# 2006-493: MEASURING CHANGES IN MOTIVATION AND LEARNING STRATEGIES: COMPARING FRESHMAN TO OTHER UNDERGRADUATES

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# MEASURING CHANGES IN MOTIVATION AND LEARNING STRATEGIES: COMPARING FRESHMAN TO OTHER UNDERGRADUATES

Abstract

The purpose of this study was to understand reported motivation and learning strategies for students enrolled in an introductory computer science course (n = 111). Comparisons were made between freshman (n = 57) and other undergraduates (n = 54) [sophomores (n = 24) and juniors (n = 30)]. A commonly used instrument called the Motivational Strategies for Learning Questionnaire (MSLQ) was used to assess motivations (value, expectancy, and affective) and learning strategies (cognitive/metacognitive and resource management strategies) of these students. Results showed variations in both motivation and learning strategies between the two groups with freshman reporting a greater task value in the course, while other undergraduates reported a greater reliance on peer learning and the use of rehearsal strategies. In comparison to other undergraduates, freshman also reported having a greater confidence in reading. While more research is needed at the classroom level to understand individual student differences, the MSLQ does appear to provide insight for caring faculty using a learner centered approach to teaching.

Introduction

Solving engineering student learning and retention problems requires adoption of proven educational practices[1]. Major investments of the National Science Foundation, US Department of Education, and other agencies have been directed toward understanding issues and identifying solutions to student learning and retention. As summarized by Svinicki[2] at the First Annual Meeting of the Center for the Advancement of Scholarship in Engineering Education (CASEE), students learn best when they set goals for study, engage in active study, add meaning to what they are learning, explain their understanding to others, and self-monitor their success in achieving goals. For several researchers in computer sciences, self-regulation and the constructs of motivation and learning strategies have started to be explored to understanding student learning and retention[3-7].

Self-regulation of learning has been shown in social cognitive research to be linked with academic achievement[8-11] and has been deemed by some as a desirable goal for the 21st century university student[12]. Today, self-regulation is defined as encompassing a students' active control of learning resources (e.g., time, effort, peers), motivation (e.g., goals, self-efficacy), and strategies (deep processing) [13-14]. Self-regulation of learning means that the student has the ability to develop knowledge, skills, and attitudes which enhance and facilitate future learning and can be transferred to other learning situations. According to Ertmer and Newby[15], motivation and learning strategies that define self-regulation are essential to the performance of expert students who are faced with solving problems in novel situations. In novel situations, an understanding of "how" to learn by using specific cognitive skills and strategies distinguishes expert students from novices who may have an equal unfamiliarity with the content.

Student retention is, in part, due to their performance in individual courses. As educators, it is a desire that students exit courses not only knowledgeable about the content, but also possessing a range of learning skills and the ability to be metacognitive about learning and themselves as learners. It is also a desire that they leave courses with a positive attitude to learning and the field, as well as the motivation to continue learning. It is also hoped that the students will have the cognitive, metacognitive, motivation, and affective characteristics which research suggests play an important role in effective university study, achievement and life long learning[16-20]. As with many engineering programs, gateway courses are introductions to different areas of engineering that allow students to shape their programs to reflect interests in one of the usual branches of engineering. A particular concern for our program was the student success rate in one of our engineering gateway Computer Sciences (Cpt S 121 - Program Design and Development) courses. Over a four year period from 2000-2004, only 57% of the students were able to complete the course with a grade of C or better, resulting in 43% of graded students "failing" this class (not including students who withdrew before receiving a grade). Because this course is crucial to retaining students in the engineering program, it was identified to pilot an instrument that could inform faculty, and more generally, engineering educators of individual student motivation and learning strategies that define self-regulation. The instrument chosen was a self-report instrument developed for university students called the Motivated Strategies for Learning Questionnaire (MSLQ) [21-22].

The Motivated Strategies for Learning Questionnaire (MSLQ) instrument was designed at the National Center for Research to Improve Postsecondary Teaching and Learning at the University of Michigan (NCRIPTAL), and according to the Manual for the Use of the Motivated Strategies for Learning Questionnaire, was designed to assess college students' motivational orientations and their use of different learning strategies for a college course[21]. The instrument does this by collecting student self-reported attitudes, thoughts, and behaviors regarding the specific academic tasks they encounter in the context of the particular classes in which they complete the MSLQ. In a nested format under the categories of motivation and learning strategies, there are 15 sub scales. The motivation section contains six subscales: intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performances, and test anxiety. The learning strategy sub scale contains nine subscales: rehearsal, elaboration, organization, critical thinking, meta-cognitive self-regulation, time and study environment management, effort regulation, peer learning, and help seeking. The MSLQ has been used previously in numerous studies and through multiple administrations in small and large classes, in a wide variety of subject areas, and at different types of institutions[11, 16, 18, 21-22].

Research has found that higher levels of academic achievement were obtained by those students relying more on effective learning strategies and were more intrinsically motivated than other students[11, 16-19]. Research in introductory information system courses by Chen[23] found that effort regulation had a positive effect and that peer learning had a negative effect on learning. Bergin and Reilly[24] found in a study of first-year students taking an object-oriented programming module that intrinsic motivation had a strong correlation with programming performance as did self-efficacy for learning and performance. Bergin, Reilly, & Traynor[25] also found that students in a third level introductory (object oriented) programming module who had high levels of intrinsic motivation and task value performed better in programming and used more metacognitive and resource management strategies than students with low levels of intrinsic motivation and task value (p. 81). While the researchers in each of the studies concluded that learning strategies and motivation do play a role in learning, they did not examine the specific research questions we were interested in. Our research team desired to explore the variability of learning strategies and motivation reported by freshman in comparison to other undergraduates taking an introductory computer sciences course. A reason for this interest was based on a study in the field of pharmacy education which found that decreases in intrinsic motivation were observed within first year matriculating students[26]. As a follow-up study, researchers found that first year students were more externally motivated and reported a greater reliance on recall ability than third-year students'[27].

Purpose

Building on prior research, the present study investigated the following: 1. What motivation strategies are reported by freshman versus other undergraduates taking an introductory computer science course?; 2. What learning strategies are reported by freshman versus other undergraduates taking an introductory computer science course?; 3. Are there differences regarding confidence levels of freshman versus other undergraduates taking an introductory computer science course in the areas of engineering, math, reading, writing, and science?

As conveyed by Felder, Woods, Stice, & Rugarcia[28] , "*The motivational and learning benefits of providing context, establishing relevance, and teaching inductively are supported throughout the literature on cognitive and educational psychology and effective pedagogy*" (p.5). By having an instrument that measures student learning strategies and motivation in the classroom, feedback from such an instrument could prove valuable for faculty as they construct and develop curriculum and instructional methods for courses to enhance learning and achievement. In addition, such a measure could provide insight regarding students who may be in jeopardy of not persisting or having difficulties in the course so remediation or interventions could be applied or developed. Thus, learning about student reported motivation and learning strategies could provide an important step in the direction of a better educational experience for all those involved.

Method

This survey research study took place with an introductory computer sciences (CptS 121) course taught in the College of Engineering at a large university in the northwest. The CptS 121 class is the first course for computer science majors. During the first five weeks of the course, the class explores the field's foundations in algorithmic problem solving, and takes a brief foray into machine organization and low-level machine languages. In the remainder of the course, students use C programming language to explore the fundamental concepts, constructs, and techniques of modern computer programming, including variables, arrays, conditionals, iteration, pointers, data structures, debugging, and software engineering. A primary aim of this course is to give students a taste of the field of computer science, and to get the students comfortable with computer programming.

Participants

Participants in this study were a convenient sampling of 111 volunteering students enrolled in an introductory computer sciences (CptS 121) course. The only demographics collected during this study were regarding the student's gender and academic major. As shown in Table 1, the majority of participants were male (92%). Based on all of the participants, Computer Science (40%) was the most reported major. Electrical engineering (18%) was the next highest number of majors, followed by Computer Engineering (14%), Mechanical Engineering (9%), Mathematics (7%), Management Information Systems (4%), Undecided (4%), and Physics (< 1%). A total of 74% of the freshman reported that they were majoring in Computer Sciences or Computer Engineering. For other undergraduates, 67% of them reported majoring in fields that were not in Computer Sciences and Computer Engineering.

Table 1
Number and Percent by Groups for Gender and Academic Major.

| | Class Standing | | | |
|---|---|---|---|---|
| | Freshman (n = 57) | | Other Undergraduates (n = 54) | |
| | n | % | n | % |
| Gender | | | | |
| Male | 51 | 89.5 | 51 | 94.4 |
| Female | 6 | 10.5 | 3 | 5.6 |
| Academic Major | | | | |
| Computer Engineering | 12 | 21.1 | 4 | 7.4 |
| Computer Science | 30 | 52.6 | 14 | 25.9 |
| Electrical Engineering | 5 | 8.8 | 15 | 27.8 |
| Engineering | 3 | 5.3 | 1 | 1.9 |
| Mathematics | 2 | 3.5 | 6 | 11.1 |
| Mechanical Engineering | 1 | 1.8 | 9 | 16.7 |
| Management Information Systems | 1 | 1.8 | 3 | 5.6 |
| Undecided | 3 | 5.3 | 1 | 1.9 |
| Physics | | | 1 | 1.9 |

Instrument

*Motivated and Learning Strategies:* The Motivated Strategies for Learning Questionnaire (MSLQ) is an 81-item inventory with fifteen subscales. Item responses are scored using a 7-point Likert-type scale, ranging from 1 (not at all true of me) to 7 (very true of me). Factor analyses of the instrument with various samples have revealed the stability of the fifteen subscales[21].

Thirty-one of the 81 survey items assessed the extent to which students used each of six distinct types of "motivational" strategies. The four items of the intrinsic goal orientation scale assessed the extent to which students perceived themselves to be engaged in academic tasks to pursue internal rewards like mastery or seeking to be challenged (e.g., ''In a class like this, I prefer course material that really challenges me so I can learn new things''). The four items of the extrinsic goal orientation scale assessed the extent to which students perceived themselves to be engaged in academic tasks to pursue external rewards like approval from others or getting good grades (e.g., ‘‘Getting a good grade in this class is the most satisfying thing for me right now’’). The six items of the task value scale measured students’ perception regarding how interesting, important, or useful they perceived the course to be (e.g., ‘‘I think I will be able to use what I learn in this course in other courses’’). The four items of the control of learning scale measured the extent to which students believed that their academic performance was dependent on factors they controlled, such as the amount of their study or effort (e.g., ‘‘If I try hard enough, then I will understand the course material’’). The eight items of the self-efficacy scale measured the extent to which students believed that they were competent in terms of task-related abilities and skills and had a high likelihood of a successful academic performance (e.g., ‘‘Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class’’). The five items of the test anxiety scale assessed the extent to which students experienced discomfort or had negative thoughts that could interfere with their test performance (e.g., ‘‘When I take a test, I think about items on other parts of the test I can’t answer’’).

Fifty of the 81 survey items assessed the extent to which students used each of the nine distinct types of “learning” strategies. The four items of the rehearsal scale assessed strategies which are best used for simple tasks and activation of information into working memory (e.g., “I memorize key words to remind me of important concepts in this class”).  The six items of the elaboration scale assessed strategies students use to integrate and connect new information with prior knowledge (e.g., When reading for this class, I try to relate the material to what I already know”). The four items of the organization scale measured the extent to which the student uses strategies to select information and construct connections among the information (e.g., I make simple charts, diagrams, or tables to help me organize course material”). The five items of the critical thinking scale assesses the students application of previous knowledge to new situations to solve problems (e.g., I often find myself questioning things I hear or read in this course to decide if I find them convincing”). The 12 items of the metacognitive self-regulation assesses the students’ awareness, knowledge, and control of cognition (e.g., “I ask myself questions to make sure I understand the material I have been studying in this class”). The eight items of the time and study environment scale measured the students’ ability to manage and regulate time as well as the setting to do their studying (e.g., “I have a regular place set aside for studying”). The four items for the effort regulation scale assessed students’ ability to control their effort and attention in times of distraction and when tasks were uninteresting (e.g., “I work hard to do well in this class even if I don’t like what we are doing”). The three items for the peer learning scale measured the students’ collaborative interaction with peers (e.g., “I try to work with other students from this class to complete course assignments”). The four items for the help seeking scale assessed students’ ability to identify and use others for support and assistance (e.g., I ask the instructor to clarify concepts I don’t understand well”).

*Demographics and Confidence:* To the MSLQ, the researchers added a student demographic questionnaire section that consisted of 2 items designed to capture demographic variables of the students volunteering to participate in the study. These variables included gender, class standing, and academic major.  It also included a question asking students to report their confidence in the following areas; Engineering, math, reading, writing, and science. Item responses two these were collected using a 5-point Likert-type scale, ranging from 1 (not at all confident) to 5 (very confident).

Data Analysis

A survey research design using non-random sampling was employed to explore the relationship of the fifteen subscales regarding the two participating groups (freshman and other undergraduates). All of the data was analyzed using SPSS 14.0 developed by SPSS Inc. The study employed descriptive analysis to review demographics of the sample means and standard deviations, as well as reliability analysis of the subscales. Inferential statistics (independent t-test) was used to examine group differences on the dependent variables[29].

Results

Demographic information for the two groups was compared using Chi-square with results revealing that the class comparison groups were fairly similar regarding gender (see Table 1). However, for the other undergraduates there was significantly more representation of majors other than Computer Sciences and Computer Engineering. This finding would be expected since many of the computer related majors would be taking this as the foundational course to their academic program, whereas other majors would be taking the class as an enhancement to their program or as an elective. Then items with missing values were examined for the individual scale items which ranged from 0 to 1.5 percent with no missing value patterns identified, so subsequent values were replaced using median values[30]. Mahalanobis distance procedures[31] was used to check for multivariate outliers with a probability estimate alpha at the $p$ <.001 level with no outliers being found.

As shown in Table 2, reliability analysis of the Motivated Strategies Learning Questionnaire (MSLQ) using Cronbach alpha internal consistency showed fairly similar levels of reliability between the original study of the MSLQ and the present study. That is except for time and study environment management and help seeking. For some researchers there is no definitive cut-off regarding the alpha levels and that satisfactory levels are actually more dependent on test use and interpretation [32].

Table 2
Group Scale Means and Standard Deviations and Reliability Analysis.

| | Class Standing | | | | Cronbach Alpha | |
|---|---|---|---|---|---|---|
| | Freshman (n = 57) | | Other Undergraduates (n = 54) | | | |
| Scale | M | SD | M | SD | Current Study | Pintrich et al.[17] |
| Motivation | | | | | | |
| Intrinsic Goal Orientation | 5.21 | .87 | 5.18 | 1.08 | .74 | .69 |
| Extrinsic Goal Orientation | 5.14 | 1.03 | 5.30 | 1.27 | .62 | .64 |
| Task Value | 5.86 | .94 | 5.43 | 1.13 | .90 | .86 |
| Control of Learning Beliefs | 5.59 | .92 | 5.41 | 1.12 | .68 | .74 |
| Self-Efficacy | 5.38 | .94 | 5.32 | 1.25 | .93 | .94 |
| Test Anxiety | 3.78 | 1.24 | 4.03 | 1.46 | .80 | .79 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Learning Strategies | | | | | | |
| Rehearsal | 3.97 | 1.11 | 4.50 | 1.21 | .69 | .67 |
| Elaboration | 4.21 | .82 | 4.52 | .92 | .76 | .63 |
| Organization | 4.05 | 1.10 | 4.38 | 1.13 | .64 | .59 |
| Critical Thinking | 3.92 | .91 | 3.97 | .85 | .80 | .67 |
| Self-Regulation | 4.40 | .64 | 4.65 | .71 | .79 | .63 |
| Time and Study Environment Management | 4.85 | .61 | 4.88 | .72 | .76 | .45 |
| Effort Regulation | 5.43 | .89 | 5.30 | 1.05 | .69 | .63 |
| Peer Learning | 3.11 | 1.36 | 3.65 | 1.33 | .76 | .71 |
| Help Seeking | 4.26 | 1.33 | 3.92 | 1.28 | .52 | .75 |

Next, we used an independent t-test to compare the fifteen subscales for the two groups (freshman vs. other undergraduates). Three statistically significant differences were found between the groups and equal variances were assumed based upon a non-significant Levene's test. The first difference was for the motivation subscale of task value. Freshman reported higher levels (M = 5.86, SD = .94) compared to the other undergraduates (M = 5.43, SD = 1.13), $t(109) = 2.181$, $p = .031$, cohen $d = .41$. Results did show a statistically significant difference, but the effect size was only in the upper range of a small effect size (.2 = small, .5 = medium, and .8 = large)[33]. A second statistically significant result was found for the learning strategy of rehearsal. Other undergraduates (M = 4.50, SD = 1.21) reported a higher level of use of this strategy in comparison to freshman (M = 3.97, SD = 1.11), [$t(109) = -2.426$, $p = .017$, cohen $d = .46$] with a nearly medium effect size between the two groups. A third statistically significant difference was found for learning strategy of peer learning. Peer learning strategies were also reportedly used more by other undergraduates (M = 3.65, SD = 1.33) compared to freshman (M = 3.11, SD = 1.36), [$t(109) = -2.129$, p = .035 cohen $d = .40$] with a small effect size in the upper range.

A final analysis was done comparing participants reported confidence levels of their skills in Engineering, Math, Reading, Writing, and Science. Once again an independent t-test was used to compare the two groups (freshman vs. other undergraduates). As shown in Table 3, statistically significant differences were found for the participants reported confidence in reading. Based on the non-significant Levene's test of equality, homogeneity of variance was assumed. Freshman (M = 4.12, SD = .91) reported a higher confidence in reading compared to the other undergraduates (M = 3.65, SD = .94) [$t(109) = 2.714$, $p = .008$, cohen $d= .51$] with a medium effect size. None of the other skill measures of engineering, math, writing, or science reported by participants were found to be significantly different for those participating in this study.

Table 3
Group Means and Standard Deviations for Confidence Skill Measures Including t and *p* Analysis Values.

| | Class Standing | | | | | |
|---|---|---|---|---|---|---|
| | Freshman (n = 57) | | Other Undergraduates (n = 54) | | | |
| Measure | M | SD | M | SD | *t*-value | *p*-value |
| Engineering | 3.16 | 1.15 | 3.44 | 1.18 | -1.300 | .196 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Math | 3.81 | 1.03 | 4.00 | .890 | -1.056 | .293 |
| Reading | 4.12 | .91 | 3.65 | .935 | 2.714 | .008 |
| Writing | 3.65 | .99 | 3.28 | 1.11 | 1.865 | .065 |
| Science | 3.72 | .82 | 3.69 | 1.04 | .192 | .848 |

## Discussion

The purpose of this study was to explore the self-regulated motivational and learning strategies reported by freshman in comparison to other undergraduates taking an introductory computer sciences course. Results found four significant differences in these students. The first significant finding was regarding task value being reported higher by freshman. Task value is related to the students' perceptions of the course material in terms of interest, importance, and utility and this means that these students could be considered as being more active and involved in their learning[21]. This finding does make sense since the majority of freshman (74%) had reported they were majoring in Computer Sciences or Computer Engineering and would have a vested interest in learning the material. A second significant difference was regarding the reported higher use of rehearsal learning strategies for other undergraduates. Rehearsal learning strategies involve reciting or naming items from a list to be learned and are assumed to influence the attention and encoding processes. However, these strategies do not help students construct internal connections among the information or integrate the information with prior knowledge[21] and this finding is consistent with prior research regarding engineering students using less deep learning approaches then any other field fields of study[20, 28, 34]. The third significant difference was that peer learning was reported higher by other undergraduates. Collaborating with one's peers has been found to have positive effects on achievement and by creating a dialogue with peers can help a learner clarify course material and reach insights they may not have reached on their own[21]. The fourth significant difference was regarding freshman reporting a higher confidence in reading. This difference could be related to task value since freshman may feel the need to learn the terms, concepts, and structure of the new curriculum in their chosen academic field.

Limitations of the study include the acquisition of the convenient sample from one university and one undergraduate computer sciences course. Next steps for researchers would be to explore gender, academic majors, cultural differences, preferred learning styles, as well as the impact of varied curricular formats, graduate teaching assistants, faculty, and amount of time in the program. Another recommendation would be to develop a longitudinal approach to studying the motivation and learning strategies of students.

## Conclusions

Our purpose of conducting this exploratory study was to provide some insight to engineering educators that learning strategies and motivation for freshman and other undergraduates do differ. Based on the results of the present study, faculty should continue to be concerned regarding enhancing task value and relevancy of course materials for their students. They also need to be concerned to ensure that strategies for deeper learning and understanding of the material are being used by students. A concern found in this study is that other undergraduates were not integrating the material with prior learning rather, but instead were merely memorizing the information for short term use. Another recommendation from this study is that faculty would benefit from enhancing the opportunities for freshman to work collaboratively with one another. As shared by Felder, Woods, Stice, & Rugarcia[28] "*No matter what your teaching style may be-flashy or congenial or scholarly-if students believe you care about them, most will be motivated to learn what you are teaching. If you convey a sense of not caring, then no matter how brilliantly or entertainly you lecture, far fewer will be so motivated*" (p. 16). While much research and questions remain regarding learning strategies and motivation, the use of an instrument like the Motivated Strategies Learning Questionnaire (MSLQ) does appear to be able to provide practical recommendations for faculty using a learner centered and caring approach to teaching.

Acknowledgements

The National Science Foundation provided the funding for this work through a NSF Departmental Level Reform Planning Grant EEC #0530708. The goal of this planning grant project is to implement engineering instructional practices that markedly increase retention, success, and satisfaction of diverse student populations across an engineering college. We would also like to acknowledge the contributions of the other researchers collaborating in the project, specifically Denny Davis, Chris Hundhausen, Jerry Maring, Reid Miller, Robert Olsen, Dave Pollock, and Richard Zollars for their guidance and contributions to this research.

References

1. Bransford, J. et al. (2000). How People Learn: Brain, Mind, Experience, and School. Washington, DC: National Academy Press.
2. Svinicki, M. (2004). Learning, Motivation, and Student Self-Regulation. Presentation at First Annual Meeting of the Center for the Advancement of Scholarship on Engineering Education (CSAEE), National Academy of Engineering, Washington, DC.
3. Bergin, S., & Reilly, R. (2005). The influence of motivation and comfort-level on learning to program. In *Proceedings of the 17th Workshop on Psychology of Programming PPIG'05*, 293-304.
4. Bergin, S., Reilly, R., & Traynor, D. (2005). *Examining the role of self-regulated learning on introductory programming performance*. In the Proceedings of the 2005 international workshop on computing education research, (pp. 81-86). Seattle, WA.
5. Cantwell-Wilson, B., & Shrock, S. (2001). Contributing to success in an introductory computer science course: A study of twelve factors. *ACM SIGCSE Bulletin, 33*(1), 184-188.
6. Campbell, P., & McCabe, G. (1984). Predicting the success o f freshman in a Computer Science major. *Communications of the ACM, 27*(11), 1108-1113.
7. Garavalia, L., & Gredler, M. (2002). Prior Achievement, Aptitude, and Use of Learning Strategies as Predictors of College Student Achievement. *College Student Journal, 36*(4), 616-625.
8. Zimmerman, B., & Schunk, D. (2001). Self-regulated learning and academic achievement: theoretical perspectives (2nd ed.). Mahwah, N.J.: Lawrence Erlbaum Associates Publishers.
9. Pokay, P., & Blumenfeld, P. (1990). Predicting achievement early and late in the semester: The role of motivation and use of learning strategies. *Journal of Educational Psychology, 82,* 41-50.
10. Pintrich, P., & De Groot, E. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology*, 82, 33-40.
11. Pintrich, P., & Garcia, T. (1991). Student orientation and self-regulation in the college classroom. In M. Maehr & P.R. Pintrich (Eds.), *Advances in motivation and achievement: Goals and self-regulatory process,* (Vol.7, pp.371-402). Greenwich, CT: JAI Press.
12. Boekaerts, M. (2002). Bringing about change in the classroom: strengths and weaknesses of the self-regulated learning approach: EARLI Presidential Address, 2001. *Learning and Instruction, 12(*6), 589-604.

13. Pintrich, P. (1995). *Understanding self-regulated learning.* In P. R. Pintrich (Ed.), Understanding self-regulated learning (pp. 3-12). San Francisco: Jossey Bass.
14. Schunk, D. (2004). *Learning Theories: An Educational Perspective (4th Edition).* Upper Saddle River, New Jersey: Pearson Education, Inc.
15. Ertmer, P. A., & Newby, T. J. (1996). The Expert Learner: Strategic, Self-Regulated, and Reflective. Instructional Science*, 24*, 1-24.
16. Pintrich, P.R., & Garcia, T. (1991). Student orientation and self-regulation in the college classroom. In M. Maehr & P.R. Pintrich (Eds.), *Advances in motivation and achievement: Goals and self-regulatory process,* (Vol.7, pp.371-402). Greenwich, CT: JAI Press.
17. Winne, P. H., & Perry, N. E. (2000). Measuring self-regulated learning. In M. Boekaerts, P. R. Pintrich, and M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 532 – 566). San Diego: Academic Press.
18. Pintrich, P., & Zusho, A. (2002). The development of academic self-regulation: The role of cognitive and motivational factors. In A. Wigfield & J. Eccles (Eds.), *Development of achievement motivation* (pp. 249-284). San Diego: Academic Press.
19. Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner, Handbook of self-regulation. San Diego, CA: Academic Press.
20. Felder, R., & Brent, R. (2005). Understanding Student Differences. *Journal of Engineering Education, 94*(1), 57-72.
21. Pintrich, P., Smith, D., Garcia, T., and McKeachie, W. (1991). *A manual for the use of the motivated strategies for learning questionnaire (MSLQ).* 91-B-004. Ann Arbor: The Regents of the University of Michigan.
22. Pintrich, P., Smith, D., Garcia, T., & McKeachie, W. (1993). Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ). *Educational and Psychological Measurement, 53,* 801-813.
23. Chen, C. (2002). Self-regulated learning strategies and achievement in an introduction to information systems course. *Information Technology, Learning, and Performance Journal, 20*(1) 11-25.
24. Bergin, S., & Reilly, R. (2005). The influence of motivation and comfort-level on learning to program. In *Proceedings of the 17th Workshop on Psychology of Programming PPIG'05*, 293-304.
25. Bergin, S., Reilly, R. & Traynor, D. (2005). *Examining the role of self-regulated learning on introductory programming performance*. In the Proceedings of the 2005 international workshop on computing education research, (pp. 81-86). Seattle, WA.
26. Hastings, J., West, D., Perrot, L., & Deloney, L. (2001). Pharmacy student motivation: Phase 1 of a longitudinal study, *American Journal of Pharmacy Education, 65*, 254-258.
27. Garavalia L., Scheuer D., & Carroll C. (2002). Comparative analysis of first and third year pharmacy students' perception of student regulated learning strategies and motivation. *American Journal of Pharmacy Education, 66,* 219-223.
28. Felder, R., Woods, D., Stice, J., & Rugarcia, A. (2000). The future of engineering education II: Teaching methods that work. *Chemical Engineering Education, 34*(1), 26-39.
29. Shannon, D., & Davenport, M. (2001). *Using SPSS to solve statistical problems: A self-instruction* guide. Prentice-Hall: Upper Saddle River, NJ.
30. SPSS. (1997) *SPSS Missing Value Analysis 7.5*. Chicago, IL: MaryAnn Hill / SPSS Inc.
31. Meyers, L., Gamst, G., & Guarino, A. (2006). *Applied multivariate research: Design and interpretation.* Thousand Oaks, CA: Sage Publications, Inc.
32. Schmitt, N. (1996). Uses and abuses of coefficient alpha. *Psychological Assessment, 8*(4) 35-353.
33. Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd ed.).* Hillsdale, NJ: Lawrence Earlbaum Associates.
34. Nelson L., Shoup, R., & Kuh, G. (2005, June). *Deep learning and college outcomes: Do fields of study differ.* Paper presented at the Annual Forum of the Association for Institutional Research. San Diego, CA.