Work in Progress - Case Study of a Technological Literacy and Non-majors Engineering Course

John J. Krupczak, Jr., Scott VanderStoep, Leslie Wessman, Nathaniel Makowski, Catherine A. Otto, Kristi Van Dyk
Hope College
Holland, MI 49423 krupczak@hope.edu

Abstract - Since 1995 engineering faculty at Hope College have taught a course for non-engineering students called: “Science and Technology of Everyday Life” The course examines the science and engineering underlying modern consumer technological devices. Distinguishing features are study of a broad sample of familiar technological devices, construction by students of working devices, and writing assignments on technological topics. Over nine years, the total enrollment of more than 1000 students has averaged 60% women and 26% pre-service teachers. To evaluate student outcomes, the Motivated Strategies for Learning Questionnaire (MSLQ) was applied. Statistically significant increases were found in intrinsic motivation, task value, and self-efficacy. A decrease in test anxiety was also found. The results are consistent across all semesters analyzed. The case study shows that non-engineering students can have increased motivation for learning science and technology, increased perceived value for science and technology, increased self-confidence about learning science and technology.

Index Terms - Engineering for non-engineers, Non-engineering students, Pre-service Teachers, Technological Literacy.

INTRODUCTION

Despite our dependence on technology, the United States is “woefully lacking in technological literacy [1].” There is an increasing recognition of the need for scientific and technological literacy for all Americans. The National Research Council places a particular emphasis on the need for K-12 teachers to be technologically and scientifically literate [2]. Also noted is the need to develop up-to-date and effective educational materials for teaching scientific and technological literacy [2] and that these materials be based on newly developed definitions of technological literacy [3].

CASE STUDY DESIGN

A total of 139 students participated during the 2003-2004 academic year: 47 students in the Fall 2003 semester, 54 in the Spring 2004 semester, and 38 in the May Term (four-week summer session) 2004. Students completed several scales of the Motivated Strategies for Learning Questionnaire—MSLQ [6] Specifically, data were collected using these scales:

- **Intrinsic Motivation:** Intrinsic motivation measures the extent to which students are inspired to learn because of the challenge of learning new things, curiosity about the topic, or the joy that comes from understanding complex material.

- **Extrinsic Motivation:** Extrinsic motivation measures the extent to which students are inspired to learn because of rewards such as praise, grades, money, or competition.

- **Task Value:** Task value measures the extent to which students feel that what they are learning is relevant, useful and personally meaningful. This measure is particularly important for this project, as one of the goals of this
project is to demonstrate to students all of the benefits that will accrue to those who learn about technology.

- **Self-Efficacy:** Self-efficacy measures students’ beliefs about their ability to achieve on school-learning tasks. If students feel competent and empowered to succeed in school, they will have high scores on self-efficacy. This measure also is particularly important for this project, as one of the goals is to increase students’ belief that science and technology learning are tasks that they can complete. This will be particularly important to students in this class, as many of them will be elementary school teachers. If the preservice teachers can develop a sense of technological self-efficacy, they can communicate that positive belief to their future students that they, too, can successfully learn about science and technology.

- **Control Beliefs:** Related to self-efficacy, the Control Beliefs sub-scale measures the extent to which students believe that hard work in school will result in positive outcomes. If students feel as though effort will result in accomplishment, they will score high on this scale.

- **Critical Thinking:** A five-item scale measuring the extent to which students analyze and critique arguments and assertions.

These MSLQ scales have been used on hundreds of campuses and translated into several languages. The psychometric properties are reliable and predict achievement, particularly in science and social science courses [7].

**RESULTS**

We conducted paired t-tests to determine if changes occurred from the beginning of the semester to the end of the semester on any of the dependent measures. Table I shows results from the Spring 2004 semester. Most of the findings were consistent across all three semesters of study, suggesting the robust nature of most of the findings. Students showed increases in intrinsic motivation, task value, control beliefs, self-efficacy, effort regulation, and decreases in extrinsic motivation and test anxiety. Somewhat puzzling was the changes on the extrinsic motivation scale. There was a decrease in extrinsic motivation. However, given that the course’s major focus is on increasing students’ interest in science and their beliefs about the value of science and technology, changes in extrinsic motivation (in either direction) were neither sought or anticipated.

**DISCUSSION**

The current study uses techniques from educational psychology in a technological literacy context. A course has been developed for non-engineering majors that demonstrated increased motivation, increased task value, and improved adaptive beliefs about science and technology. Given that many of the students enrolled in this course were pre-service elementary teachers who will be teaching science in their classrooms, it is very important to lower anxiety, increased perceived value, and increase motivation for science and technology learning. This course accomplished those objectives.

<table>
<thead>
<tr>
<th>MSLQ Scale</th>
<th>Pretest Mean</th>
<th>Post Mean</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrinsic Motivation</td>
<td>4.67</td>
<td>5.19</td>
<td>4.87</td>
<td>&lt; 0.001</td>
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<td>Extrinsic Motivation</td>
<td>4.77</td>
<td>4.41</td>
<td>2.40</td>
<td>0.021</td>
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<td>Task Value</td>
<td>5.22</td>
<td>5.70</td>
<td>4.00</td>
<td>&lt; 0.001</td>
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<td>Control Belief</td>
<td>5.43</td>
<td>5.80</td>
<td>2.25</td>
<td>0.029</td>
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<tr>
<td>Self Efficacy</td>
<td>5.22</td>
<td>6.02</td>
<td>5.87</td>
<td>&lt; 0.001</td>
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<tr>
<td>Test Anxiety</td>
<td>3.33</td>
<td>2.78</td>
<td>2.85</td>
<td>0.007</td>
</tr>
<tr>
<td>Critical Thinking</td>
<td>4.22</td>
<td>4.06</td>
<td>1.23</td>
<td>NS</td>
</tr>
</tbody>
</table>

These results are encouraging for the prospect of technological literacy for all Americans. Future research hopes to explore modifying the existing structure to serve as an introductory engineering course to determine if similar findings can be obtained. Ultimately, it may be possible to use this approach to improve diversity in engineering education by making it more attractive and available to undergraduates who did not enter college anticipating a career in engineering.

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**REFERENCES**


