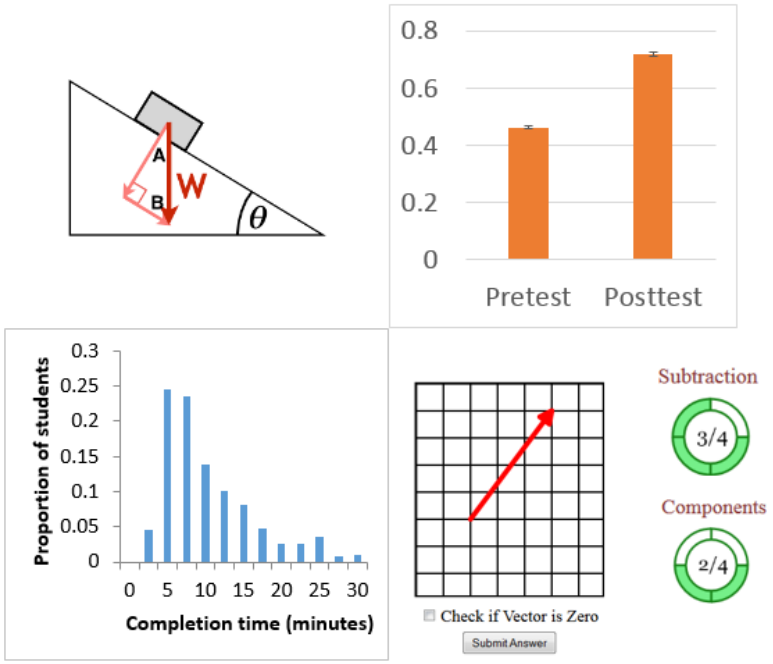
2015a Departmental Impact Grant Project Charter

Department of Physics

Essentials Skills Practice for Introductory Physics Students



Based on physics learning research and cognitive science principles, this project will expand, implement and iteratively improve an online application that provides students with carefully designed practice sessions to improve their basic skills that are essential to success in introductory physics courses.

A pilot version is currently running for one course, and this project will make needed improvements and additions in order to roll this out to 4 courses (over 6000 students/year) for permanent adoption by the department.

Stakeholders

DEPARTMENT

Project Lead

- **Andrew Heckler** <heckler.6@osu.edu>
  Associate Professor

Team

- **Thomas Gramila** <gramila.@osu.edu>
  Associate Professor, Vice Chair for Undergraduate Studies
- **Rajiv Ramnath** <ramnath.6@osu.edu>
  Associate Professor-Clinical, Computer Science and Engineering
- **Terry Bradley** <bradley.77@osu.edu>
  Systems manager, IT Liaison/Support
- **Brendon Mikula** <mikula.20@osu.edu>
  Graduate student content developer, Physics
- **Nathaniel Amos** <amos.93@buckeyemail.osu.edu>
  Graduate student content developer, Physics
- **Jaganath Narasimhan <**narasimhan.23@osu.edu>
  Graduate Student, software developer, CSE
- **Lakshmi Anusha Pasagadugula** <pasagadugula.1@buckeyemail.osu.edu>
  Graduate Student, software developer, CSE

Chair

- **James Beatty** <beatty@mps.ohio-state.edu>

Financial Officer

- **Jean Ball** <balljg@mps.ohio-state.edu>

Office of Distance Education and eLearning

Project Lead

- **Henry Griffy** <griffy.2@osu.edu>
  ODEE Grants Coordinator

ODEE Constituents

- **Jessica Phillips** <phillips.1507@osu.edu>
  Instructional Designer, ODEE Distance Education, Universal Design and Accessibility
- **David Gerad** <gerad.2@osu.edu>
  Associate, ODEE Marketing and Communications
- **Robert Griffiths** <griffiths.44@osu.edu>
  Director, Digital Scholarship and Development

Background

The courses targeted for this proposal are a) the calculus-based intro physics series, enrolled mostly with engineering students; and b) the algebra-based intro physics series enrolled with premeds and other programs that need physics. These courses are the main service courses of the department with over 6000 enrollments per year. The courses typically have ~200 students per lecture section, and 24 per recitation (sometimes 3 recitation sections in a room). The recitations are typically used for quizzes and homework review. Homework assignments are online end-of-chapter problems.

The courses are lecture intensive with typically some small amount of interaction/questions during lecture. There are math prerequisites/co-requisites, and students are expected to have already mastered basic math skills needed to solve physics problems. Because of full agendas and large classes, it is not uncommon for instructors to spend only brief amounts of time on introducing and explaining essential basic skills needed to solve the problems. Often these are math-related skills, such as: vector math, physics-related application of algebra and calculus concepts and skills, and constructing and interpreting graphs and diagrams. As a result, students often struggle in this environment with minimal practice and lack of personalized feedback on basic skills needed. In fact, our team, which includes a faculty member who researches physics learning, has found through in-depth interviews and testing that enrolled students are typically significantly below sufficient mastery of skills essential for intro physics courses. While this is an issue for the overwhelming majority of students, this deficit is especially critical for less-prepared students in the course, who are constantly struggling with the math skills, let alone understanding the physics concepts and solving physics problems.

To address these challenges and prepare more students to engage more effectively with the physics content of the course, an online system has been built and piloted to provide students the opportunity to practice essential skills before encountering related material in class. Built on principles of mastery, interleaved and spaced practice, the system provides students with a series of question-types about various skills of vector manipulation. Wrong answers result in feedback and advice. The preliminary pilot of this system demonstrates significant improvement. With the investment of less than 20 minutes per week, student performance on physics problems shows consistent, measurable improvement.

This project will build on this pilot in two ways. First, we will address specific opportunities with the interface design and system sustainability. Second, we will expand the reach of the system by adding more content and incorporating the system in more courses for more students.

Project Goal(s)

This project will improve the student experience of introductory physics students by improving an existing responsive online platform students can use to strengthen fundamental math and physics skills through guided practice and making it available to students in a wider range of courses and a wider range of skills.

Project Objectives contributing to Project Goals

- Create and provide additional content:
  - Refine vector skills content
  - Calculus for physics students
- Improve the existing online system:
  - Expand and fix needed improvements in existing vector skills unit
  - Make user experience and responsive web design improvements
  - Coordinate accessibility review
- Make infrastructure improvements to the system
  - Refine code for long-term viability
  - Automate and better integrate data upload to Carmen
  - Integrate development process with established campus practices

Program and Process Goals and Objectives

- Collaborate with course coordinators and instructors to incorporate the system in Physics 1200, 1201, 1250, and 1251.
- Train course coordinators and instructors (when feasible) in the most effective use of the system and build documentation.

Research Questions

- Are the essential skills assignments improving student accuracy and speed in these skills?
- To what extent do skill improvements translate into other performance gains?

Project Scope

In-Scope

- Implementation for Physics 1250, 1251, 1200 and 1201.
- Compatibility with browsers on mainstream laptop, tablet and desktop devices
- Expansion and improvement of vector skills unit, including the addition of a vector workspace.
- Creation of a Calculus-for-physics-students unit.
- User experience improvements as recommended by design consultant
- Accessibility review and improvements as recommended by OSU WAC (Web Accessibility Center)

Future Scope Areas to be Defined:

- User Experience/Interface Improvement
- Infrastructure and Sustainability
- Curricular Integration

Out-of-Scope

- Addition of major features and feature enhancements (such as gamification)
- Creation of units in addition to those listed above, especially for the 1200-1201 series.
- Fundamental changes to content management system
- Compatibility with browsers on mainstream smaller screen mobile devices
- Creation of units which employ natural language processing.
- Addition of units for other physics courses

Assessment Plan

Overall

We will assess improvement in each objective by pre- and post-course surveys (of both subject competence and subjective assessment of the system) and regular measures of participant interaction with the system. Assessment will begin with and build on instruments developed in earlier pilots:

- Pre-course survey
- Post-course survey
- System analytics

Objective #1: Additional Content

- Completion time for each module will be roughly 20 minutes (90% < 20 minutes).
- Student performance will improve between pre- and post-test.
- Patterns in student use of explanations and feedback. Student ratings of feedback helpfulness (if implemented).

Objective #2: User Experience Improvements

- Student assessment of the interface and user experience.
- Rate and magnitude of suggestions for improvements will decrease.
- Expert review: accessibility, design

Objective #3: Infrastructural Improvements

- Everything works.
- Expert review: code, sustainability, load testing
- Other?

Objective #4: Curricular integration/Expansion to main service courses

- "We will assess the success of our implementation of this objective by successful implementation of pilot for 1200 and 1250 in SU15 and in 1200, 1201, 1250 and 1251 for AU15."

- Student and instructor survey questions:

    - Student participation rates
    - Student perception of integration with other course materials
    - Instructor participation rates
    - Instructor perception of integration with other course materials

- Perceptions of instructor administration
- Focus group/interview of instructors

Budget

Monetary Expenditures

[If money will be spent on direct outlays for equipment, licenses, hiring people not on salary, etc., list those here]

Money will be spent to	Approx.
Coding Support (Jagan and Anusha)	$12,000
Content Designer Support (Nathaniel + Brendon)	$8,000
User Interface	$2,250
Total	$22,500

Time Expenditures

We estimate that this part of the project will take	Hours
Coding instructional units in app (Jagan, Anusha)	300
Instructor page improvements (Jagan, Anusha)	50
Code stability, documentation, improvements (Jagan, Anusha)	400
User experience accessibility improvements (ODEE, Jagan, Anusha)	400
Improvements to existing units (Brendon, Nathaniel, Jagan, Anusha)	100
Writing, researching calculus units (Nathaniel , Brendon)	600
Writing, researching other units (Nathaniel , Brendon)	100
App functionality improvements (practice space, more problem types) (Jagan, Anusha, Brendon, Nathaniel)	200
Technical oversight and liaison (Terry Bradley)	80
Project oversight (Andrew Heckler)	160
Total	2390

Team Member Time Commitments

Accordingly, it is estimated that the following team members will need to commit to the project the following amounts of time during the course of the project

Team member	Hours
Jaganath Narasimhan	600
Lakshmi Anusha Pasagadugula	600
Brendon Mikula	200
Nathaniel Amos	600
Terry Bradley	80
Andrew Heckler	160
Total	2000

ODEE promises to contribute at least the following hours.

Task/objective	Hours
Project planning and guidance	40
Instructional design	40
Accessibility and code review coordination	40
Research and publication assistance	40
Design and coding consultation	20
Communication and outreach	20
Total	200

Risk Assessment

Risk Analysis

- Major programming bugs or user error
- Carmen integration is problematic or flawed
- Accessibility analysis reveals major needs
- Code review reveals major needs
- Infrastructure problems (inability to handle load at increased scale)
- Continuity of personnel
- Research data-gathering errors
- Instructor resistance
- Other instructional implementation complications
- Student participation / communication failures
- Support and maintenance resources insufficient

Schedule Considerations / Other Projects / Related Projects

What other commitments and events are anticipated during the course of the project that might affect its successful completion?

Department

- Identification of Physics support staff
- Implementation of SU15 pilot
- Programmer turnover
- Gaps in essential skills tasks for second semester physics.

ODEE

- 5 other Impact Grant projects will overlap in whole or in part
- Impact Grant application/selection processes in October-November and April-May
- Innovate Conference March 25-26, 2014

Project Milestones and Major Deliverables

Month/Objective	Big Picture / Academic Calendar	Content Expansion and Revision	Design, User Experience, and Accessibility	Code Stabilization, and Continuity	Curricular Integration
February	• Assess needs • Sub-tasks fully mapped	• Objectives defined	• Design goals shared w ODEE • Accessibility Review requested	• Continuity needs assessment begun	• Contact with course coordinator(s)
March	• Create detailed plans and punch-lists for various threads	• Vector revisions planned	• Accessibility review done	• Code Review initiated	• Course integration plan done (in collaboration with course coordinator(s)
April	• Work	• Calculus problems and questions designed and tested	• Accessibility remediation plan done (in collaboration with WAC) • Practice space ready for testing	• Code continuity and Code Review completed and remediation plan completed (in collaboration with ASCTech), as needed	•
May	• Work • Complete work necessary for summer pilot	• Calculus content done	• Design plan done (in collaboration with ODEE designers)	• Code continuity plan implemented (with ASCTech): Github, etc.) • Load- and stress-testing done	• Carmen integration built
SUMMER TERM BEGINS 6/15 – ALL WORK READY TO PILOT					

June	• Work	•	• Practice space ready to pilot • ODEE Designers: meeting held and work begun	•	•
July	• Work • Final Testing	• Final testing	• Accessibility final sign-off • Final testing	• Final testing	• Training/messaging for lecturers & TAs complete • Final testing
SUMMER TERM ENDS 8/5					
FALL TERM STARTS 8/25 – ALL WORK READY TO PILOT					
August	• Monitor + Assess • Begin next iteration of system enhancement	• Planning for additional content • Planning for content improvement	• Planning for additional features • Planning for design improvements	• Planning for additional stability • Planning for better performance • Planning for developer continuity	• Planning for additional courses • Planning for additional activities or fuller integration in 1101-1152
September	• Monitor + Assess	•	•	•	•
October	• Monitor + Assess	•	•	•	•
November	• Monitor + Assess	•	•	•	•
FALL TERM ENDS 12/9					
December	• Last day of classes (12/9)	•	•	•	•
January 2016	• Final Report (1/31)	•	•	•	•

Milestone/Deliverable	**Target**
Project Plan Complete	2/28/2015
IRB amendments submitted	5/31/2015
Phase-out agreement	12/31/2015
Final Report	1/31/2016
Submission to Peer-reviewed Journal	4/1/2016