Effects of Hands-on Nanotechnology Training on the Retention and Success Rates of Freshmen Students at WSU

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Abstract

Retention and success rates of freshmen students are of great interest in many universities, and much attention has been given to increasing these rates in the U.S. for more than two decades. Freshmen student retention and success rates at Wichita State University (WSU) are currently around 70%, which is considerably lower than the national average (80%). For the present study, a zero-credit-hour course, “ME 360B Hands-on Nanotechnology Experience,” was developed and taught during Fall 2012 and Spring 2013 semesters. A total of 62 freshmen students enrolled in different WSU colleges were trained during these two semesters. The major goal of the present course was to increase the retention and success rate of WSU’s freshmen students using the newly developed nanotechnology teaching facilities in the College of Engineering (CoE) at WSU. These opportunities were aimed at enhancing the educational level of WSU’s freshmen students and informing them about the educational, economic, and social implications of developments in the field, which might be useful in the retention and success of WSU students. These assessment studies showed that more than 95% of freshmen students who joined the nanotechnology training sessions during these last two semesters indicated that they planned on remaining in their current programs in the following years. As a result, this study shows that the nanotechnology education is one of the major options for keeping freshmen students in their programs.

Keywords: Freshmen Students, Retention and Success, Nanotechnology, Hands-on Experience.

1. Introduction
1.1 Motivation

Retention and success rates of freshmen students at Wichita State University (WSU) are one of the most important measures of performance. Although a number of different programs in the colleges have been implemented to increase retention and success rates, the level of these rates is still considerably low at 70%, which needs to be improved up to 80% by 2020 [1-3]. University administration, faculty members, parents, and students are all concerned about this and, hence, are looking for a solution to increase these rates at WSU.

Our major goal of this study was to address the problem associated with retention and success rates of freshmen students through undergraduate research experience in the nanotechnology laboratory at WSU. Also, we expect that this will considerably improve the graduation rate (40%) of first-time, full-time freshmen students at WSU. The specific objectives of this study were as follows: (i) to educate freshmen science and engineering students based on hands-on experience in different nanotechnology subjects, (ii) to promote interest in this emerging
technology, (iii) to create an awareness of nanomaterials fabrication and characterization techniques, and (iv) to provide students with fundamental knowledge and an understanding of nanoscience, nanotechnology, and associated technologies.

1.2 Student Retention and Success

Student retention refers to the extent to which students remain within a higher education institution and continue on to complete their programs in a specified period of time. In spite of the personal, social, and economic values of a college education, it has been stated that every year, more freshmen and sophomore students leave college or change their programs prior to degree completion for several reasons (e.g., family and financial problems, loneliness, homesickness, weather, lack of concentration and focus, activities, jobs, etc.). Furthermore, even though the great majority of freshmen students who enroll in programs intend to complete their first year and then graduate in their major field of study on time, approximately 30% to 40% of them do not return the sophomore year [1]. Overall, these rates match closely with WSU students but vary depending on college, department, program, and national ranking. For example, Columbia University and Yale University have the highest freshmen retention rate (99%) in the nation because of the numerous technological and educational opportunities as well as on- and off-campus housing, diversity, facilities, campus dining, and nightlife provided to students [3].

Many universities strive to enhance freshmen student success using a combination of academics, wellness, and engagement to encourage students to identify their individual strengths and take full advantage of campus resources designed to help them succeed. During the preparation of this proposal, we searched a number of studies, literature reviews, and research work related to improving freshmen student retention and success [1-6]. Many research studies suggest that factors contributing to improving freshmen student retention and success are the following [1,2,7]:

- Affordability, preparation, and engagement.
- Information, advice, and guidance in making informed higher education (HE) choices.
- Preparation, including developing realistic expectations and skills.
- Induction and transition support.
- Social engagement with peers and HE staff.
- Integrated or aligned academic development.
- A range of student services.
- Monitoring and data using.
- Comprehensive curriculum design, learning, teaching, and related assessments.

Another study also showed that the most effective freshmen student retention programs address several major components, including financial aid packages; course and laboratory availability and content; and the implementation of support mechanisms such as tutoring, mentoring, engagement, and career counseling. It is also imperative to have a means of tracking students through school and of monitoring a program’s success so that the institution may identify which methods are effective and those that need improvement [2].
In this project, we tried to address some of the factors affecting freshmen student retention and success rates, and also provide a laboratory option to increase these rates while utilizing the newly developed Nanotechnology Teaching Laboratory (Nanolab) in the College of Engineering (CoE) at WSU. Students in this laboratory mainly engaged in goal-setting activities and learned about techniques that allow successful students to be most effective and efficient with their time and energy. We believe that students left this hands-on nanotechnology training with specific tools and strategies for active listening, note-taking, reading, discussing, and critical thinking abilities. At the end of both semesters, the five most successful students were determined by the PI and the graduate teaching assistant (GTA) of the class, and depending on the availability of support, they were invited to do more advanced studies for the remainder of their academic life at WSU.

2. Methodology
2.1 Nanotechnology Laboratory

We developed the nanotechnology teaching laboratory in order to fabricate a number of different nanobased materials. The Nanolab space (~1500 ft2) is located in both Wallace Hall and the Beggs Hall, and is also utilized to support three other courses. Major equipment in the Nanolab includes the following: electrospinning units, corrosion and degradation testing units, fume hoods, glow box, spin-coating apparatus, temperature and humidity chamber, sensitive balances, injection molding apparatus, autoclave, press, potentiostat, centrifuges, DI water, air table, vacuum pumps, ovens, furnaces, VARTM, UV photolithography, UV-Vis spectrometer, zeta potential/nanosizer, and Gamry unit. A GTA, who is currently a PhD student under the PI, was hired to operate these pieces of equipment. The GTA utilized his expertise and skills for increasing the retention and success rates of the WSU students.

2.2 Hands-on Nanotechnology Experience Courses

In the present study, a zero-credit-hour course, “ME 360B Hands-on Nanotechnology Experience,” was developed and taught during Fall 2012 and Spring 2013 semesters. The research approach to addressing the goals and specific objectives of this course was conducted during two semesters. The research plan was to fabricate several nanomaterials and tests, and then evaluate their performances for further development by the freshmen students. This was the first such endeavor of this kind, unique to WSU as well as the United States and most likely the world. We conducted ten different experiments for the WSU freshmen students in the following areas:

- Week 1: Magnetic nanoparticles fabrication and characterization
- Week 2: Ferrofluid fabrication and characterization
- Week 3: Carbon nanotube (CNT) nanocomposites fabrication and characterization
- Week 4: TiO₂ nanoparticles fabrication and characterization
- Week 5: Annealing and crystallization of nanomaterials
- Week 6: Sol-gel-based nanomaterials fabrication and characterization
- Week 7: Electrospun nanofibers fabrication and characterization
- Week 8: Nanomaterials-based thermoelectric generators and working principles
- Week 9: Nanomaterials-based solar energy systems
Week 10: Bionanomaterials

Following these experiments, the students were asked to write a short report about nanomaterials fabrication and characterization, and the fundamental reasons behind these experiments/materials/property improvements. We adamantly believe that there is much need for and a strong correlation between improvement in the quality of academic success and the rate of freshmen student retention using high-tech research and teaching opportunities for WSU students.

During the past two semesters, we trained 62 freshmen students, mainly from the CoE and Fairmount College of Liberal Arts and Sciences (LAS), at WSU. These students were selected on a first-come first-served basis after an announcement was made on the WSU webpage. Figure 1 shows a photograph of some of the freshmen students with the GTA in the Nanolab prior to the nano experiment. These developments were also very useful for reaching the six strategic goals of Foresight 2020 (presented to the Kansas Board of Regents, September, 2010 [4]) and Engineer of 2020 programs at WSU. At the end of both semesters, all students who attended the Nanolab session received a nanotechnology training certificate to keep in their records.

![Figure 1. GTA and freshmen students in Nanolab prior to nano experiment.](image)

3. Results and Discussion
3.1 Evaluation of Survey Questions

Based on the goals and objectives, the class (30 freshmen students each semester) was given a list of survey questions in order to evaluate their strengths and observations about the sessions. Here they listed their personal strengths; improvement areas; insights about their knowledge of nanoscience, nanotechnology, and nanomanufacturing; and their willingness to continue on with their programs. Some of the following survey questions were chosen for the assessment of the activities:

- What are the three strengths of these lab sessions?
- What are the top three things that you have learned?
- What are the three improvements that would help you learn better?
- How can these improvements be made?
- What action plans can be put in place to help you learn more?
- What have you learned about your own learning process during the Nanolab sessions?
- Did the nanolab sessions change your mindset about nanotechnology?
- Are you willing to attend the Open House Competition and present your data in the Undergraduate Research and Creative Activity Forum (URCAF) at WSU?
- Are you willing to publish your data in the journals and conference proceedings?
- Are you willing to stay in your program?
- Do you plan to complete your B.S. degree on time?

Most of the high school students returned their questionnaires. Figures 2 to 8 show the results of the survey questions for the assessment of the Nanolab activities. These questions provided useful information about freshmen student retention and success, and their attendance, and confirmed the types of learning (e.g., visual learning, active learning, etc.) that are most effective in the laboratory. Statistical values of the obtained survey results were discussed with the chairs, deans, Faculty Senate members, and other faculty members at WSU. The laboratory sessions provided substantial support for the WSU Foresight 2020 and CoE Engineer of 2020 programs by allowing the freshmen students to gain new high-tech research experiences.

![What do you like about the course?](image)

Figure 2. Results of survey question: “What do you like about the course?”
Figure 3. Results of survey question: “What did you mainly learn from this course?”

Figure 4. Results of survey question: “How/What can be improved?”
Figure 5. Results of survey question: “How can these improvements be made?”

Figure 6. Results of survey question: “Did nanolabs change your mindset about the nanotechnology?”

These results also explained if the Nanolab projects affected freshmen retention and success rates and other relevant factors that affect students’ performance. Furthermore, student involvement in the Nanolab sessions does not only contribute to the main objective of the project specified previously, but it also generates multiple secondary benefits, including the following [5]:

- Constructing a learning environment.
• Allowing students to discover by themselves about the early signals that affect their retention and success rates.
• Observing the peer academic mentoring, training, and peer interaction on their performance in the college.

Figure 7. Results of survey question: “Are you willing to stay in your program?”

Figure 8. Results of survey question: “Do you plan to complete your BS degree in time?”

Figures 7 and 8 mainly illustrate the retention and success rates of freshmen students in their current programs. In both cases, these students who took the survey questions clearly mentioned that they were planning to stay on in their current programs and graduate on time. This indicates
that the new high-tech teaching and learning will have a large impact on their retention and success rates.

3.3 Comments of Freshmen Students

As part of this retention grant, a total of 62 freshmen students were trained on different nanotechnology subjects. During the experiments, the GTA and the instructor had many conversations with the students about the subjects, retention, student successes, future goals and visions, etc. Some of their comments are summarized below:

- The hands-on nanotechnology experience program should continue with more experiments in the following years.
- It is a great experience because everyone felt comfortable to ask questions and contribute to the discussions about the subjects.
- The labs are great and they really got me into nanoscience. If I decide to join the graduate school in the future, I really want to study nanomaterials and their applications.
- I would like to take more elective classes in nanotechnology, biotechnology, and related technologies.
- I would like to learn more about nanotechnology, nanoscience, nanoproducts, and their industrial and commercial applications.
- I will do my Engineer 2020 requirement in the nanotechnology lab.

One of the undergraduate female students (Esra Barut) in the Bioengineering Program was so excited about the lab sessions and opportunities that she decided to continue her degree at WSU. She also said that “Learning in a traditional classroom setting with lecture structures is only one aspect of the learning experience. A hands-on experience allows the individual to combine their background knowledge from lectures to real-life work. Since the students themselves perform the experiments and personally understand what they’re working on, they will have higher retention rates. In a regular lecture setting, students just listen to how experiments are carried out, but this does not give substantial retention rates when compared to hands-on experiences like this one. The ‘ME 360B Hands-on Nanotechnology Experience’ course provides a hand-on experience with studies concerning nanotechnology and other useful researches to improve human lifestyles. It is an intellectually stimulating and a very helpful course that gives the necessary experience for future lab researches. As freshman students enter their university years, they try to figure out what major or career area is best for them. The course and activities can be one of the major factors for students’ retention and success.”

4. Conclusions

In the present work, we developed the “Hands-on Nanotechnology Education” course at WSU and taught it in the Fall 2012 and Spring 2013 semesters. This zero-credit-hour course met once a week for 90 minutes during the 14-week semester to improve the retention and success rates of WSU freshmen students. There were ten different nanomaterials fabrication and characterization experiments, and the students were mostly involved in these experiments. The students learned fundamental and practical knowledge on how to fabricate and characterize nanomaterials/devices using different techniques/procedures. Survey results showed that all students who took the
Nanolab sessions stated that they planned to remain in their current programs. It is concluded that nanotechnology training is one of the promising methods to keep students in their own programs and increase their success rates.

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References


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