AUTHENTIC TEACHING AND LEARNING THROUGH EXTRA-CURRICULAR ACTIVITIES

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Abstract

The role and effect of student organizations on the academic and professional development of students has been a subject of research by many educators. It has been proven that there is a positive relationship between the academic performance of students and their extracurricular involvement through student organizations [1]. This study emphasized the value of student organizations from an "authentic teaching and learning" perspective by exemplifying the "Toy Production" activities of an Engineering Graphics and Design student organization at a four-year undergraduate technology program. The activities are explained step-by-step from developing the design idea to selling the finished product. A detailed analysis of the toy production process identified the potential benefits of the activities for the students. Integration of retention, advising and recruitment functions into the club activities is described as well. At the conclusion of the paper, the results of two surveys are provided to present the students' attitudes towards the student organization. Students' perceptions of acquired professional and academic skills demonstrate the value of the club activities.

Introduction

At institutions of higher education, the responsibilities of faculty encompass three areas: teaching, research and service. Although expectations and workloads for each area differ depending on the type of the institution, teaching is always considered to be the central mission of faculty at comprehensive universities [2]. Most of the time, roles and responsibilities of educators in those areas overlap conceptually and practically. With the limited time and resources available, it is desirable to integrate different roles and responsibilities in one task. As presented in this study, embedding authentic teaching activities into service-oriented tasks would fulfill both teaching and service responsibilities. This study focused on developing an extracurricular activity by adopting authentic teaching methods and incorporating service tasks for retention, advising and recruitment purposes.

Teaching has been changing and evolving continuously with the introduction of new methods, tools and settings [3], [4]. New strategies such as experiments, field work, discussions, tests, papers and projects are transforming education from a passive, unidirectional activity to an interactive, empowered and learner-oriented process [5-7]. Rather than just transferring the knowledge, more emphasis is laid on teaching how to effectively use those skills and knowledge in real life through authentic teaching tasks [8]. Engineering and technology students, who are described as "do-ers", would benefit more from kinesthetic-based learning with more hands-on and problem-based teaching strategies [9]. In this regard, technical fields require different approaches than liberal arts or natural sciences. The common problem is the lack of enough authentic problem-solving and project-based activities in the curricula [8].

At most institutions, service is considered to be of less importance [2], but there are times that retention, advising and recruitment efforts become more critical for academic programs. Currently, unpredictability of the world's economy, decline of the population of 18-year-olds, federal- and state-level financial-aid cuts and college tuition increases have negatively impacted enrollment in higher education in the U.S. [10-12]. Retention and recruitment efforts are more crucial for technology programs because of the public's negative views of production- and manufacturing-related careers [13]. For most people in the U.S., manufacturing is still considered to be dirty, unsafe and uninteresting [14]. Another factor contributing to the enrollment drop in technical fields is the future trend in manufacturing jobs. Since 1975, global outsourcing and high worker productivity ratings have created a steady decline in the number of manufacturing jobs in the United States [15], [16]. The Employment Projections report for 2020 indicates that the decline will continue for design, drafting and manufacturing occupations until the year 2020 [17]. As a result, high school students and their parents have a negative view of careers in manufacturing [13]. According to a 2012 survey, only 17% of high school students are encouraged by their parents to pursue a career in manufacturing and 80% believe that manufacturing jobs are the first to be outsourced or moved to other countries [18]. In these circumstances, retaining, recruiting and educating the next generations of skilled workers for industry has become more challenging.

Literature Review

At higher education institutions of engineering and technology, many types of student organizations operate with different functions and purposes. Among all student organizations, four types get the most interest [19]: student chapters of professional organizations (e.g., the Association of Technology, Management, and Applied Engineering; the American Society for Engineering Education; and, the Society of Manufacturing Engineers), honor societies of engineering and technology majors (e.g., the International Honor Society for Technology; and, the Engineering Technology National Honor Society), diversity organizations (e.g., the National Society of Black Engineers; the Society of Women Engineers; and, the Society of Hispanic Professional Engineers) and project-oriented organizations. These student organizations or teams focus on design/build projects to participate in collegiate competitions such as the American Solar Challenge, Baja SAE and Solar Splash. These projects provide ideal conditions for practical applications of technical skills, time management, interpersonal skills and leadership [20-22].

Certainly, not all projects or activities of student organizations can be regarded as authentic learning activities. Moreover, the real challenge is transforming the authentic tasks and their context into a learning tool. The most significant characteristic of authentic learning can be described as an enhanced educational setting with increased motivation and enthusiasm. [23]. Studies prove that authentic learning can be successfully adopted for any level of education, from K-12 to graduate education [24], [25]. Four elements mentioned in the literature to be the most crucial traits of any authentic learning task are: 1) real-world problems that engage learners in the work of professionals; 2) inquiry activities that practice thinking skills and metacognition; 3) discourse among a community of learners; and, 4) student empowerment through choice. In this regard, previously mentioned competition projects possess potential value as Authentic Learning activities [26].

Considerable research has been conducted and many theories have been developed around extracurricular activities and their effects on student development. It is necessary to state that there is a positive relationship between academic performance and extracurricular involvement [27]. This is significant because extracurricular involvement is generally considered as a distraction that diverts students from academic studies [28]. Cognitive and communicative skills are found to be associated with both academic and extracurricular involvement, but self-confidence and interpersonal skills are primarily associated with extracurricular involvement [27]. There is also a significant association between student involvement in student organizations and psychological development in the areas of establishing and clarifying purpose, educational involvement, career planning, life management and cultural participation [29]. Meaningful involvement is crucial for developing leadership skills [30]. In this regard, involvement experience is considered as training ground where students clarify personal values, learn about self and develop new skills [30].

The value of student organizations becomes more apparent at times of economic crisis. A downturn in the nation's economy influences the public universities in two ways: budget cuts and dropping student enrollments [31]. One potential solution to dropping student enrollment is recruitment and retention efforts being carried out by academic departments. It is also a proven strategy to utilize student organizations for recruiting new students and retaining current students [32]. Among many alternative recruitment strategies, Wasburn and Miller [33] demonstrated how to employ student organizations for recruitment purposes through on-campus workshops with families, hands-on laboratory experiences for prospective students, and participation in national conferences. There is a significant positive relationship between student involvement in student organizations and retention rates [27]. Moreover, it is considered by most faculty members that helping with student retention and student satisfaction is an important part of academic advising [34].

About the Student Association of Engineering Graphics and Design

The Association of Engineering Graphics and Design (AEGD) is a very active student organization on the campus of Murray State University. Although AEGD is comprised primarily of students in the Engineering Graphics and Design (EGD) program, it is not unusual to have student participation from other degree programs. The AEGD faculty advisor, supporting faculty and student advisors believe that the first and the most important goal is to retain and recruit as many EGD students as possible. For this purpose, a wide variety of activities are organized throughout the academic year to reach out to the new students. These activities are structured to promote interpersonal relationships and support between EGD students that will continue after graduation. EGD faculty believe that relationships and connections formed during involvement in AEGD create the foundation of a professional network. This professional network can be used as leverage in starting their careers. AEGD activities typically include meetings, industry trips, cookouts, wallyball games, video game nights, toy production and outdoor activities such as hiking, zip-lining, snow skiing and whitewater rafting.

Most of the aforementioned AEGD activities serve multiple purposes. For example, a wallyball is a fun activity that can help AEGD members by building and strengthening relationships, developing organization and team skills, and an opportunity to improve social skills. Likewise, industry trips serve as a means of extending classroom learning by exposing students to current trends in the profession, allowing interaction with industry professionals, and providing opportunities to market themselves for internships and full-time positions. Among all of the AEGD activities, toy production deserves special attention and analysis as it applies to authentic learning.

Method for Extracurricular Activities

Designing

Each year, AEGD students design, manufacture and sell approximately 150 wooden toys. This lengthy and multi-faceted process starts at the beginning of the fall semester with a club meeting. In the first meeting, new students are informed of the toy production project. Project process flow, goals and expected schedule of key steps are explained to the new students. The students are also instructed about the fundamentals of design and manufacturing processes, limitations and requirements of the final product. After setting the common rules and principles, students are assigned to find a toy design idea and bring a hand sketch to the next meeting. Figure 1 provides an example of a hand sketch. A typical toy idea is usually a vehicle, construction machinery or agricultural machinery.

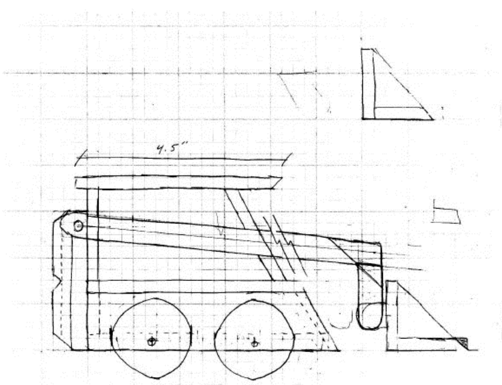

Figure 1. Hand Sketch of a Toy Idea

At the next meeting, all ideas and suggestions are analyzed and compared for initial design criteria. Usually, overall appeal and look, manufacturability and manufacturing time are considered for the final decision. At the end of the meeting, one toy idea is selected by a majority vote. The next step is to develop three-dimensional (3D) computer-aided design (CAD) models. Figure 2 provides an example of a 3D CAD model. Two or three modeling teams are assembled to generate alternative versions of 3D CAD models for the next meeting.

Figure 2. 3D CAD Model of a Toy Idea Created in SolidWorks

At the third design meeting, a more rigorous analysis is performed to select the best design among the provided 3D models. The initial evaluation is based on the manufacturability of the design in a limited period of time. The best time to sell toys is before the end of the fall semester, while the university is still in session. With Christmas being just a few weeks away, the toys are considered a nice gift by faculty, staff and students. Therefore, toy production has to be completed and on-campus sales must begin no later than the first week of December.

Considering a specific deadline, students are informed about the relationship between design and manufacturing. Students must consider the relationship between number of components and component sizes and features, and how they impact manufacturability and overall manufacturing time. At this point, faculty and students with previous toy production experience play a key role in finalizing the design. The design should be appealing to potential customers, easily manufactured and assembled, and engaging for the students who want to participate in toy production. The design evolves as students transition through various design iterations. Using parametric CAD software, a student applies changes to the 3D CAD model as other students follow the changes on the projector screen. The final design is completed by mixing and synthesizing characteristics of the alternative 3D CAD models.

Material selection and buy/make decisions are also discussed in the same meeting. Components can be purchased or made in the woodworking lab. Each part is analyzed for its manufacturability. If a component is impossible, time-consuming or unsafe to make with the available equipment in the lab, it is purchased. Toys usually consist of three or four different types of woods. Using different types of wood for the toys leads to contrasting colors. Contrasting colors assist in achieving better appearance and makes each part stand out on the final assembly. Purchased parts such as wheels, pins, caps and dowels are determined as part of the design decisions.

Rapid Prototyping

Following the approved design and dimensions, each component is manufactured on a fused deposition modeling (FDM) rapid prototyping machine. The prototyping process provides invaluable information about the toy design including size, appearance and ease of assembly. Figure 3 shows a toy design prototype. Based on the prototype, suggestions and any final design changes are made to the 3D model.

Figure 3. An Assembled Toy Made of Rapid-Prototyped Parts

Drafting

At this stage, individual component and assembly drawings are created for manufacturing. Drawings are dimensioned considering the capability of machining and measurement equipment available in the lab. The basic principle is to avoid using angular dimensions and inch fractions smaller than 1/16 of an inch. Thus, drawings are usually generated by junior and senior students with previous toy production experience.

Manufacturing

Before production starts, students are given safety instructions and properly trained on the use of the manufacturing equipment. At the beginning of the first manufacturing day, a summary-of-processes chart is created on a large whiteboard in the woodworking lab, which is visible and accessible by everyone. On the chart, each component is listed with its material specification, sequence of operations and required quantity. As the production progresses, the chart is updated at the end of each day to present the completed parts and processes and remaining work to be completed.

For the remaining three months, students and faculty work on producing 150 wooden toys in the construction lab, as seen in Figure 4. Usually, production sessions are scheduled for two consecutive days a week and last for four hours. During that time period, students work based on their availability.

Figure 4. Students Dipping Finished Toys into Toy Oil

Manufacturing is the process that makes the toy production experience different than previously mentioned typical design/build projects performed by student organizations. The design approach to a single unit final product is different than designing for mass production. A single-unit design project is more similar to a custom-made product in which the designing and building phases continue concurrently. Design always changes according to the mistakes, shortcomings or unexpected situations along the building stage. A student with good hands-on skills can implement solutions to these problems even if they make the design more complex or time consuming without the need of going back to the drawing table. Moreover, these projects are designed for competitions. Product characteristics such as speed, strength or durability are more important than feasibility, manufacturability or assemblability. For toy production, cost should be less than the sale price and the design should be easy to manufacture and assemble. In a real manufacturing environment, cost, complexity and production time are critical manufacturing parameters. For the toy production, these parameters are addressed at the design stage, because after production starts, changes can be difficult and costly to incorporate. Thus, designing, modeling and prototyping stages in toy production are more relevant to modern industry practices of today.

Toy production is also an educational opportunity to discuss material usage and process selection for manufacturing. A component can be cut by different machines in many different ways. However, safety, ease of production, material usage, waste, and finish quality depend on machine and process selection. Students are required to determine the amount of material required for each component as well as consider optimal manufacturing processes to achieve minimal waste.

After components are cut, sanded, assembled and oiled, the finished toy is ready to be sold. Figure 5 shows a finished wooden toy.

Figure 5. A Finished and Oiled Wooden Toy

Industry Trip

Students sell toys to faculty, staff and other students on campus. The money earned is used to finance an industry trip and cover expenses such as transportation, lodging and extracurricular activities. Spring industry trips are usually three-day-long trips to industry and amusement centers. On the first day, AEGD students visit one or two industries to experience real-world applications of design and manufacturing (see Figure 6). The next two days are spent engaging in outdoor recreational activities like skiing, hiking, white-water rafting and zip-lining. The spring industry trip is a combination of outside classroom learning and a reward for hard work on toy production.

Surveys

Faculty advisors believe that student involvement and empowerment are key requirements for a beneficial, positive club experience. Student approach and attitude towards the club and club activities are frequently monitored with casual conversations by the faculty. In the 2011-2012 academic year, two surveys were conducted to gauge student attitudes toward AEGD and toy production. The first survey was conducted at the beginning of the manufacturing phase of toy project. The main goal of the survey was to learn about the student expectations of and approach to toy production. Twelve students, who were present for the first toy production session, completed the survey. All participants were Engineering Graphics and Design majors. Among twelve students, all female students and one male student provided their GPAs. Background information of the participants is presented in Table 1.

Figure 6. An Industry Trip to Remington Arms Company

Table 1. Background Information of the Twelve Students that Participated in the First Survey

		Male	Female	Total
Class	Freshman	1	0	1
	Sophomore	0	0	0
	Junior	1	1	2
	Senior	5	4	9
Ave. GPA		2.9	3.4	3.3

The survey consisted of three open-ended questions, three yes/no questions, two questions regarding personal information and five response statements. Yes/no and open-ended questions were asked to gain information about the students' past participations in AEGD activities and their thoughts, expectations and suggestions about toy production activities. For the response statement questions, a five-point scale was used (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree). Statements and their corresponding mean values are given in Table 2.

Table 2. Statement Questions and Corresponding Mean Values for the First Survey

#	Statement	Mean
1	Building new friendships motivates me to participate in toy production	4.3
2	Socializing with the friends motivates me to participate in toy production	4.6
3	Building relationships with faculty motivates me to participate in toy production	4.5
4	Free spring trip motivates me to participate in toy production	4.8
5	I see the toy production as an opportunity to improve my design and manufacturing skills	4.6

From the statement questions, it can be concluded that students appreciate toy production for its educational, social and professional values. It is also significant to note that, with a mean value of 4.8, the possibility of a free spring trip is the highest-rated motivator to participate in toy production. This provides faculty with insight into the motivations as to why students decide to engage in toy production. For continuous success, it is crucial that students appreciate the organization and the activities surrounding it. A freshman EGD student summarizes his expectations as: "to get experience doing a full design and production of something, and get to know more people in my area for possible internships." In his answer, he summarizes many other students' answers and indicates the conformity between the club advisors' and students' vision and expectations.

The second survey was conducted in the last month of the academic year after all of the previously mentioned club activities were completed. The survey was completed at a club meeting by 16 Engineering Graphics and Design, one undeclared, one Civil Engineering Technology, one Manufacturing Technology and one Technology Education students. Among twenty students, two female and eight male students provided their GPAs. Background information of the participants is presented in Table 3.

Table 3. Background Information of the Twenty Students that Participated in the Second Survey

		Male	Female	Total
Class	Freshman	3	1	4
	Sophomore	0	0	0
	Junior	9	2	11
	Senior	3	2	5
Ave. GPA		3.2	3.2	3.2

The survey consisted of 13 statement questions with a five-point scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree) and a blank space under each sentence for students to express their opinion about the statement. Also, three open-ended questions were asked to gain information about the students' past participations in AEGD activities and their thoughts, expectations and suggestions about AEGD activities. Survey results are shown in Table 4.

Table 4. Statement Questions and Corresponding Mean Values for the Second Survey

#	Statement	Mean
1	Belonging to AEGD is important to me	4.5
2	I joined AEGD because my friends are in AEGD	3.4
3	I joined AEGD because it looks good on my resume	3.9
4	I joined AEGD because my advisor urged me to	4
5	AEGD has positively influenced me to stay in the program	4.3
6	Joining AEGD helps me to grow professionally	4.45
7	Joining AEGD helps me to grow academically	4.05
8	Joining AEGD helps me to strengthen leadership skills	4.1
9	Joining AEGD helps me to build a greater communications network	4.35
10	Joining AEGD helps me to strengthen my communication skills	4
11	I can relate AEGD "toy production" activities to professional life	4.25
12	I can relate AEGD "toy production" activities to the classes I'm taking	4.05
13	I don't participate in AEGD	1.95

Students were asked 13 statement questions to analyze their reasons for joining the club and participating in toy production. With a mean score of 4.5, all 20 students indicated that AEGD is important to them (Question #1). It should be noted that the faculty advisor has a major influence on the success of the student organization. The club advisor promotes, motivates and encourages member and non-member students to join the club and engage in all activities. The survey supports the significance of the advisor's efforts by a mean value of 4.0 (Question #4). With a mean score of 4.3, AEGD's positive effect on retention is also supported by the survey (Question #5). From the calculated mean values, it can be concluded that students have a high positive perception about the club and its possible benefits (Questions 6-10). Students value AEGD mainly for the academic, professional and social skills they develop as a result of participating in club activities. In regard to one of the open-ended questions, "what is the most beneficial thing about AEGD", the majority of students stated that networking opportunities, industry exposure and leadership development were key elements that made AEGD beneficial. Lastly, it is evident that, with mean values of 4.25 and 4.05, toy production has a constructive educational value for students (Questions 11 and 12).

Evaluation of AEGD Activities

Toy production is an opportunity for faculty members to engage students in authentic teaching/learning outside the classroom. Students appreciate the value of toy production from an educational perspective, as well. They realize how the concepts they learn in courses such as project management, scheduling, CAD modeling, dimensioning and design for manufacturability are applied to real-world scenarios. As shown by the student perception survey, year-long interaction fosters student/faculty relationships and assists in academic retention. As anecdotal evidence, from 2009 to 2012, six EGD students dropped out of school. These students had never participated in any club activity.

On- and off-campus recruitment efforts continue throughout the year. Recruitment activities consist of hosting high school students for competitions, educational tours and campus visits or introducing the program at a host high school through an hour-long presentation. AEGD students contribute to the recruitment activities by leading campus tours, organizing the activities, attending high schools and sharing their experiences with students.

During an academic year, AEGD students participate in numerous activities. Interaction between seniors and freshmen occurs naturally. Career-building connections and relationships established early in the freshman year can lead to internships or even full-time positions in the future. In 2012, graduates of the EGD program from two manufacturing companies visited the Murray State campus in order to interview junior and senior students for internship and full-time positions. Five full-time employees and three interns were hired by those companies. Over the year, faculty advisors spend more than 200 hours with the AEGD students. For faculty advisors, AEGD provides a valuable opportunity to monitor and help develop the professional skills of the students.

Conclusions and Discussion

As demonstrated by toy production, student organizations can be used as an educational tool. Every step of the activity has an educational dimension. From initial ideation sketches to selling toys on campus, students learn, practice and appreciate the concepts and skills they develop from their involvement in toy production. Sketching, design for manufacture modeling, drafting, detailing and dimensioning, manufacturing, waste reduction, project/time management and budgeting are all concepts that the students experience through toy production. It was also demonstrated that student organizations can help academic departments, programs and faculty members reach administrative goals. For recruitment and retention purposes, club activities should engage students and faculty throughout the continuation of the academic year.

Student organizations can be the starting point to establishing a professional network for students. Today, companies visited on the industry trips and past graduates are the main sources of internship and full-time positions for EGD students. The success of a student organization depends heavily on the efforts of advising faculty. The faculty advisor's role in a club constantly changes from that of leader to educator to friend and mentor. Having a positive impact on the academic, social and professional development of students is considered to be a part of academic advising responsibilities by the club advisors. However, creating a purposeful organization that engages students in meaningful, authentic learning can assist in skill development and prepare them for their respective careers.

Limitations

The surveys in this study are limited to the current students of the Engineering Graphics and Design program. A quantitative or a qualitative study can be performed to investigate the opinions of graduates and faculty members in search of EGD program and AEGD improvement as well as recruiting and retention rates. Research can be further extended with a pre-test/post-test design to analyze the association between club involvement and student development in academic, social and professional areas.

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