e-Learning Modules for Improving Lifelong Learning Ability

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Abstract

This project is developing two e-learning modules to support the development of independent, lifelong learners. The modules introduce undergraduate engineering students to metacognition (or thinking about thinking and learning) and motivation concepts and subsequently describe strategies to improve learning. To assess lifelong learning ability, students also take the Self-Directed Learning Readiness Survey (SDLRS). The pre to post change in SDLRS score was analyzed to determine whether the modules had an effect. The data analysis was taken a step further to identify four factors from the SDLRS results: viewing learning as a tool for life, self-confidence, responsibility for learning, and curiosity. The modules and SDLRS were administered over six semesters in two mechanical engineering classes: a sophomore level manufacturing class and a junior level design processes class. Also, seniors in the capstone design class took the SDLRS. Many students took the modules more than once. Thus, we are able to look at the relationship between number of exposures to the module and SDLRS score. Average SDLRS scores increased with age and number of exposures; however, the changes were not statistically significant. Two factors—self-confidence and responsibility—increased with exposure to the intervention at statistically significant levels.

Introduction

Engineering graduates of today must be prepared for a lifetime of learning and adaptation. Thus, one of the goals of engineering education is to create self-regulated, independent, lifelong learners. Pintrich identifies four areas of self-regulation: cognition, motivation/affect, behavior, and context[1]. This project focuses on the first two areas—cognition and motivation. Our objective is to develop and test two e-learning modules that raise student awareness of their own cognition and motivation and subsequently provide strategies for improving learning. We test whether a short intervention—spending 60-90 minutes taking the modules—can have an effect on indicators of lifelong learning ability.

Methods

Figures 1 and 2 show the architectures of the two modules that have been developed. In the area of cognition, we focus on learning styles. For motivation, we focus on two aspects: task value and control beliefs. The modules were designed such that module takers would experience different learning styles and levels of motivation. Both modules begin with an instrument (learning style inventory or motivation questionnaire), then a tutorial that gives students a first hand experience of the influence of learning style or motivation, then questions of understanding, then a tutorial about learning style or motivation strategies, then reflection questions, and finally an evaluation of the module.

Learning Styles Module The learning styles module begins with a Barsch learning style inventory[2]. This module creates the "first hand experience" by asking students to learn material that is presented in different learning styles. It presents tutorials on mitosis and Punnett squares, with one presented in the most preferred style and one in the least preferred style. Biology topics were chosen because they would be unfamiliar to most mechanical engineering students. Students answer quiz questions before and after each tutorial. The biology tutorials are followed by a tutorial about learning styles and strategies targeted to each style. At the end of the module students reflect on the experience and evaluate the module.

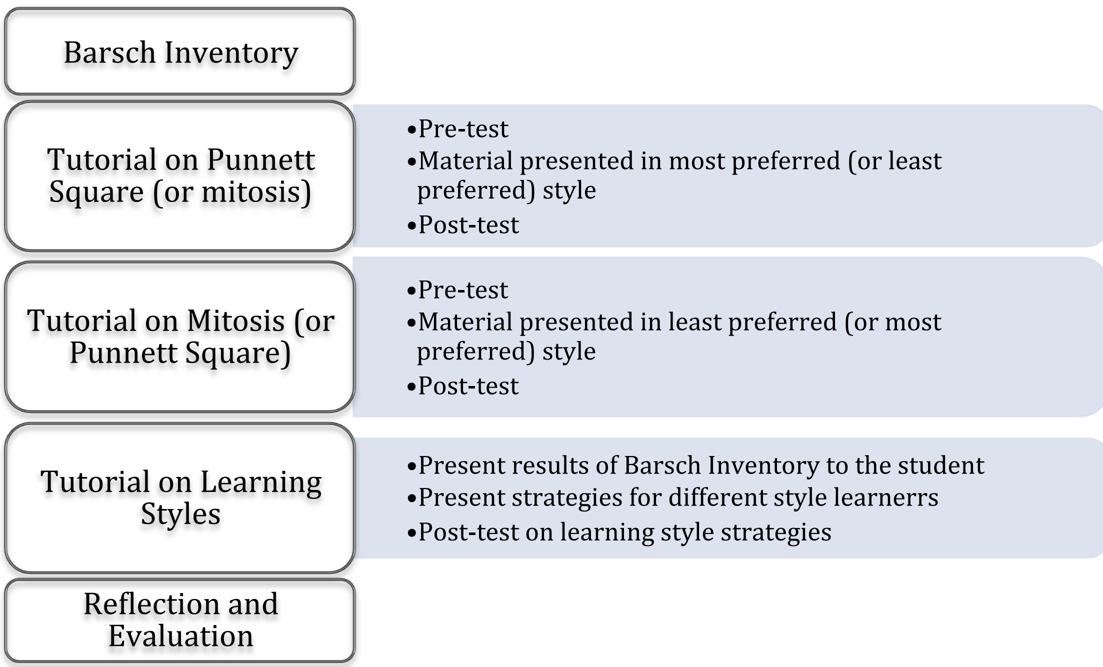

Figure 1. Outline of learning styles module

Motivation Module The motivation module consists of an MSLQ[3] (motivated strategies for learning questionnaire) followed by three tutorial sections. The MSLQ assessment determines motivation across six factors: control beliefs, extrinsic motivation, intrinsic motivation, self-efficacy, task value, and test anxiety. Next, the module manipulates task value by exposing students to tutorials on the Northern Lights and osmosis. The intention was that one of the topics would be more interesting than the other, and thus have a higher task value. Then, the module manipulates control beliefs by means of tutorials on aluminum can manufacturing and photosynthesis. The intention was that mechanical engineering students would have higher control beliefs (belief that effort would result in learning) for the manufacturing topic. The third tutorial section is about motivation and strategies for increasing motivation. The module concludes with reflection and evaluation questions.

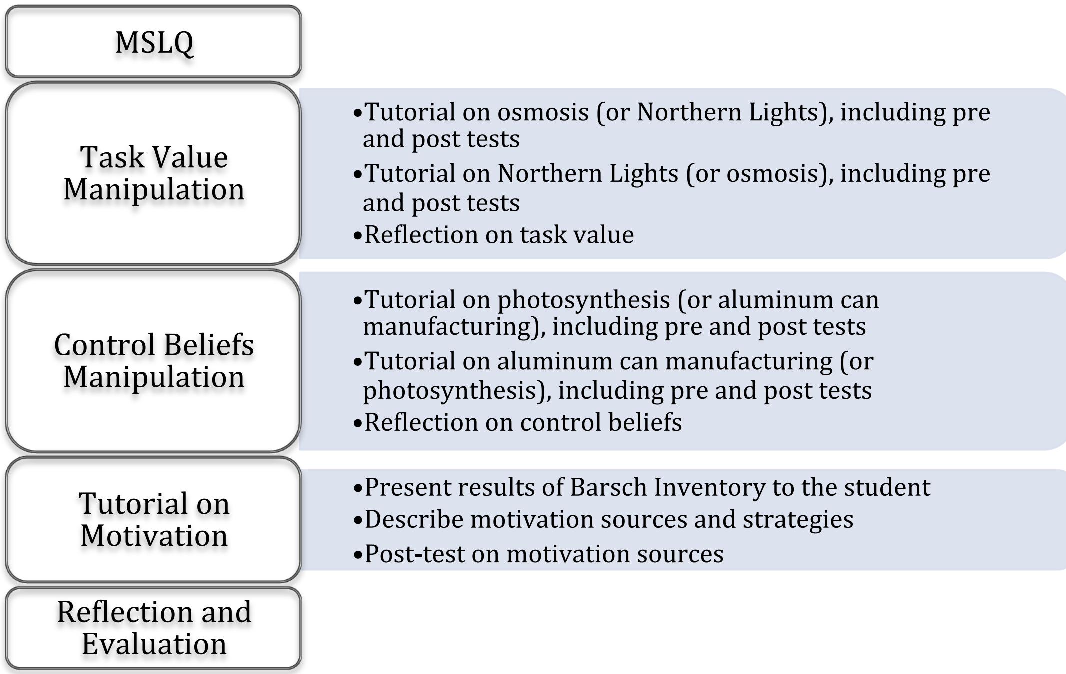

Figure 2. Outline of motivation module

SDLRS To assess lifelong learning ability, students take the Self-Directed Learning Readiness Survey (SDLRS)[4]. Students are randomly assigned to take the SDLRS either before or after the modules. The pre to post change in score is then analyzed to determine whether the modules are having an effect. The data analysis can be taken one step further as the SDLRS can identify scores for four factors: viewing learning as a tool for life, self-confidence, responsibility for learning, and curiosity[5].

Data Collection The modules have been implemented for six consecutive semesters in two mechanical engineering classes: a sophomore level manufacturing class and a junior level design processes class. Also, for the last two semesters, seniors in the capstone design class have taken the SDLRS. These were extra credit assignments in the three classes. Note that the manufacturing class is a pre-req for the design class, which is a pre-req for the capstone class. Students do not necessarily take these three classes in their 2nd, 3rd, and 4th years as laid out in the ideal curriculum flowchart, but they do take them in this order. We are able to look at the relationship between SDLRS score and class year. Also, because many students took the modules more than once, we are able to look at a relationship between number of exposures and SDLRS score.

Results

SDLRS Total Score Figure 3(a) shows how average SDLRS score changes with age or class year. Again, students do not necessarily take the three classes in the ideal flowchart year, but they do take them in succession in different semesters. Figure 3(b) shows how average SDLRS score changes with number of times the e-learning modules were taken. Students taking the module once may have taken it in either the manufacturing or design class. Students taking the module twice took it in both classes. The average SDLRS tends to increase with age, as might be expected. However, it increases more substantially for students that took the modules.

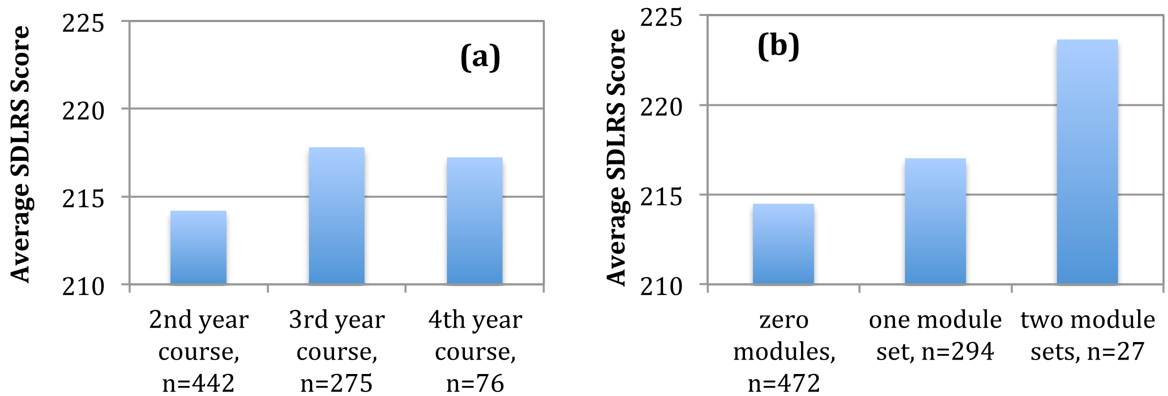

Figure 3. Effect of (a) age and (b) number of times modules were taken on SDLRS score

The graphs in Figure 3 conflate the age and module effects. To test the significance of each effect, it is necessary to separate them as shown in Figure 4. This figure excludes the data for 4th year course students and two module sets taken since these sample sizes are relatively small. Although it appears that both age and module exposure have an effect, t-tests reveal that the effects are not statistically significant. Table 1 summarizes the t-test comparisons.

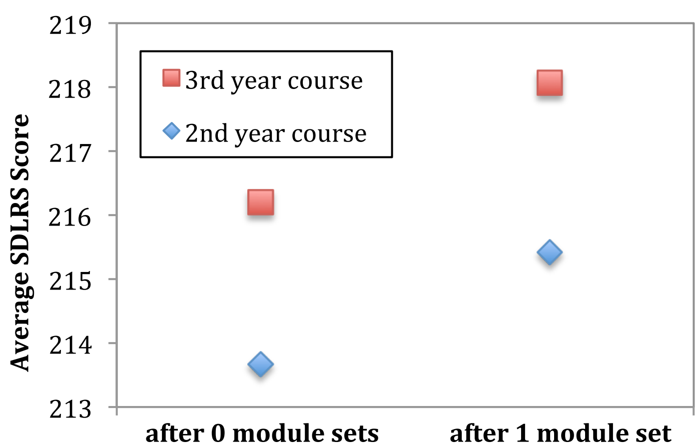

Figure 4. Effects of age and number of times modules were taken on SDLRS score

Table 1. Independent t-test results comparing SDLRS scores for groups that differ by number of times modules were taken (pre means 0 times and post means 1 time) and by class year

Comparison Groups	**p-value**
2nd year, pre (*n*=313) vs. post (*n*=128)	0.48
3rd year, pre (*n*=122) vs. post (*n*=132)	0.54
Pre, 2nd year (*n*=313) vs. 3rd year (*n*=122)	0.32
Post, 2nd year (*n*=128) vs. 3rd year (*n*=132)	0.37

SDLRS Factor Scores The SDLRS score can be broken down into component factors. Figure 5 shows how age affects the average component scores. The maximum score for each component is five. Figure 6 shows how module exposure affects the component scores. All factors increase with self-confidence and responsibility for one's own learning increasing the most.

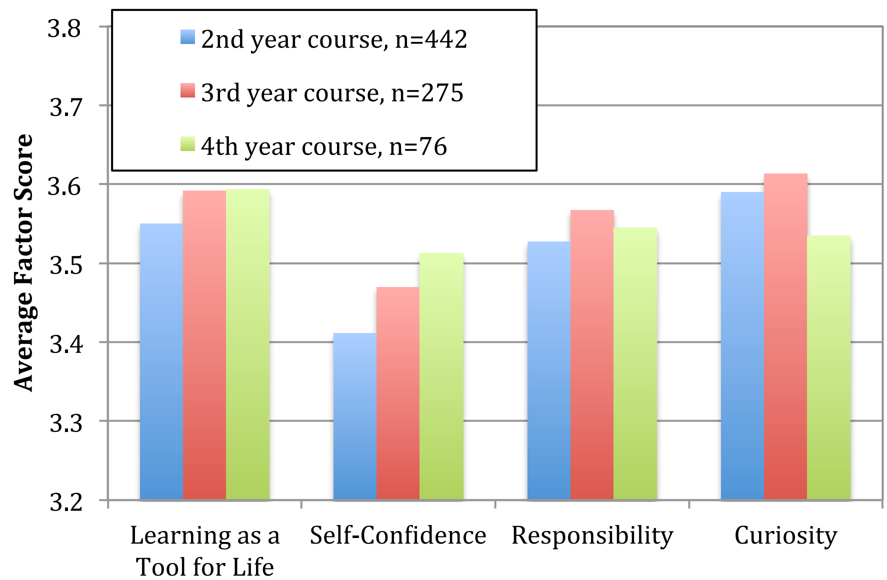

Figure 5. Effect of age on SDLRS factor scores

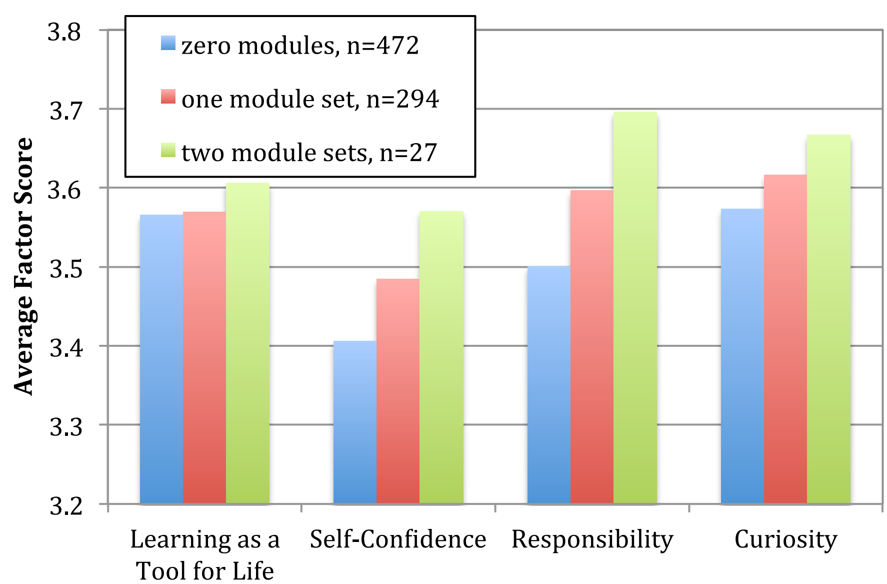

Figure 6. Effect of number of times modules were taken on SDLRS factor scores

Again, further analysis is necessary to determine statistical significance of the age and module effects. Based on independent t-tests, Learning as a Tool for Life and Curiosity did not have statistically significant changes with age or module exposure. Figure 7(a) compares the pre and post average factor scores for responsibility. This factor increased from pre to post-intervention for both 2nd and 3rd year course students (p=0.02 for 2nd year course students and p=0.08 for 3rd year course students). Figure 7(b) compares the pre and post average factor scores for self-confidence. Self-confidence increased for the 2nd year course students from pre to post-intervention (p=0.005). Also, in the pre-intervention condition, 3rd year course students had higher self-confidence than 2nd year course students (p=0.04).

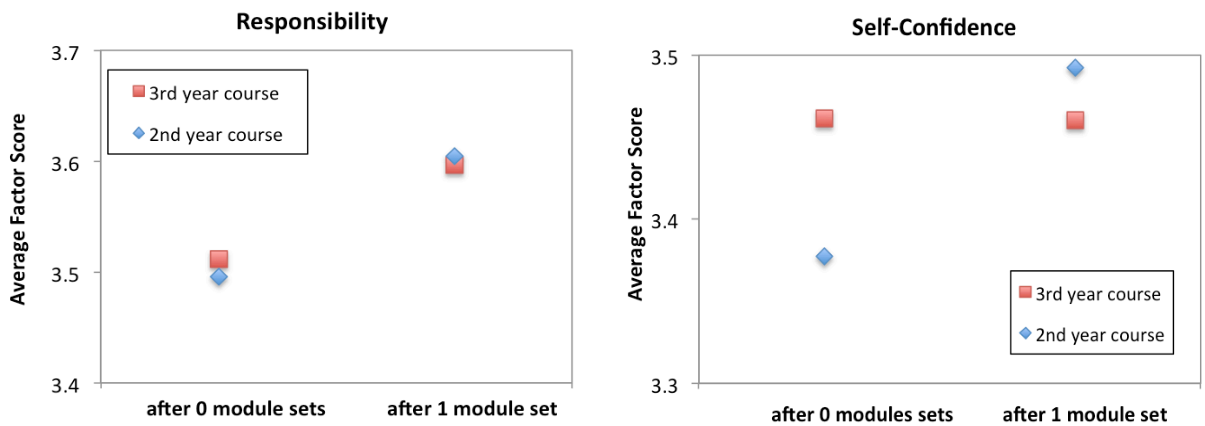

Figure 7. Effect of age and number of times modules were taken on (a) responsibility for learning and (b) self-confidence

A limitation of this study is that students self-select. Because the modules are an extra credit assignment, it is possible that the more responsible students, for example, choose to take the modules. Even if that is the case, the results show that responsibility further increases by taking the modules.

Gender Comparison We also compared results based on gender. The average SDLRS scores were 219.7 and 215.2 for female (n=96) and male (n=698) students, respectively. A t-test of whether the difference in scores is statistically significant yields a p-value of 0.08. Figure 8 compares the factor scores based on gender. The female averages are higher for three of the four factors, but not at a statistically significant level. The male average is higher for responsibility at a statistically significant level (p=0.06).

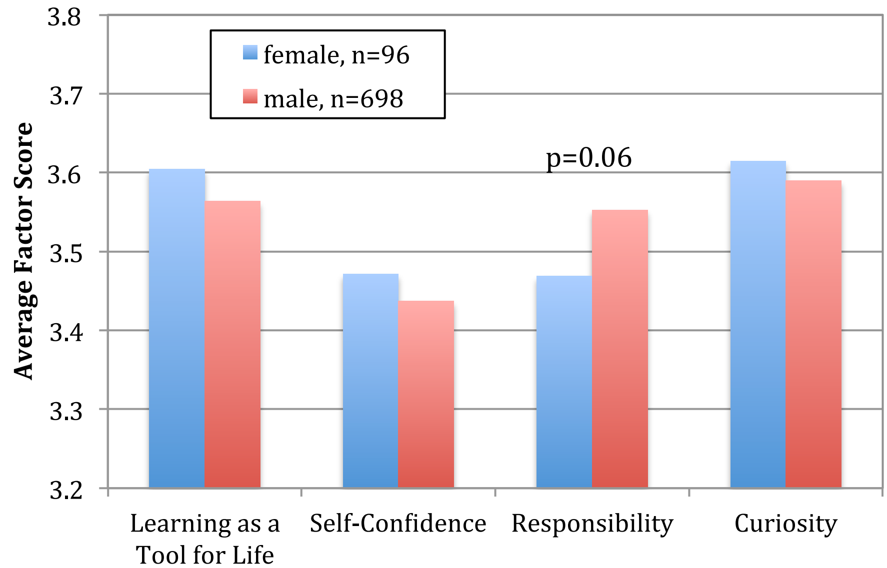

Figure 8. Comparison of SDLRS factors by gender

Conclusions and Future Work

The results described above suggest that the modules are having a positive effect on self-confidence and responsibility for learning—two factors that contribute to lifelong learning ability. The modules themselves collect a large amount of data (quiz scores, answers to reflection and evaluation questions). These responses have also been analyzed to better understand what students experience while taking the module. For example, is motivation manipulated in the way that we intended? This analysis is reported elsewhere[6].

Based on student evaluations of the modules, we recently made significant modifications to both modules. For example, students reported they were already familiar with their preferred learning style based on the categories of visual, auditory, tactile, and kinesthetic. In response, we replaced the Barsch learning style inventory with the Felder-Silverman[7] one to expose students to additional less familiar aspects of learning styles. Also, in the first version, students found the tutorial materials on topics such as osmosis, mitosis, and Punnett squares to be boring. The second version includes topics that students may find more relevant to their lives, such as food and nutrition. Additional testing of the new modules is underway.

Acknowledgments

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