Integrating Engagement and First Year Problem Solving Using Game Controller Technology

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Abstract - **Entering college students in computer science and computer engineering face not only a challenging first year experience, but also typically must complete a grueling programming class for which many students are ill-prepared. While much work has focused on difficulties in such classes, our experience is that students who are ill prepared yet capable need a motivating and engaging factor to offset their challenges in the class. In this paper, we describe an ongoing project that integrates the Nintendo Wii Remote into such freshman class. By integrating a technically rich, familiar device into the classwork, students are challenged to learn about the device and engaged by learning how to use it in their coursework. We will describe technical and pedagogical challenges and their respective solutions. We also present initial feedback in using the Wii Remote in a Computer Engineering freshman problem-solving course.**

Index Terms – Problem solving, Freshman, Computer Engineering, Programming.

INTRODUCTION

This paper introduces a novel laboratory and pedagogical approach for freshman problem solving classes in Computer Science and Engineering (CSE) programs based on the Nintendo Wii Remote or “wiimote”. This approach allows students to accomplish new learning objectives while addressing pedagogical and engagement issues that CSE freshman and their instructors face during the first year experience.

The wiimote approach to freshman CSE problem solving combines engagement, discovery learning, laboratory realism, relational goals. This is achieved through programming lab exercises that exploit a simple, realtime interface to the wiimote’s sensor data developed as part of this effort. Having a simple interface that students can readily access allows for laboratories that focus on inductive and active learning. These learning experiences are not only engaging, but induce students to independently investigate solutions to problems presented to them. These problems go well beyond programming and traditional mathematics problems.

FRESHMAN PROBLEM SOLVING IN COMPUTER ENGINEERING

In 2008, wiimotes were introduced into “CPRE 185: Introduction to Computer Engineering and Problem Solving 1.” It is taught as 2 hours of lecture and 2 hours of laboratory per week where students perform 3 written examinations, 3 substantial homework exercises, and 12 laboratory reports. CPRE 185 enrolls about 140 students in its primary (Fall) semester and more than 95% of those students are first year college students majoring in Computer Engineering, Undeclared Engineering, or Software Engineering.

Course Content/Objectives

CPRE 185 introduces students to computer engineering and working in small groups to solve problems. Students solve problems in a laboratory setting primarily by writing programs in the C programming language. Spreadsheets are introduced and available for use by students in the laboratory. Students write technical lab reports that instructors evaluate for completeness of writeup, effort expended, and description of approach. Laboratory teams of 2--3 students work together to solve laboratory problem, but individuals are expected to complete their own writeup. The author has taught the class once per year (90-140 students/year) for 3 years.

THE WIIMOTE APPROACH

The wiimote approach is to use a laboratory environment that focuses on engagement in the face of the above observations while addressing a number of pedagogical goals described below. This section describes the pedagogical goals targeted and describes the motivation in using the wiimote in the laboratory.

Pedagogical Goals

Beyond engagement, retention, and recruitment, the project has goals specific to the pedagogical approach. These are quite general, but map to a list of specific learning objectives covered in a later section.

- **Allow students to build problem solving skills in their own way:** The primary goal of the laboratory exercises is to help students discover how they deal with problems and give them time to practice these skills. Lectures discuss general problem solving skills as well as extensive C programming topics and examples but do not discuss the wiimote or its functionality in any depth. The idea is to create an environment where students can get data from a familiar device for which no motivating example is needed. The laboratory exercises help them build tools to understand the data, determine what the data is telling them, and get them to use that data to solve the problem given to them. As part of their lab report, students are required to describe their problem solving process, their implementation, and the result of their effort.

- **Induce in the student a sense of discovery about computing systems, sensors, and embedded systems in students:** Students are very familiar with many computing systems from their daily lives, but most know little about their internals and the challenges that computer engineers face to develop these systems. Such embedded systems are a good example of how they exist in students' everyday lives. The wiimote is an embedded system containing a variety of sensors, wireless communication system, and a microprocessor.
- **Provide a novel source of data and inspiration for problem solving exercises:** The wiimote is wireless and provides sensor data that are not commonly available in computing systems. Students are challenged to understand how the device senses accelerations, gravity, and position.
- **Relate the students' learning in Calculus, Physics, and Signals classes to their CSE experience:** Interpreting the wiimote sensor outputs and using them in actual applications brings real applications of calculus, physics, and signals to the forefront. The problems are motivating in the sense that no deep understanding is addressed, but the goal is to give students a reason to engage during these other subjects. The long term goal is that CSE students will realize that these classes have direct application to their careers and computing systems in their everyday lives.

Related Work

Games and novel embedded devices have been considered as platforms for a wide variety of CSE classroom approaches. Gaming consoles and game writing have been used as retention and recruitment approaches [1-2]. Using gaming consoles in a freshman class has the disadvantage of a less transparent development environment. A transparent environment, one that makes the behavior of a student's program more predictable and observable, makes it easier for the student to interact with and debug their code. The wiimote approach uses PCs, not the Wii Console, thereby allowing the use of standard PC integrated development environments. Using the writing of games as a teaching approach is controversial [3] with concerns that the gender ineqity of CSE programs may be increased. The wiimote approach does not emphasize teaching students to write games as only one lab assignment involves writing a game.

Others have suggested novel computing devices for a wide range of classes, but most are not appropriate for freshmen. These devices include robots [4] and game consoles [1].

INTEGRATING WIIMOTES INTO FRESHMAN PROBLEM SOLVING

Integrating wiimotes into the classroom experience requires both technical and pedagogical consideration. This section briefly covers background on Nintendo Wii platform and the technical developments necessary to equip a functioning education laboratory with them. The technical aspects complement the goals and help address the issues described above.

The Wiimote

Introduced in 2007, the Nintendo Wii video game console is widely described as the fastest selling video game system in history [5]. The unique and innovative aspect of the Wii is the wireless controller system that forms the primary user interface method. Each Wii Remote, or wiimote, is a device resembling a television remote control that allows users to control the console as well as get audible and rumble feedback. The wiimote communicates wirelessly with the console (or desktop computer in the case of the laboratory) via the Bluetooth personal area networking protocol, IEEE 802.15.1.2005. This link allows the host system to receive realtime data updates from the sensors on the wiimote as well as allowing the host to control the output devices onboard the wiimote. In the current lab environment, students have been able to receive approximately 100 updates per second from the wiimote. Furthermore, despite the potential for radio frequency interference, the author has shown that 15 simultaneously operating wiimotes can be used in a single lab environment. Hence, at least 30 teams of 2 students each can work without noticeably interfering with each other. Further experiments would be needed to identify an upper bound on the number of devices that can be used in the same laboratory.

The wiimote's input devices comprise an accelerometer, an infrared light sensing apparatus, and 12 buttons [6]. The wiimote's internal microcontroller samples inputs from these devices and sends them out as messages over the microcontroller's integrated transceiver in packet form. The device used most in the laboratory environment is the ADXL330 Micro-Electro-Mechanical System 3-axis accelerometer [7]. The ADXL330 is an analog integrated circuit that uses a polysilicon spring bearing a mass suspended over the wafer's surface to measure acceleration. The other major sensor on the wiimote is the infrared sensor/processor [6]. This sensor incorporates a 1024 by 768 CCD camera mounted behind a window on the front of the wiimote.

Output from the camera is processed by an embedded processor that extracts the coordinates and size of the four brightest points on the CCD image. These data are also returned in by the wiimote. The purpose of the infrared sensor is to allow the Wii to precisely measure where the wiimote is pointing by sensing the coordinates of two infrared LED clusters mounted to the top of the television. The labs described in the document do not currently use the infrared sensor, but there are plans to create such labs in the Fall 2008 semester. A major issue is that the LEDs of one set of students may interfere with the readings of another team in a low-space classroom. One workaround is to use the wiimote in a stationary mode and then move LEDs to activate the sensor. Another approach is to move infrared reflective material in an environment that is well illuminated with infrared sources. These will be compared perhaps as a lab exercise in itself in upcoming semesters.

The final sensing devices on the wiimote are buttons. The press and release of each button is indicated by messages in the packets sent by the wiimote. Multiple buttons can be pressed simultaneously without causing problems.

Technical Approach

The technical approach to outfitting the laboratory can be broken into hardware and software considerations. A relatively minor investment in software development and hardware supports a lab class size of 30 students. As described below, care must be taken in choosing hardware and software for compatibility reasons. Furthermore, the software that was developed provides an interface that is readily useable to the student for both simple problem solving activities and more complex programming projects.

Laboratory Hardware Needed

Although the labs are based on the wiimote, all student programming is done on commodity PCs running Windows XP. Care must be taken to ensure that the Bluetooth network interface card chosen as well as the included drivers are compatible with the wiimote. Hobbyists have provided significant guidance in finding compatible hardware and software stacks on the WiiLi Wiki [6].

In the described environment, each PC was outfitted with a DBT-120 Bluetooth adapter manufactured by D-Link. The Bluetooth stack developed by Toshiba was included with these adapters and will readily peer with a wiimote. As the DBT-120 is a very small USB device prone to theft, the IT staff chose to mount the device inside the PC's case using a short USB extension cable. Despite being inside a partially metallic enclosure, the wiimote and PC could still reliably communicate at a distance of 6 meters. No effort was made to measure the maximum effective range.

Before receiving data from the wiimote, the PC must be paired with the wiimote. The pairing operation, which varies among Bluetooth stacks, requires administrator privileges. Because the students are not granted such rights on the lab PCs, it was necessary to have an administrator pair a specific wiimote to a specific PC and mark the wiimote with the PC's identification number. Students could then connect a wiimote only if it had been previously paired with their station's PC.

The Student Application Programming Interface

Several choices were considered for the application programming interface (API) to employ for the class. The primary goals for the API were simplicity of use, transparency, and suitability for non-programming labs. An approach based on an external application piped to standard input of the student's program was chosen at the expense of restricting student programs to unidirectional communication with the wiimote.

```
U:\wiiwrap>wiiwrap /h /C  /T /A
Connected
,Count,time(ms),a_x, a_y, a_z
,1,94,0.440000, -0.074074, 0.888889
,2,102,0.320000, 0.037037, 0.962963
,3,115,0.160000, 0.037037, 1.074074
,4,125,-0.080000, 0.148148, 1.333333
,5,133,-0.280000, 0.111111, 1.259259
,6,143,-0.400000, 0.074074, 1.111111
,7,156,-0.400000, -0.111111, 0.851852
,8,164,-0.560000, 0.037037, 1.037037
,9,174,-0.560000, 0.037037, 0.925926
,10,188,-0.600000, 0.037037, 0.962963
,11,195,-0.600000, 0.037037, 0.925926
,12,205,-0.600000, 0.037037, 0.925926
,13,213,-0.600000, 0.037037, 0.925926
,14,227,-0.640000, 0.037037, 0.925926
,15,234,-0.640000, 0.037037, 0.925926
,16,258,-0.640000, 0.037037, 0.925926
,17,279,-0.600000, 0.037037, 0.925926
,18,285,-0.600000, 0.037037, 0.925926
,19,295,-0.600000, 0.037037, 0.962963
,20,309,-0.560000, 0.037037, 0.962963
,21,318,-0.520000, 0.037037, 0.962963
,22,326,-0.480000, -0.074074, 0.962963
,23,334,-0.440000, 0.074074, 1.074074
,24,348,-0.320000, -0.037037, 1.037037
,25,357,-0.120000, 0.074074, 1.259259
^C

U:\wiirap\WIIWRAP \T \A \B \H > TAB.csv
```

FIGURE I
TWO SAMPLE RUNS OF WIIWRAP DEMONSTRATING ITS OUTPUT AND USAGE.

The API was developed as an independent application named wiiwrap. Based on the demonstration application included with the WiiYourself library [8], wiiwrap receives status updates from the wiimote and at every change outputs a comma delimited line of text. The user can control which readings are output and in what order by specifying command line options. Command line switches are also included that request a counter indicating the number of lines output as well as a the number of milliseconds elapsed since wiiwrap was started. Wiiwrap is licensed under a BSD-style, open source license, and available at http://www.ece.iastate.edu/~daniels/cegw.html.

The developed API is simple. Students can redirect wiiwrap output to a file for analysis or pipe it to their programs for their lab work. Each line of output is easily parsed with single scanf statement that second or third week programmers can write. Furthermore, non-programming labs such as spreadsheet work with the data is very convenient as the output of wiiwrap consists of lines of comma separated values–a format that spreadsheets readily import.

A C library/header file for a wiimote interface was considered as were simplifications of other libraries

```
CONNECTED
TIME(MS),A_X, A_Y, A_Z,A, B, +, H, -, 1, 2, U, D, L, R
72,-0.080000, 0.037037, 1.000000,1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
96,-0.200000, 0.074074, 1.037037,1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
105,-0.200000, 0.074074, 1.037037,1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
113,-0.240000, 0.074074, 1.037037,1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
121,-0.280000, 0.074074, 1.037037,1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
137,-0.360000, 0.074074, 1.037037,1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
144,-0.400000, 0.074074, 1.037037,1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
154,-0.440000, 0.037037, 1.037037,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
166,-0.440000, 0.037037, 1.000000,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
176,-0.240000, 0.111111, 1.037037,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
185,-0.200000, 0.037037, 1.000000,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
193,-0.120000, 0.074074, 1.000000,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
207,-0.080000, 0.037037, 1.000000,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
215,-0.120000, 0.037037, 1.000000,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
224,-0.120000, 0.037037, 1.000000,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
238,-0.200000, 0.037037, 1.037037,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
246,-0.240000, 0.037037, 1.037037,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
256,-0.320000, 0.000000, 1.037037,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
265,-0.280000, 0.037037, 1.037037,0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
277,-0.160000, 0.074074, 1.111111,1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
287,-0.280000, -0.037037, 1.074074,1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
295,0.000000, 0.111111, 1.074074,1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
```

FIGURE II

FIRST 25 LINES OF TAB.CSV AS COLLECTED IN PREVIOUS FIGURE. THE FIRST COLUMN IS TIME FROM START OF WIIWRAP IN MS. A_X, A_Y, AND A_Z ARE CALIBRATED ACCELERATION FIGURES IN UNITS AS A FACTOR OF G'S, THE ACCELERATION DUE TO GRAVITY.

available on the Internet. This approach was rejected as it introduced the added complexity and intransparency of learning another set of functions and debugging their use. The wiiwrap approach is relatively transparent as it allows students to easily see the readings that their programs will input. No added programming skills or libraries are required as a simple scanf call will retrieve a reading. Furthermore, this approach allows students to debug their programs by typing input into their program by hand.

The wiiwrap interface is simple enough that learning the output's meaning can be the problem solving lab exercise. This is described in the Lab Exercises Section.

A major deficiency of the wiiwrap API is that students can not use it to send commands to the wiimote making the rumble, LED, and speaker features inaccessible to them. Future work may look at how to use these features through some reasonable interface for beginning programmers.

PEDAGOGICAL APPROACH

The author's approach is primarily limited to laboratory work where students solve problems, but it also includes a small amount of related lecture coverage specific to the laboratory. The goal is not to teach students about the wiimote, but to get students to actively analyze the problem, the wiimote's behavior, and search for solutions. While the wiimote's sensors and realtime behavior provide interesting ties to related fields where students will do coursework, the familiarity of the device coupled with the mystery of how the wiimote functions makes it a compelling tool for engaging students.

Specific Learning Objectives

The specific learning objectives developed to address the issues discussed in earlier sections can be broken down into categories related to discovery, problem solving, relational, and core CSE knowledge.

The one discovery objective relates to Bruner's notion of constructivist discovery learning [9] which has been refuted in its pure form by many researchers [10]. In this case however, the goal is not to induce students to discover deep concepts simply by playing with a problem, but rather to familiarize the student with the process that they use to infer and understand the behavior of a new system. This is a key skill that seems to be frequently overlooked yet needed by students every time they learn to program with a new API or interface with an unfamiliar device or cope with a new learning environment. In further defense of the goal, the approach is far from a ``pure'' form of discovery learning as lab assignments do give guidelines and hints towards a solution. Teaching assistants also typically briefly lecture at the beginning of the lab about the general principle(s) in play that day.

Lab Exercises

Laboratories for this course are taught by Teaching Assistants in coordination with our learning community peer mentors. Several are listed below.

Discovering Wiimote Behavior (Discovery Objective) Students receive instruction in pairing wiimotes to their PCs, running wiiwrap, and web links to spreadsheet tutorials. Students are encouraged to play around with the wiimote and watch the produced data. They are then given specific orientations for the wiimote and shown how to record the resulting data to a file. Finally, the students are told to record 10-15 seconds of data of a reasonably reproducible movement of the wiimote.

The required lab report must graph the accelarations measured by the wiimote as a function of time. Students are instructed to annotate the graphs with their interpretation of the data sets and then explain what the sensors are telling them.

Although it may seem that students are highly constrained in this endeavor, the underlying discovery task is to understand what the numbers from the wiimote are telling them. The guidelines and tutorials provided are tools that we help them conceptualize that the accelerometers (when at rest) are indicating the orientation of the wiimote with respect to the gravity field. This is the basis for many uses of the wiimote during game play. Teaching assistants were instructed not to directly assist with answers regarding these points. Instead, they guided the students' thinking through questions and analogies.

Evaluation: During weekly meetings with the TAs, the author found that after 4 wiimote laboratories that students had transitioned to discovery approaches. During these post-lab meetings, the author asked about the types of questions asked by students. It was found that students quickly adapted to searching for ways to deal with inputs from the wiimotes. This was accentuated when interpretation of user button presses was required in the Wiiqualizer lab. The students were given the command line flag to request button presses (``\\B"), but not told how to parse or interpret the resulting data.

No questions were reported about parsing of the new inputs and about 3 lab groups in every 15 asked about processing the button press. This is more difficult than it may seem as one button press typically result in a stream on signals while the button remains pressed as in column 5 of Figure II.

Relational Objective Labs: The author has observed that CSE students often do not understand the applicability and reasoning behind course requirements such as physics, mathematics, statistics, and signals and systems. Some student's perceptions seem to vary from ``only rocket scientists use this stuff" to ``these are weed-out courses."

The wiimote labs allow for a hands-on experience that relates these fields directly to a physical device that the majority of students have used previously. Furthermore, as the wiimote is part a of gaming system, those uses were likely to have been enjoyable.

Relational labs combine a computer programming practice problem assignment and some aspect of one of our relational areas. A challenging aspect of this integration is finding initial projects that are meaningful and use the wiimote data in some useful way. It should be noted that most labs support several objectives of several types.

In 2007, 13 labs were taught over the fall semester. Of those, 9 were wiimote-based. Because some wiimote labs were multi-session, 22 hours of lab session used the wiimote. The list below describes three sample laboratories briefly along with their objectives.

What's Up?, 1 Lab session, Discovery, Problem Solving (all), Relational (vectors): This lab involves programming the PC to interpret the orientation of the wiimote when it is at rest and indicate which of its six faces is pointing up. In a previous introductory lab, students were asked to compute the magnitude of the acceleration and relate it to what was being done with the wiimote at the time. Hence, the idea is to get them to measure the magnitude of the acceleration vector, compare it to 1 g, and then write conditional statments that print the appropriate orientation of the device.

Wiiqualizer and Moving Averages}, 2 Lab Sessions, Problem Solving(all), Relational(statistics, signals, trigonometry): In these two exercises, students are told to write a program that graphs the pitch and roll of the wiimote on the text screen in real time. This lab is based on functions (required), loops, and conditionals. It also induces the students to work out expressions to normalize the input value into a number of marks to the right or left of the center point. In the second lab session, the concept of moving average is introduced (requiring arrays) as a programming component. The students then experiment with varying lengths of averages and report the effect on quickly moving (high frequency) behaviors by observing their realtime graphical output. Students are asked what lengths might be appropriate for a number of different applications.

The Wiiqualizer lab relates their work to trigonometry (calculating pitch or roll), gives them hands on experience with signals and systems work (moving average filters) required in computer engineering programs as well as basic statistics. Students are instructed to allow the wiimote to rock back and forth on its rounded bottom and report on the observed behavior. The graph is a clear case of oscillation being damped by the friction and air resistance–something students will encounter in physics.

Wiimaze 2 Lab Sessions, Problem Solving(all), Relational(signals, random numbers), Core(State Diagrams): Wiimaze builds on the student's experience from Wiiqualizer to build an interactive game. In Wiimaze, students use their filters to smooth out pitch measurements to control a character that is falling down the screen. Students also must use a pseudorandom number generator to fill the screen with a percentage of randomly-placed obstacles.

The relational objective satisfied here is the use of probability (randomness) and how its needed for even simple computer games. The core learning objective addressed here is implementing a state machine that defines the rules of the game. In later labs, students are asked to draw a state machine to encode their approach to solving a problem.

Evaluation

Evaluating any new project is a difficult task especially when the goals are as diverse as these, but initial results are promising. One course evaluation question indicates signs of improved engagement. The same course has been taught by the same instructor in two previous years doing typical programming-related problem solving in C. We use the previous two years as a baseline.

Standardized course evaluation questions were at least as positive (or showed no improvement) as in the past. Most indicative of engagement and discovery objectives, Question 20 (Q20) asked students to indicate on a 1 to 5 scale (5 being very strongly) how motivated the class made them to continue learning about related material outside of class. Table I shows the results for the last three years the author has taught the course.

In 2005, the class did not include the learning community group while in 2006, the class only contained the learning community group. The third row of the table shows the result of combining the responses of both groups to create a roughly equivalent control group for comparison in 2007.

The mean μ and standard deviation σ are shown for Q20 for each set. Each of the three sets is compared to the 2007 (experimental) group using a one-sided t-test [11] to compare the means of the distributions. The t-test chosen assumes non-equal variance as the variance of each distribution was observed to be somewhat different. The p-values obtained are shown in the table as are the fraction of increase in the response mean versus the experimental group, $\delta Q20$.

TABLE I
COMPARISON OF RELATIONAL OBJECTIVE QUESTION RESULTS

Year	Note	n	Q20 μ	Q20 σ	t-test p-value	δQ20
2005	NonLC	36	3.11	0.98	4.3e-6	29%
2006	LC Only	81	3.70	1.11	0.02	9.7%
2005/6	Both	117	3.52	1.10	1.6e-4	14%
2007	Both	71	4.03	0.79	N/A	0%

The differences in the mean between the wiimote group(2007) and the others is significant with $\alpha = 0.05$ in all cases, but more importantly consider that the 2006 group were solely composed of learning community students whereas only 75% of the 2007 group were in the learning community. Despite the observation that learning community students in the program are typically better prepared, the experimental group of mixed students still indicated greater motivation by 9.7% extent. To create a more representative control group, 2005 and 2006 raw responses were combined showing a 14% improvement in Q20 mean with very low p-value. In the case of the mixed control group, the 95% confidence interval began at an 8% increase in mean response.

As discussed above, observation of student questions during the labs indicate that students did achieve the discovery objective. As new aspects of the wiimote were unveiled, students discovered how to parse the data, interpret it, and solve the problem. Over time, students were observed to spend most of their effort on programming aspects and debugging than interpreting the wiimote data.

The effectiveness of this approach in achieving the relational objectives requires long-term study to evaluate. Ostensibly, the vast majority of students did complete these labs and wrote about their findings in their lab reports. A fundamental question to be resolved is whether the relational efforts have real effect on retention of students or in improving their performance or interest in non-major technical classes. Clearly, the students were made aware of relationships and induced to solve related problems.

CONCLUSIONS AND FUTURE PLANS

The integration of the Nintendo Wii Remote into a CSE First Year Problem Solving course improves student engagement while targeting problem solving, relational, discovery, and core learning objectives. The approach allows for a low cost laboratory with an easy to use API for students to use in their projects. The developed tool is amenable to use with any language or even spreadsheets and is available to the community for class development.

By carefully developing lab assignments, students can be induced to develop skills in learning to interpret and analyze new sources of data or APIs. The wiimote also makes an excellent platform to motivate the relationship of CSE and other fields.

Future work will develop new laboratories that exploit the wiimote infrared sensor as well as relationships to other fields that are relevant. Another area of interest is to develop a framework that generalizes on the properties of a device and the laboratories that will satisfy the described goals and objectives. It is probable that as students' perspectives and interests change that new devices will be more effective at engagement.

Finally, as these students progress in the program, aggregate figures for grades in the related coursework as well as retention could be compared to historical figures to examine retention effects. These will require long-term, more focused data collection from students.

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