WebAssign Homework System ($90) (see Statement of Transformation)

Average Number of Students per Course Section Affected by Project in One Academic Year
24

Average Number of Sections Affected by Project in One Academic Year
4

Total Number of Students Affected by Project in One Academic Year

96

Average Number of Students Affected per Summer Semester
0

Average Number of Students Affected per Fall Semester
48

Average Number of Students Affected per Spring Semester
48

Original Total Cost per Student
$150-$355 (see Statement of Transformation)

Post-Project Cost per Student
$32.50

Post-Project Savings per Student
$117.50-$289 (see Statement of Transformation)

Projected Total Annual Student Savings per Academic Year
$11,280-$27,740 (see Statement of Transformation)

Using OpenStax Textbook?
Yes

Project Goals
We plan to enhance student success and engagement while reducing the financial burden associated with taking a university physics course. We will move from the WebAssign OHS (online homework system, providing randomized problems and computerized grading of homework) and the Halliday & Resnick physics textbook to the new OpenStax University Physics text and the ExpertTA OHS. We will use open source software as well as hardware (i.e., designs/licenses freely available to anyone wanting to produce their own hardware) to provide our student population with skills in programming and data collection that they are likely to use in future classes and in whatever job or graduate school may follow. We hope to see increased learning gains and higher levels of student engagement and satisfaction, as well as lower DFW rates.

Statement of Transformation

Recently, we were awarded a Textbook Transformation Grant, completed in 2018, for PHYS 2211K (introductory mechanics – note that the “K” represents the fact that the lecture and lab portions of the course are now combined into the same time slot so that the division of time between lecture and lab can be altered to match weekly needs and instructor preferences). This grant involved the adoption of the OpenStax textbook and the creation of video homework solutions. We used the newly-available class time to introduce some basic computer programming using VPython (an open-source package built to make illustrating physical concepts easier). We felt that this was an all-around improvement for both faculty and students; faculty did not have to spend an hour a week solving essentially the same problems each semester and stronger students did not have to sit through solutions of problems they had already mastered. Weaker students were also able to watch solutions repeatedly if the process did not "click” for them the first time through.

Replacing our current Halliday & Resnick book with the OpenStax University Physics series will result in a significant cost savings for our students. From the 2017-2018 Georgia Southern Common Data Set *1 , books and supplies are projected to represent, on average, 15% of the total cost of in-state tuition, fees, and books/supplies. Our numbers indicate that if not for our careful attention to costs, PHYS 2212K would be disproportionately expensive in this regard. We can say that it is difficult to accurately and honestly calculate the effective savings. We have for some years made an effort to reduce student costs by not using the latest edition of a textbook. We find very few substantive changes from edition to edition, but the latest edition of our current book is available at Amazon for an astonishing $267. Used copies start at $195 and even a semester-long rental, which we believe is a truly false economy for a subject which is foundational for many of our students, is over $70. By using the 9th edition instead of the 10th, students can buy a used copy for about $60.

The current online homework system (OHS), WebAssign, is almost three times the price of the system we are planning to use if the proposal is funded. To be fair, the WebAssign fee of $90 includes an electronic copy of the textbook, but that copy expires after one semester. For an additional $30, students can use that particular edition on WebAssign forever (as long as the course they are taking uses that edition; it is not transferrable to another edition or to another student). Whether in electronic or physical form, we believe the text will be a reference for at least some of these STEM students for some years to come – we are not interested in the philosophy that treats these materials as something to rent for one semester and then discard.

The larger problem is that old editions will not be available forever, even at Amazon; our bookstore has complained to us many times that they cannot source old editions in quantity. The WebAssign OHS currently provides both the 9th and 10th editions of our current book, but no older editions are usable. The license agreement requires us to certify that we are using a particular text, and we can only choose problems from that text. Therefore, even if we had a large supply of old editions, they would eventually age out of the homework system. If we didn’t care about student expenses at all (and if we wanted to improve the apparent savings figures for this application), we would require the 10th edition.

We administered the attitude survey that was part of our previous ALG grant in Fall 2017 to our 2211K students who were using the Halliday & Resnick book, and we also gave the survey to our Spring 2018 2211K students who used the OpenStax book. When responding to the statement “Buying the textbook was or would have been a significant financial strain”, two thirds of the students in each course (n=28 in Fall 2017, n=26 in Spring 2018) answered “Agree” or “Strongly Agree”. In a more worrying development, there is a section where students can rank the utility of various learning aids from 5 (very useful) down to 2 (not at all useful) and then 1 (did not try to use). We found 36% of the students in the Fall answered “did not try to use” to the question about the textbook. While this does not prove they did not buy the book (and we regret not adding this question specifically), it certainly suggests it. Finally, 21% of the students both reported not using the book and that buying it would have been a financial hardship.

Transformative Impact - We would now like to bring our PHYS 2212K (electricity & magnetism, light & optics) into alignment with our transformed PHYS 2211K. We again propose to introduce video solutions of homework problems to recapture class time, but we now plan to move beyond VPython since our students will have already used that in PHYS 2211K. We now want to integrate the Arduino system into our labs. Briefly, Arduinos are microcontroller boards which are open-source hardware and they are programmed in an environment which is also open-source.

This means that anyone can build and sell his/her own Arduino-compatible clone, and this has served to drive the price of the clone hardware down to less than $20 for each basic setup. There is an enormously large ecosystem of Arduino programs already available for download, so it is quite easy to get started. The programming environment shares similarities with Java and C++, but was designed to be friendly to non-STEM users. We plan to implement three lab exercises which will involve experiments similar to those we (and most other universities) already do, but which will be performed in this case with Arduinos rather than multimeters, oscilloscopes, etc.

Because our student population is almost exclusively STEM majors, familiarity with programming and sensors/data collection will allow them to connect the topics discussed in physics with real-world problems. As in the previous ALG grant, the goal is not to turn the introductory physics sequence into a substitute for any computer science course; our aim is merely to show the students how simple it can be to get started, and the commonalities between different

programming environments (since they will have had some experience with VPython by the time they encounter the Arduino).

We have calculated the savings based on our expectations for 2019. We have typically had two 24-person sections of PHYS 2212K, one in the spring and one in the fall. Our projections (reflected in our schedule currently being created for spring) are that we will need twice that many sections in 2019, as we are already seeing an increase in the 2211K population. Since first being announced, the merger has promised many more engineering students on campus, all of whom must take both semesters of calculus-based physics. Chemistry & Biochemistry majors (most of whom formerly took the algebra-based sequence 1111/1112) will now all take 2211/2212. According to the 2016 Armstrong Fact Book *2 (the last one available before consolidation), Chemistry and Biochemistry had a total of 213 majors. This alone, ignoring engineering or any projected growth, would approximately double the 2018 enrollment.

We are also discussing the implementation of our previous ALG grant for 2211K with our new colleagues in Statesboro, and they have so far been receptive. We are planning to submit an application in the next round under the Scaling Up OER category. Our hope is that, should this application be successful, the joint physics faculty will have a cohesive two-semester solution involving the key elements of both proposals and will therefore greatly magnify their effects.

The idea that introductory physics courses are great places to learn programming is not an original one. Even a cursory review of the literature of Physics Education Research (PER) shows that programming has been used to augment introductory physics classes *3 *4 *5 *6 *7 for 50 years or more, from the venerable FORTRAN to the Arduino itself. We introduced programming through Microsoft Excel years ago, but we have moved our focus to open-source offerings such as Python (e.g., the recent ALG grant) and this would further that transition. The added benefit to the students in this case is that if one of our Arduino labs does spark their interest in sensors and data collection, they will be able to acquire their own system for home use and experimentation for $50 or less rather than the multi-thousand-dollar expense associated with some physics lab equipment.

*1http://em.georgiasouthern.edu/ir/wp-content/uploads/sites/5/cds17-18.pdf

*2 http://em.georgiasouthern.edu/ir/wp-content/uploads/sites/5/2016_Fact_Book_Armstrong.pdf

*3 Alfred M. Bork, Instructional uses of the Computer: 1130 FORTRAN Mechanics Programs, Am. J. Phys 36, 907 (1968).

*4 Edward F. Redish and Jack M. Wilson, Student programming in the introductory physics course M.U.P.P.E.T., Am. J. Phys. 61, 222 (1993).

*5 Ludwik Kowalski, Programming to learn physics, Phys. Teach. 25, 318 (1987).

*6 F. Bouquet, J. Bobroff, M. Fuchs-Gallezot, and L. Maurines, Project-based physics labs using low-cost open-source hardware, Am. J. Phys. 85, 216 (2017).

*7 Arjit Roy, Abhishek Mallick, Apama Adhikari, Priyanka Guin, and Dibyendu Chatterjee, Theory and experiment on charging and discharging a capacitor through a reverse-biased diode, Am. J. Phys. 86, 417 (2018).

Transformation Action Plan

Drs. Baird and Secrest will jointly identify appropriate homework problems from the collection available through ExpertTA. Dr. Baird will record video solutions to all problems to be posted after the due date for each homework. Since Summer 2016, Dr. Baird has recorded over 700 videos solving homework problems (about 175 per course, including 167 with closed captioning for the ongoing Textbook Transformation Grant for 2211K) and has found the time spent doing so is worth the recovered class time. Dr. Secrest will handle the IRB application (which we expect to be judged either exempt or eligible for expedited review as the attitude survey is essentially the only item at issue).

The PIs will work together to identify suitable Arduino-based labs in the literature (viz. Refs. 6 and 7) and/or develop their own. Since PHYS 2212K is focused on electricity and magnetism, including circuits and optics, we already have plans for some exercises but will remain open to better ideas that may already be available. Any instructor who may have an interest will be provided with the lab materials. We especially hope to see our new colleagues adopt some of these activities. The extra class/lab time needed to add these programming assignments will come from the time recovered by the use of video homework solutions.

Quantitative & Qualitative Measures

The materials will be used for PHYS 2212K in Spring 2019. We have long employed a standard assessment instrument known as the Conceptual Survey of Electricity and Magnetism (CSEM), a widely-used 32-question test of concepts discussed in second-semester physics courses. We have (and will) administer this as a pre/post-test. The normalized gain, defined as (post-pre)/(32-pre), where pre and post are the CSEM scores at the beginning and end of the semester, will be calculated. This number is commonly reported in the Physics Educational literature, since it quantifies the student's prior familiarity with the subject. We will compare this gain with existing CSEM results gathered at GSU-Armstrong in past semesters. Drs. Baird and Secrest offer extra-credit incentives to students based on performance on the final CSEM to ensure that students try to do well on it.

Students will be given a survey about the text (attached) and their use of it, as well as the other course resources available (video homework solutions, online class notes, etc.) and their answers will be compared with data gathered during the previous semester. This will allow us to record student attitudes and opinions about the course materials, as well as providing them the opportunity to mention other resources they found to be helpful. We will investigate any student proposals for these added resources, and adjust our focus on existing materials in response to the multiple-choice questions. Finally, DFW rates will be compared to historical averages.

We have been informed that this will require IRB approval, but we do not foresee any difficulty in obtaining it. The surveys will be anonymous from their creation, and we have always destroyed our assessment test sheets after recording the data from them. We only report class-average normalized gains when discussing student performance in our courses.

Timeline

October 1, 2018 – As soon as notification of the award is received, the PIs will begin to identify homework problems and laboratory exercises. Dr. Secrest will prepare the IRB paperwork for submission for both Fall 2018 PHYS 2212K and Spring 2019 PHYS 2212K so that we may gather survey data before and after the transformation.

October 15, 2018 – We expect to have chosen most, if not all, of the homework problems at this point and Dr. Baird will begin recording video solutions while Dr. Secrest starts planning the particular activities to be performed in each lab and orders necessary supplies.

November 15, 2018 – We estimate Dr. Baird will have recorded one half to two thirds of the homework solutions by this point. These are more time-consuming than might otherwise be expected due to the necessity to add closed captioning to the videos. While YouTube does some of this automatically, there is a great deal of editing required when going over equations and other concepts from physics problems that don't typically appear in YouTube dialog. Dr. Secrest will have two of the three labs finalized at this point.

November 30, 2018 - Last day of classes. Dr. Baird will administer the CSEM as a post-test and the Student Survey of Course Resources (SSCR).

December 15, 2018 – By this time, the homework solutions should be finished as well as the lab exercises. We expect to be ready for the Spring semester, but this timeline will give us an additional month before classes actually start in case there are unforeseen difficulties.

January 14, 2019 – Classes begin at GSU-Armstrong. Dr. Baird will administer the CSEM pre-test during the first PHYS 2212K class.

Spring Semester, 2019 – The PIs will meet regularly to discuss the progress of the course and any issues with labs or homework videos. If needed, adjustments will be made to these materials.

May 3, 2019 – Last day of classes. Dr. Baird will administer the CSEM as a post-test and the Student Survey of Course Resources (SSCR).

Summer 2019 – The PIs will assemble the data from the DFW rates, the CSEM tests, and the SSCR surveys. We will perform tests of statistical validity on our data and prepare the final report.

Budget

We request $5,000 salary for each PI. We also request $800 to be used for supplies and travel. The supplies are expected to consist of Arduino boards and sensors, while the travel funds would be used for registration, mileage, and hotel expenses for events such as the required kick-off meeting and/or conferences where the results of this work may find an audience (e.g., SACS-AAPT, etc.).

Salary, Dr. Baird - $5,000
Salary, Dr. Secrest - $5,000
Travel and Supplies - $800
Total - $10,800

Sustainability Plan

We believe the sustainability is the easiest part of this process. When we talk to faculty, it seems the largest hurdle to overcome in a course transformation is inertia; if things are already working well, change for the sake of change or for minimal benefit will not be received warmly. To be clear, the content provided in the current Halliday & Resnick book is excellent, as are the homework problems found there. If price were not a factor, we would not consider a change.

Our sole objection to the text we use now is financial: when a new book is approaching the $300 mark, and the difference from one edition to the next would be hard to see without a careful dissection, it begins to gnaw at the conscience to require it. On a more practical level, we know that a sizable fraction of the students will just not buy a book that expensive. Perhaps there are some disciplines where everything in the text can be fully covered in classroom lectures, but physics is certainly not one of them. We're shocked at the prices of the books, but in their defense, they do exceed 1200 pages!

While the OpenStax book may not quite be at the level of Halliday and Resnick yet, it is in our opinion more than good enough to justify the trade. Once we have changed over all of our homework assignments and video solutions, and we know we are saving the students quite a bit of money, it is frankly hard to imagine what could motivate a switch back to an expensive book.

As our department is in the process of expanding, we expect to receive permission to conduct a search for a tenure-track position to replace a retired colleague this year. When the new physicist arrives on campus and has at least two classes for which to prepare, we believe that providing him or her with our fully developed course package of textbook, homework, video solutions, and labs will prove to be a strong incentive to continue what we are doing.

Of course, we expect some evolution of the course with time, but it is much easier to decide to replace 10 or 20 of the homework problems with new ones (and new solutions) than to create nearly 200 of them from scratch. All of our materials will be available to our new colleagues in Statesboro. We plan to present our work at one of their weekly colloquia. Even if only one or two of them made this transformation, the number of students affected would climb dramatically.

Acknowledgment

Grant Acceptance

[Acknowledged] I understand and acknowledge that acceptance of Affordable Learning Georgia grant funding constitutes a commitment to comply with the required activities listed in the RFP and that my submitted proposal will serve as the statement of work that must be completed by my project team. I further understand and acknowledge that failure to complete the deliverables in the statement of work may result in termination of the agreement and funding.

August 28, 2018

Affordable Learning Georgia
Textbook Transformation Grant Review Committee

Dear Review Committee,

I am pleased to provide my highest support for Affordable Learning Georgia Textbook Transformation grant proposal submitted by Dr. William Baird and Dr. Jeffery Secrest of the Department of Physics at Georgia Southern's Armstrong Campus. Their proposal, entitled "Electrical and Electronic Experiments in Physics (EEEP)"," to extend the current use of OpenStax University Physics digital textbook in PHYS 2211K to PHYS 2212K. In addition, the team will record additional videos of homework solutions (they have recorded approximately 700 videos thus far for Physics courses) to accompany the OpenStax. Finally, they will integrate Arduino microcontroller systems into the labs to allow for open-source programming and the implementation of low cost lab materials (similar to the previous PHYS 2211 ALG project that used VPython).

Professors Baird and Secrest have been previously funded to use of open-source materials and VPython in PHYS 2211K. Funding this second phase of the project will assure that no STEM majors, whose program requires a full year of physics, will have to purchase a textbook (especially a textbook that they would only use for one semester). This amounts to significant savings for students. The grant requests funding to support the creative portion of the project, which is the time and cost heavy part. Once created, however, the materials will be easy to revise and maintain so that it will be a sustainable resource for several academic cycles. The team is experienced with ALG grants and their assessment, and I have confidence that they will deliver on their stated goals.

The College of Science and Mathematics recognizes the importance of engaging our students in the STEM disciplines and the proposed project will further this objective, by utilizing modem technology to assist student learning in this challenging area. I am pleased to wholeheartedly support this project.

Thank you for your consideration,

Delana A. Gajdosik-Nivens
Dean
College of Science and Mathematics

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cosm@georgiasouthern.edu

Textbook Transformation Grants, Round Twelve (Fall 2018-2019)

Proposal Form and Narrative

Notes

- The proposal form and narrative .docx file is for offline drafting and review. Submitters must use the InfoReady Review online form for proposal submission.
- The only way to submit the official proposal is through the online form in Georgia Tech's InfoReady Review. The link to the online application is on the Round 12 RFP Page.
- The italic text we provide is meant for clarifications and can be deleted.

Applicant, Team, and Sponsor Information

The **applicant** is the proposed Project Lead for the grant project. The **submitter** is the person submitting the application (which may be a Grants Officer or Administrator). The submitter will often be the applicant – if so, leave the submitter fields blank.

Institution(s)	Georgia Southern University (Armstrong Campus)
Applicant Name	William Baird
Applicant Email	wbaird@georgiasouthern.edu
Applicant Phone #	(912) 344-2708
Applicant Position/Title	Professor of Physics
Submitter Name	
Submitter Email	
Submitter Phone #	
Submitter Position	

Please provide the first/last names and email addresses of all team members within the proposed project. Include the applicant (Project Lead) in this list. Do not include prefixes or suffixes such as Ms., Dr., Ph.D., etc.

	Name	Email Address
Team Member 1	William Baird	wbaird@georgiasouthern.edu
Team Member 2	Jeffery Secrest	jsecrest@georgiasouthern.edu
Team Member 3		
Team Member 4		

If you have any more team members to add, please enter their names and email addresses in the text box below.

Please provide the sponsor's name, title, department, and institution. The sponsor is the provider of your Letter of Support.

Delana Nivens, Dean of the College of Science and Mathematics, Georgia Southern University

Project Information and Impact Data

Title of Grant Project	Electrical & Electronic Experiments in Physics (EEEP)
Type of Grant	No-or-Low-Cost-to-Students Learning Materials
Requested Amount of Funding	$10,800
Course Names and Course Numbers	PHYS 2212 Principles of Physics II
Final Semester of Project	Summer 2019
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Total Number of Students Affected by Project in One Academic Year	96
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Narrative Section

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We have calculated the savings based on our expectations for 2019. We have typically had two 24-person sections of PHYS 2212K, one in the spring and one in the fall. Our projections (reflected in our schedule currently being created for spring) are that we will need twice that many sections in 2019, as we are already seeing an increase in the 2211K population. Since first being announced, the merger has promised many more engineering students on campus, all of whom must take both semesters of calculus-based physics. Chemistry & Biochemistry majors (most of whom formerly took the algebra-based sequence 1111/1112) will now all take 2211/2212. According to the 2016 Armstrong Fact Book[2] (the last one available before consolidation), Chemistry and Biochemistry had a total of 213 majors. This alone, ignoring engineering or any projected growth, would approximately double the 2018 enrollment.

We are also discussing the implementation of our previous ALG grant for 2211K with our new colleagues in Statesboro, and they have so far been receptive. We are planning to submit an application in the next round under the Scaling Up OER category. Our hope is that, should this application be successful, the joint physics faculty will have a cohesive two-semester solution involving the key elements of both proposals and will therefore greatly magnify their effects.

The idea that introductory physics courses are great places to learn programming is not an original one. Even a cursory review of the literature of Physics Education Research (PER) shows that programming has been used to augment introductory physics classes[i, ii, iii, iv, v] for 50 years or more, from the venerable FORTRAN to the Arduino itself. We introduced programming through Microsoft Excel years ago, but we have moved our focus to open-source offerings such as Python (e.g., the recent ALG grant) and this would further that transition. The added benefit to the students in this case is that if one of our Arduino labs does spark their interest in sensors and data collection, they will be able to acquire their own system for home use and experimentation for $50 or less rather than the multi-thousand-dollar expense associated with some physics lab equipment.

3. Transformation Action Plan

Drs. Baird and Secrest will jointly identify appropriate homework problems from the collection available through ExpertTA. Dr. Baird will record video solutions to all problems to be posted after the due date for each homework. Since Summer 2016, Dr. Baird has recorded over 700 videos solving homework problems (about 175 per course, including 167 with closed captioning for the ongoing Textbook Transformation Grant for 2211K) and has found the time spent doing so is worth the recovered class time. Dr. Secrest will handle the IRB application (which we

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2 http://em.georgiasouthern.edu/ir/wp-content/uploads/sites/5/2016_Fact_Book_Armstrong.pdf

expect to be judged either exempt or eligible for expedited review as the attitude survey is essentially the only item at issue).

The PIs will work together to identify suitable Arduino-based labs in the literature (viz. Refs. 4 and 5) and/or develop their own. Since PHYS 2212K is focused on electricity and magnetism, including circuits and optics, we already have plans for some exercises but will remain open to better ideas that may already be available. Any instructor who may have an interest will be provided with the lab materials. We especially hope to see our new colleagues adopt some of these activities. The extra class/lab time needed to add these programming assignments will come from the time recovered by the use of video homework solutions.

4. Quantitative and Qualitative Measures

The materials will be used for PHYS 2212K in Spring 2019. We have long employed a standard assessment instrument known as the Conceptual Survey of Electricity and Magnetism (CSEM), a widely-used 32-question test of concepts discussed in second-semester physics courses. We have (and will) administer this as a pre/post-test. The normalized gain, defined as (post-pre)/(32-pre), where pre and post are the CSEM scores at the beginning and end of the semester, will be calculated. This number is commonly reported in the Physics Educational literature, since it quantifies the student's prior familiarity with the subject. We will compare this gain with existing CSEM results gathered at GSU-Armstrong in past semesters. Drs. Baird and Secrest offer extra-credit incentives to students based on performance on the final CSEM to ensure that students try to do well on it.

Students will be given a survey about the text (attached) and their use of it, as well as the other course resources available (video homework solutions, online class notes, etc.) and their answers will be compared with data gathered during the previous semester. This will allow us to record student attitudes and opinions about the course materials, as well as providing them the opportunity to mention other resources they found to be helpful. We will investigate any student proposals for these added resources, and adjust our focus on existing materials in response to the multiple-choice questions. Finally, DFW rates will be compared to historical averages.

We have been informed that this will require IRB approval, but we do not foresee any difficulty in obtaining it. The surveys will be anonymous from their creation, and we have always destroyed our assessment test sheets after recording the data from them. We only report class-average normalized gains when discussing student performance in our courses.

5. Timeline

October 1, 2018 – As soon as notification of the award is received, the PIs will begin to identify homework problems and laboratory exercises. Dr. Secrest will prepare the IRB paperwork for submission for both Fall 2018 PHYS 2212K and Spring 2019 PHYS 2212K so that we may gather survey data before and after the transformation.

October 15, 2018 – We expect to have chosen most, if not all, of the homework problems at this point and Dr. Baird will begin recording video solutions while Dr. Secrest starts planning the particular activities to be performed in each lab and orders necessary supplies.

November 15, 2018 – We estimate Dr. Baird will have recorded one half to two thirds of the homework solutions by this point. These are more time-consuming than might otherwise be expected due to the necessity to add closed captioning to the videos. While YouTube does some of this automatically, there is a great deal of editing required when going over equations and other concepts from physics problems that don't typically appear in YouTube dialog. Dr. Secrest will have two of the three labs finalized at this point.

November 30, 2018 - Last day of classes. Dr. Baird will administer the CSEM as a post-test and the Student Survey of Course Resources (SSCR).

December 15, 2018 – By this time, the homework solutions should be finished as well as the lab exercises. We expect to be ready for the Spring semester, but this timeline will give us an additional month before classes actually start in case there are unforeseen difficulties.

January 14, 2019 – Classes begin at GSU-Armstrong. Dr. Baird will administer the CSEM pre-test during the first PHYS 2212K class.

Spring Semester, 2019 – The PIs will meet regularly to discuss the progress of the course and any issues with labs or homework videos. If needed, adjustments will be made to these materials.

May 3, 2019 – Last day of classes. Dr. Baird will administer the CSEM as a post-test and the Student Survey of Course Resources (SSCR).

Summer 2019 – The PIs will assemble the data from the DFW rates, the CSEM tests, and the SSCR surveys. We will perform tests of statistical validity on our data and prepare the final report.

6. Budget

We request $5,000 salary for each PI. We also request $800 to be used for supplies and travel. The supplies are expected to consist of Arduino boards and sensors, while the travel funds would be used for registration, mileage, and hotel expenses for events such as the required kick-off meeting and/or conferences where the results of this work may find an audience (e.g., SACS-AAPT, etc.).

Salary, Dr. Baird - $5,000
Salary, Dr. Secrest - $5,000
Travel and Supplies - $800
Total - $10,800

7. Sustainability Plan

We believe the sustainability is the easiest part of this process. When we talk to faculty, it seems the largest hurdle to overcome in a course transformation is inertia; if things are already working well, change for the sake of change or for minimal benefit will not be received warmly. To be clear, the content provided in the current Halliday & Resnick book is excellent, as are the homework problems found there. If price were not a factor, we would not consider a change.

Our sole objection to the text we use now is financial: when a new book is approaching the $300 mark, and the difference from one edition to the next would be hard to see without a careful dissection, it begins to gnaw at the conscience to require it. On a more practical level, we know that a sizable fraction of the students will just not buy a book that expensive. Perhaps there are some disciplines where everything in the text can be fully covered in classroom lectures, but physics is certainly not one of them. We're shocked at the prices of the books, but in their defense, they do exceed 1200 pages!

While the OpenStax book may not quite be at the level of Halliday and Resnick yet, it is in our opinion more than good enough to justify the trade. Once we have changed over all of our homework assignments and video solutions, **and** we know we are saving the students quite a bit of money, it is frankly hard to imagine what could motivate a switch *back* to an expensive book.

As our department is in the process of expanding, we expect to receive permission to conduct a search for a tenure-track position to replace a retired colleague this year. When the new physicist arrives on campus and has at least two classes for which to prepare, we believe that providing him or her with our fully developed course package of textbook, homework, video solutions, and labs will prove to be a strong incentive to continue what we are doing.

Of course, we expect some evolution of the course with time, but it is much easier to decide to replace 10 or 20 of the homework problems with new ones (and new solutions) than to create nearly 200 of them from scratch. All of our materials will be available to our new colleagues in Statesboro. We plan to present our work at one of their weekly colloquia. Even if only one or two of them made this transformation, the number of students affected would climb dramatically.

Note: Letter of Support

Attached

Additional: Survey

Student Survey of Course Resources – Fall 2018

I identify as Male Female Other Prefer not to answer

Major_____

My current status is

<30 credit hours (Fr) 30-59 cr hrs (Soph) 60-89 cr hrs (Jr) >90 cr hrs (Sr)

Buying a textbook would have been a significant financial strain

Strongly Agree Agree Disagree Strongly Disagree

Did you actually purchase the book (not including the WebAssign associated copy) Y N

Hours/week I used the OpenStax book: <3 3-5.9 6-8.9 9-11.9 >12

If the cost for each were the same, I would prefer a physical (i.e., paper) book to a PDF or an e-book

Strongly Agree Agree Disagree Strongly Disagree

Please rank the following resources in order of their importance to your success in this course (5 = very useful, 4 = somewhat useful, 3 = not very useful 2= not at all useful, 1 = did not try to use)

Textbook _____ Lectures in class_____ Online class notes_____

Work w/fellow students_____ ExpertTA_____ Non-ExpertTA problems_____

Video Homework Solutions_____ Video lectures provided by instructor_____

Online resources not listed here_____ Tutoring Center_____ Other books_____

Other_____ (please describe below)

_____

What are your thoughts about the required text for this course?
_____

_____

_____

For the items above you listed as most/least useful, can you explain why?
_____
_____
_____

What do you think **could** have been useful to you for this course?
_____

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i Alfred M. Bork, *Instructional uses of the Computer: 1130 FORTRAN Mechanics Programs*, Am. J. Phys **36**, 907 (1968).

ii Edward F. Redish and Jack M. Wilson, *Student programming in the introductory physics course M.U.P.P.E.T.*, Am. J. Phys. **61**, 222 (1993).

iii Ludwik Kowalski, *Programming to learn physics*, Phys. Teach. **25**, 318 (1987).

iv F. Bouquet, J. Bobroff, M. Fuchs-Gallezot, and L. Maurines, *Project-based physics labs using low-cost open-source hardware*, Am. J. Phys. **85**, 216 (2017).

v Arjit Roy, Abhishek Mallick, Apama Adhikari, Priyanka Guin, and Dibyendu Chatterjee, *Theory and experiment on charging and discharging a capacitor through a reverse-biased diode*, Am. J. Phys. **86**, 417 (2018).