AC 2010-1597: A STUDENT-RUN HELP DESK TO FACILITATE A ROBOTICS-BASED COURSE SEQUENCE

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Abstract

Many engineering programs have implemented project-based, first-year experiences to foster the development of skills and attitudes that improve student retention and better prepare students for an increasingly dynamic and global workplace. Project-focused approaches increase the workload of already busy faculty members and can be difficult to sustain, particularly when budgets are tight. Added responsibilities such as ordering and managing supplies, resolving technical issues faced by students, and maintaining tools and machinery rob faculty of time that could be better spent focusing on the learning experience.

Louisiana Tech University has addressed this issue by implementing a project-focused curriculum that we call *Living with the Lab*. This curriculum decreases a portion of the faculty workload by transferring the ownership and maintenance of laboratory platforms and tools from the university to the students. Each student purchases a robotics kit with a programmable controller, sensors, servos, and software. In addition, students are required to purchase a kit that includes a majority of the tools necessary to complete the required projects in the new curriculum. The robotics kit and toolkit provide the foundation for a laboratory and design platform that is completely mobile and accessible at all times. Despite Louisiana Tech's transition to a student-owned laboratory and design platform, a significant portion of the faculty workload still includes tasks necessary to appropriately facilitate our project-based approach.

To increase the sustainability of the curriculum, our faculty team has implemented a student-run help desk that is responsible for many of the tasks required to sustain the curriculum. By analyzing help desk data collected throughout the year, we measure and identify the types of activities performed by the student-run help desk as well as the utilization of it by Louisiana Tech's first-year engineering students. This paper describes our first-year approach, the management of project supplies and equipment, the help desk, and the assessment data collected throughout the year.

Introduction

In 1998 the College of Engineering and Science at Louisiana Tech University implemented an integrated engineering curriculum based on the educational practices of the early NSF coalitions[1]. The University provided seed money in 2002 to pilot a robotics-centered, project focused version of the integrated curriculum for a group of 21 students. After seeing positive results, the new curriculum was expanded to 40 students during the 2003-2004 academic year. The program was adopted as the honors engineering curriculum from 2004 to 2007. The new freshman curriculum became known as *Living with the Lab* (LWTL)[2], and funding from the National Science Foundation provided the opportunity to extend the program to more than 400 students in fall of 2008.

Louisiana Tech operates on a quarter system, thereby allowing three general engineering courses to be offered per year. The three courses (ENGR 120, 121, and 122) are hybrid lecture/laboratory classes that meet for 110 minutes, two times per week. Table 1 shows these

courses along with the other technical courses in the freshman curriculum. As a part of this LWTL course sequence each student is required to purchases a toolkit (approximately $70) and a robotics kit[3] (approximately $110) with a programmable controller, sensors, servos, and software. These provide the students with a portable laboratory and design platform for project-based learning.

Table 1: Freshman Year Technical Courses

Fall Quarter		Winter Quarter		Spring Quarter	
Course	Credits	Course	Credits	Course	Credits
ENGR 120	2	ENGR 121	2	ENGR 122	2
MATH 240	3	MATH 241	3	MATH 242	3
CHEM 100	2	CHEM 101/103	2/1	PHYS 201*	3

* Students in chemical engineering postpone physics and take an additional chemistry in this quarter.

A major advantage of the LWTL curriculum is that the students are able to continue experiential learning outside of the engineering classroom. In fact, a majority of the students' hands-on laboratory activities can be accomplished without the presence of a faculty member because students own and maintain their own lab. This student-owned approach coupled with frequent projects provides a context for engineering education and fosters creativity and confidence in first-year students.

An additional benefit of student-owned laboratories is that the time traditionally devoted to maintaining laboratory equipment and supplies by technical staff members is decreased significantly. This frees the faculty to spend more time focusing on the fundamental educational needs of the students as well as enhancing the development of the students' problem solving skills via hand-on activities.

Despite the advantages that student-owned laboratories provide, certain time-intensive activities still remain that can consume faculty time. To address these issues, the College of Engineering and Science has implemented a student-run "help desk". This paper describes the activities associated with the help desk and details several key factors that we believe are necessary for a successful student-run help desk.

Living with the Lab Help Desk

The help desk is operated by student workers that have completed the freshman LWTL curriculum. This provides the workers with a personal knowledge of the issues that students face and better equips the workers to help the students succeed. The help desk operates two hours per night (6 p.m. – 8 p.m.), five nights per week (Sunday – Thursday). The primary tasks handled by help desk workers include classroom maintenance, software installation, homework assistance, supplemental instruction, project kit assembly, robotics parts distribution, pump testing, and design exposition setup. Each of these tasks is detailed below. See Figure 1 for picture of the help desk workers assisting a student (center of picture) with a robotics assignment.

Figure 1: Help Desk Workers Assisting with a Robotics Assignment

1. Classroom Maintenance

The freshman ENGR classes are the only classes taught in the allocated classrooms. The college maintains two freshmen engineering classrooms. The primary classroom has a capacity of 44 students and is used for non-honors courses. The second classroom is for honors courses and has a maximum capacity of 20 students. The primary classroom houses ten milling machines, two lathes, six rivet guns, two hand-operated metal shear/brakes, and a soldering station, as seen in Figure 2.

Figure 2: Primary Classroom Used for Freshmen Engineering Courses

All freshman LWTL courses require hands-on laboratory activities, and most class periods consist of a lecture period as well as a laboratory period. Help desk workers are responsible for ensuring all work stations are properly stocked with supplies and necessary tools. They also prepare the classroom for upcoming activities and are responsible for general cleaning as well as machine maintenance.

Another important aspect of classroom maintenance includes stocking and organizing the supply closet and the teachers' supply cabinets in the classrooms. The need for additional parts and supplies during the lab setting of the classes is inevitable. To ensure that the instructors can

quickly access the needed parts while not having to leave the classroom, supply cabinets have been set up in both classrooms for each of the three freshman engineering courses. These cabinets are stocked with spares of all the different parts given to the students in their kits and other resources for the instructors such as completed example projects and other items that may be needed to test the functionality of the student projects. See Figure 3 for a picture of one of the three supply cabinets.

Figure 3: One of Three Supply Cabinets Used for Freshmen Engineering Courses

The supply closet, while open to instructors, is primarily for the benefit of the help desk workers. The closet gives the workers an organized space to store all the different supplies needed for all three courses in one place. This helps the workers to quickly resupply the instructors' supply cabinets and to keep track of the parts and supplies needed to assemble kits. This closet also stores the necessary cleaning supplies for the rooms, tools needed to keep the machinery in good working order, and resources for supplemental instruction and tutoring. See Figure 4 for a picture of the supply closet.

Figure 4: Supply Closest Used for Freshmen Engineering Courses

2. Software Installation

Freshman engineering students are required to purchase the following software packages during their first quarter: Microsoft Office, SolidWorks, Mathcad, and the Basic Stamp Editor (free download). While most of these packages are purchased and installed independently of the help desk, the Louisiana Tech College of Engineering and Science has a site license that allows students to use SolidWorks for the duration of their undergraduate career. Help desk workers install SolidWorks on the students' laptops, collect the associated fees, and keep records of students that have (and have not) loaded the software. Additionally, the workers help students resolve problems encountered with any software associated with the course.

3. Homework Assistance

Students are allowed to visit the help desk when difficulties on homework assignments arise. Homework assignments are required for each class period in ENGR 120, 121, and 122. Typical assignments include quantitative calculations, Boe-Bot program assignments, and computer-related activities (Excel, Mathcad, SolidWorks). Student workers are directed not to give out solutions nor help students that have not provided a good faith effort to attempt the homework assignment in question.

4. Supplemental Instruction

Although students are strongly encouraged to seek further explanation of difficult material from their professors during office hours, they are also allowed to seek supplemental instruction from the help desk. This is done so the students can see the material presented from a different point of view than that of the professor. Many times a student's problem in understanding the material comes from simply not understanding or following a professor's teaching process. By allowing the help desk workers to present their understanding of a topic, the student has a greater chance of resolving their problem in understanding the material.

5. Kit Assembly

Student workers assemble kits of materials that are distributed to students prior to the initiation of the project for the quarter. The initial course, ENGR 120, requires students to model, fabricate, and evaluate the performance of a centrifugal pump[4]. Table 2 provides a list of parts included in the kit. Figure 5 provides a picture of a pump kit and a completed pump.

The second course, ENGR 121, requires students to produce a system that provides a closed-loop control of the temperature and salinity of a small volume of water[5]. Within this project, students fabricate and calibrate their own conductivity sensor and resistance temperature detector. This is known as the "fishtank project". See Figure 6 for photographs of completed "fishtanks."

The final course, ENGR 122, consists of an open-ended design project that requires students to conceive, design, fabricate, test, and demonstrate a smart product[6]. The nature of this course is not conducive to kits. Instead, the students purchase materials necessary to fabricate their products. They are allowed to borrow sensors from a library maintained by the College. The

Table 2: Parts Included in Pump Kit

Vendor	part number	Description	Packaging	Price	Amount Required	per kit cost
McMaster-Carr	8660K43	2" x 2" x 0.9" type 1 PVC gray rod	by the foot	16.23	0.9 inch	$ 1.35
McMaster-Carr	87545K751	2" x 2" blue tint type 1 PVC sheet	square foot	27.60	0.028 ft^2	$ 0.85
McMaster-Carr	9263K131	1.6 mm wide, 2.2 mm ID o-ring (viton)	pack of 25	3.45	1	$ 0.14
McMaster-Carr	9452K85	1 1/16" ID x 1 1/4 OD o-ring with 3/32" width	pack of 50	4.32	1	$ 0.09
McMaster-Carr	5116K82	nylon barbed fitting - 3/16" tube ID, 1/8 NPT male	pack of 100	2.66	2	$ 0.53
McMaster-Carr	90190A153	#6 sheet metal screws - 1" long	pack of 100	5.91	4	$ 0.12
McMaster-Carr	8971K44	Ultra-machinable bearing grade 5/16" dia. bronze rod	6' length	41.35	5/16 inch	$ 0.18
Walmart	51213	8" cable ties (~0.095" wide)	pack of 20	0.97	2	$ 0.10
Jameco Electronics	206949	9-30V, 0.35A,4930 rpm,44.5 g-cm DC motor (shaft: 0.090" OD & 0.45" long)	each	1.37	1	$ 1.37
			Total Pump Cost:			**$ 4.72**

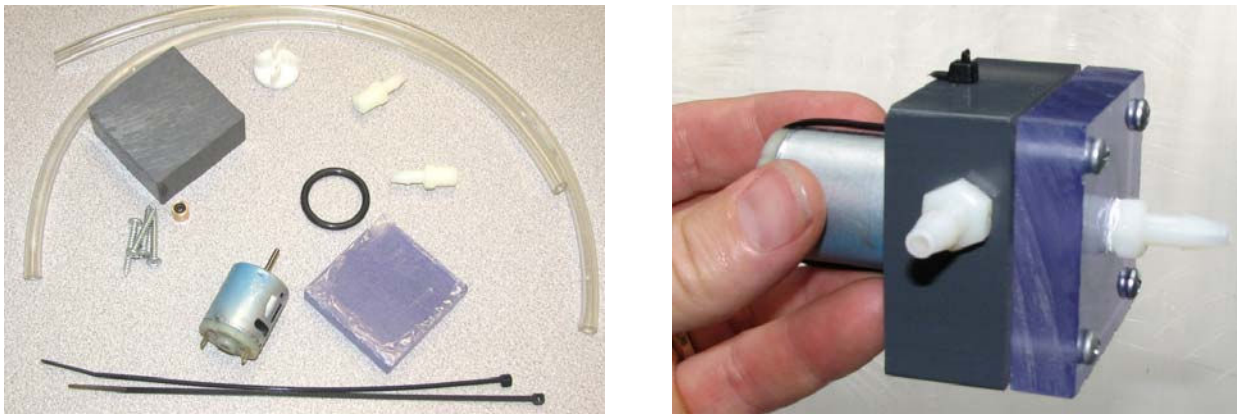

Figure 5: ENGR 120 Pump Kit Materials and Completed Pump

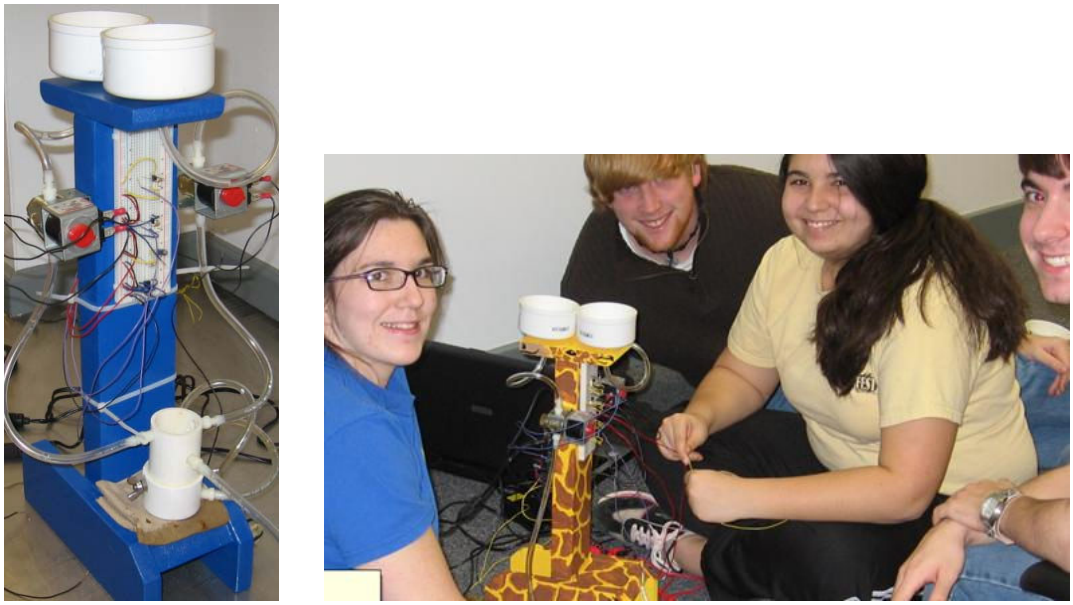

Figure 6: ENGR 121 Completed Fishtanks

sensors must be returned by the end of the quarter, and any mechanical damages are the students' responsibility. Due to the financial responsibility of the sensor library, it is maintained by a faculty member.

6. Pump Testing

Once the fabrication of the centrifugal pumps is completed, the students in ENGR 120 test the pump systems for efficiency by measuring the electrical energy input to the motor and the kinetic and potential energy transmitted to the water. See Figure 7 for a graphic of the pump testing configuration and a picture of actual pump testing stations.

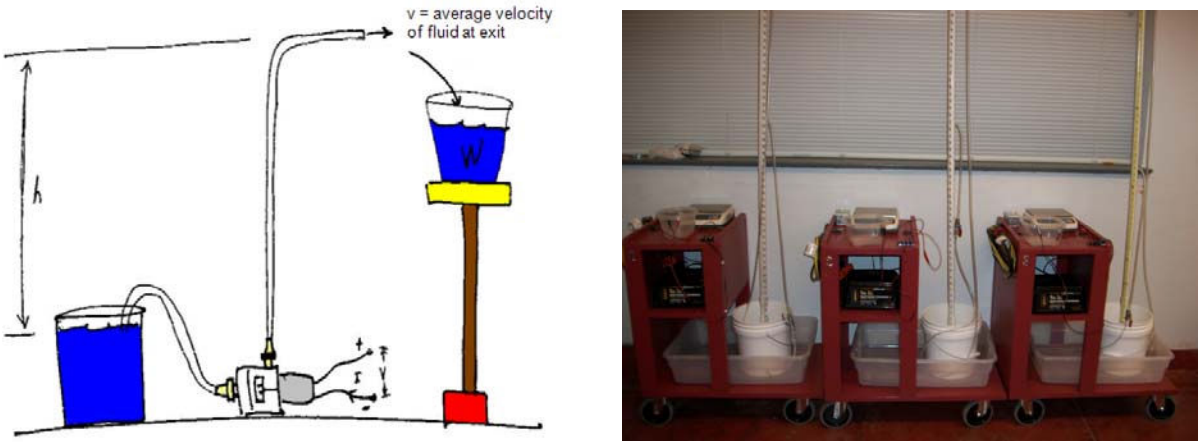

Figure 7: Graphic and Picture of Pump Testing Configuration

Students complete pump testing as a homework assignment. Initially, faculty members volunteered to come after normal working hours to allow the students to complete the testing. To alleviate this extra burden on the faculty, the help desk workers became responsible for all aspects of pump testing. The help desk workers set up the stations, monitor all aspects of the experiment, help students troubleshoot their pumps, and clean up after testing is completed.

7. Robotics Parts Distribution

The robotics kits purchased by the students from Parallax (Boe-Bots) include numerous parts (sensors, wiring, LEDs, resistors, etc.). Students often misplace parts and need replacements. Originally, the help desk workers freely distributed inexpensive parts (purchased by the College) to students needing replacement parts, and more expensive items were the students' responsibility. Sustainability issues associated with this service led to the purchase of a vending machine that the help desk workers stock with Boe-Bot parts as well as various items included in the LWTL project kits. See Figure 8 for a picture of the "Engineering Vending Machine."

For more expensive sensors (primarily associated with ENGR 122), the college maintains a library that is available for students to check out on a quarterly basis. Special care is given to

checking the sensors in and out and also inspecting the sensors when they are returned to ensure they are functioning properly. One of the professors usually handles the checking out and in process while the help desk workers are responsible for testing the sensors once returned. By allowing the help desk workers to inspect the sensors and accessories, it keeps the workers familiar with the operation of the sensors which better enables them to help students that have problems implementing the sensors.

Figure 8: Vending Machine Used for Freshmen Engineering Projects

8. Design Exposition

The freshman engineering course sequence culminates in a design exposition. Students in ENGR 122 are required to conceive, design, fabricate, test, and demonstrate a smart product. The design exposition and competition is the outlet where students demonstrate their products. The exposition is free and open to the public. Projects are judged by a panel usually consisting of a representative from a local industry, a faculty member from the College of Engineering and Science, a faculty member from the School of Business, and an upper-level or graduate engineering student.

A great deal of effort is put into the design exposition and competition, and the help desk workers are responsible for most of the general labor involved. Responsibilities include loading tables, dividers, and chairs; transporting these items to and from the location of the exposition; all aspects of the set-up and take-down process; and general cleaning of the location used for the exposition. Figure 9 shows a picture of the award presentation for a recent design exposition and competition.

Figure 9: Awards Presentation at an ENGR 122 Design Exposition and Competition

Keys to a Successful Student-Run Help Desk

We have implemented a student-run help desk to reduce the faculty workload required to sustain a project-based learning experience. We feel that a successful help desk results from having a stated purpose, a faculty supervisor, well-rounded student workers, successful marketing, and necessary funding. Each of these factors is detailed below.

1. Purpose

The freshman year in engineering can be difficult for students because it is such a change of pace from the high school curriculum that they have just completed. The help desk provides a place where students can receive positive reinforcement for their efforts. Often, students become frustrated and do not feel as if they are progressing in their studies. By providing a place where

students can come to finish projects or develop a better understanding of course fundamentals, we can give them the boost they need to persevere and succeed.

Another purpose of the help desk is to reinforce the concept of working in teams – a foundation on which our freshman curriculum is built. Many times, one student's questions are the same as another. Providing an environment that encourages students to work and learn together helps develop the personal connections that foster the development of "community."

2. Faculty Supervisor

While an objective of the student help-desk is to reduce the faculty members' workloads, faculty involvement is a key component of success. The faculty member in charge of the help desk plays the role of purchaser, accountant, trainer, and supervisor.

Project-based approaches require the purchase of parts, materials, tools, and equipment necessary for hands-on learning. The faculty supervisor is also responsible for training the help-desk workers to perform the job requirements. Training includes hands-on instruction and writing detailed job descriptions. Initially, these are demanding tasks for the faculty member; however, future time demands are minimized because experienced student workers are able to train future student workers. In addition to training student workers, the faculty supervisor must also supervise the student workers to ensure tasks are accomplished on schedule.

3. Well-Rounded Student Workers

The student workers are the face of the help desk. Ideal student workers are technologically savvy, have good organizational skills, have good communication skills, and have the heart of a teacher. Help desk workers should be able to assist a student who is having difficulty installing SolidWorks, sweep a dirty floor, organize a messy cabinet, and encourage a student who is down, all in the same evening. Academically strong students who are good at troubleshooting hardware and software applications are desirable. The dream student is one that takes ownership of the laboratory and in their role as a mentor.

4. Marketing

As with any successful venture, promotion of the product is a key to success. Initially, the faculty members teaching in the freshman program placed an emphasis on the availability of the help desk as well as the services provided by the help desk. In addition, strategically placed signage provided additional exposure. The best advertising tool, however, proved to be word of mouth - students discussing amongst themselves their experiences with the help desk. Fortunately, most students seem to have found the help desk experience to be beneficial, thus increasing the positive perception of the help desk in their eyes.

5. Funding

The funding required to pay the help desk workers initially came from a National Science Foundation grant. More recently, funding has come from primarily from the sale of software.

The fees collected pay the help desk workers and provide funding for supplies, new sensors, and equipment maintenance. The project-based curriculum is now fully self-supported.

Assessment of Help Desk Data

Data detailing the number of times student workers performed certain tasks have been recorded for the past three quarters (Spring 2009, Fall 2009, and Winter 2010). Table 3 provides a numerical summary of the data; Figure 10 provides a graphical representation of the data.

Table 3: Number of Occurrences of Help Desk Tasks

Help Desk Tasks	Number of Occurrences
Classroom Maintenance	137
Software Installation/Help	453
Homework/Supplemental Instruction	60
Kit Assembly	19
Robotics Parts Distribution	13
Pump Testing	103
Design Exposition	1

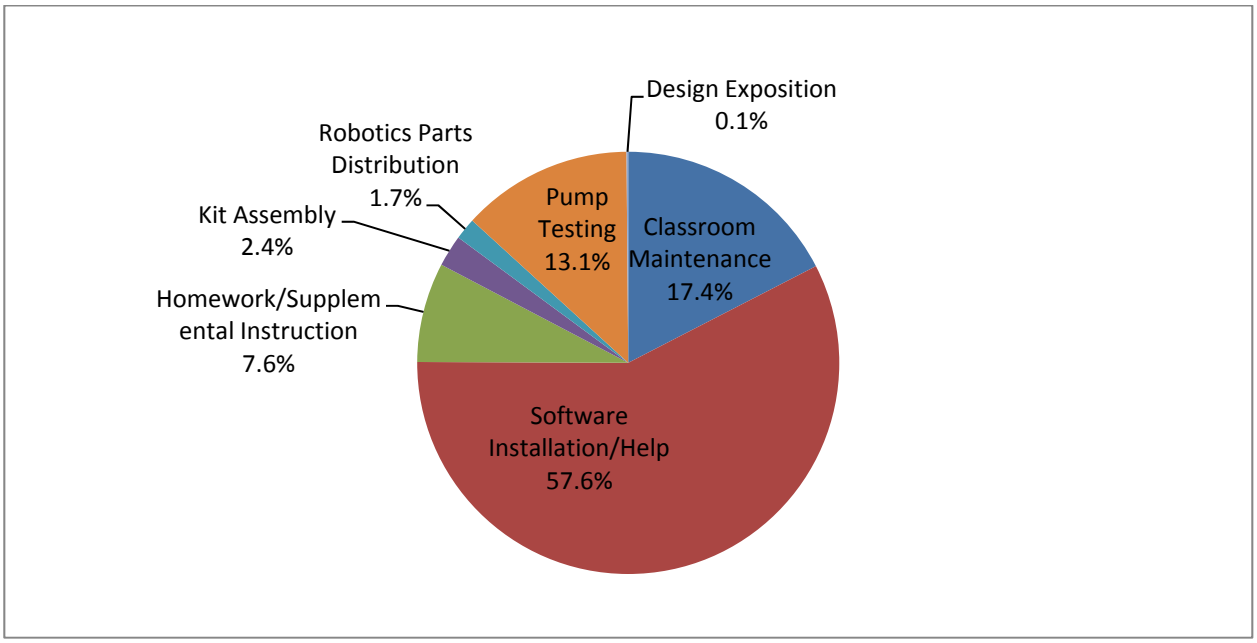

Figure 10: Percentage Breakdown of Occurrences of Help Desk Tasks

The data reveal that a majority of the tasks performed by the help desk involve software installation and/or help with software issues (57.6% of tasks). This outcome was anticipated because of the site license we have for SolidWorks that allows students to rent the software for

the duration of their undergraduate career. Because of this, essentially every freshman visits the help desk during the initial quarter. In addition to installing SolidWorks, the help desk workers are so versed in resolving software issues (i.e., for all software packages associated with the freshman courses) that most instructors direct students to the help desk to resolve issues that are not easily identified. Removing these responsibilities from the faculty members has resulted in immeasurable time savings as well as easing the burden of the need for instructors to learn solutions to numerous software issues.

Classroom maintenance is the second most frequent activity (17.4% of tasks). While general cleaning duties are performed by the College's janitorial staff, help desk workers must perform maintenance and repair operations on machinery, ensure project supplies are stocked in their appropriate locations, and prepare the classroom for upcoming activities. The removal of these duties from the faculty has also resulted in significant time savings.

Supervising centrifugal pump testing during ENGR 120 is another common task associated with the help desk (13.1% of tasks). Prior to our initiation of the help desk, a certain portion of class time was set apart for pump testing. During this time, only a small percentage of students were able to complete the testing process, and instructors were forced to volunteer their time during the evening to staff the pump testing stations. Transferring pump testing operations to the help desk not only alleviated instructors of late night shifts, but also opened up a portion of class time that could be devoted to focusing on other topics associated with the class.

Homework assistance and supplemental instruction (7.6% of tasks) provided through the help desk is not primarily looked at as a task that saves faculty time. Instead, it is a service that allows students to get help at times that their instructors are not available. In addition, the help desk workers are often able to explain difficult material from a viewpoint not offered by instructor. The expected result is a student with an enhanced and more complete understanding of the material.

The remaining tasks are kit assembly (2.4%), robotics part distribution (1.7%), and design exposition activities (1 occurrence or 0.1%). These are tasks that are performed infrequently but are time intensive activities. Kit assembly not only includes packing parts into containers, but it also requires fabrication of certain parts associated with the projects. Robotics parts distribution requires student workers to place specified supplies into packages, load the packages into the engineering vending machine, and service the machine periodically to remove proceeds and restock supplies. The design exposition (culmination of ENGR 122) occurs in each of the three primary quarters; however, the spring quarter is when a majority of the students take ENGR 122. During this quarter, the exposition is held in a location other than the classroom. Because of this, student workers are responsible for all set-up, take-down, and cleaning activities.

Data was also collected data to determine the percentage of female and male students utilizing the help desk. Table 4 shows the data collected for the last three quarters. These percentages correlate well with the overall mix of female and male students during the 2008-2009 school year (15.8% female and 84.2% male students).

Table 4: Number of Female and Male Students that Utilized the Help Desk

Gender	Number of Visits	Percentage
Female	128	15.1%
Male	717	84.9%

We feel the correlation of this data is important because it does not indicate a bias associated with the help desk toward any particular gender. The help desk is a place where any student should feel comfortable attending and expect to receive valuable and constructive assistance.

Conclusion

Project-based, first-year engineering programs foster the development of skills and attitudes that improve student retention and better prepare students for the workplace. The downside is that project-based programs increase the workload of faculty members and are consequently difficult to sustain. The workload sustainability issue has been partially addressed by transferring the ownership and maintenance of laboratory platforms and tools from the university to the students. Despite our transition to a student-owned laboratory and design platform, a significant portion of the faculty workload still includes tasks necessary to appropriately facilitate our project-based approach. To further promote the sustainability our curriculum, we implemented a student-run help desk. The data collected over the past three quarters clearly show that the help desk provides a significant amount of assistance for our students and significantly contributes to the sustainability of our project-based freshman engineering program.

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