FACULTY PERCEPTIONS OF TEACHING IN UNDERGRADUATE COMPUTER SCIENCE EDUCATION

A Dissertation

Presented to

The Faculty of the Curry School of Education

University of Virginia

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

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by

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May 2009

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APPROVAL OF THE DISSERTATION

This dissertation, Faculty Perceptions of Teaching in Undergraduate Computer Science, has been approved by the Graduate Faculty of the Curry School of Education in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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Abstract

The purpose of this dissertation is to examine the attitudes of computer science faculty members towards undergraduate teaching. The questions addressed in this study are: (1) How important is effective teaching to computer science faculty members at the undergraduate level and how important do they perceive effective teaching to be to their institution? 2) How much teacher training have computer science faculty members received? 3) What do computer science faculty members believe about teaching? 4) What are the current teaching practices of computer science faculty members and what influences those practices? 5) What incentives or rewards are offered to faculty members who try innovative teaching methods or receive additional training? The motivation for investigating these questions is a general dissatisfaction among students with teaching quality and a desire of faculty members to improve the efficacy of recruitment and retention of students in computer science programs.

Over three hundred faculty members participated in an online survey that addressed the questions stated above. The results of this study helped the author develop and make recommendations to help computer science departments understand faculty attitudes towards teaching and influence their choices of teaching methods.

This thesis is dedicated to my husband, Tarek, who has been there for me through the good and the bad and has always supported me. It is also dedicated to the memory of my mother Lillian G. Peck, who always did her best to learn new things despite her blindness.

Acknowledgement

When I had first embarked upon this project I had thought it would be like any other paper or project I had done. I thought it would simply be a matter of choosing a topic and purpose, follow through and write about it. However, I soon discovered it was much more involved than I first thought. If it were not for the patience and guidance of my advisor Dr. John Bunch I might have given up in frustration. With his help and the help of my other committee members I worked through the difficult stages of this project. There were other people who helped me through this process as well. Some just were sounding boards for ideas and some just listened to my frustrations. I am thankful for all the help no matter how small.

I wish to extend my sincerest thanks and appreciation to the following people for their extensive support and patience:

Dr. John Bunch

Dr. Glen Bull

Dr. Harold Burbach

Dr. Bruce Gansneder

The entire computer science faculty I pestered

My friends and fellow students who understood the painful process

I would especially like to thank the man who supported me the most even when he got frustrated with me and my moods, my husband Tarek

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Chapter I

Introduction

This study addresses several important questions regarding the attitudes of computer science faculty towards undergraduate education, the preparation for teaching, the incentives offered by their institutions to encourage teaching innovation, the prevalent teaching practices, and the factors that affect them. Understanding the relations between the above variables is of great importance to efforts that aim to improve computer science education. The study is motivated by a perceived general dissatisfaction of computer science undergraduates in their instruction that comes at a time when computer science departments struggle to improve student recruitment and retention. According to a survey by the Computing Research Association (CRA), released in March 2008 the number of undergraduate CS degree enrollments has decreased steadily over the last 10 years in surveyed institutions (Vegso, 2008),. For example, it dropped approximately in half between years 2000 and 2007.

This chapter describes the primary motivations and goals for this study, places it in context, and describes the conceptual framework. The chapter begins with an introduction to computer science and computer science instruction, followed by a brief description of contemporary students and their expectations. Next, a brief overview is presented of some studies that involve the use of alternative teaching methods in undergraduate computer science education. This chapter also includes definitions of terms that will be used throughout this study in order to give readers a better understanding of what is being discussed. The chapter concludes with the conceptual framework that drives this study through the theories of constructivism and behaviorism, followed by the problem statement that outlines the questions this study intends to answer.

Computer Science and Instruction

In order to comprehend the significance of addressing computer science education specifically, as opposed to borrowing observations from previous education studies in other fields, one needs to understand the additional challenges offered by the nature of computer science as a discipline. Computer science is a rapidly changing field of study. It effectively becomes a reinvented every 5-7 years (Tucker, 1996). However, the pedagogical approach has changed very little over the course of time. Unlike mature fields such as physics, chemistry, and humanities, where the relative stability of content makes it possible to amortize development and refinement of teaching materials over a long period of time, in computer science and similar rapidly-evolving fields, many syllabi are revised nontrivially every year (Wilkens, Kumar, Ramamurthy, Harmeyer, Olan & D'Antonio, 2004). Due to the frequency of these changes, it is next to impossible for CS instructors to keep up with all of the developments in their area (Wilkens, Kumar, Ramamurthy, Harmeyer, Olan &D'Antonio, 2004).

The rapid changes in computer science theory and technology affect instructional delivery (Tucker, 1996). It might not be a coincidence, therefore, that most computer science instructors (despite familiarity with modern technology) use the simple lecture approach as the exclusive method of teaching (Prey, 1995, Knight, Prey, &Wulf, 1994, Booth, 2001, Wilkens, Kumar, Ramamurthy, Harmeyer, Olan &D'Antonio, 2004). In fact, over 90% of instruction in college and university classrooms relies exclusively on lecture (Hativa, 2000). In 1979, Dunn and Dunn suggested that teachers teach in the manner in which they learned. Given that many computer science faculty have little or no training in teaching (Huang, Turns, &Yellin, 2005), this is a fair assumption to help explain the state of teaching practice in computer science courses. The above challenges pertaining to computer science motivate a closer look at education in this quickly-evolving field, and hence support the need for this study.

The Millennial Generation

In order to address computer science instruction, it is essential to understand the needs and desires of contemporary students. This section addresses the needs and desires of the millennial generation of students who are beginning to enter post-secondary education. It makes the observation that the educational challenges in computer science are further complicated by the students' shifting expectations, explored in recent literature (Wilson, 2004).

Pedagogical approaches, such as lecture, assume that the students receive information from the teacher and file it for later use. This later use often amounts to a simple regurgitation of information (Baxter-Magolda, 1992). More effective instruction is needed for these students to make the knowledge their own. As students develop academically, they begin to acknowledge that the instructor is not the only source of information and that the instructor does not know everything (Baxter-Magolda, 1992). They begin to look for other sources of knowledge such as their peers and public sources (e.g. the web) (Baxter-Magolda, 1992). The lecture style of teaching does not effectively take advantage of such developmental changes (Baxter-Magolda, 1992).

Moreover, with recent advances in teaching methodologies and with the increased use of hands-on, cooperative learning, and other non-lecture teaching styles in high-school classrooms (Wilson, 2004) the expectations of college students are changing. As more students of the millennial generation, born after 1982, enter college, universities will see an increase in the number of students looking for different approaches to learning (Coomes & DeBard, 2004). The increased gap between the expectations and the reality of instruction in CS classrooms further contributes to an unsatisfactory experience for many CS undergraduate students. For example, at one of the campuses of the University of Illinois, which ranks in the top five among graduate schools for CS in the nation, the undergraduate CS classes have one of the lowest satisfaction ratings for professors and teaching in the entire university (Ory, 2006).

Students of the millennial generation look for clear expectations, explicitly defined syllabi, and well-defined assignments (Wilson, 2004). For educators, this becomes a challenge because students rely more on the self and less on the authority figures (Coomes & DeBard, 2004). This shift in student attitudes implies that the lecture approach to instruction will become less effective for students of the millennial generation because all the information comes from the instructor, the authority figure (Coomes & DeBard, 2004). In order to accommodate millennial generation students, faculty members will need to be willing to expand their repertoire of teaching styles in the computer science classroom. Faculty members can create study groups and use other methods of collaborative learning to help students meet the high expectations of the undergraduate classroom (Coomes & DeBard, 2004). Faculty members have begun to realize that: *"What we hear, we forget. What we see, we remember. What we do we learn (Chinese Proverb)."* This idea is borne out by Edgar Dale's Cone of Experience (Dale, 1954), shown in Figure 1.

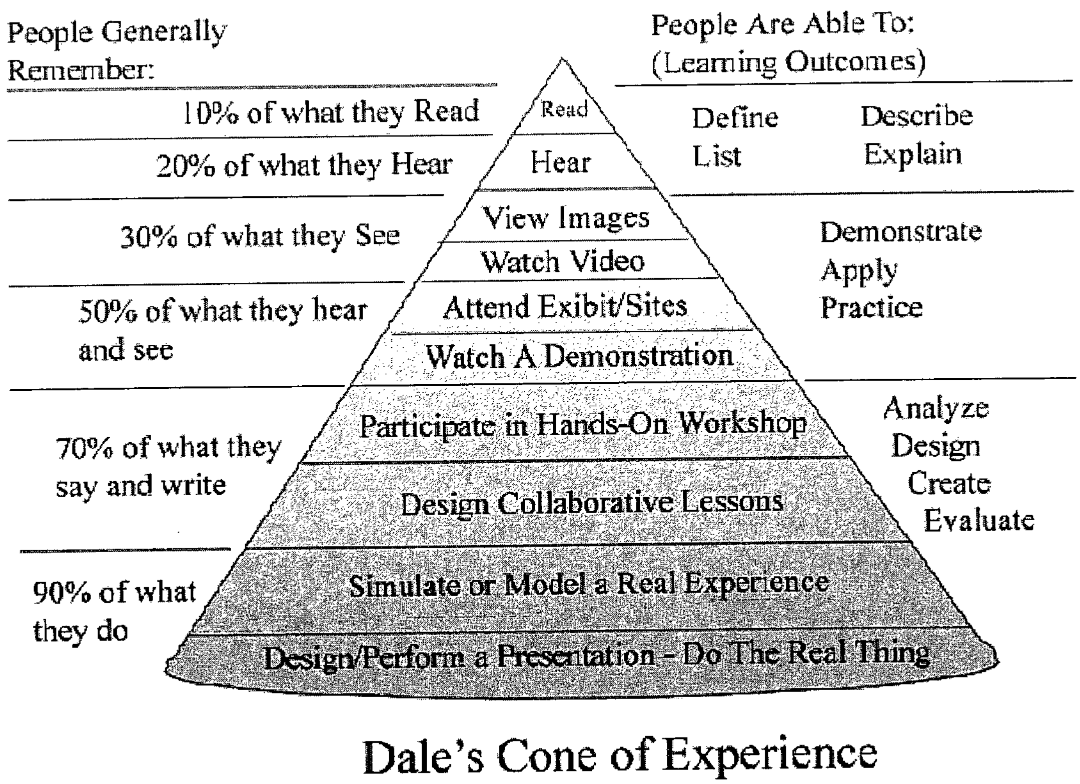


Figure 1. Dale's Cone of Experience (Dale, 1954).

According to the Cone of Experience, students retain only about 5% of information when delivered in a lecture format, 30% of demonstrated information, 50% of information they discuss, 75% of what they actively participate in doing and 90% of information when teaching others and getting immediate use out of the material (Dale, 1954). This cone of learning refers to using such teaching methods as modeling, discussion groups, hands-on practice, and jigsaw learning (individuals or groups become experts on a topic and teach to the rest of the class).

Alternative Methods

In order to address the needs and desires of contemporary students it might be necessary to employ alternative methods of teaching in the undergraduate classroom. Much research has been conducted to examine the effects of using alternative methodologies in the undergraduate computer science classrooms. This section introduces the reader to such available alternatives, and to studies outlining the results of their use in classrooms, in order to set the backdrop against which currently prevalent practices in computer science education and their implications may be better understood. A more detailed review of prior work will be presented in chapter two.

Research has shown that students show less frustration with assignments and class work when allowed to construct their own knowledge. This is accomplished through the implementation of cooperative groups and through working collaboratively with other students in the computer science classroom (Prey, 1995). This above student preference is an important factor to consider given students' dissatisfaction with teaching methods and a general disconnect between undergraduate learning and post-degree job expectations (Prey, 1995). While such breaks from the traditional lecture approach may be difficult at first, if students have not been introduced to the concept before, often this problem is relieved after students are given clear expectations of what should occur during the instructional period (Prey, 1995).

To further support Prey's (1995) research, Chase and Okie (2000) found that the use of cooperative learning and peer instruction reduced the withdrawal rate and the number of students receiving Ds or Fs (WDF) in an introductory computer science class. Cooperative learning in this study is referred to as manipulating students into planned learning environments that uses peer groups. Peer instruction refers to the pairing of an undergraduate student with a faculty instructor to plan, prepare, and present the course material. The undergraduate student, in the end, teaches the course with support from the faculty instructor. WDF rates over all were reduced from a 56% average to 32.5. The improvement was even more dramatic for female students in the course. These students went from a 53% WDF rate to a 15% WDF rate. This improvement in the WDF rate for women seemed to support Walker's (1997) belief that the use of cooperative learning strategies would have a positive impact on female students.

While Chase and Okie (2000) looked at cooperative learning and peer instruction; Barker, Garvin-Doxas and Roberts (2005), looked at teaching computer science through a fine arts approach to instruction. They compared a traditionally taught computer science course and an information technology certificate (ITC) program in terms of the pedagogical approaches each program used. Barker, et al. (2005) found that in the traditional CS course, students had few opportunities to share knowledge with each other, whether in the lecture or lab or when being assessed. During homework assignments, lab activities and assessments student interaction was forbidden. In contrast, the ITC program used an approach that forced the students to elicit information from one another. Students would often call out to the professor or peers asking for assistance and the other students would leave their places to assist the student in need of help. In this manner, the students became accustomed to hearing other people's ideas and solutions rather than just the instructor's point of view.

Students, in the computer science program, interviewed during this study reported many instances in which women and men were treated differently during classes. The women believed they were being held to higher standards than the men and were afraid to answer incorrectly if called upon, for fear of reinforcing the belief that women do not belong. About 2/3 of the women expressed feeling discomfort in classes, they reported feeling isolated yet conspicuous and felt they had to hide their femininity. Conversely, in the ITC program more than half of the graduates were women. Students described a collaborative environment and women did not feel as though they were treated differently. Based on the results of the study it appears that the collaborative environment helps to mitigate some of the gender bias present in these areas of study.

The aforementioned studies discuss student satisfaction based on different teaching methods. Student satisfaction is essential to the continued success of a given academic program. Students often choose a program and their subsequent focus within the program based on information received from students who are currently in or have completed the program. If previous students were not happy with the education they received, students will be less likely to choose that program. Given the changes in student expectations (DeBard, 2004), it seems imperative that teaching methods need to change in computer science in order to increase student satisfaction. However, the likelihood of effective change depends on how computer science faculty members perceive teaching and on their knowledge and willingness to use alternative methods of instruction.

Faculty members tend to develop teaching styles that are comfortable for them, rather than what works best for the student population (Lee, 2001). Unfortunately, the majority of post-secondary education faculty members have not been exposed to modern teaching methodologies or technologies; therefore they are less comfortable with these methodologies (Lee, 2001). Additionally, it is generally assumed that post-secondary faculty members are capable of teaching and managing the learning experience of students even though they themselves do not have any formal instructional training to build upon and have only few or no mentors to follow (Lee, 2001). Historically, it has been the practice to believe that the completion of a higher degree implies that the faculty member has the ability to teach despite the lack of formal pedagogical training (Lee, 2001). Thus, while new computer science faculty may have some teaching experience as a graduate teaching assistant, their exposure to teaching and learning styles remains minimal (Lee, 2001). As a result, it is not surprising that most faculty members tend to rely on a single teaching style (Sirotnik, 1983).

It is important to note the differences between teaching style and teaching method. A dictionary definition, as stated by Grasha (2002), says that teaching styles are "modes of performing." Within each type of teaching style, there are different teaching methods which can be described as instructional processes (Grasha, 2002). The freeonline-dictionary.com (2008) defines teaching method as the principles and methods of instruction, with methods being further broken down to mean a systematic way of doing something that implies a specific arrangement of steps ("Teaching Method," 2008).

One reason for an instructor's use of a single teaching style may be the lack of knowledge of alternative teaching methodologies which would enable the instructor to integrate more into his or her class (Lee, 2001). Another reason may be that the instructor does not have time to incorporate new teaching methods into his/her instruction (Lee, 2001). Too many institutions tend to value faculty research and grant writing at the expense of effective teaching at the undergraduate level (Tucker, 1996). While the above studies analyzed published statistics, the purpose of this study is to ascertain the degree to which the above factors affect contemporary education in computer science from the perspective of computer science faculty.

Theoretical Framework

The theoretical framework used in this study is based on the theories of behaviorism and constructivism that explain how individuals learn and provide insight into instructional practices that are prevalent in today's educational environments. Guided with those theories one is able to interpret views and practices of CS faculty, as well as determine the degree to which they are consistent with each other.

Educational theories, such as Skinner's behaviorism and Bruner's constructivism, have proponents and opponents to their uses in classroom environments. Behaviorism is a more passive approach to learning and is teacher directed (Saettler, 1990), whereas constructivism is more student centered and students are active participants of their own learning (Reigeluth, 1999, Anglin, 1995). The following sections will discuss the constructs of behaviorism and constructivism and will ultimately tie them into this study.

Behaviorism

Behaviorism has been the more traditional approach to educational techniques (Jonassen, 1999). Behaviorism is a philosophy based on the belief that behavior is determined by forces in the environment rather than by free will (McNergney & Herbert, 1998). Objectivist, or behavioral, concepts of learning assume that knowledge can be transferred from teachers to learners or transmitted by technologies to learners (Jonassen, 1999). Behaviorists believe that learning happens when a correct response is demonstrated following the presentation stimulus, whether it is from the teacher or another external source (Dick, Carey, & Carey, 2005). Learning can therefore be measured by direct observation of the learner over a period of time. Thus, emphasis is placed on observable and measurable behaviors (Dabbagh, 2006).

Behaviorism contains the use of operant conditioning. Operant conditioning is the use of consequences to modify the occurrence and form of behavior. Operant conditioning is not the same as classical or respondent conditioning in that operant conditioning involves the modification of "voluntary behavior" while classical conditioning modifies involuntary behavior (Domjan, 2003). Operant behavior is behavior that is controlled by the environment and is maintained by its own consequences, while behaviors conditioned via classical conditioning are not maintained by consequences (Domjan, 2003). Classical conditioning deals with the conditioning of respondent behaviors which are elicited by antecedent conditions.

Behaviorist approaches to instruction include the use of specific behavioral objectives (Dick et al., 2005, Dabbagh, 2006), which are related to intended outcomes rather than the process. Objectives must be specific, observable and measurable rather than broad and intangible (Mager, 1997). The Dick, Carey, and Carey (2005) model of instruction is based on the behaviorist view that there is a predictable link between a stimulus and the response from learners (Dabbagh, 2006). According to the Dick, Carey and Carey model of instruction the instructor must determine the skills and sub-skills necessary to achieve mastery (Dabbagh, 2006, Dick et al., 2005). It is also the instructor's responsibility to choose the stimulus and strategy for instruction, in order to assemble the sub-skills (Dabbagh, 2006). The basic steps in the Dick, Carey and Carey (2005) instructional design model are: 1) Determine the instructional goals for the lesson, 2) Break down the instructional goal, 3) Analyze learners and contexts (introduce learners and their learning level), 4) Write behavioral objectives, 5) Develop assessment instruments, 6) Develop instructional strategy (Introductory activity, engagement activity, and closure activity), 7) Determine the materials needed for the lesson, 8) Design and conduct formative evaluation, 9) Revise instruction during and after lesson and 10) Create and conduct summative evaluation (Figure 2).

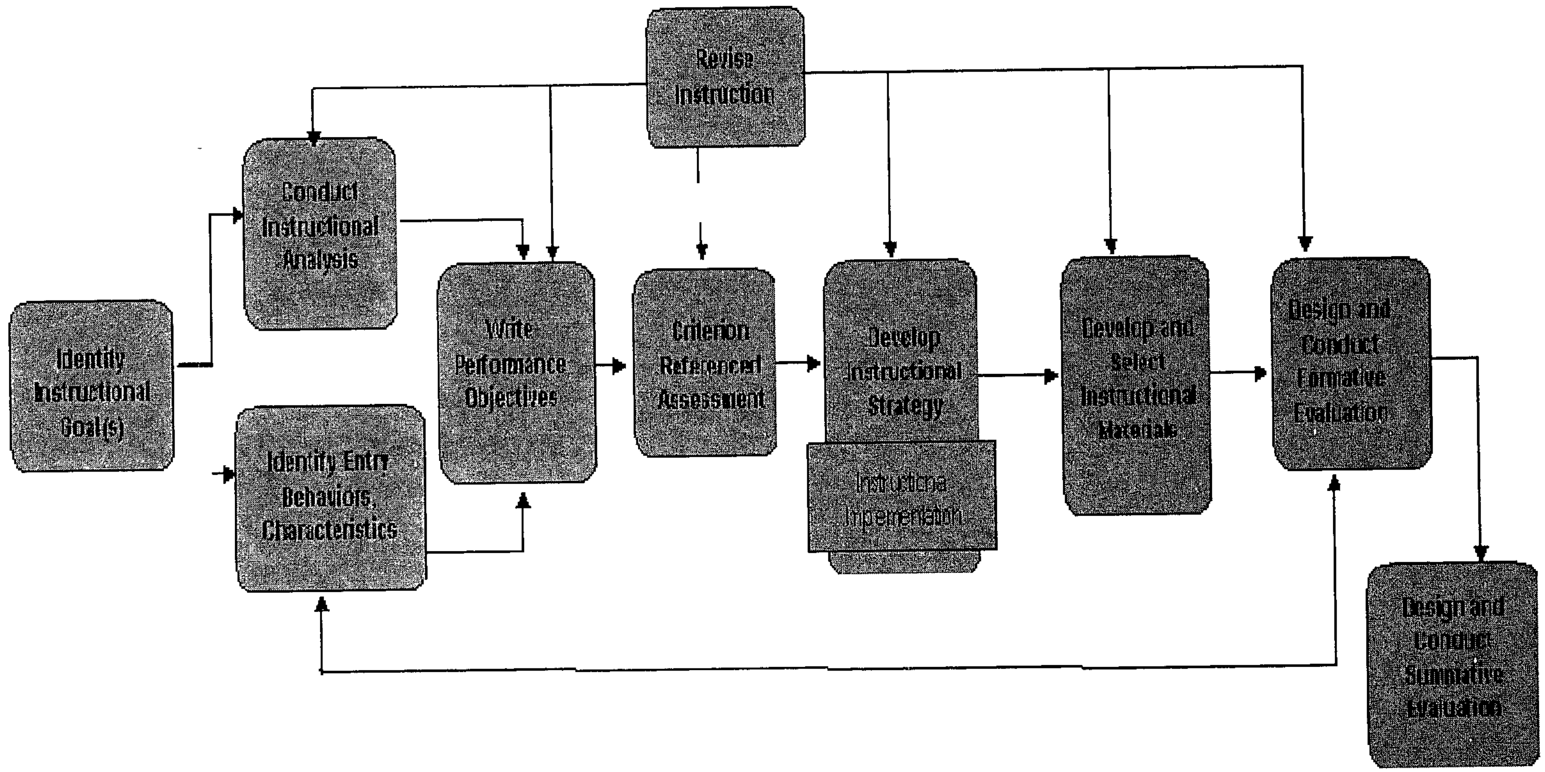


Figure 2 . Dick, Carey & Carey (2005) Instructional Design Model

Constructivism

Instructional design models look at constructivism as having the following basic principles as stated by Dabbagh (2006):

- Learners build personal interpretations of the world based on experiences and interactions.
- Knowledge is embedded in the context in which it is used (authentic tasks in meaningful realistic settings).
- [Instructors should] create novel and situation-specific understandings by "assembling" knowledge from diverse sources appropriate to the problem at hand (flexible use of knowledge).
- [A Constructivist] believes that there are many ways (multiple perspectives) of structuring the world and its entities.
- [A Constructivist] believes that meaning is imposed by the individual rather than existing in the world independently (p. 1).

Using these principles, constructivism involves building knowledge structures from one's experiences. Learners create interpretations of the world based on past experiences and interactions (Cunningham, 1992). Due to learners creating interpretations from personal experience, there is not one predetermined "right" answer or meaning (Dabbagh, 2006). Learning is an active process of constructing rather than acquiring knowledge (Dabbagh, 2006). In order for learners to construct knowledge the instructor's job is not to necessarily communicate knowledge but to support knowledge construction (Cunningham, 1992). In order to support knowledge construction, an instructor should engage the learner in the actual use of the tools using real world situations (Duffy & Jonassen, 1992). As such, learning activities should be authentic and should center on the problem as seen by the learner (Dabbagh, 2006).

These theoretical constructs form the basis of understanding instructional methods. This understanding will help form the survey on which this study will be based.

Definitions

Analysis of Variance (ANOVA) (Luthra, 2009)- "Statistical technique for determining the degree of difference or similarity between two or more groups of data. It is based on the comparison of the average value of a common component."

Behaviorism- A philosophy of learning that is based on the belief that behavior is determined by forces in the environment rather than by free will (McNergney & Herbert, 1998).

Computer Science- "The systematic study of computing systems and computation. The body of knowledge resulting from this discipline contains theories for understanding computing systems and methods; design methodology, algorithms, and tools; methods for the testing of concepts; methods of analysis and verification; and knowledge representation and implementation" (National Science and Technology Council, 1995, Glossary p. 1).

Constructivism- A philosophy of learning based on the idea that, by looking at our experiences, we can construct our own understanding of the world and the activities we engage in (Brooks & Brooks, 1999).

Descriptives- Refers to the calculations of means, population Ns and standard deviations based on given data.

Learning Style- The way, in which a person takes in information, processes it and makes decisions for its later use.

N's- Refers to the numbers of the population studied.

Pearson's Correlation – (Correlation coefficient) - determines the extent to which values of two variables are "proportional" to each other (Pearson's, 2008).

Reliability- the extent to which an instrument yields consistent results.

Teaching Method- the mode of delivery for educational content

Teaching Style- "a manner or mode of acting or performing" (Grasha, 2002, p. 3) developed based on instructors' beliefs about what constitutes good teaching, their personal preferences, abilities, and the norms of their particular subject (Grasha, 2002).

Validity- the extent to which an instrument measures what it is intended to measure.

Problem Statement

Computer science, though a relatively new and rapidly changing field, is a valuable field of study and practice in today's society.

A key mission, both historically and currently, of computer science departments is that of attracting and retaining students, especially women. However, there is research that shows a considerable amount of dissatisfaction with undergraduate CS courses on the part of the students. A disconnect exists between the expectations of contemporary students and current teaching styles. This disconnect may contribute to some of the dissatisfaction with undergraduate CS courses. To the extent that this is true, it is in the best interests of CS programs to determine the major factors that influence the CS faculty members' use of teaching methods. Additionally, it is in their best interests to determine what interventions may work to mitigate the problem. The problem guiding this research is that the main factors that influence teaching in the CS department are unknown.

The purpose of this study is to look at and examine how faculty members in computer science look at teaching in the undergraduate curriculum. The questions that guide this study are:

- How important is effective teaching to computer science faculty members at the undergraduate level and how important do they perceive effective teaching to be to their institution?
- How much teacher training have computer science faculty members received?
- What do computer science faculty members believe about teaching?
- What are the current teaching practices of computer science faculty members and what influences those practices?

- What incentives or rewards are offered to faculty members who try innovative teaching methods or receive additional training?

Chapter II

Literature Review

Introduction

The purpose of this chapter is to look at the supporting literature for the study of faculty perceptions of teaching in undergraduate computer science education. It is important to note, that while many studies refer to the attracting and retention of women in the field of computer science, there were no studies directly related to how teaching relates to that retention. There were multiple studies that focused on alternative teaching methods that happened to show greater satisfaction and success by women as a byproduct.

This chapter begins with a discussion and exploration of teaching styles and alternative methods of instruction; this will be followed by a description of the two prevalent learning theories of behaviorism and constructivism that are driving this study. The learning theories discussion will be followed by a brief discussion of the field of computer science and higher education as a whole. The final section of this chapter will look at the preparation and beliefs of computer science faculty members.

Teaching Styles

Teaching styles, as defined by Grasha (2002), are “a manner or mode of acting or performing.” (pg. 3) An instructor’s teaching style can strongly influence their choice of teaching methodology; therefore it is important to understand some of the different teaching styles that an instructor may have, before looking at teaching methodology.

Felder and Silverman (1988) stated that students learn in many ways and as such, teaching styles and methods also vary. Some instructors lecture, others use demonstration or discussion, and some focus on the theoretical while others focus on the application of theories (Felder & Silverman, 1988). In part, a student's ability to learn in a given class is a function of the student's natural ability and previous preparation, but it is also, in part, a function of the compatibility of the student's learning style with the instructor's teaching style (Felder & Silverman, 1988). Incompatibility exists between the common learning styles of students and the traditional teaching styles of instructors in engineering. It is because of this incompatibility that, as researchers and/or instructors, it is necessary to understand what is meant by teaching styles and what styles and methods are available.

In the following section, teaching styles and methods are discussed. The section begins with an exploration of Grasha's (2002) research on teaching styles and methods and then continues with a discussion of alternative teaching methods that have been utilized in undergraduate computer science classrooms.

Grasha's teaching styles and methods

Grasha (2002) did a lot of research on teaching styles and methods which he presented in his book *Teaching with Style.* He presented inventories and questionnaires in his book that are designed to help teachers and instructors determine what their teaching style is, based on their preferences for different aspects of teaching. He based these teaching styles on behaviorist, constructivist, and humanist approaches to education, but for the purpose of this study only the theories of behaviorism and constructivism were considered. This choice was based on the popularity of behaviorism and constructivism compared to humanism. Once instructors have determined their teaching style, Grasha offers different teaching methods to suit the styles. The information contained in Grasha (2002) is integral to this study because it helps determine faculty members' beliefs and the different teaching methods that suit the faculty member's style.

Defining teaching style

Defining teaching style is a difficult problem; like the story of three blind men examining an elephant, the style that is displayed at any given moment contains several different elements (Grasha, 2002). Teaching style is a multidimensional construct that contains several different perspectives (Grasha, 2002). According to Grasha (2002), a dictionary definition of teaching style is "a manner or mode of acting or performing" (p. 3). Many authors focus, either wholly or in part, on the actions that teachers employ when discussing teaching style. Among other definitions, Grasha (2002) includes is the definition by Eble (1976, as cited by Grasha, 2002). He defines teaching style as "a complex array of mental, spiritual, and physical acts affecting others." (p. 3) Meanwhile, Lowman (1984, as cited by Grasha, 2002) states that "teaching is a performing art."

Teaching Comfort Zone

Every school campus has professors and instructors whose styles make them respected, admired, and popular with the student body (Grasha, 2002). Likewise, there are instructors and professors that elicit the opposite response. It is possible for instructors to become "type cast" based on their teaching style (Grasha, 2002). For example, an instructor may become known for their high use of technology and for making good use of case-studies or role-plays while another instructor becomes known for being a very dynamic lecturer (Grasha, 2002). Becoming well-known for a particular style tends to elicit comments from administrators, colleagues, and students (Grasha, 2002). Grasha (2002) notes that compliments, while appreciated by the instructor, tend to have two unintentional side effects. One such side effect is that the instructor becomes bonded to the particular teaching style and as a result becomes unwilling to explore alternative methods. The other side effect is that, one particular method may become the master style for any course regardless of content, physical environment or population (Grasha, 2002). For example, Grasha discusses a "dynamic lecturer" that exclusively used direct presentation in small classes of 4-6 doctoral students and in other courses where discussion and student interactions would have worked better. Grasha (2002) states that, "Excellent teachers use their voices, gestures, and movements to elicit and maintain attention and to stimulate student's emotions." (p. 3)

Regardless of how faculty members teach they must keep in mind five fundamental questions (Grasha, 2002):

- How can I help students acquire and retain information?

- What can I do to enhance the ability of students to concentrate during class?
- How can I encourage students to think critically?
- What will help motivate my students?
- How can I help them to become self-directed learners? (p. 207)

Teaching Models

Grasha (2002) pointed out that new models of teaching tend to emerge for many reasons. These models are typically based on teaching theory. Such reasons could be that new information does not fit in the current models, some models may not work well in practice, or people may be looking for something better. He uses the example of the behavioral model of instruction and how the cognitive or constructivist approach has taken the stage. Grasha (2002) notes that behaviorism is still used, despite the shifting emphasis of modern classrooms. He notes that behavioral approaches have been de-emphasized despite evidence of the effectiveness of environmental stimulus manipulation that is used to prompt, trigger, encourage and reward behaviors that are desired in the classroom (Grasha, 2002). Behavioral principles are still very much in use as evidenced by the use of tangible rewards such as grades or points to motivate students. Sometimes hybrid models emerge to combine the best of multiple models such as the model that combines cognitivism and behaviorism called cognitive-behaviorism (Grasha, 2002).

Integrated model

Grasha (2002) went on to develop an integrated model of teaching that combined the teaching styles of faculty and the learning styles of students. He broke down his model into five teaching styles; expert, formal authority, personal model, facilitator and delegator. An expert instructor possesses knowledge and expertise that students need (Grasha, 2002). Experts are concerned with transmitting information and ensuring that students are well prepared while striving to maintain status as an expert. A formal authority instructor has status among the students because they are member of the faculty and possess knowledge. They are concerned with the correct, standard, and acceptable ways of doing things (Grasha, 2002). An instructor who teaches with the personal model style believes in teaching by example. They encourage students to observe and emulate the instructor. A facilitator emphasizes the personal nature of teacher-student interaction. They guide students by asking questions, exploring their options, and encouraging them (Grasha, 2002). The final teaching style is that of the delegator. They are concerned with developing the students' capacity for functioning in an autonomous fashion. Grasha (2002) further defined his integrated model by breaking the teaching styles down into four clusters and placing the teaching styles in primary and secondary categories within the cluster (Figure 3). These blends reflect the fact that college instructors use some styles more often than others (Grasha, 2002).

Cluster 1 **Primary:** **Expert** **Formal authority** **Secondary:** personal model facilitator delegator Methods: Lecture, teacher-centered questioning, and discussions, tutorials and technology-based presentations	Cluster 2 **Primary:** **Personal model** **Expert** **Formal authority** **Secondary:** facilitator delegator Methods: role-modeling by illustration, direct action, coaching, and guiding students
Cluster 3 **Primary:** **Personal model** **Expert** **Facilitator** **Secondary:** formal authority delegator Methods: case studies, critical thinking discussion, guided reading, role-playing or simulations and roundtable discussion	Cluster 4 **Primary:** **Delegators** **Expert** **Facilitators** **Secondary:** formal authority personal models Methods: contract teaching, debate formats, learning pairs, position papers, small group work and student journals

Figure 3. Four Clusters of Teaching Styles and Methods (Grasha, 2002).

Influences

Grasha (2002) collected responses from teachers and college faculty members in workshops and seminars that he conducted. The reasons most frequently stated for what influences their choice of teaching style included: whether the class was required or not and whether it was only open to majors or if non-majors were included, size of the class, subject matter (i.e. hard sciences or humanities), grade level, how much they enjoyed the class, time constraints, information about alternative teaching methods, willingness to take risks and not wanting to deviate from the department or college norms for teaching (Grasha, 2002). Expert and formal authority approaches were most popular in large classes, tended to be required for the major, and the students were first or second year or there were time constraints for the faculty members. The formal authority and expert blend was also considered a good way to get through courses they disliked. The delegator, facilitator, and personal model blend was most likely to be used by those most willing to take risks and were used many with upper-undergraduates and graduate students.

Suggested Methods

Grasha (2002) lays out teaching methods that are most commonly associated with each of the four clusters of teaching and learning styles (Figure 3). Instructors with the formal authority or expert styles tend to emphasize the importance of exams and grades while the approaches of personal model, facilitator, or delegator find grades a necessary evil that must be assigned. The latter styles tend to find alternative means of gathering grades for students rather than exams.

Conceptual Base

Grasha (2002) states the importance of identifying one's conceptual base in regards to teaching. For this study, the base concepts are those of constructivism and behaviorism. Grasha (2002) says, "It would be fair to say that a conceptual base is at least implicit in whatever teaching style someone adopts." (pg. 99) However, he is quick to point out that not everyone is aware of the conceptual base that they are working from. A philosophy of teaching would be useful, if one can identify different components and decide which parts to keep or discard.

Grasha (2002) also felt that by consciously basing a teaching style on a conceptual base it would allow instructors to challenge their personal belief set about effective instruction. An example provided by Grasha is a story about a political science instructor who began to realize that his lecture-discussion approach while a form of active-learning to himself was not compatible with the concept of active learning for his students. Therefore, he realized he needed to find a way to bring the benefits of active learning to his students. An additional benefit of consciously identifying and selecting the conceptual basis that underlie one's teaching style is that it allows instructors to begin to overcome "mindless" (pg. 100) ways of designing courses.

There are four components to a conceptual base that every instructor has: a) each has some basic assumptions about teaching and learning, b) they develop personal definitions of teaching, c) instructors have a basis of formal principles of teaching and learning and d) they have personal views of human nature. Each of these components play a part in choosing one's teaching style, as such, it is important to bring each of these components into conscious awareness (Grasha, 2002). Through achieving conscious awareness, one might discover that some components of the conceptual base are better developed than others. By focusing on each component, though interrelated, one can begin to modify and change the underlying rationale for teaching choices.

Grasha offers several self-reflection activities that reflect the different components of a conceptual base. The self-reflection activity that is focused on for this study (question17) is the self-reflection activity that looks at the theoretical base for teaching-learning assumptions. Grasha felt that, despite having little or no formal training in teaching and a relative lack of awareness about the prevalent literature about teaching and learning, instructors often have instructional beliefs that fit one of the existing theoretical bases of teaching and learning. Grasha (2002) emphasizes that instructors do not focus on only one theory and that their practices often reflect more than one theory.

Grasha in this study. The literature provided by Grasha's research helped to form two of the research questions driving this study. By using Grasha's research, the current practices and beliefs of computer science faculty members become a stepping stone to help mitigate some of the issues surrounding undergraduate computer science programs.

Some of the methods mentioned by Grasha (2002) are what can be considered non-traditional methods, in the sense that they are rarely used in the context of computer science classrooms. Therefore it is important to explore some of the alternative methods that have been tried in computer science courses to see how they may have impacted student satisfaction or how they have been used.

Alternative Teaching Methods and Undergraduate CS

Studies have been conducted on the effectiveness of alternative teaching methods in undergraduate computer science classes. These studies have been conducted in an effort to get computer science faculty to move away from a traditional lecture approach to instruction in undergraduate classes. Interestingly, while not part of their main objective, many of these studies note a marked difference in the retention and satisfaction of women, an area of intense interest to most computer science departments. The following studies discuss the effectiveness of collaborative and active learning in the undergraduate computer science environment.

Cooperative Learning in Undergraduate Computer Science

In her 1995 paper, Jane Prey discusses how little the pedagogy of computer science has changed. Much of the computer science instruction is lecture based and uses lecture as the exclusive method of delivering the fundamentals of the material. These classes also relied on programming assignments, completed outside of class to ensure the development of programming skills (Prey, 1995). Prey (1995) compares the skills learned in the curriculum of the University of Virginia's computer science program with the skills required of practicing computer scientists. There is a large difference between what is taught and what is needed in the field. For example, in the courses, programming work is done individually while in the job field, programming is a team effort. Prey

(1995) even refers to the skills needed in the field as the "antitheses" of what is being taught.

Based on this information, Prey introduced the pedagogical method of cooperative learning into the computer science curriculum of the University of Virginia. The new curriculum uses a closed laboratory in the first four courses of the new curriculum. These closed laboratories encourage students to work together to solve problems and students are encouraged to make mistakes and learn from them. This is a change from the previous method of working independently on code where working with other students was not allowed. When these changes were assessed, responses from the students were extremely positive and they expressed less frustration and higher motivation.

Prey's (1995) study is not the only study that showed a positive impact of the teaching style on student perceptions. Barker, Gavin-Doxas, and Roberts (2005), also found that there was a positive influence of using cooperative learning, discussion and other student involved approaches. Barker, et al. (2005), mentions a study done by Barker and Gavin-Doxas in 2004 that found that the individualized atmosphere of the introductory computer science courses made it difficult for students to rate their abilities accurately in comparison with their classmates. Barker et al., (2005), compared the approaches of a traditional CS curriculum and an IT certificate program. The CS curriculum, consistent with the Computing Curricula 2001, emphasized a "programming first" approach. The programming first approach means that the early instruction in the computer science major focuses on programming (Barker et al., 2005). Such instruction tends to occur in large lecture groups with the students working independently in labs to learn and practice the skills. The CS program in question, typically graduates fewer women than men, which may be explained by the fact that the women in this study expressed a feeling of discomfort and felt they were treated differently than the men. The men in this study felt no such discrepancy between the treatment of men and women.

The ITC program that Barker et al., (2005) looked at, focused on students learning in-depth skills with software packages such as Photoshop or Flash, as well as some HTML programming. Programming courses in C++ or Java were optional choices. The program required that students take six courses of which three of the courses focus on projects that have both individual and group assignments. The introductory course teaches basic HTML with the content centering on the societal aspects of technologies for communication. Unlike the computer science program, slightly more than half of the students enrolled in the ITC program are women. The ITC students expressed a feeling of supportiveness and a collaborative environment, with no perceptions of difference in the treatment of men and women.

Barker et al. (2005) found that CS students had fewer opportunities to share knowledge with their peers during the learning and assessment processes. In contrast, the ITC program, which used a fine arts approach to instruction, forced the students to elicit knowledge from their peers and their instructors. As a result, the students in the ITC program became accustomed to talking about his/her own work and hearing others discuss their work. This put the knowledge in the students' terms instead of the instructor's terms exclusively, offering the material from a new point of view.

Barker et al. (2005) notes that while the pedagogical differences play a factor in the success of the ITC program, they also concede that it would be impossible to institute such pedagogy in all CS classes given the theoretical aspects of the subject. They do believe, however, that integrating the idea of students sharing knowledge with peers and displaying their own work and knowledge can be done for every class.

Active Learning

A look at active learning. Lee (2001) discusses alternative teaching strategies in his paper. He points out that even if new faculty members have been exposed to alternative techniques embedded in lectures, they rarely recognize that fact, unless they had been sensitized to the use of different techniques. One reason for this; is that the most effective mentors and teachers are the ones whose management methods and teaching styles are so smoothly embedded as to be non-distractive (Lee, 2001). Students are often concerned with how they learn the material, not with how it has been presented, thus when required to explain the material, they concentrate on the content not the delivery method.

One alternative approach to learning that Lee (2001) proposes is the use of active learning. Unlike the traditional passive approach, where the knowledge is passed from the instructor to the student, active learning shares the responsibility for learning between the teacher or "learning manager" (Lee, 2001, p. 27) and the student. Lee (2001) gives the following five steps for developing an active learning project and states that they should be common to any learning strategy.

1. The discovery and realization of the problem;
2. The identification of the tools and resources to solve the problem;
3. The examination of alternative strategies for solution;
4. The implementation of a chosen solution; and
5. Reflection on the solution, assessment of the outcome, and reworking of the process of solution identification (p. 27)

These steps can be re-organized to reflect pre-, in- and post-class activities. They can also be assigned to individuals for exploration, group collaborative efforts, or whole class activities. According to Lee (2001), it has been the common practice to assign steps one and two as pre-class individual assignments, while step three lends itself to a group activity. Implementation and reflection tend to be excellent topics for in-class discussions.

Lee (2001) recognizes that many faculty members may feel that with active learning, one cannot cover as much content in class, requires too much time for class preparation and seems impossible to use in a large classes. In addition, materials and resources are lacking and faculty members need to consider the risks including how colleagues will perceive the approach, how student evaluations will be effected, and the possible effects on tenure and promotion.

Another view of active learning. According to McConnell (1996) student learning and the depth of the student's knowledge tend to increase when active learning methods are used in the classroom. Active learning gets students actively involved in the lesson rather than sitting passively listening to a lecture. Activity can include, but is not limited to reading, writing, class discussion, responding to thought provoking questions and problem solving (McConnell, 1996). These activities serve to get the students thinking about the material, which is important because according to Stuart and Rutherford (1978, as cited by McConnell, 1996) passive students tend to lose concentration after about 10-15 minutes of lecture.

McConnell (1996) points out that members of the faculty learn actively by preparing lecture notes, reading, comparing readings with experiences, synthesizing material into notes, and developing examples to illustrate the material. These active learning processes lead to a greater understanding of the material. McConnell (1996) believes that by using active learning approaches, faculty members can increase the depth of understanding that students have about the material, increase their comfort with the material, and improve student confidence. In most sciences, the value of active learning is already recognized and implemented in laboratories or, in the case of computer science, through the use of programming projects (McConnell, 1996).

There is the perception that active learning has higher risks than other teaching styles such as lecture and is not appropriate for large classes, but this is not necessarily true (McConnell, 1996). The fear is that content will have to be sacrificed for active learning to be used and that pre-class preparation time is higher (McConnell, 1996). McConnell (1996) believes that another fear for the faculty members is that of giving up control of the classroom. Lecture allows the professor to decide what to say and when to say it, whereas student-centered activities may raise questions and issues the instructor was not ready to discuss.

Games and Play

Pollard and Duvall proposed in their 2006 paper that by expanding the teaching styles used in the computer science classroom, the audience of students that enjoy and succeed in technology related classes would increase. Rather than focusing on curriculum wide changes they suggest expansions of the teaching styles, specifically, teaching styles that are reminiscent of kindergarten classrooms (Pollard & Duvall, 2006). The use of games, toys, stories and play, help to promote an active learning environment, make the learning arena more level for non-technical or non-major students, provide motivation other than grades and make class time more fun (Pollard & Duvall, 2006).

Pollard and Duvall (2006) integrated the use of games, toys, stories, and play into their regular computer science classes rather than relegating these techniques solely to labs. By using motivational techniques, physical interactions and games on a daily basis rather than just as a special occasion they were able to make the learning interactive. Pollard and Duvall (2006) noted that the immediate result was a more fun environment in the classroom. They hoped that the long term effects would be better student performance, student diversity, and increased enrollment.

Manipulatives

The use of toys or manipulatives in the classroom helps make abstract concepts more concrete (Pollard & Duvall, 2006). For students that are intimidated by technical skills, manipulatives give confidence and ease the apprehension. As cited by Pollard and

Duvall (1996), Froebel developed the original kindergarten in 1837 and introduced the use of physical objects to describe concepts; he believed that the concrete should be introduced before the abstract. Pollard and Duvall (2006) give an example of how manipulatives helped students in Discrete Math. The problem that was to be solved involved proving that a checkerboard with one square removed can be completely covered with L-shaped tiles. Normally, given as an in-class assignment, none of the students had been able to solve the proof during class time. During their more recent class they gave students a checkerboard, a marker to mark off the square removed and L shaped pieces of paper. During this class, only one group was not able to finish without assistance before the end of class (Pollard & Duvall, 2006). In addition to their own example, Pollard and Duvall offer examples of manipulatives that can be used for other computer science topics including arrays, algorithms, and String functions.

Why it helps. Using play in the classroom gets students up and moving and gets them physically engaged in the learning environment. Pollard and Duvall (2006) point out that these activities tend to increase student motivation, give opportunities for immediate feedback, and involve the students in higher order analysis, in addition to helping students create personal connections to the concepts. The use of play is an excellent way to introduce topics or even a complete discipline (Pollard & Duvall, 2006). Students might be motivated to further study a topic outside of class if they are asked to create a song, video, or commercial about a given topic (Pollard & Duvall, 2006).

Storytelling

The final technique that Pollard and Duvall suggest is the use of storytelling as extended metaphors and mnemonic devices. Embedding concepts into a context that would make it easier to recall later is a ways to make it more interesting for the listener and more fun for the instructor to deliver. They point out that women are particularly interested in storytelling, but that even more compelling is that stories help students remember concepts.

However, instructors need to be aware of the possible pitfalls of using storytelling techniques and advise that instructors look at things from a student's point of view. Instructors are not always aware of the social statements that may be made by the use of stories. Stories should be reviewed to make sure they don't have a bias in race, gender or creed and that they are socially correct. Group work should be done carefully so as not to isolate minority students and physical activities should not ask students to reveal information or do acts they are not comfortable with. They also caution that instructors must make sure not to sacrifice content for the sake of fun.

Using Multiple Techniques in the CS Class

As cited by Stamm (2004), Bonwell and Elson (2001) claim that most students have learning styles that are best served by using teaching methods other than that of lecture. Therefore, Stamm states that using the lecture/homework approach to teaching computer science may not be the best way to maintain student attention. Stamm suggests that a good way to keep the attention of the entire class is to use a plethora of techniques that cater to different learning styles. This idea was also supported by Felder (1996); he noted that if instructors teach in ways that do not favor the students' preferred learning styles then the discomfort of the students might be great enough to interfere with the learning process. Felder's research has focused on engineering schools, in which computer science is usually included. Stamm (2004) uses Felder's research to bolster his beliefs that concepts should be taught in as many different methods as possible in order to reach the largest number of students.

Stamm (2004) suggests using atypical techniques as ways to help gain students' attention and address various learning styles as well as to reiterate concepts. Stamm suggests active learning exercises such as debates, role-playing, or simulating algorithms using the class as data. One way he suggests for gaining the students' attention and maintaining it is to do something jarring at the beginning of class by acting in a way that is unpredictable. An example of something jarring that an instructor can do at the beginning of class is suddenly scream, or do something that is not considered normal for an instructor to do, such as being dressed differently than normal or acting differently.

Stamm (2004) concludes his paper by saying that atypical techniques can help instructors in computer science become more effective when teaching introductory topics in computer science. It piques the curiosity of the students, caters to their learning styles, and helps them relate to ideas in new ways. By keeping students interested in class, reiterating concepts without them seeming repetitive, and by using different methods, the instructor can reach more students in the classroom by addressing different learning styles.

In conclusion. The papers and studies discussed in this section present compelling evidence and reasons for incorporating alternative teaching methods into the computer science curriculum. If faculty members choose to incorporate alternative methods into their instructional toolbox they will be able to choose from a plethora of different ideas that will enable them to reach the largest numbers of students possible.

This section helps to drive the study through the creation of a catalog of methods that have been used successfully in computer science classrooms. This catalog enables the author to compare the current beliefs and practices of faculty members with potential methods they can use in the future.

Behaviorism vs. Constructivism

Educational theories such as Skinner's behaviorism and Bruner's constructivism have proponents and opponents to their uses in classroom environments. Behaviorism is a more passive approach to learning and is teacher directed (Saettler, 1990), whereas constructivism is more student centered and students are active participants of their own learning (Reigeluth, 1999, Anglin, 1995).

Behaviorism

Behaviorism has been the more traditional approach to educational techniques (Jonassen, 1999). Behaviorism is a philosophy based on the belief that behavior is determined by forces in the environment rather than by free will (McNergney & Herbert, 1998). According to Scheurman (1998), the behaviorist view is that "reality exists independently of learners and knowledge is received exclusively through the senses." (p. 6) According to Skinner (1974), all forms of behavior, such as reasoning, habit, and emotional reaction, are stimulus-response events; which are both observable and measurable. A child's attitude toward something can be traced back to a specific stimulus; once that stimulus is determined; the behavior can be predicted based on that stimulus (Skinner, 1974). According to Skinner, knowledge is gained when the connection between a stimulus and a response is strengthened by use of reinforcement (Scheurman, 1998).

The behaviorist model has undergone a dramatic change over the last several decades (Scheurman, 1998). The major shift is that it is no longer the prime belief that students are empty receptacles waiting to receive knowledge. The belief has shifted to tapping into the prior knowledge a student has and building upon that previous experience (Scheurman, 1998). The Dick, Carey, and Carey (2005) model of instruction is based on the behaviorist view that there is a predictable link between a stimulus and the response from learners (Dabbagh, 2006). The instructor must determine the skills and sub-skills necessary to achieve mastery (Dabbagh, 2006, Dick et al., 2005). It is the instructor's responsibility to choose the stimulus and strategy for instruction in order to assemble the sub-skills (Dabbagh, 2006).

Constructivism

Instructional design models look at constructivism as having the following basic principles as stated by Dabbagh (2006):

> Learners build personal interpretation of the world based on experiences and interactions.
>
> Knowledge is embedded in the context in which it is used (authentic tasks in meaningful realistic settings).
>
> [Instructors should] create novel and situation-specific understandings by "assembling" knowledge from diverse sources appropriate to the problem at hand (flexible use of knowledge).
>
> [A Constructivist] believes that there are many ways (multiple perspectives) of structuring the world and its entities.
>
> [A Constructivist] believes that meaning is imposed by the individual rather than existing in the world independently (p. 1).

In constructivism, learners do not just take in and store information. They develop interpretations of experiences and then begin to elaborate and test those interpretations (Perkins, 1992). Thus, learning is an active process of constructing rather than acquiring knowledge (Dabbagh, 2006). In order for learners to construct knowledge, the instructor's job is not to necessarily communicate knowledge but to support knowledge construction (Cunningham, 1992). An instructor should engage the learner in the actual use of the tools in real world situations (Duffy & Jonassen, 1992). As such, learning activities should be authentic and should center on the problem as seen by the learner (Dabbagh, 2006). If learning has the inherent characteristics of the constructive approach then it stands to reason that teaching practices need to be supportive of the knowledge construction that needs to happen (Perkins, 1992).

Why alternative methods. Understanding how some alternative methods and the learning theories surrounding them can be used in the computer science classroom is important, but understanding the students who will be in the classroom is also important. The information provided by Baxter-Magolda's theory will give a better understanding of undergraduate college students at different stages of their development and how men and women differ. This understanding is an essential part of being able to make choices about teaching methods and being an effective teacher to the largest number of students possible.

College Student Development

The following sections will give a brief look at the theory of Baxter Magolda in the area of college student development. While college student development theory is used primarily by student affairs practitioners to guide students throughout their college careers, it can be a helpful tool to understand undergraduate students and thus to help inform the selection of teaching methods.

Baxter Magolda

About Baxter Magolda. Marcia Baxter Magolda obtained her Ph.D. degree in college student personnel services from Ohio State University (Baxter Magolda, 1992). Baxter Magolda's main research focus centered on issues of intellectual development and gender in young adults (Baxter Magolda, 1992). Through the differing concepts of knowledge that emerged from her research, Baxter Magolda felt she had identified an important gap in the research that had been done to date. She felt there was a need to address gender differences in cognitive development including both men and women.

Baxter Magolda's Theory. Baxter Magolda was interested in the differences between the ways of knowing for men and women. During the course of her longitudinal five year study she closely followed 101 students (Evans et al., 1998, Baxter Magolda, 1992). She began her interviews in 1986 beginning with the students' first year and continued to interview students every year until the year after graduation (Evans et al., 1998, Baxter Magolda, 1992). Of the original 101 students 70 remained in the study throughout the five years of the study.

The Epistemological Reflection Model that resulted from Baxter Magolda's longitudinal study contains four stages; gender-related patterns are reflected in the first three of those stages. The four stages are *absolute knowing, transitional knowing, independent knowing,* and *contextual knowing* (Evans et al., 1998, Baxter Magolda, 1992). Each of the four stages has two different patterns of knowing contained within the stage (Evans et al., 1998). In each of the first three stages there tends to be a distinct difference between the patterns of knowing of women and men. The fourth stage of contextual knowing reflects convergence of the gender-related differences of the previous three stages (Baxter Magolda, 1992).

Baxter Magolda emphasized during the development of her model that there were more similarities than differences between the ways of knowing of men and women (Evans et al., 1998, Baxter Magolda, 1992). She stressed that the patterns were related to but not dictated by gender and that variability existed among members of each gender

(Evans et al., 1998, Baxter Magolda, 1992). Some limitations of her study that inhibit its use for diverse student populations are that all of her participants were traditional-aged students of a white, middle-class background (Evans et al., 1998, Baxter Magolda, 1992). These students were immersed in a student culture that valued tradition, high involvement, and academic achievement (Evans et al., 1998, Baxter Magolda, 1992). Baxter Magolda also noted that these ways of knowing were socially constructed and could not be expected to apply automatically to other young adults (Evans et al., 1998, Baxter Magolda, 1992).

Why Baxter-Magolda is Important

Baxter-Magolda looked at the different ways that men and women develop in their ways of learning and knowing. She pointed out that men and women learn and "know" differently throughout many of the stages of development. This is especially important to computer science programs that are trying to figure out how to recruit and retain women in their programs. Few women enter the field of computer science, and even fewer stay in the program long enough to graduate. Baxter-Magolda's theory might help computer science faculty adapt their instructional methods to help reduce the attrition of women in the computer science field.

In conclusion. The theory discussed in this section is just one of the possible theories that undergraduate computer science instructors can use to help understand their students. It is important to have at least minimal understanding of college student development theory so that when looking at the computer science program and higher education as a whole, one can understand what the undergraduate student is ready for and capable of handling. Some computer science instructors may think that all students are on the same level as the graduate students with whom they may have a closer personal and working relationship. However, a brief understanding of college student development may help them realize this is not necessarily true and may help to lend support to the question of the current practices and beliefs.

With a brief understanding of how students develop in college as it pertains to their education it is important to examine where computer science is as a field and what factors influence higher education as a whole.

Computer Science and Higher Education

At the same time that there are mitigating factors in computer science, there are also factors that impact higher education as a whole. In order to fully understand what is needed in an undergraduate computer science program it is important to understand the mitigating factors in computer science and higher education. The following section explores the factors that have an impact on computer science programs.

Change is occurring constantly in any discipline, but it is especially true in the field of computer science (Wilkens, Kumar, Ramamurthy, Harmeyer, Olan, & D'Antonio, 2004). The computer science discipline is essentially reinvented every five to seven years (Lee, 2001). Additionally, the gap between the foundations of computing and the continuing research and application aspects is considerably smaller than that in other fields (Tucker, 1996). Educators in this field face constant pressure to keep up with the continual technological changes. In addition, they need to modify the curriculum, integrate new critical developments, and prepare students for these changes (Tucker, 1996). In the 1990's there were dramatic changes in the teaching environment throughout higher education, especially as related to the ability to take advantage of technological advances (Lee, 2001). These rapid changes in technology have an impact on the process of delivery. Tucker (1996) proposes that the advances in networking and graphics have made it possible for instructors to develop effective pedagogical tools and share them among other instructors.

The children of generation x, or students who entered school beginning in the eighties, and the millennial generation, who are entering higher education today, have been educated in a world of technology and hands-on education (Coomes, 2004). These students have also been taught to use all the resources available to them including their peers in order to succeed (DeBard, 2004). The problem occurs as these students enter a field that is mainly based in theory.

Computer science traditionally has been taught using a passive approach such as lecture. This traditional style of teaching is based on assumptions that the students receive the pertinent information from the instructor and immediately file it for later reuse (Booth, 2001). In addition, many CS instructors teach the material based on theory and do not give the students a basis in the practical uses of the material (Barker, Gavin-Doxas, & Roberts, 2005). As such, lectures are often given with the general principles first and are followed by an explanation of why a person might need to know the theory or method (Barker et al., 2005). However, as pointed out by Barker, Garvin-Doxas, and Roberts (2005), the students seem to focus on specific applications where the general principle might apply, while the professors are thinking of the general principle in terms of specific contexts. This study shows a distinct difference in how students attempt to understand computer science from how the professors teach.

Computer Science Faculty

Preparation to become teachers

The following studies and papers look at the training that future and current computer science faculty members receive to prepare for teaching their classes. The level of preparation that future and current faculty members receive is an important clue to how faculty members determine the method of instruction in their undergraduate classes. It was learned from Lee (2001) that it has typically been the belief that the completion of a higher degree implies that faculty members have the ability to teach. This belief is held despite the faculty member's lack of any formal pedagogical training (Lee, 2001). Despite faculty members having some teaching experience as teaching assistants, having knowledge of the content does not ensure effective teaching practices.

There are three main papers that refer to faculty preparation that will be discussed in this section. Lee (2001), Huang, Yelin, & Turn, (2005) and Felder (2003) have all contributed to the research on faculty preparation.

Teaching knowledge and preparation for future computer science faculty.

Huang, Yelin, and Turn, (2005), looked at the way graduate engineering students are prepared for teaching in the future. They point out that while there are many programs that help to prepare future faculty, graduate engineering students have few opportunities to pursue such programs. It is noted that the discrepancy between the training that future faculty members receive and what they need to enable them to teach has led to an increasing dissatisfaction from those institutions that hire them.

Huang et al. (2005) list the primary duties of engineering faculty as teaching, research, and service. Most PhD programs provide opportunities for the students to supervise and conduct research, yet few programs offer students the opportunity to familiarize themselves with the responsibilities that are related to teaching, such as discussing teaching philosophies and decision-making. In addition to decision making and discussing teaching philosophies, faculty members need to develop instructional design methods based on the study of teaching practices. Huang et al. (2005) noted that the 2000 National Doctoral Program Survey showed that only 42% of engineering respondents felt that the graduate teaching experiences prepared them for an academic/teaching career.

Due to the fact that most engineering faculty receive little or no preparation for their teaching roles, it is not surprising that they teach the way they were taught (Huang et al., 2005). The instructor's perception of learning and teaching influences how he/she approaches delivery. A large amount of teaching in the engineering field is done through the lecture method with little feedback or mentoring (Huang et al., 2005). Brent and Felder, (2000) point out that teaching at the college level may be the only profession that requires skilled practitioners, but does not routinely provide training to its new members. Due to this statement, Huang et al. (2005) is lead to the assumption that engineering faculty members often have little, if any idea about the extent of their teaching responsibilities. Thus, the teaching beliefs and practices of new faculty members are heavily based on prior experiences. These faculty members are provided with limited training opportunities or teaching assistance in the university setting (Huang et al., 2005).

Huang et al. (2005) looked at engineering graduate students' concepts of teaching. They looked at a program called the Engineering Teaching Portfolio Program (ETP) which was created to study the preparations in engineering teaching and learning designed to increase the use of effective pedagogies in the engineering classrooms. The program is peer-led and takes place in sessions lasting eight weeks. Huang et al. examined the concept of teaching as indicated by the creation of teaching portfolios. The Huang et al. study is different from other studies that investigate the concepts of teaching in higher education because it focuses solely on future engineering educators. The data they collected was from the pilot section of ETP. There were a total of 15 participants, seven women and eight men, who took part in the study and agreed to participate in the ETP program. Six of the participants were in Computer Science and Engineering, four were in Mechanical Engineering, three were in Civil and Environmental Engineering, and two were in Electrical Engineering. All but one participant were engineering PhD students. The other participant was a post-doctoral associate in Civil and Environmental Engineering.

The ETP program consisted of weekly meetings that lasted for an hour and a half each. Participants were encouraged to provide constructive criticism to peers and receive similar feedback from peers. The objectives of the program were to help participants create a beginning teacher portfolio, create a network of fellow graduate students and early post doctorates interested in teaching, discuss teaching issues, look at teaching as decision making and explore the teaching responsibilities that they will encounter as a faculty member. The end result of the ETP program included creating a personal teaching philosophy, identify two to five teaching items, annotate the teaching items, develop a diversity statement, and complete a draft of a teaching portfolio.

The participants in the Huang et al. (2005) study had a range of teaching experiences from very little or no formal experience to extensive experience attained through teaching assistantships, giving lectures or lab assistantships. Some of the participants had previously worked as a lecturer. As a lecturer they were responsible for designing and giving lectures while supervising other teaching assistants. While many of the participants expressed interest in looking for a general faculty position, a couple of the participants were specifically interested in institutions that were more focused on teaching rather than research.

There was some confusion among the participants when it came to discussing what constitutes teaching. One participant mentioned that he/she did not see what constituted teaching, such as tutoring. A second participant felt that the types of activity one engages in as a consultant constitutes teaching. Many of the participants could articulate the kinds of activities they thought constituted teaching but often they disagreed and challenged each other as to what really constituted teaching. Their concepts of what constituted good teaching also varied from covering the main topics, and trying different styles to reach more students, to self reflection after each and every class.

When the study's participants were asked about the decision making aspects of teaching, the topics ranged from the teaching contexts to accommodating different learning styles. The participants tended to realize that they were the primary decision makers for what material to present and how it would be presented. Some of the participants had reported times when they had to make decisions on class size, location, and time constraints. Other participants made comments about making delivery decisions based on the students' ethnicity or backgrounds while others made decisions based on students' learning styles. For example, one participant discussed how women possibly learn better in a more hands-on approach to learning.

Later in the Huang et al. (2005) study the participants talked about recognizing, applying, and analyzing pedagogy. In recognizing pedagogy, the participants showed their awareness of pedagogy both with and without using the common terminology of pedagogy. In applying pedagogy, the participants showed some evidence of using the pedagogical training in their teaching. One participant mentioned that he/she was going to look more at publications that relate to teaching practices and was going to try the methods suggested. Another participant expressed having a bad experience with non-lecture style teaching methods. In analyzing pedagogy, diversity was a big topic of discussion among the participants. During the discussion of the efficacy of different teaching methodologies, one participant mentioned the diversity caused by gender and how it influenced all aspects of a faculty member's career.

Huang et al. (2005) noted that while the participants recognized the importance of teaching in higher education and looked to get external assistance to shape their own teaching practices, the results were limited due to the fact that participants were self-selected. The participants volunteered for the ETP program and therefore they were already motivated to investigate teaching and the accompanying topics. The high level of interest and exposure to teaching that these participants showed was not necessarily applicable to all engineering students. However, Huang et al. (2005) did express the belief that the ETP program provides an opportunity for graduate students interested in a faculty position to approach teaching in a scholarly way.

Preparation and practices of current computer science faculty

Lee (2001) points out that while there has been a drastic change in the teaching environment due to technological advances, there has also been a change in the expectations of the students, which are influenced by their previous learning experiences. It has only been recently that faculty members have become aware of Dale's (1954) cone of learning, in which the most retention of knowledge occurs during hands-on learning. In hands-on learning, students actively participate in the lesson. Faculty members have begun to realize that lecture is not the only method to achieve the goal of learning by the students (Lee, 2001). Instead, learning can be achieved through the active and collaborative participation of the students. Lee (2001) brings forth the idea that it is necessary for post-secondary institutions to use the best possible methods of teaching in order to bring out the best in their students.

Unfortunately, Lee (2001) points out that the majority of graduate students who will become college faculty, have not been exposed to the most modern teaching methods or technologies. Difficulty arises because most future faculty are assumed to be able to teach and to be capable of creating effective learning environments without having any experience to build upon. It has long been the belief that completing a graduate degree gives the future faculty member the ability to teach, despite the lack of formal training. Often they have neither the experience nor a mentor to follow. As a result, Lee (2001) points out that, faculty members preparing to teach a course for the first time will often take the path of least resistance and fall back on their personal learning experiences. This fallback method often leads to the new faculty member relying on their own experiences in similar classes and the notes he/she received during the class. This frequently leads to a lecture-based approach with take-home assignments (Lee, 2001). This often causes less stress for the instructor than other techniques that take more preparation time. Some faculty members may have had some experience as teaching assistants. However as teaching assistants, their exposure to teaching is very minimal and determining what and how to teach is usually determined by the faculty member for whom they work (Lee, 2001).

Lee (2001) goes on to discuss the role of computers and technology in the modern classroom. While technology use continues to grow, the classroom use of computers is still minimal. He mentions web course development tools such as WebCT and CourseInfo. While they contain some on-line assessments through the use of multiple-choice testing, they are primarily passive-learning environments. Additionally, while distance education has become a large part of 21st century education it has not been a part of the experience of the new faculty members (Lee, 2001). To properly effect learning through distance education, the faculty member needs to develop methods of interaction that will provide hands-on experience and practice for students.

Teacher Training for Faculty

Felder (1993) states that while some people are born with an innate sense for teaching, most are not. Additionally, while professionals such as doctors, mechanics, engineers, and K-12 teachers get intense training for their professional careers, professors do not. Most individuals who receive their PhDs, "join a faculty, and set off to teach their first course without so much as five seconds on how one does that." (p. 176) As a result, new professors do not have extensive knowledge of teaching and tend to default to the teaching methods they were exposed to as students and that were "relatively ineffective" (p. 176). Felder (1993) points out that as the professors attempt to make the course material as interesting and understandable as possible they often encounter inattentive students, poor exam grades, and evaluations that rate the instructor and the course as poor. Some of these professors learn better ways to teach during the course of their careers, but others never do, and as a result use ineffective teaching methods throughout their careers.

Felder (2003) acknowledges that the problem of teacher training for college professors is not unknown and that some universities are taking steps to address the situation. Some of these schools offer graduate courses on teaching, hold teaching workshops for faculty, and provide teaching consultations that critique video-taped lessons and end-of-course evaluations. According to Felder (2003), these are worthwhile programs and should become the norm rather than the exception at universities, but are limited in what they can accomplish. He states that one cannot become a skilled teacher in the course of one-hour consultations or over the course of a semester. Felder (2003) also stated that "True skill development only occurs through repeated practice and feedback." (p. 176)

The majority of academic departments in each institution have at least one professor that is acknowledged as an outstanding teacher by their peers and the students (Felder, 2002). These model teachers have learned how to put together interesting yet rigorous lectures and have designed tests and assignments that are comprehensive and challenging yet are also interactive and fair. These professors have found a way to motivate the students and become involved in their own learning, in addition to helping them develop critical thinking and problem-solving skills.

Many professors collaborate on research, but usually they do not collaborate on teaching (Felder, 1993). Thus, many professors go through their own trial and error approach to teaching, leading them to seldom having the benefit of their colleague's knowledge and experience. Felder (2003) has several recommendations to help professors learn effective teaching practices and creating a peer network for sharing effective ideas. He recommends a team teaching effort between the new faculty member and a faculty member that has received recognition as an excellent teacher. He also recommends a minimum of two courses taught in this co-teaching manner. One course would be taught primarily by the senior professor acting as a mentor and the second course would be taught primarily by the junior professor with the senior professor acting as a consultant. The mentor will observe classes, offer feedback, and participate in meetings to discuss the class. The mentor should help the protégé find the methods that best work for him/her and are best suited to their strengths and weaknesses.

To help generate interest and alleviate stress for the senior faculty member, Felder (2003) recommends that the department head should offer incentives for the senior faculty member to participate. Ideally these incentives might include additional compensation, like a summer stipend, release time or a travel grant. Felder (2003) sees this as a mutually beneficial situation for improving teaching quality.

In conclusion. In the aforementioned studies and papers, two of the researchers, Lee (2001) and Felder (2003) looked primarily at faculty already in the field, the level of preparation of those faculty members and the way they taught. Huang, et al. on the other hand looked at future faculty members that will be teaching, what they knew about teaching and their experience levels. The Huang et al. study was limited in the fact that participants were self-selected but they did participate in the ETP program, giving the participants tools and knowledge to use in their teaching. An interesting factor that was present in all three studies is that they all mentioned that without additional pedagogical training, faculty members tend to revert to what they know and typically use a lecture-style instructional method.

The literature contained in this section was the driving factors in asking what sort of teacher training computer science faculty members received. By understanding the amount of training faculty members received it will be easier to springboard interventions and additional training to reduce the effect of minimal teaching method usage on student satisfaction and thus retention.

Looking at the preparation faculty members receive prior to teaching an undergraduate computer science course is important in that it gives us an insight into how and why instructors choose their methods of instruction. The amount of training they received, the knowledge they possess about pedagogical approaches, and their comfort in a classroom may also influence their beliefs about how important effective teaching is, especially if they were comfortable using methods that they themselves learned from successfully.

Beliefs about the importance of effective teaching

It is necessary to look at the importance that computer science faculty members place on effective teaching practices in order to understand their point of view towards teaching in general. It is possible that some faculty members perceive teaching as a chore that they must do for their jobs and feel that it is not necessary to teach the material in ways that reach the most students. While other faculty members might feel that teaching is just as important as other job aspects and look for ways to reach students more effectively. This section presents the primary study of engineering schools as a whole. Despite the fact that only 4% of the respondents are computer science faculty, the responses are significant in that it is still looking at faculty members who are required to teach with little or no formal training.

Brawner, Felder, Allen, and Brent (2002) looked at the importance of effective teaching to engineering faculty and administration. Brawner et al. (2002) surveyed members of the Southeastern University and College Coalition for Engineering Education (SUCCEED) which includes among its goals, "persuading and preparing engineering faculty to adopt effective teaching practices and improving the campus climate for undergraduate engineering education." (p. 1) SUCCEED is made up of eight engineering schools in the Southeastern United Sates. These schools include Clemson University, Florida A & M, Florida State, Georgia Tech, North Carolina A & T, North Carolina State University of Florida, University of North Carolina, and Virginia Polytechnic University.

The SUCCEED program was designed and implemented as a faculty development program which includes workshops for teaching effectiveness, workshops geared toward helping administrators mentor and support new faculty members and implementing measures to create and sustain engineering faculty development. Assessing these efforts was undertaken through two administrations using a survey in 1997 and 1999. The primary direction of the survey focused on rating the importance of effective teaching to the faculty member, the faculty member's colleagues, the administrators of the institution and the rewards for faculty for innovative teaching.

The survey

The survey was sent to all 1621 SUCCEED faculty members using e-mail addresses. A month later, faculty members who had not responded were sent a follow-up survey. Duplicate surveys were discarded through the use of the respondents e-mail addresses, and if available the names of the respondents. In the case of such duplications the first survey submitted was the one used. After discarding duplicates and blank or unfinished surveys there were a total of 586 viable surveys, a return rate of 36%. Of the 586 respondents, 579 reported their gender and 91% of those were men. The respondents had an average of 15 years of experience as a faculty member.

The respondents' sex, rank, position, years of service, Carnegie classification, attendance to teaching seminars and workshops and their level of involvement with SUCCEED were the attributes used to categorize the survey responses. In order to identify significant differences among groups, they eliminated some low incidence groups from the analysis. For example, if there was a woman who was among the "instructor/lecturer" group she would be excluded from the rank analysis but would be included in the gender analysis. They made three adjustments to the data. The first such adjustment eliminated the 53 respondents who listed their rank as anything other than assistant professor, associate professor, or full professor. Department heads were combined with the "dean's office/other administration" category. With this change 19 people were eliminated due to having listed their position as research or other. The final adjustment took place in the level of involvement in SUCCEED, eliminating the four individuals who listed their involvement with SUCCEED as "other." In order to ensure a better portrayal of those faculty members that teach undergraduate classes, the 75 faculty members that indicated that they had not recently (during the prior three years) taught undergraduates were asked to complete only demographic questions. In the 1997 survey the faculty members who were not currently teaching undergrads had not been eliminated.

The results were similar across both the 1997 and the 1999 survey in regards to the importance of effective teaching with a few exceptions. Effective teaching was defined by Brawner et al. (2002) as "teaching that sets high but attainable standards, enables most students to meet or exceed the standards, and produces high levels of satisfaction and self-confidence in students." (p. 8) The average rating for the importance of effective teaching, as it related to colleagues, had decreased a significant amount from a mean of 5.42 in 1997 to a mean of 5.21 in 1999. This indicated that faculty members felt that the importance of effective teaching had decreased for their fellow faculty members. Additionally, the importance of innovative teaching as part of the reward system also decreased from a 3.72 to a 3.50. The faculty members rated the importance very highly in regards to themselves. However, they gave their department heads significantly lower ratings and gave the administrators, colleagues, and dean even lower ratings than they gave the department heads. The ratings for importance of effective teaching were especially shown to change at research institutions and the importance of innovative teaching dropped among those faculty members who had attended a teaching seminar during the previous year.

The 1999 survey showed some success in SUCCEED's goal to persuade faculty members to adopt instructional practices that had been proven to promote learning effectively, such as active learning and group based activities. However, according to the researchers, the survey showed that the climate for teaching at their institutions grew worse though they did not present numbers for this claim. There was a wide-spread belief among the respondents that while effective teaching was very important to them personally it was less important to their colleagues, department heads, deans, and administrators. Both male and female respondents had a mean of 6.50 on the question regarding how important effective teaching was to them personally, where as for how important it was to colleagues, department heads deans and in a reward system the means were much lower. Men typically rated the importance to others higher than did women. Men typically had a means between 5.16 and 5.63 for other members of the university settings where as the women had means from 4.63 to 5.10. Additionally there was general agreement that effective and innovative teaching ("testing new instructional methods, writing textbooks or instructional software" (p. 8)) did not factor highly into the faculty reward system. Both subgroups had means around 3 for importance of effective teaching in a reward system and innovative teaching in a reward system. Again, the men typically had a mean of about .2 higher than the women.

Women respondents typically rated effective teaching as lower importance to the administrators and colleagues than did men (a mean of 4.63 as opposed to a mean of 5.27 for men). According to the researchers, assistant professors rated effective teaching lower than did associate professors and in turn associate professors rated effective teaching lower than did full professors. However, there were no numbers presented to back up this claim. They did present the number of faculty members that participated in the survey based on rank but did not break down the survey results according to rank. The administrators rated both the importance of effective teaching to themselves and their colleagues consistently higher than the rest of the faculty. They also rated the reward system higher. Overall the ratings were higher at masters (or teaching) universities than they were at research institutions. While they did present means and standard deviations for survey results based on primary academic functions (teaching vs. teaching/research or administration) it was unclear whether they were determining the differences between teaching universities and research institutions from this data.

Brawner, Felder, Allen, & Brent (2002) inferred that those faculty members who spend time in faculty development programs as well as learning and implementing new teaching techniques do so in spite of a belief that such efforts will not be appreciated or rewarded by their institutions or colleagues. However, despite this belief, Brawner et al. (2002) found that many faculty members choose to put forth the effort to make teaching more effective.

The mission

According to Felder and Brent (1999), each organization whether it is a corporation or an academic institution has two separate missions. Each organization has a *stated mission,* that is designed for public consumption and a *true mission*, that determines how resources are allocated and performance is rewarded (Felder & Brent, 1999). In the modern university, teaching is only one of several functions that are of importance. Universities are also interested in research, and service (Felder & Brent, 1999). The true mission of a university might be to maximize research funding and expenditures, tuition revenues, national rankings and the rate of graduating students (Felder & Brent, 1999). Too many institutions value research and grant writing by faculty at the expense of effective teaching at the undergraduate level (Tucker, 1996), in which case instructors might feel pressures to put as many students as they can through the program in as little time as possible (Felder & Brent, 1999). Depending on where teaching ranks among the important functions of the true mission, the attitudes of the faculty members may differ on how important they find teaching.

In conclusion. The study discussed in this section focused primarily on the importance that computer science instructors place on effective teaching. The Brawner et al. (2002) study also discussed how rewards and incentives influenced the importance faculty members placed on effective teaching. These two premises are two of the driving questions of this study and as such are of utmost importance. There is a difference between teaching and effective teaching. Effective teaching involves delivering content in a way that ensures the success of the largest number of students without compromising content, while teaching is just the act of delivering material to the students.

Summary

The literature contained in this chapter helped the development of the research questions in multiple ways. The first research question about the importance of effective teaching to CS instructors teaching undergraduate courses was mainly influenced by the Brawner, et al. (2002) study. The results of the Brawner, et al. (2002) survey show how faculty members rate the importance of effective teaching based on how important they perceive their institution rates teaching. However, only 4% of the respondents of the Brawner, et al. (2002) survey were from computer science departments. Therefore it is essential to query a larger sample of computer science faculty to see if the data in the Brawner, et al. (2002) study holds true. The importance of effective teaching to faculty members is essential. If faculty members don't feel effective teaching is important, they will likely be less willing to try new methods in their classroom.

Additionally, as a subset of the importance of effective teaching is the question of incentives and rewards for innovative teaching methods. This question is directly related to the importance of effective teaching because organizations that find teaching to be of extreme importance would be more likely to offer more incentives and rewards for effective and innovative teaching.

It is known, based on the literature of teaching styles and methods, what is typically used in the computer science classroom and what methods can be used. It is also know based on the information provided by Lee (2001), Brawner et al. (2002), and Brent and Felder (2000) that most institutions do not offer incentives or rewards for teaching innovation. Brawner, et al., and Lee point out that most faculty members who try new methods usually do so without expectations of recognition.

The information contained in this chapter about teaching methods as well as the college student development theory helps to answer the question about effective teaching. In order for college professors to teach effectively they need to understand how students think and what teaching methods are available. Additionally, the information about teaching styles and methods in computer science classes help to identify the current teaching practices and beliefs of computer science faculty.

Teacher training that computer science faculty members receive is an important aspect of teaching to consider. As pointed out by Lee (2001), Felder (2000), and Huang, et al. (2005) most college professors are considered qualified to teach because they have a higher degree. However, the amount of preparation they receive is usually minimal. In order to understand their beliefs and practices in the classroom the level of teacher training needs to be examined. This is why the literature about teaching methods and college student development is of importance to this study.

Chapter III

Methodology

This chapter is designed to explain how the study was conducted. It begins with the purpose of the study and the questions that guided the research. A description of why these questions are important then follows. Next, the procedures used in selecting participants are discussed, followed by a description of the data collection process and the instrument of measurement. Instrument validity and reliability are then assessed, followed by a description of data analysis that summarizes the methods used to analyze the data and answer each of the research questions.

Purpose and Research Questions

The purpose of this study is to examine how faculty members of computer science view teaching in undergraduate classes. The questions that guided this study are: 1) How important is effective teaching to computer science faculty members at the undergraduate level and how important do they perceive effective teaching to be to their institution? 2) How much teacher training have computer science faculty members received? 3) What do computer science faculty members believe about teaching? 4) What are the current teaching practices of computer science faculty members and what influences those practices? 5) What incentives or rewards are offered to faculty members who try innovative teaching methods or receive additional training?

Research question one looks at the importance of effective teaching to faculty members who teach undergraduate computer science courses. This is important to this study because many faculty members apply to institutions that reflect what they desire most in their careers. Faculty members who prefer to focus on teaching rather than research would be more likely to end up at a college or a university that puts more emphasis on teaching. Likewise, faculty members who are more interested in research are more likely to look primarily for research positions in which teaching matters little or not at all. In computer science departments that achieve a higher rank for undergraduate education, teaching is usually given higher priority than research. This is not to say that teaching, especially at the undergraduate level, is not important at schools that give higher priority to research.

In the past, computer science has tended to be well-funded by research and, as a result; many of the students at the graduate level have had their tuition paid by the department. With research funding becoming more difficult to acquire, these institutions have begun to realize that undergraduate students are a major source of revenue that they can't afford to overlook. In order to increase this revenue, faculty members are encouraged to focus on bringing in more undergraduate students. One way to achieve this goal is to increase the emphasis on teaching, both at the institutional level and at the individual level.

It is important to understand how faculty members perceive the importance of teaching at their institution because it may influence their willingness to invest extra time in teaching. Perceived importance may also be related to job title and/or current tenure status. Non-tenured faculty members tend to be younger professionals, just out of graduate school, or individuals hired only as teaching faculty. The younger faculty members may have been exposed to alternative, more student-oriented methods of teaching during their school careers and, as a result, may be more willing to try such methods in their own classes. However, because they are new faculty members, their future tenure cases hinge in-part on research and teaching. As a result of this pressure, they may be less willing to deviate from a traditional method for fear it will adversely impact their chances of getting tenure. While teaching faculty members do not work toward tenure, they may have more pedagogical training. Therefore, due to the additional training they may try alternative teaching methods. However, they may also be afraid to deviate from traditional methods for fear of losing their jobs.

On the other end of the spectrum are the tenured faculty members. Tenured faculty members are typically individuals who have been a member of the faculty for a minimum of six years. Tenure usually gives faculty members job security because they cannot be fired unless found guilty of a gross misconduct, which tends to be a lengthy, expensive, and uncommon procedure. Therefore, the teaching practices of tenured faculty can be influenced in one of two ways. Due to the fact that they have tenure, faculty members may feel that they no longer have to worry about how students perceive their teaching because it will not change their job status, though it may have some small impact on yearly raises. Alternatively, they may choose to try different methods because they can experiment and try new things without fear of reprisal.

Research questions two, three, and four investigate the amount of teacher training faculty members received, their theoretical beliefs and their current teaching practices, respectively. These questions are discussed together below, because their answers may be inter-related. Teacher training may affect instructor beliefs, which in turn may affect their practices.

Understanding the amount of teacher training that computer science faculty received (research question two) is important because it may help explain their beliefs and practices. The behaviorist methods of teaching have been immensely popular in the past (Grasha, 2002). As a result, the majority of current faculty members were probably taught using the behaviorist methods such as lecture, or question and answer sessions. Behaviorist methods are largely teacher-oriented in which the instructor delivers the information to the students and then expects specific responses to given stimuli. According to Lee (2001), faculty members tend to follow the path of least resistance and teach the way they were taught. Therefore, it is expected, by the researcher, that faculty members with little teacher training will teach in the same way.

The current, more popular theory of instruction is constructivism. Teacher training workshops and programs tend to focus on the most popular approaches to instruction at the current time; therefore the training would most likely have occurred after the decline of the behaviorist popularity. Therefore, it stands to reason that faculty members who have had teacher training may be more oriented to the constructivist view of teaching practice. Research question three investigates the beliefs of computer science faculty. Together research question two and three can therefore help understand whether indeed training and beliefs are related and to what degree this relation is consistent with the conjecture stated above.

The constructivist view is largely student-oriented, rather than teacher-oriented and controlled (Felder, 1993). The instructor that uses the constructivist view tends to facilitate the students' construction of knowledge, rather than simple memorization and regurgitation of material. Among the more constructivist approaches to instruction are peer instruction, active learning and cooperative groups. Research question four investigates current teaching practices and the factors that influence them. It is especially interesting to observe whether practices are truly consistent with beliefs. For example, do faculty members who appear to believe in constructivism truly follow the constructivist practice? It is also interesting to understand the extent to which teacher training translates into constructivist practice. For example, do those computer science faculty members who receive more training tend towards practices that are more consistent with constructivism? Yet another interesting issue is to understand factors that affect exploratory practice. For example, are faculty members with tenure more likely to experiment with new teaching methods?

Research question five looks at the incentives and rewards that faculty members currently have access to and the ones they desire. Incentives and rewards are essential to understand because they are sources of motivation for faculty members. If the incentives and rewards are not sufficient, faculty members will not be as inclined to innovative teaching. Related to the use of incentives and rewards for teaching are the deterrents that influence the choices related to teaching methods. While it is important to understand what faculty members would prefer for an incentive or reward for good teaching it is also important to understand what keeps them from trying new methods.

Participants

The participants of this study were randomly selected from computer science departments in American colleges and universities. Seventy schools were randomly selected from all American colleges and universities that have an undergraduate computer science program. From these schools, an email database was manually compiled by the researcher in order to elicit participants. Extreme care was taken to exclude faculty members who did not meet the criteria for this study. Those excluded were faculty members who: a) do not teach undergraduate courses, b) were emeritus professors or c) were adjunct or part-time professors. Adjuncts and part-time faculty were excluded because many of these faculty members were from other departments and rarely taught exclusively undergraduate computer science courses. The final list contained approximately 1000 email addresses spanning a minimum of 70 colleges and universities. To increase the possibility of responses, the researcher recruited a well-known computer science researcher, and faculty member, to help communicate with other faculty members. Due to a conflict of interest, this computer science researcher did not participate in the study but helped solicit responses.

The participants were solicited through emails sent in July 2008 using Survey Monkey's (www.surveymonkey.com) email tool. The survey was hosted on Survey Monkey's secure site which allows researchers to send emails and track the responses anonymously. This allows the researcher to track responses without accessing what had been answered by a particular respondent

Though approximately 1000 emails were sent out initially over 300 emails were returned as incorrect or no longer valid and, as such, undeliverable. Though an attempt was made to correct the invalid addresses, more current addresses were not available. Of the remaining 700 emails that were delivered, more than 150 resulted in an auto-reply of being out of the office due to vacation or sabbatical. Additionally, a small number of emails were rejected by the recipients' server because the researcher's email address was unknown to the recipient. Additional attempts were made to contact those faculty members who were on vacation.

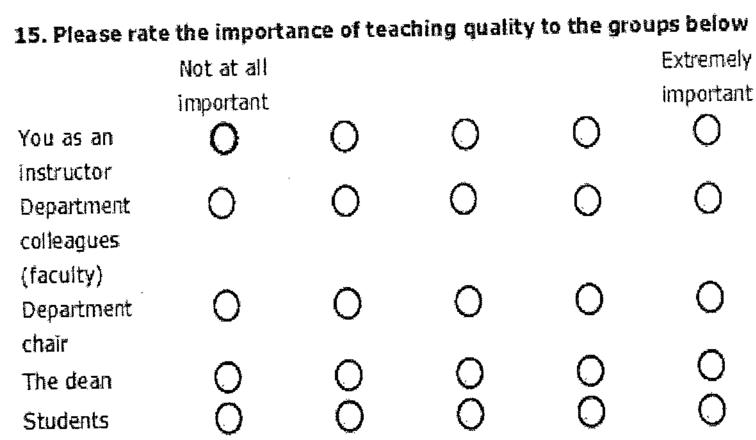
Participants were computer science faculty members who teach at the undergraduate level at colleges and universities. The term faculty members refer to Instructors, Assistant Professors, Associate Professors, Full Professors and those identified as "Other" in all areas of computer science. Computer science faculty members include Americans and foreign nationals. The breakdown of participant percentages will be discussed in chapter four. For the purpose of this study, the original nationality of the professors will not be examined beyond frequencies. The participants were grouped according to job title and number of years of experience.

Data Collection

Introduction

The data collection process was carried out through the use of a web-based survey (Appendix A) hosted on Survey Monkey (http://www.surveymonkey.com) in July and August of 2008, and was sponsored by the researcher. Survey Monkey is a web-based company that is dedicated "to enable **anyone** to create professional online surveys quickly and easily (The Simple Way to, 2008)." A web-based survey was chosen as the method for data collection in deference to the preferences of the population being surveyed. A brief personal survey was taken of approximately 30 computer science faculty members. These faculty members were asked which type of survey they would be more likely to complete, paper-based or web-based. All but one faculty member responded web-based because they would be less likely to lose it and more likely to complete it when received.

The survey consisted of questions adapted from Grasha (2002), and Brawner, et al. (2002), as well as some newly constructed questions. Grasha (2002) explores teaching styles and methods at the college level as they apply to constructivism, behaviorism, and humanism. For the purpose of this study, the questions adapted from Grasha's (2002) research included ones about teaching styles and ones referring to constructivist and behaviorist teaching theories. Humanism was not among the teaching theories explored in this study and therefore was not included in the survey questions. The reasoning behind excluding humanism is that it is not one of the more prevalent learning theories in today's educational environment. The Brawner, et al. survey focuses on the importance of effective teaching at the college level. For the purpose of this study the questions about effectiveness and its importance were adapted for use. Examples of those questions are shown in Figure 4. Additional questions were developed to solicit demographic information and determine reward or incentive systems that are currently in place or are desired by faculty members.



15. Please rate the importance of teaching quality to the groups below

	Not at all important				Extremely important
You as an instructor	○	○	○	○	○
Department colleagues (faculty)	○	○	○	○	○
Department chair	○	○	○	○	○
The dean	○	○	○	○	○
Students	○	○	○	○	○

Figure 4. Example of question about importance of effective teaching (adapted from Brawner, et al. 2002).

The questions that were adapted from the Grasha and Brawner, et al. surveys were rephrased to make comprehension easier. The mode of answering was also changed in some cases, for example, by changing from rank ordering to a yes/no response. These changes were made in an effort to make the data analysis simpler and to reduce the complexity of the instructions. An example of a question that has been reworded is shown in Figure 5. Important consideration was given to determining the presence of any bias, which might unintentionally lead participants toward a given answer.

17. Rate each of the following statements as to how well they fit your beliefs teaching.

Adapted from Grasha(2002)

	Strongly Disagree	Slightly Disagree	Slightly Agree	Strongly Agree
The development of students' capacity to solve problems is most important.	○	○	○	○
Students learn best if material is broken down into small discrete steps rather than giving them a big chunk of information at once.	○	○	○	○
Problem solving must be taught to students rather than assuming that problem solving is already a skill the students possess.	○	○	○	○
The best way to motivate all students is through grades rather than through content or teaching method.	○	○	○	○
Coursework should be used to develop critical thinking abilities.	○	○	○	○
In order for learning to occur, organization and structure are essential.	○	○	○	○
The natural limitations of students' information processing abilities should be taken into account when planning instruction.	○	○	○	○
Instructors should allow time in the course for students to learn at their own pace.	○	○	○	○
Presenting information in several different contexts help students learn the concept thoroughly and help them to generalize the concept to other contexts.	○	○	○	○
Students should be allowed to retake course exams until mastery is achieved.	○	○	○	○
Students need to develop ways of organizing information for themselves.	○	○	○	○
Students need to be extrinsically rewarded for completing course assignments in order to develop and maintain an interest in them rather than be intrinsically motivated by teaching method or course material.	○	○	○	○

Figure 5. Example of a question that has been reworded and mode of answering has been changed. (Adapted from Grasha, 2002).

Newly developed questions were tested on two small focus groups made up of five computer science PhD students and five faculty members. The PhD students were used as part of a focus group because they had been TA's in charge of an entire class or in charge of review classes. The questions were tested by having the focus groups answer the questions and then write beneath the question what they thought they were being asked. Between the faculty members and the PhD students there was an 80% agreement on what was being asked.

An initial email soliciting participation was sent using Survey Monkey's email tool. Survey Monkey's email tool helped to preserve the anonymity of the respondents. The email tool sends a unique link to each email address, and tracks the responses as participants complete the survey or opt-out. While it is possible for the researcher to view which email addresses have responded, he/she cannot view the individual responses. A follow-up email was sent, after three weeks, to faculty members who had not responded in order to elicit additional responses. These email solicitations resulted in a total of 321 responses. Though there was the possibility of collecting additional responses if a second follow-up email was sent, this number of responses was deemed sufficient. Moreover, the researcher hesitated in sending an additional follow-up email to the potential participants because she did not wish to alienate the population she was trying to help. Due to Survey Monkey's tracking ability there were no duplicate submissions. However, some surveys had to be removed because they were largely incomplete or had no teaching experience with undergraduate classes.

Instrumentation

The instrument of measurement was a survey hosted on the secure web survey site www.surveymonkey.com. This site stored the data on its server until the researcher was ready to download it and analyze it. This section describes the instrument (survey) used to collect the data. The discussion of which survey questions were used to address each of the different research questions is presented later in this chapter under Analysis of the Data.

The 37 question survey (Appendix A) was broken into six sections of different sizes. Prior to beginning the survey, a page with a disclaimer, including implied consent and the researcher's contact information, welcomed potential participants. Withdrawal from the study was not possible due to the anonymous nature of the data collection. If the respondent clicked next, they agreed to take part in the study with the understanding that they had the right to quit the survey at anytime or to skip questions. They also agreed that there were no direct benefits to the study.

The first section included 12 demographics questions, primarily questions 1-6, 8,9, and 11-14. They asked for information such as participant age, highest degree, and job title, along with other questions. The second section of the survey had two questions. The first question had five-parts in which respondents were asked to rank the importance of effective teaching to themselves and other members of their department (see Figure 4). This question was modified and used with permission from Brawner et al. (2002). The second question asked if teaching quality was recognized as part of an incentive or reward program at their institution. While these questions were not part of the data analysis for the research questions, they were integral in understanding the results of the data analysis.

Section three of the survey contained nine questions that were designed to determine faculty members' teaching practices and beliefs. The first question, number 17 (Figure 5), adapted from Grasha (2002), was used to determine whether faculty members tended to believe more in constructivism or behaviorism. Unlike Grasha's original measure, the statements reflecting the theory based on humanism have been removed, since this study is based primarily on constructivism and behaviorism. Scoring for this particular series of statements was on a four point Likert scale, which is different from Grasha's original seven point Likert scale. The score for the six statements for constructivism and the six for behaviorism were added together, resulting in a behaviorist score and a constructivist score. The higher score was considered the most prevalent theory upon which faculty members base their teaching beliefs. The next four questions, 18 through 21, pertained to class preparation, office hours, and advising undergraduate students. Question 22 asked faculty members to choose the statement that best reflected how they expected students to gather information.

The final questions in this section pertained to how often faculty members used certain teaching methods in their classrooms (question 23), the personal interactions between faculty and students (questions 24), and the use of team projects (question 25). Questions 17 through 23 explored what faculty members believed about teaching and what practices they used in their classroom.

The fourth section of the survey was designed to determine the amount of teacher training or preparation that faculty members received. Question 26 asked which services faculty members had available to them at their institution, while question 27 asked which of those services they used. Questions 28 and 29 involved the likelihood of attending teaching development workshops if they were offered and how likely the respondents would be to experiment with new teaching methods. They were followed by one (question 30) that asked what factors deterred a faculty member from experimenting with new teaching methods. The final three questions (questions 31 through 33) investigated the frequency with which faculty members collaborated with fellow faculty or graduate students and how frequently they solicited feedback from the students.

The fifth section of the survey asked about the incentive and reward programs that were in place for faculty members to learn or attempt new teaching methods. Question 34 asked to what extent innovative teaching was considered as part of the rewards program. Question 35 inquired about the incentives that were available to faculty members for innovative teaching while question 36 asked what faculty members liked to have for incentives or reward programs.

The final section contained one multi-part question that asked the faculty members to rate how much each factor influenced their choice of teaching methods. These influencing factors included items such as knowledge of different methods, time, availability of support, and class size. This question, in conjunction with question 30 were used determine the major influencing factors that tended to encourage or deter faculty members when it came to choosing teaching methods. On the final page, an open-ended comments and suggestions text box was provided for participants to use if they chose.

On completion of the survey a new page opened, containing a thank you note with the contact information of the researcher. A link on this final page directed the participants to the researcher's web page, which contained contact information and curriculum vitae.

Reliability and Validity

In order to address the reliability and validity of this instrumentation, it is best to review the definitions of reliability and validity. Reliability refers to the extent to which an instrument yields consistent results. Validity refers to the extent to which an instrument measures what it is intended to measure.

Content Validity

Prior to the administration of this instrument, both face and content validity had been determined. As face validity is not rigorous enough and is largely ineffective in truly determining validity (McGartland Rubio, 2005), a content validity index (CVI) was performed. The CVI was performed with two computer science faculty members and three educators as experts. The CVI looked at all questions except the demographic questions (items 1 through 14) and asked the experts to determine the representativeness of the questions. In order to do this, each question was defined by the researcher to state what was being measured. Based on this definition, the experts were asked to score how closely this question represented what the researcher intended on a four point scale. A score of one indicated that the item was not representative, and a score of two indicated the item needed major revisions. These two scores are considered as a negative response in relation to the CVI. A score of three indicated the item needed minor revisions, and a score of four indicated the item was representative. These scores are considered as a positive response and count toward the percentage of validity.

When scoring the CVI, the scores are broken into two categories, scores of one or two and scores of three or four. To calculate the CVI the percentage of questions with a score of three or four is determined. In this instance, there was one question that two members of the expert panel felt needed major revisions thereby making the CVI 97%. The item in question, item 30, was repaired by rewording some of the parts.

Reliability

This survey was designed to record individual opinions on a Likert scale, rather than defined answers; this complicated the reliability analysis through more traditional reliability measures, such as, test-retest reliability. In cases where more traditional methods of testing reliability are not feasible, researchers can use Cronbach's alpha, also known as the correlation coefficient. Cronbach's alpha is based on the mean (absolute value) correlation for all possible variable pairs, thus providing a conservative estimate of reliability. This conservative estimate generally represents the lower bound to the reliability of a scale of items (Guidelines for, 2008). To test the reliability of this instrument, Cronbach's alpha was calculated for different subsets within the survey that were intended to measure different constructs. These constructs were measuring participants' level of agreement with a given statement on a Likert scale. The first scales that were measured with Cronbach's alpha were the scales that determined the importance of teaching quality to different groups. They are represented by question number 15. Cronbach's alpha for this scale was .69, which is slightly lower than the .70 threshold for reliability. However, due to the fact that Cronbach's alpha is a conservative estimate of reliability, one could still consider this scale reliable.

The Cronbach's alpha for the questions intended to measure the behaviorist and constructivist scales individually were extremely low with .35 and .45 consecutively. These scales were borrowed from Grasha's (2002) self-assessment for theoretical beliefs and though he reported consistent results he did not mention reliability measures. However, Grasha (2002) emphasizes that instructors do not focus on only one theory and that their practices often reflect more than one theory. In other words, instructors often mix and match elements of different beliefs, combining both behaviorist and constructivist ideas. This "mixing and matching" tends to lead to lower correlations between answers to questions intended to measure the same belief, and hence lead to a low Cronbach's alpha. With that interpretation, the researcher decided to use Grasha's scale, despite its low reliability, as it remains a probable indication of the respondent's prevalent (albeit non-exclusive) belief.

Analysis of the Data

Survey Information

The survey data were exported from Survey Monkey into SPSS 13.0 statistical software for analysis. Survey responses were classified according to respondent's age, position, and the years of teaching. Means, population sizes (Ns), and standard deviations were calculated for the data. In addition, Pearson's Correlations and one-factor analysis of variance (ANOVA) were used in some instances to determine significant differences between groups. For ANOVAs with more than one comparison group, Tukey's post hoc tests were completed. All significances were determined at the .05 alpha level.

Out of the initial 321 responses received, six surveys were discarded due to being more than 50% incomplete, leaving a total of 315 valid survey responses. These responses were used in the following analyses.

Research Question Testing

Research Question 1: Importance of Teaching. To answer research question one, which addresses the importance of effective teaching to both the individual and the institution, analysis was performed on the data involving job titles, tenure, and primary job responsibility, of which teaching is a part. The survey questions related to these data were question five, which asks for faculty member's job titles, question seven, which asked for the importance of various job responsibilities (such as teaching, research and service) to the respondents, question eight, which asked if faculty members currently have tenure and question 10, which asked faculty members what they perceive as their institution's prioritization of the same responsibilities. In order to comprehend the breakdown of percentages based on the answers of the participants, the data were presented as crosstabulations describing the relations between job title and the personal importance of teaching, job title and the perceived importance of teaching to the institution, tenure status and the personal importance of teaching and tenure status and the perceived importance of teaching to the institution. Other demographics were not found to be consequential in relation to the importance of teaching; therefore their relation to the importance of teaching was not presented.

In order to analyze the data related to the importance of teaching several one-factor ANOVAs were used to determine the statistical significance of difference in responses between groups. Prior to running the ANOVA, respondents were divided by job title, and descriptives (means, population sizes and standard deviations) were run on the data to determine the relation between the respondents' job titles and the importance of different job responsibilities to them personally. The first one-factor ANOVA that was performed looked at differences in the importance of various job responsibilities to the participants based on their job titles. Due to the fact that more than two groups were being compared, a Tukey's post hoc test was run to determine where the differences lay. Significance was determined at the .05 alpha level.

The second part of analyzing the importance of different job responsibilities to the individual and the perceived importance of these responsibilities to the institution involved examining the data from question 10, which asked faculty members for their perceptions of the priorities of the institution and question five, which asked for job titles. Prior to running an ANOVA, descriptives were run to determine the relation between the participants' perceptions of the priorities of the institution and their job title. Due to a significant difference between groups for the priority of teaching, a Tukey's post hoc test was run to determine where the difference was located.

To further analyze the data pertaining to the importance of teaching to self and the institution, a Pearson's correlation was run based on the personal priorities of job purpose compared to the perceived job priorities of the institution. Pearson's correlation was also run to compare the personal priorities of job purpose. Correlations were deemed significant based on the .05 two-tailed alpha level.

Research Question 2: Teacher Training. To answer research question two, which addresses the amount of teacher training faculty members received, analysis was performed on the data involving job titles, training received prior to teaching undergraduate computer science, teacher training services offered by the institution, and teacher training services used by the participants. The survey questions related to these data were question five, which asked for faculty member's job titles, question 13, which asked if participants had received teacher training prior to beginning to teach, question 26 which asked participants what teacher training services are offered by their institution and question 27 which asked participants what teacher training services they used. Data on the teacher training services offered and used were re-coded for easier analysis. Recoding the data involved assigning a value of one for services that were offered or used and a value of zero for services that were not offered or used. To calculate the amount of teacher training faculty members received, the values from the six different teacher training services offered or used were added together to create a sum score, the higher the number the more training services participants had used.

In order to comprehend the breakdown of percentages based on the answers of the participants, the data were presented as crosstabulations describing the relation between job title and the amount of teacher training received at the institution, the relation between teacher training received prior to beginning to teach and the amount of teacher training received at the institution, and the relation between the amount of teacher training services offered by the institution and the amount of teacher training received at the institution. In order to further explore the relationship of the data regarding teacher training, descriptives for teacher training received prior to beginning to teach, the amount of teacher training services offered by the institution and the amount of teacher training services used were presented. In addition, two Pearson's correlations were performed on the data. The first Pearson's correlation compared the data on teacher training received prior to beginning to teach and the amount of teacher training services used at the institution. The second Pearson's correlation performed compared the data on the amount of teacher training services offered by the institution and the amount of teacher training services used by the participants.

Research Question 3: Teacher Beliefs. To answer research question three, which addressed the beliefs of faculty members as they relate to the theoretical constructs of behaviorism and constructivism, analysis was performed on the data involving job titles, age, behaviorist vs. constructivist beliefs, how students are expected to gather information, the amount of teacher training services used and teaching ability. The survey questions related to these data are question two which asked for participants age, question five, which asked for participant's job titles, question 14, which asked participants how they rate their teaching ability, question 17, which asked participants what they believe about teaching as it related to behaviorism and constructivism, question 22, which asked participants how they expect students to gather information and question

27, which asked participants which teacher training services they have used. The data involving the behaviorist and constructivist beliefs were used with extreme caution. Cronbach's alpha for these scales were extremely low, however, the researcher chose to still use the data. In order to use the data more efficiently the data was re-coded. The scores for the six items for each scale were added together then as the behaviorist scores were typically the lowest scores they were subtracted from the constructivist scores. The resulting scores were designated as the prevalent theoretical belief. Behaviorists were re-coded as zero, undetermined were re-coded as one, and constructivists were re-coded as two. The undetermined scores were those scores that showed the difference between constructivist and behaviorist scores to be .5 or less. Frequencies were subsequently determined for the prevalent belief of the participants.

In order to comprehend the breakdown of percentages based on the answers of the participants, the data were presented as crosstabulations describing the relations between age and prevalent belief, job title and prevalent belief, teaching ability and prevalent belief, ways students are expected to gather info and prevalent belief and the amount of teacher training services used and prevalent belief. In order to further explore the relationship of the data regarding the theoretical beliefs of participants, and to explore possible reasons for the lack of suitable reliability, the scores for behaviorist and constructivist beliefs were correlated with the scale items measuring these beliefs.

Research Question 4: Teacher Practices and Influencing Factors. In order to answer research question four, which pertains to faculty members practices and the factors that influence those practices, analysis was performed on the data involving participant's job titles (survey question five), current tenure status (survey question eight), participants theoretical beliefs (survey question 17), the average number of students in the classes (survey question 18), Average number of hours used for class preparation time per week (survey question 19), how many hours are set aside for office hours per week (survey question 20), and how many hours per week are set aside for advising undergraduates outside of office hours (survey question 21). In addition to these questions, survey question 24, which asked how well participants know their students names, question 25, which asked how often the participants uses team projects in their classes, and question 29, which asked how likely participants would be to experiment with new methods were also used. Descriptives and boxplots, showing means and medians, were calculated for the average number of hours amount of time spent for class preparation per week, the average number of office hours set aside for undergraduate classes, and the average number of hours set aside for the advising of undergraduate students outside of office hours. In addition to the descriptives and boxplots, crosstabulations were performed for the use of selected instructional methods based on job titles, the average number of students per class based on job titles, and the use of a team project in undergraduate classes based on job titles. Descriptives (Means, Ns and Standard Deviations), as well as, Pearson's correlations at the two-tailed .05 alpha level were calculated for current classroom practices and related factors such as the participant's behaviorist or constructivist beliefs and training received. These correlations were used to determine if there was a connection between behaviorist or constructivist beliefs and current teaching practices. Pearson's correlation was also used to determine if there was a connection between the amount of teacher training received and the teaching practices of the instructor. Finally, descriptive, and ANOVA calculations were performed on the likelihood to experiment based on tenure status, selected instructional methods based on job titles, knowing student names based on job titles, and the use of team projects based on job titles.

Research Question 5: Incentives and rewards. In order to answer research question number five, which involves looking at what rewards and incentives were available to faculty members for innovative teaching methods or participating in additional training, the questions involving the availability of rewards and incentives for the innovation of teaching were examined. Crosstabulations were performed for the incentives that were available (survey question 35) based on job title (survey question five) and the incentives that were desired (survey question 36) based on job title. Also looked at closely were the data involving the deterrents of using new methods (question 30) based on job title.

Additional Analysis

The data collected from the respondents was also analyzed by looking for dominant connections between questions; the researcher looked to see if certain groups tended to answer a certain way. For example, did professors, over the age of 50, answer that they were expert teachers or that they spent a large number of hours preparing for class. These connections were looked for by carefully studying the answers of the respondents and through the use of Rapid Miner, data mining software, available free of charge online. Unlike classical techniques for data analysis that require a researcher to identify dependent and independent variables then study their relations, data mining software automatically searches large data sets of dominant rules and correlations, then returns these dominant rules and correlations to the researcher. Data mining is therefore good at uncovering unexpected relations in large volumes of data that may not have been anticipated and hence may not have been explicitly looked at in other analysis. The researcher did not rely entirely on the data mining software analysis. If the data miner noted a specific trend; the researcher looked more closely at that portion of the data in order to draw her own conclusions.

The purpose of the analyses presented in this chapter is to determine how professors and instructors of computer science at the undergraduate level perceived the importance of teaching, how much training they received, their beliefs and practices as they related to teaching and what incentives they had for getting additional training or using other methods in the classroom. The hope is that by understanding these influencing factors, the researcher can help make recommendations to mitigate some of the issues facing computer science faculty members and the dissatisfaction of undergraduate students.

Chapter IV

Results

Organization of Findings

The purpose of this study was to examine how faculty members who teach computer science view teaching in undergraduate classes. This study was undertaken due to concerns, voiced by faculty members, about a general dissatisfaction on the part of students with the way the undergraduate courses were taught. Its intent was to examine the importance of effective teaching to computer science faculty and its perceived importance to their institutions. In addition to teaching importance, the beliefs and practices of the faculty members, the amount of teacher training received as well as the incentive and reward program were also examined. The following questions guided the development of the survey and the subsequent analysis of the data:

- How important is effective teaching to computer science faculty members at the undergraduate level and how important do they perceive effective teaching to be to their institution?
- How much teacher training have computer science faculty members received?
- What do computer science faculty members believe about teaching?
- What are the current teaching practices of computer science faculty members and what influences those practices?

- What incentives or rewards are offered to faculty members who try innovative teaching methods or receive additional training?

This chapter presents the analysis of the data from the web survey, and discusses results drawn from the data. The research questions are examined and answered as supported by the data. Other findings are discussed, based on data gathered from the participants and by the examination of trends found in the data set.

Survey Responses

Emails were sent in July 2008 to approximately 1000 potential participants; over 300 emails bounced back due to incorrect or invalid email addresses. Over the course of an eight week time frame, 10 people opted out and 10-15 individuals emailed the researcher explaining that while they would like to participate in the study they had various time constraints such as proposals for grants and paper deadlines that made it difficult to spare the time for the survey.

Additionally, approximately 30 faculty members emailed the researcher explaining why they felt that they would not be suitable for the study. For example, one person felt that, although he was co-listed as a mathematics and computer science faculty member, he would not be appropriate for the study due to the fact that he only taught a discrete mathematics course once, every other year, and that the designation as a computer science faculty member was only honorary. A few of the other faculty members that emailed the researcher about their unsuitability were surprised to find out that they were listed on the faculty page of the computer science department. They were surprised because they primarily teach in another non-related field, such as biology or medicine. These individuals had not been eliminated from the email list because there had been no indication that they were not computer science faculty. Taking into consideration the undeliverable emails, vacationing or absent professors and professors that were proven to be unsuitable for the study the total of 321 responses represented a return rate of approximately 50%.

Demographics

The questions

The survey included a total of 12 questions on demographics. Faculty members were asked to answer questions about the type of institution they were at, their age, native country, highest degree held, job title, focus within computer science, current and past tenure, years teaching, frequency of teaching undergraduate classes, training prior to teaching and teaching ability. The responses to these questions will be discussed in the subsequent paragraphs; however, for the purpose of this study only the data involving age, years of experience, job title, and current tenure status will be used in further analysis. Other demographics did not prove to be of significant correlation with answers to research questions posed in this study and hence analysis of those demographics is not reported.

The responses

The responses for all the demographics questions are contained in this section. These responses are discussed in terms of frequency. For those demographic questions used in the rest of the study, charts of responses are also presented.

Survey question one. Faculty members were asked what type of institution they worked at; Large or small state institution or large or small private institution. A total of 213 participants out of 320 (67%) answered that they worked at a large state institution, 83 (25.9%) worked at a large private institution. No participants answered that they worked at a small state institution and only 22 (6.9%) answered that they worked at a small private institution. There were two (.6%) participants that answered "Other", one answered that his/her institution was both private and state, and the other answered that his/her institution was semi-private and large.

Survey question two. The participants ranged in age from the 25-30 age bracket to the over 50 age bracket, with the highest number of participants (112 or 35.4 %) being over 50 years of age **(Error! Reference source not found.)**. Not surprisingly, given the participants ages, the largest number (91 or 28%) of participants had over 20 years of experience teaching undergraduate computer science courses. Less than 2% of the participants (6 respondents) responded that they had never taught undergraduate computer science but 73 (23%) of the participants responded that they had five years or less experience with teaching undergraduate computer science courses (Figure 7).

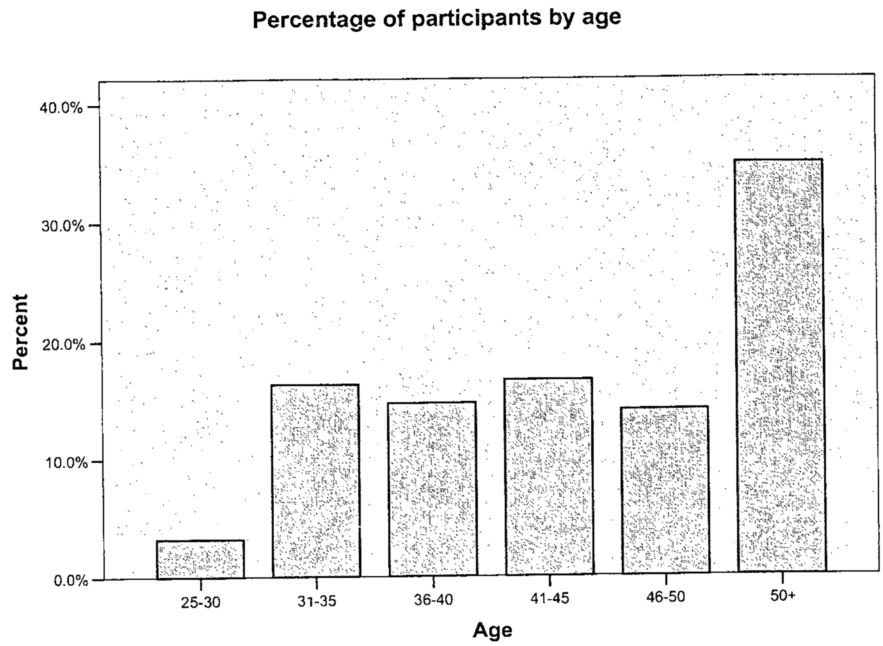


Figure 6. Percentage of participants by age.

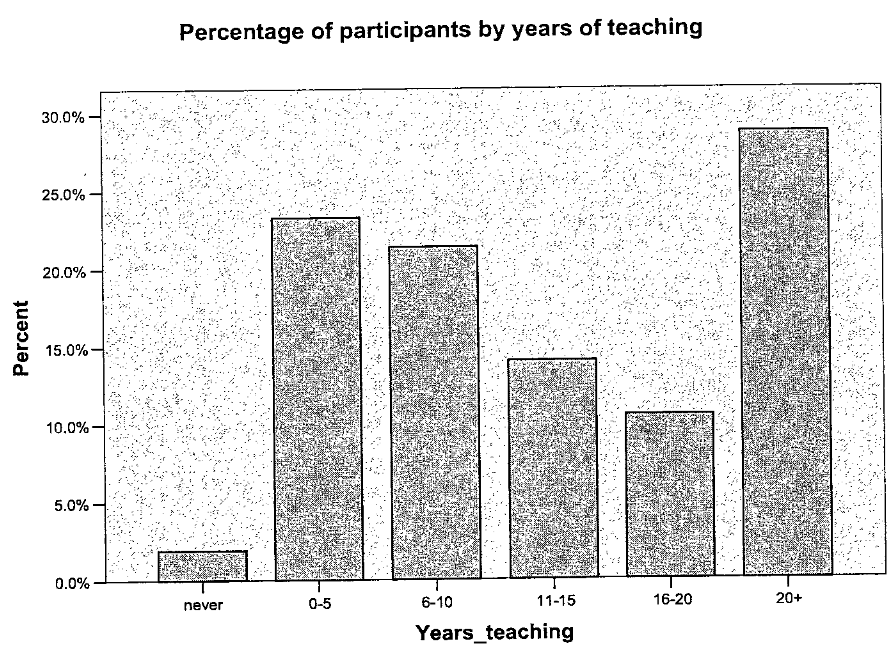


Figure 7. Percentage of participants by years of teaching.

Survey question three. In response to the question regarding the participants' native country, 213 (67%) of the participants listed the United States. The second and third most prevalent nationalities were India (8.5%) and China/Taiwan (3.8%), consecutively. Fifty-four participants (17.1%) listed their native country as "Other", 12 of the "Other" category listed their country as England or the United Kingdom. For the countries of Canada, Italy, Sweden, France, and Portugal, each was listed by 3 or fewer participants. Additional countries such as Russia, and Romania were specified by the participants who selected the "Other" category.

Survey questions four and five. When asked for the highest degree received by the participant, 285 (89.3%) answered that they had achieved the level of a doctorate degree. Twenty faculty members answered "Other" and ten (3.1%) answered master's. There were four participants (1.3%) who answered that the highest degree they had received was a bachelor's degree. In relation to the highest degree received, faculty members were asked to list their job title for the current academic year. More than 42% (135) of the participants listed their job title as Full Professor. This usually means that they have had tenure for at least 6 years in order to have been promoted from Associate Professor. Seventy-seven faculty members (24.2%) stated that they were Associate Professors, and 52 (19.5%) listed their job title as Assistant Professors (**Error! Reference source not found.**). Eleven faculty members (3.5%) listed their job title as Instructors and 33 (10.4%) listed their job title as "Other." Among the job titles in the "Other" category were research scientists, associate deans, and department chairs.

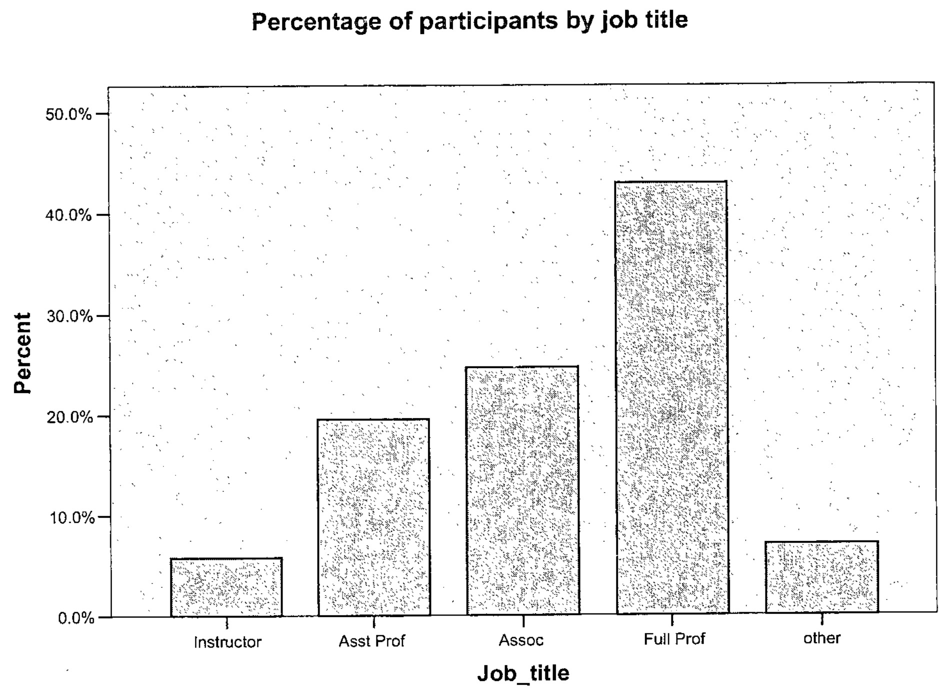


Figure 8. Percentage of participants by job title.

Survey questions six, eight, and nine. These questions asked faculty members about their current focus areas within computer science, as well as whether they had tenure at their current and any previous institution. The focus areas of these faculty members covered a multitude of topics including theory, real-time systems and networking, to name a few. Of the faculty members who participated, 67% (211) said that they had tenure at the time (Figure 9). Thirty-seven faculty members (11.8%) said that they had previously received tenure at another institution.

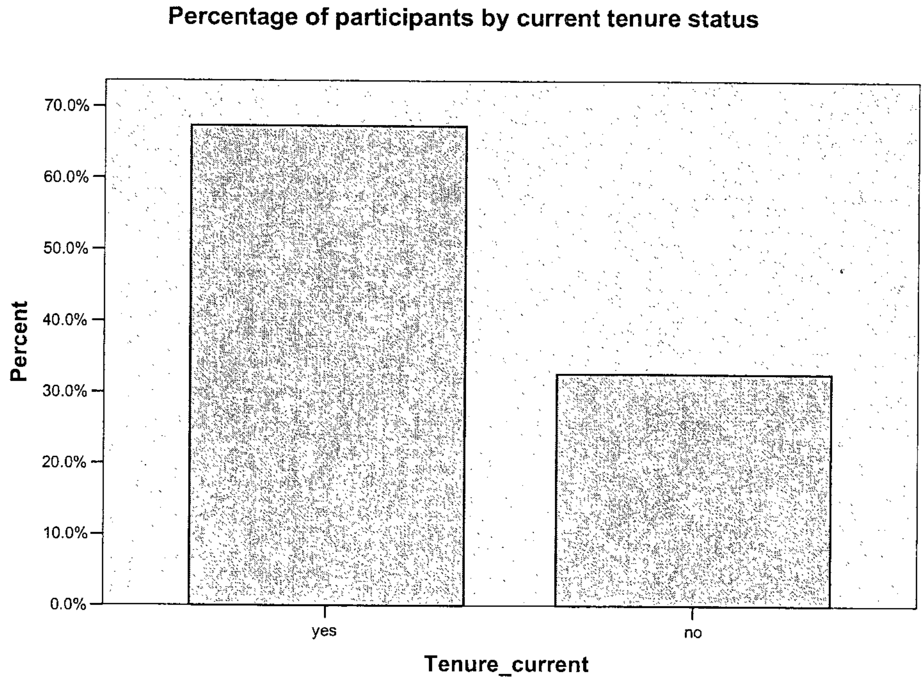


Figure 9. Percentage of participants by current tenure status.

Survey questions eleven and twelve. When asked about the number of years participants spent teaching undergraduate computer science courses, answers ranged from never to more than 20 years. Six (1.9%) faculty members stated that they had never taught undergraduate computer science courses and as a result had not completed the survey. Those participants were excluded from the survey. Seventy-three (23.1%) stated they had been teaching less than five years, and 68 (21.5%) stated that they had taught between six and ten years. Forty-five (14.2%) participants taught between 11 and 15 years while 33 (10.4%) participants taught between 16 and 20 years. More than 28% (91) of the participants taught undergraduate computer science for more than 20 years.

Related to the number of years faculty members have been teaching was the data on the frequency of teaching such courses per year. The majority of the faculty members (170 or 53.5%) stated that they taught undergraduate courses one semester a year; while 93 faculty members (29.2%) stated that they taught an undergraduate course every semester. A total of 23 (7.2%) faculty members stated that they taught undergraduate computer science once every two years or less. Twenty faculty members (6.3%) selected the "Other" category and stated that they taught based on quarters rather than semesters.

Survey questions thirteen and fourteen. When asked whether they received any teacher training prior to beginning to teach, 209 faculty members (66.1%) stated that they had not received any training, while 82 (25.9%) stated that they had partially received training. Only 25 (7.9%) stated that they had received teacher training prior to beginning to teach. When asked to rate their teaching ability, only six faculty members listed their teaching ability as novice, 133 (42%) listed their ability as average, and 178 (56.2%) listed their teaching ability as expert.

Frequencies and percentages for each of the survey questions are available in appendix B. The figures presented in the above section represent the key demographics that are going to be used in further analysis; namely, participants' age, years of experience, job title, and tenure status.

Similarities and Difference

The response rate for this study was approximately 50%. As such, there are ways in which those who did not respond could be alike or unlike the faculty members who did respond to the survey. The faculty members, who did not respond, were probably like the respondents in that they suffered from a lack of time.

The researcher conjectures, based on the results of ages and job titles, that those faculty members who did not respond were more likely to be below the age of 50 and have the job titles of Instructors, Assistant or Associate Professor. The reason for this conjecture is that the largest percentages of respondents were over the age of 50 and held the title of Full Professor, which the researcher believes was disproportionate to the percentage of professors and instructors over fifty who were initially contacted.

Research Questions

The research questions that guided the data analysis in this section were: 1) How important is effective teaching to computer science faculty members at the undergraduate level and how important do they perceive effective teaching to be to their institution? 2) How much teacher training have computer science faculty members received? 3) What do computer science faculty members believe about teaching? 4) What are the current teaching practices of computer science faculty members and what influences those practices? 5) What incentives or rewards are offered to faculty members who try innovative teaching methods or receive additional training? In the following subsections, the researcher addresses the above research questions, respectively, and presents data analysis results pertaining to each question.

Importance of Teaching as a Job Responsibility

In other to answer research question one, which investigates the importance of teaching to the individual and the perceived importance of teaching to the institution, data from survey questions five, seven, eight, and 10 were used. Faculty members were asked to rate the importance of research, teaching, service, and student placement as job responsibilities, both to themselves (survey question seven) and to their institution (survey question 10). The factors (independent variables) whose effects on teaching importance the researcher analyzed were job title (survey question five) and current tenure status (survey question eight). Frequencies and percentages of respondent answers to these questions are presented in Appendix B. A breakdown of percentages of the dependent variables based on the independent variables is presented in the next section. Following the breakdown of percentages, the tables representing the analysis of the data are presented and discussed.

Crosstabulation tables for the importance of teaching

Table 1.

Percentages of Different Levels of Importance for Teaching as a Job Responsibility to Faculty Members Based on Job Title

Job_title * Importance of Teaching to faculty members Crosstabulation

			Teaching			
			somewhat unimport	Somewhat important	Extremely important	Total
Job_title	Instructor	Count	0	0	18	18
		% within Job_title	.0%	.0%	100.0%	100.0%
	Asst Prof	Count	4	25	32	61
		% within Job_title	6.6%	41.0%	52.5%	100.0%
	Assoc	Count	3	33	41	77
		% within Job_title	3.9%	42.9%	53.2%	100.0%
	Full Prof	Count	1	35	98	134
		% within Job_title	.7%	26.1%	73.1%	100.0%
	other	Count	0	9	13	22
		% within Job_title	.0%	40.9%	59.1%	100.0%
Total		Count	8	102	202	312
		% within Job_title	2.6%	32.7%	64.7%	100.0%

Table 2.

Percentages of Different Levels of -Perceived Importance for Teaching as a Job Responsibility to the Institution Based on Job Title

Job_title * Perceived importance of Teaching to the Institution Crosstabulation

			Perceived Teaching importance to the Institution				
			not at all import	somewhat unimport	Somewhat important	Extremely important	Total
Job_title	Instructor	Count	1	4	11	2	18
		% within Job_title	5.6%	22.2%	61.1%	11.1%	100.0%
	Asst Prof	Count	5	4	38	14	61
		% within Job_title	8.2%	6.6%	62.3%	23.0%	100.0%
	Assoc	Count	1	11	55	10	77
		% within Job_title	1.3%	14.3%	71.4%	13.0%	100.0%
	Full Prof	Count	3	9	74	48	134
		% within Job_title	2.2%	6.7%	55.2%	35.8%	100.0%
	other	Count	0	3	12	7	22
		% within Job_title	.0%	13.6%	54.5%	31.8%	100.0%
Total		Count	10	31	190	81	312
		% within Job_title	3.2%	9.9%	60.9%	26.0%	100.0%

Table 3.

A Comparison of the Personal Importance of Teaching and Perceived Importance of Teaching to the Institution Based on Job Title

Job Title	A Comparison of the Personal Importance of Teaching and Perceived Importance of Teaching to Institution							
	Not at all important		Somewhat unimportant		Somewhat Important		Extremely important	
	Self	Institut.	Self	Institut.	Self	Institut	Self	Insitut
Instructor	0	1	0	4	0	11	18	2
	0%	5.6%	0%	22.2%	0%	61.1%	100%	11.1%
Assistant Professor	0	5	4	4	25	38	32	14
	0%	8.2%	6.6%	6.6%	41%	62.3%	52%	23%
Associate Professor	0	1	3	11	33	55	41	10
	0%	1.3%	3.9%	14.3%	42.9%	71.4%	53.2%	13.%
Full Professor	0	3	1	9	35	74	98	48
	0%	2.2%	.7%	6.7%	26.1%	55.2%	73.1%	35.8%
Other	0	0	0	3	9	12	13	7
	0%	13.6%	0%	54.5%	40.9%	54.5%	59.1%	31.8%

As seen in Table 1, when grouped by Job Title, 73.1% (98) of Full Professors indicated that teaching was extremely important, 26.1% (35) indicated it was somewhat important, and .7% (1) indicated it was somewhat unimportant. In contrast, 53.2% (41) of Associate Professors and 52.5% (32) of Assistant Professors indicated that teaching was extremely important, 42.9% (33) of Associate Professors and 42% (25) of Assistant Professors said it was somewhat important, and 3.9% (3) of Associate Professors and 6.6% (4) of Assistant Professors said it was somewhat unimportant. The eighteen faculty members listed as “Instructors” unanimously ranked teaching as extremely important. Of the faculty members in the “Other” category, 59.1% (13) said it was extremely important while 40.9% (9) said it was somewhat important.

Table 2 shows the percentages of different levels of perceived importance of teaching to the institution based on faculty members' job titles. When asked how important teaching was to their institution, 35.8% (48) of Full Professors indicated that teaching was extremely important, 55.2% (74) indicated it was somewhat important, 6.7% (9) indicated it was somewhat unimportant and 2.2% (3) indicated it was not at all important. In contrast, 13.0% (10) of Associate Professors and 23% (14) of Assistant Professors indicated that teaching was extremely important, 55.2% (74) of Associate Professors and 62.3% (38) of Assistant Professors said it was somewhat important, 14.3% (11) of Associate Professors and 6.6% (4) of Assistant Professors said it was somewhat unimportant and 1.3% (1) of Associate Professors and 8.2% (5) of Assistant Professors said teaching was not at all important to their institution . The majority of all job titles said that teaching was only somewhat important to their institution and only faculty members in the "Other" category did not have anyone state that teaching was not at all important to their institution.

For convenience, Table 3 compares the data in Table 1 and

Table 2, to contrast the personal importance of teaching, as expressed by the participants, to their perception of the importance of teaching to their institutions. An examination of these data reveals that participants generally felt that teaching was less important to their institution than it was to them personally. The largest such difference in reported importance was observed in the answers of Instructors. While 100% of Instructors answered that teaching was extremely important to them, only 11.1% answered that it was extremely important to their institution. The lowest difference in teaching importance was reported by Assistant Professors. Of those, 52% answered that teaching was extremely important to them personally, while 23% answered that it was extremely important to their institution. The category with the highest "faith" in the institution appeared to be Full Professors. As many as 35.8% of Full Professors answered that teaching was extremely important to their institution, while 73.1% answered that teaching was extremely important to them personally. One might expect that Associate Professors fall somewhere between Assistant Professors and Full Professors. They did not. As few as 13% of Associate Professors answered that teaching was extremely important to their institution, while 53.2% answered that it was extremely important to them personally.

Crosstabulations comparing tenure status to the importance of teaching

Table 4.

Percentages of Different Levels Importance for Teaching as a Job Responsibility to Faculty Based on Tenure Status

Tenure_current * Importance of Teaching to Faculty Members Crosstabulation

			Importance of Teaching to Faculty Members			
			somewhat unimport	Somewhat important	Extremely important	Total
Tenure_current	yes	Count	3	71	136	210
		% within Tenure_current	1.4%	33.8%	64.8%	100.0%
	no	Count	5	33	64	102
		% within Tenure_current	4.9%	32.4%	62.7%	100.0%
Total		Count	8	104	200	312
		% within Tenure_current	2.6%	33.3%	64.1%	100.0%

Table 5.

Percentages of Different Levels of Perceived Importance for Teaching as a Job Responsibility to the Institution Based on Tenure Status

Tenure_current * Perceived Importance of Teaching to the Institution Crosstabulation

			Perceived Importance of Teaching to the Institution				
			not at all import	somewhat unimport	Somewhat important	Extremely important	Total
Tenure_current	yes	Count	4	20	129	57	210
		% within Tenure_current	1.9%	9.5%	61.4%	27.1%	100%
	no	Count	6	11	60	25	102
		% within Tenure_current	5.9%	10.8%	58.8%	24.5%	100%
Total		Count	10	31	189	82	312
		% within Tenure_current	3.2%	9.9%	60.6%	26.3%	100%

Table 4 represents the importance of teaching to the faculty member based on current tenure status. Based on Table 4 there is no discernable difference in the importance of teaching to faculty members based on tenure status. Of those faculty members who have tenure, 64% said that teaching was extremely important and 33% said that teaching was somewhat important. In contrast, 62% of non-tenured faculty said teaching was extremely important and 32% said it was somewhat important.

The perceived importance of teaching to the institution is presented in Table 5. The data in Table 5 shows that there is not much difference in the perceived importance of teaching to the institution based on tenure status. Of faculty members with tenure, 27% said teaching was extremely important, and 61% said that teaching was somewhat important to their institution. In contrast, 24% of non-tenured faculty members said that teaching was extremely important to their institution and 58% said that teaching was somewhat important. The largest difference between tenured and non-tenured faculty existed between those faculty members who said teaching was not at all important to their institution. A total of 5.9% of non-tenured faculty and 1.9% of tenured faculty members said that teaching was not at all important to their institution. Therefore, the data suggest that tenure status does not influence the perceived importance of teaching to the institution.

In the following subsections, the researcher first separately analyzes the relation between job title and participants' personal importance of teaching (and other job responsibilities) as well as the relation between job title and the perception of the importance of teaching (and other job responsibilities) to the institution. These analyses are followed by Pearson's correlation tables showing the correlations between the personal importance of job responsibilities and the perceived importance of job responsibilities to the institution, as well as the correlations among the personal importance of different job responsibilities.

Analysis of personal importance of teaching and other job responsibilities

The data analyses in this section were performed using the data on job titles (survey question five), job responsibilities, and importance of teaching to both the individual (survey question seven) and the institution (survey question 10). The researcher did not perform separate analyses based on tenure (survey question eight) because such data can be largely inferred from data on job titles (by noticing that Instructors and Assistant Professors generally do not have tenure, while Associate and Full Professors do). Though research question one only investigates the importance of teaching, analysis was performed using all four of the primary job responsibilities of computer science faculty. These analyses were run in order to examine if the importance of the job responsibilities of research, student placement and service had any effect on the importance of teaching.

Below, descriptives (Means, Ns and Standard Deviations), ANOVA tables, and Tukey's Posthoc tests are shown for the data analyses on the personal importance of job responsibilities (q. 7) based on job title (q. 5).

Descriptives, and ANOVAs as they pertain to the importance of teaching

Table 6.

Means, Ns, and Standard Deviations for Importance of Job Responsibilities to the Participants Based on Job Title.

Descriptives

Job purpose	Job Title	N	Mean	Std. Deviation
Research	Instructor	18	2.22	1.114
	Asst Prof	61	3.87	.465
	Assoc	77	3.95	.276
	Full Prof	134	3.92	.276
	Other	22	3.45	1.101
Teaching	Instructor	18	4.00	.000
	Asst Prof	61	3.46	.621
	Assoc	77	3.49	.576
	Full Prof	134	3.72	.465
	Other	22	3.59	.503
Service	Instructor	18	2.56	.784
	Asst Prof	61	2.72	.756
	Assoc	77	2.84	.563
	Full Prof	134	2.96	.599
	Other	22	2.55	.912
Student_placement	Instructor	18	2.06	.938
	Asst Prof	61	3.13	.718
	Assoc	75	3.07	.811
	Full Prof	133	2.80	.805
	Other	21	2.71	784

Table 7.

Summary of ANOVA to Determine Whether the Importance of Job Responsibilities to the Participants have a Significant Difference

ANOVA

Job purpose based on Job title		Sum of Squares	Df	Mean Square	F	Sig.
Research	Between Groups	51.206	4	12.802	52.119	.000
	Within Groups	75.406	307	.246		
	Total	126.612	311			
Teaching	Between Groups	6.876	4	1.719	6.397	.000
	Within Groups	82.496	307	.269		
	Total	89.372	311			
Service	Between Groups	5.974	4	1.494	3.421	.009
	Within Groups	134.022	307	.437		
	Total	139.997	311			
Student_place ment	Between Groups	20.189	4	5.047	7.950	.000
	Within Groups	192.366	303	.635		
	Total	212.555	307			

Table 8.

Tukey's HSD for Importance of Job Responsibilities to the Participants Based on Job Titles

Dependent Variable		(I) Job_title	(J) Job_title	Mean Difference (I-J)	Std. Error	Sig.
Research	Tukey HSD	Instructor	Asst Prof	-1.647(*)	.133	.000
			Assoc	-1.726(*)	.130	.000
			Full Prof	-1.696(*)	.124	.000
			other	-1.232(*)	.158	.000
		Asst Prof	Instructor	1.647(*)	.133	.000
			Assoc	-.079	.085	.884
			Full Prof	-.049	.077	.968
			other	.414(*)	.123	.008
		Assoc	Instructor	1.726(*)	.130	.000
			Asst Prof	.079	.085	.884
			Full Prof	.030	.071	.993
			other	.494(*)	.120	.000
		Full Prof	Instructor	1.696(*)	.124	.000
			Asst Prof	.049	.077	.968
			Assoc	-.030	.071	.993
			other	.463(*)	.114	.001
		Other	Instructor	1.232(*)	.158	.000
			Asst Prof	-.414(*)	.123	.008
			Assoc	-.494(*)	.120	.000
			Full Prof	-.463(*)	.114	.001
Teaching	Tukey HSD	Instructor	Asst Prof	.541(*)	.139	.001
			Assoc	.506(*)	.136	.002
			Full Prof	.276	.130	.213
			other	.409	.165	.097
		Asst Prof	Instructor	-.541(*)	.139	.001
			Assoc	-.034	.089	.995
			Full Prof	-.265(*)	.080	.009
			other	-.132	.129	.845
		Assoc	Instructor	-.506(*)	.136	.002
			Asst Prof	.034	.089	.995
			Full Prof	-.230(*)	.074	.017
			other	-.097	.125	.937
		Full Prof	Instructor	-.276	.130	.213
			Asst Prof	.265(*)	.080	.009
			Assoc	.230(*)	.074	.017
			other	.133	.119	.799

		Other	Instructor	-.409	.165	.097
			Asst Prof	.132	.129	.845
			Assoc	.097	.125	.937
			Full Prof	-.133	.119	.799
Service	Tukey HSD	Instructor	Asst Prof	-.166	.177	.883
			Assoc	-.289	.173	.455
			Full Prof	-.400	.166	.115
			other	.010	.210	1.000
		Asst Prof	Instructor	.166	.177	.883
			Assoc	-.123	.113	.814
			Full Prof	-.234	.102	.150
			other	.176	.164	.822
		Assoc	Instructor	.289	.173	.455
			Asst Prof	.123	.113	.814
			Full Prof	-.111	.094	.765
			other	.299	.160	.336
		Full Prof	Instructor	.400	.166	.115
			Asst Prof	.234	.102	.150
			Assoc	.111	.094	.765
			other	.410	.152	.057
		Other	Instructor	-.010	.210	1.000
			Asst Prof	-.176	.164	.822
			Assoc	-.299	.160	.336
			Full Prof	-.410	.152	.057
Student_placement	Tukey HSD	Instructor	Asst Prof	-1.076(*)	.214	.000
			Assoc	-1.011(*)	.209	.000
			Full Prof	-.741(*)	.200	.002
			other	-.659	.256	.078
		Asst Prof	Instructor	1.076(*)	.214	.000
			Assoc	.064	.137	.990
			Full Prof	.334	.123	.055
			other	.417	.202	.237
		Assoc	Instructor	1.011(*)	.209	.000
			Asst Prof	-.064	.137	.990
			Full Prof	.270	.115	.134
			other	.352	.197	.381
		Full Prof	Instructor	.741(*)	.200	.002
			Asst Prof	-.334	.123	.055
			Assoc	-.270	.115	.134
			other	.083	.187	.992
		Other	Instructor	.659	.256	.078
			Asst Prof	-.417	.202	.237
			Assoc	-.352	.197	.381
			Full Prof	-.083	.187	.992

The descriptive statistics suggest that service was least important to all five groups (Table 6). With means ranging from 2.5 to 2.9, the importance of job responsibilities of faculty members showed that service was somewhat unimportant to them. Associate and Full Professors gave the highest rating for the importance of service as a job responsibility for them personally. Student placement as a job responsibility was also low in priority. The overall mean for student placement was a 2.62 but Associate and Assistant Professors rated student placement as somewhat important by giving it around 2.7 out of 4 on the scale. While Table 1 shows that Instructors and Full Professors overwhelmingly answered that teaching was extremely important to them, more so than any other category of faculty members, they are also the categories with the some of the lowest means for the importance of student placement, according to Table 6.

Table 6 also shows that for the job responsibilities of research and teaching, the mean ratings were 3.79 and 3.62 respectively meaning that the faculty members rated the importance of these two job purposes as extremely high. Instructors tended to rate the importance of research as somewhat unimportant while assistant, Associate and Full Professors rated it as extremely important. Faculty members in the "Other" category averaged 3.45 out of 4 thereby stating that research was only somewhat important to them. The "Other" category contained faculty members who are department chairs and research scientists as well as a few associate deans. For importance of teaching, Instructors gave the highest scores possible as it relates to job responsibilities, scoring it as a full four points. Full Professors were the faculty members who gave teaching the second highest rating of importance with a score of 3.72.

As can be seen in

Table 7, there were significant differences ($p < .05$ or greater, See sig. column) between the five groups on each job responsibility. Post hoc tests (See

Table 8) revealed the following differences in research importance (significant differences denoted with * in Mean Difference column). Instructors tended to rate research much lower in importance than did all other groups. On average they rated research as 1.5 points lower in importance than any other group. Assistant, Associate and Full Professors tended to rate research significantly higher in importance than did faculty members in the "Other" category.

For teaching there were fewer significant differences. Instructors tended to rate teaching as higher in importance than did any other faculty group but this difference was only significant ($p < .05$ or greater) in comparison with assistant (.541 difference) and Associate (.506 difference) professors. Full Professors rated teaching significantly higher in importance than Associate (.265 difference) and Assistant (.230 difference) Professors.

There were no significant differences between the five groups in rating the job importance of service. For student placement there was a significant difference between the importance rating given to it by instructors and by those given to it by Assistant, Associate and Full Professors. Instructors tended to rate student placement more than a full point lower in importance than did Assistant or Associate Professors whereas they tended to rate it .74 points lower in importance than did Full Professors. The discrepancy between the Instructors' significantly higher rating for the importance of teaching and their significantly lower rating for the importance of student placement, compared to other groups, was puzzling as if educating college students and preparing them for successful careers were distinctly different goals. There were no significant differences between the importance ratings of student placement by Instructors and faculty identified as "Other".

Analysis of perceived importance of job responsibilities to the institution

Table 9.

Means, Ns, and Standard Deviations for Perceived Importance of Job Responsibilities to the Institution Based on Job Title

Descriptives

perceived importance of job responsibilities to the institution based on Job title		N	Mean	Std. Deviation
Research	Instructor	18	4.00	.000
	Asst Prof	61	3.97	.180
	Assoc	77	3.97	.160
	Full Prof	134	3.93	.280
	Other	22	4.00	.000
Teaching	Instructor	18	2.78	.732
	Asst Prof	61	3.00	.796
	Assoc	77	2.96	.572
	Full Prof	134	3.25	.677
	Other	22	3.18	.664
Service	Instructor	18	2.33	.840
	Asst Prof	61	2.61	.737
	Assoc	77	2.64	.605
	Full Prof	134	2.66	.614
	Other	22	2.68	.646
Student_placement	Instructor	18	2.39	.979
	Asst Prof	61	2.79	.839
	Assoc	77	2.74	.801
	Full Prof	134	2.49	.847
	Other	21	2.62	.921

Table 10.

Summary of ANOVA to Determine Whether Perceived Importance of Job Responsibilities to the Institution have a Significant Difference

ANOVA

Perceived job purpose based on Job title		Sum of Squares	Df	Mean Square	F	Sig.
Research	Between Groups	.180	4	.045	.969	.424
	Within Groups	14.278	307	.047		
	Total	14.458	311			
Teaching	Between Groups	6.975	4	1.744	3.766	.005
	Within Groups	142.140	307	.463		
	Total	149.115	311			
Service	Between Groups	1.768	4	.442	1.033	.390
	Within Groups	131.357	307	.428		
	Total	133.125	311			
Student_placement	Between Groups	6.188	4	1.547	2.154	.074
	Within Groups	219.735	306	.718		
	Total	225.923	310			

Table 11.

Tukey's HSD for Perceived Importance of Job Responsibilities to the Institution Based on Job Titles

Multiple Comparisons

Dependent Variable		(I) Job_title	(J) Job_title	Mean Difference (I-J)
Research	Tukey HSD	Instructor	Asst Prof	.033
			Assoc	.026
			Full Prof	.067
			other	.000
		Asst Prof	Instructor	-.033
			Assoc	-.007
			Full Prof	.034
			other	-.033
		Assoc	Instructor	-.026
			Asst Prof	.007
			Full Prof	.041
			other	-.026
		Full Prof	Instructor	-.067
			Asst Prof	-.034
			Assoc	-.041
			other	-.067
		other	Instructor	.000
			Asst Prof	.033
			Assoc	.026
			Full Prof	.067
Teaching2	Tukey HSD	Instructor	Asst Prof	-.222
			Assoc	-.183
			Full Prof	-.468
			other	-.404
		Asst Prof	Instructor	.222
			Assoc	.039
			Full Prof	-.246
			other	-.182
		Assoc	Instructor	.183
			Asst Prof	-.039
			Full Prof	-.285(*)
			other	-.221
		Full Prof	Instructor	.468

			Asst Prof	.246
			Assoc	.285(*)
			other	.064
		other	Instructor	.404
			Asst Prof	.182
			Assoc	.221
			Full Prof	-.064
Service2	Tukey HSD	Instructor	Asst Prof	-.273
			Assoc	-.303
			Full Prof	-.323
			other	-.348
		Asst Prof	Instructor	.273
			Assoc	-.030
			Full Prof	-.050
			other	-.075
		Assoc	Instructor	.303
			Asst Prof	.030
			Full Prof	-.020
			other	-.045
		Full Prof	Instructor	.323
			Asst Prof	.050
			Assoc	.020
			other	-.025
		other	Instructor	.348
			Asst Prof	.075
			Assoc	.045
			Full Prof	.025
Student_placement2	Tukey HSD	Instructor	Asst Prof	-.398
			Assoc	-.351
			Full Prof	-.096
			other	-.230
		Asst Prof	Instructor	.398
			Assoc	.047
			Full Prof	.302
			other	.168
		Assoc	Instructor	.351
			Asst Prof	-.047
			Full Prof	.255
			other	.121
		Full Prof	Instructor	.096
			Asst Prof	-.302
			Assoc	-.255
			other	-.134
		other	Instructor	.230
			Asst Prof	-.168
			Assoc	-.121
			Full Prof	.134

* The mean difference is significant at the .05 level.

Faculty were asked to rate the importance of research, teaching, service, and student placement in terms of importance of job responsibilities of their institutions. They were also asked to indicate their job title. Descriptive data for job responsibility by job title are given in Table 9. A summary of one-way ANOVA's is given in Table 10, and Tukey's HSD posthoc tests are provided in Table 11.

The descriptive statistics suggest that service and student placement were perceived least important to the institution by all five groups. With means ranging from 2.3 to 2.7 the perceived importance of job responsibilities to the institution by faculty members showed that service and student placement was somewhat unimportant to their schools. Associate and Full Professors gave the highest rating for the importance of service as a job responsibility. Student placement as a job responsibility was also fairly low in priority. The overall mean for student placement was a 2.61 but Associate and Assistant Professors rated student placement as being somewhat important by rating it around 2.7.out of 4 on the scale.

For the job responsibilities of research and teaching the mean ratings were 3.96 and 3.10 respectively meaning that the faculty members perceived the importance of these two job responsibilities as extremely important to their schools. Instructors and the faculty members in the "Other" category rated the importance of research as extremely important to their schools by giving it a full four points. The "Other" category contained faculty members who are department chairs and research scientists as well as a few associate deans. While Assistant (3.97), Associate (3.97) and Full Professors (3.93) rated it as extremely important. Full Professors were the faculty members who gave teaching the highest rating of importance to their schools with a score of 3.25.

As can be seen in Table 10 there were no significant differences (p <.05 or greater) between the five groups except for the perceived importance of teaching to their institution. Post hoc tests (Table 11) revealed the following differences in teaching importance. Full Professors tended to rate teaching higher in importance to their school than did all other groups. On average they rated teaching as .26 points higher in importance than any other group. A significant difference existed between Full Professors and Associate Professors in which Full Professors rated teaching as .285 points higher in importance to their institutions than did Associates. There were no significant differences between the five groups in rating the perceived job importance of research, student placement and service.

Correlations between personal and perceived institutional job responsibilities

Table 12.

Pearson's Correlation Table Between the Personal Importance of Job Responsibilities of Faculty Members and the Perceived Importance of Job Responsibilities to the Institution

Correlations

Importance of job responsibilities to the participants			Perceived Priorities of the institution		Student_placement
		Research	Teaching	Service	
Research	Pearson Correlation	.076	.141(*)	.031	.152(**)
	Sig. (2-tailed)	.181	.012	.579	.007
	N	315	315	315	314
Teaching	Pearson Correlation	.112(*)	.195(**)	.112(*)	-.025
	Sig. (2-tailed)	.047	.001	.046	.657
	N	315	315	315	314
Service	Pearson Correlation	.063	.124(*)	.388(**)	.176(**)
	Sig. (2-tailed)	.264	.028	.000	.002
	N	315	315	315	314
Student placement	Pearson Correlation	.159(**)	.098	.242(**)	.494(**)
	Sig. (2-tailed)	.005	.086	.000	.000
	N	311	311	311	311

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

The Pearson's correlations between importance of job responsibilities to the participants and the perceived importance of job responsibilities to the institution are given in Table 12. The highest correlation was found for the job responsibility of student placement (.494). However, student placement was rated one of the least important responsibilities to all five groups for personal importance and was also rated low in importance for the institution. The job responsibility of service showed the second highest significant correlation between the personal importance of job responsibilities to the participants and perceived importance of job responsibilities to the institution with an r of .388. Teaching also showed a significant but weak correlation with a correlation of .195. Research was the smallest and only non-significant correlation (.076).

Correlations between importances of job responsibilities to the participants

Table 13.

Correlation between the Importances of the Four Personal Priorities of Faculty Members

Correlations

importance of job responsibilities to the participants		Research	Teaching	Service	Student_placement
Research	Pearson Correlation	1	-.164(**)	.097	.261(**)
	Sig. (2-tailed)		.004	.087	.000
	N	315	315	315	311
Teaching	Pearson Correlation	-.164(**)	1	.232(**)	.020
	Sig. (2-tailed)	.004		.000	.730
	N	315	315	315	311
Service	Pearson Correlation	.097	.232(**)	1	.275(**)
	Sig. (2-tailed)	.087	.000		.000
	N	315	315	315	311
Student_placement	Pearson Correlation	.261(**)	.020	.275(**)	1
	Sig. (2-tailed)	.000	.730	.000	
	N	311	311	311	311

The Pearson's correlation between importances of the four job responsibilities to the participants is presented in Table 13. The Pearson's correlations suggest that there is a significant ($p<.05$ or greater) negative correlation between the personal importance of teaching and research as job responsibilities of faculty members. This observation is remarkable in that it shows that faculty tend to value teaching less when they value research more and vice versa. There were significant positive correlations between the job responsibilities of student placement and research, teaching and service, and service and student placement. The highest correlation was found for the job importance of student placement and service (.275). As was the case in Table 12, student placement is correlated directly with the areas of research and service but not with teaching. Research and service (especially external service, such as service on editorial boards of journals and technical program committees of peer-reviewed conferences) tend to be activities more common at graduate research schools. The correlation with student placement might suggest that faculty in graduate schools are more concerned with student placement than those in undergraduate institutions. As Tables 7 and 8 have already shown, surveyed Instructors (those whose job is expressly teaching) appeared to have a sharp disassociation between the priorities of teaching and student placement.

Teacher Training

Research question two investigates the amount of teacher training that faculty members received. Of particular interest is to understand the relation, for different job titles, between 1) the amount of teacher training services used by different categories of faculty members and 2) the amount of teacher training offered by their institution, as well as 3) the amount of teacher training they received prior to joining the institution. These relations will help appreciate the efficacy of teacher training programs offered by institutions as well as the populations of faculty members that such programs affect most.

Analysis in this section is based on survey questions five, which asked faculty members to state their job title, survey question 13, which asked whether faculty members had received teacher training prior to beginning to teach, survey question 26, which asked what teacher training services were offered for the faculty members to use, and survey question 27, which asked what teacher training services faculty members did use. The following tables show crosstabulations performed on the data for the amounts of teacher training received, training offered, training received prior to teaching, and job titles. The crosstabulations are: teacher training received at the current institution versus job title, teacher training received at the current institution versus training received prior to teaching, and teacher training received at the current institution versus the amount of teacher training offered by the institution. These crosstabulations give insight into the sources from which faculty members receive training and their relation to training opportunities offered.

Crosstabulations involving the amount of teacher training received

Table 14.

Percentages Showing the Amount of Teacher Training Received Based on Job Title

Job_title * Current_Training_Received Crosstabulation

			Training Services Used							
			none	one type	two types	three types	four types	five types	six types	Total
Job_title	Inst.	Count	5	1	6	4	2	0	0	18
		% within Job_title	28%	5.6%	33.3%	22.2%	11.1%	.0%	.0%	100%
	Asst. Prof	Count	27	14	13	4	1	2	0	61
		% within Job_title	44%	23.0%	21.3%	6.6%	1.6%	3.3%	.0%	100%
	Assoc. Prof.	Count	32	22	16	0	6	0	1	77
		% within Job_title	42%	28.6%	20.8%	.0%	7.8%	.0%	1.3%	100%
	full Prof	Count	63	28	27	11	4	1	0	134
		% within Job_title	47%	20.9%	20.1%	8.2%	3.0%	.7%	.0%	100%
	Other	Count	14	4	3	1	0	0	0	22
		% within Job_title	64%	18.2%	13.6%	4.5%	.0%	.0%	.0%	100%
Total		Count	141	69	65	20	13	3	1	312
		% within Job_title	45%	22.1%	20.8%	6.4%	4.2%	1.0%	.3%	100%

Table 15.

Percentages Showing the Amount of Teacher Training Received Based on Training Prior to Teaching

teacher training received * Prior Training_received Crosstabulation

			prior Training_received			Total
			no	Partially	Yes	
teachertraining	none	Count	111	24	7	142
		% within Training_ received	53.1%	29.6%	29.2%	45.2%
	one tpye	Count	47	17	5	69
		% within Training_ received	22.5%	21.0%	20.8%	22.0%
	two types	Count	32	25	8	65
		% within Training_ received	15.3%	30.9%	33.3%	20.7%
	three types	Count	12	6	2	20
		% within Training_ received	5.7%	7.4%	8.3%	6.4%
	four types	Count	5	7	1	13
		% within Training_ received	2.4%	8.6%	4.2%	4.1%
	five types	Count	1	2	1	4
		% within Training_ received	.5%	2.5%	4.2%	1.3%
	six types	Count	1	0	0	1
		% within Training_ received	.5%	.0%	.0%	.3%
Total		Count	209	81	24	314
		% within Training_ received	100.0%	100.0%	100.0%	100.0%

Table 16.

Percentages Showing the Amount of Teacher Training Received Based on the Amount of Teacher Training Offered by the Institution

training_offered * Training_Received Crosstabulation

			Training Services Used							
			none	1 type	2 types	3 types	4 types	5 types	6 types	Total
Training Services offered	none	Count	38	0	0	0	0	0	0	38
		% within training_ offered	100%	.0%	.0%	.0%	.0%	.0%	.0%	100%
	1 type	Count	24	12	0	0	0	0	0	36
		% within training_ offered	66.7%	33%	.0%	.0%	.0%	.0%	.0%	100%
	2 types	Count	19	14	14	0	0	0	0	47
		% within training_ offered	40.4%	30%	30%	.0%	.0%	.0%	.0%	100%
	3 types	Count	28	20	14	5	0	0	0	67
		% within training_ offered	41.8%	30%	21%	7.5%	.0%	.0%	.0%	100%
	4 types	Count	23	17	21	6	6	0	0	73
		% within training_ offered	31.5%	23%	29%	8.2%	8.2%	.0%	.0%	100%
	5 types	Count	7	3	9	6	2	2	0	29
		% within training_ offered	24.1%	10%	31%	21%	6.9%	6.9%	.0%	100%
	6 types	Count	4	3	7	3	5	2	1	25
		% within training_ offered	16.0%	12%	28%	12%	20%	8.0%	4.0%	100%
Total		Count	143	69	65	20	13	4	1	315
		% within training_ offered	45.4%	22%	21%	6.3%	4.1%	1.3%	.3%	100%

Table 14 shows the crosstabulation of the number of types of teacher training used based on faculty members' job titles. The data shows that faculty members in the "Other" category were the ones who used teacher training services the least (64% said they used none). Full (47%), Assistant (44%) and Associate Professors (42%) all had similar percentages of faculty members who said they had not used any of the teacher training services. Of particular note is that a large percentage of the faculty members who listed their job title as Instructor (28%) said they had not used any teacher training services. As Instructors are hired primarily as teaching faculty the high percentage is surprising. However, Instructors are also the faculty members who had the most participants indicate they had used teacher training services. Almost half (45%) of all participants said that they had not availed themselves of teacher training services at their institution.

Table 15 shows the crosstabulations of teacher training services used based on teacher training received prior to beginning to teach undergraduate computer science classes. Nearly half of all faculty members said that they had not availed themselves of teacher training services at their institution (45%), but more than 70% of those who had prior training elsewhere did use at least one teacher training service at the current institution. In fact, approximately 50% of them said they used at least two services at the current institution, compared to less than 25% of those who had no prior training. The data in this table suggest that faculty members without prior teacher training were less likely to use teacher training services offered at their institution. While ironic, this observation is not unexpected. Those who opted out from teacher training opportunities earlier apparently had a higher chance of continuing to do so at their current institution.

The crosstabulation showing the amount of teacher training services offered and the amount of teacher training services used is shown in Table 16. The data suggest that the more types of teacher training services are offered by an institution the more likely faculty members will be to use at least one type of teacher training service. A total of 84% of faculty members at schools that offer six different types of teacher training services had used at least one training service. This is the largest percentage of faculty members of all the schools who offer teacher training services. Of those schools that offer five different types of teacher training services 76% of faculty members say they have used at least one. Further, 69% of faculty members at schools that offer four different teacher training services have used at least one. For both schools that offer two and three different teacher training services, 60% of faculty reported using at least one training service, and 33% of those faculty at schools who only offer one training service have used it.

Data analysis of the amount of teacher training received

Table 17.

Means, Ns and Standard Deviations Showing the Amount of Teacher Training Received

Descriptive Statistics

	N	Mean	Std. Deviation
Prior_Training	314	1.41	.629
training_offered	315	2.91	1.735
Training_Received	315	1.0698	1.25234
Valid N (listwise)	314		

Faculty members were asked whether they had received teacher training prior to beginning to teach undergraduate computer science courses, what teacher training services are offered by their institution and what teacher training services they have used. Table 17 shows the means, Ns and standard deviations for those three questions. The means show that participants had not received training prior to beginning to teach, with a mean of 1.41 that is in between the scores for no (1) and some (2). The mean of 2.91 shows that the average number of teacher training services provided by the participants' institutions was around three and with a mean of 1.06 participants tended to only use one of those training services.

Table 18.

Correlation between Teacher Training Received Prior to Beginning to Teach and Teacher Training Services Used by Participants

Correlations

		Training Services used	Prior_Training
Training services used	Pearson Correlation	1	.229**
	Sig. (2-tailed)		.000
	N	315	314
Prior_Training	Pearson Correlation	.229**	1
	Sig. (2-tailed)	.000	
	N	314	314

**. Correlation is significant at the 0.01 level (2-tailed).

Table 19.

Correlation between Teacher Training Services Offered by the Institution and Teacher Training Services Used by Participants

Correlations

		training_ offered	Training Services used
training_offered	Pearson Correlation	1	.533**
	Sig. (2-tailed)		.000
	N	315	315
Training Services Used	Pearson Correlation	.533**	1
	Sig. (2-tailed)	.000	
	N	315	315

**. Correlation is significant at the 0.01 level (2-tailed).

The Pearson's correlation between teacher training received prior to beginning to teach and the teacher training services used by the participants is presented in Table 18.

The Pearson's correlation suggests that there is a significant ($p<.05$ or greater) positive correlation between teacher training received prior to beginning to teach and the use of teacher training services at the participants' institution (.229). This correlation indicates that faculty members who had received teacher training prior to beginning to teach would be more likely to use the teacher training services offered by the institution.

Pearson's correlation between the teacher training services offered by the institution and the teacher training services used by the participants is presented in Table 19. The Pearson's correlation suggests that there is a significant positive correlation between the teacher training services offered by the institution and the teacher training services used by the participants (.533). This indicates that the more services offered by the institution the more likely faculty members were to use them.

Teaching Beliefs

Research question three investigates what faculty members in undergraduate computer science believe about teaching. A prevalent belief is determined for faculty based on their answers to survey question 17. To gain confidence in the scale that measures the prevalent belief, Pearson's Correlations are presented, demonstrating a high positive correlation between behaviorist and constructivist scores and the scale items that measure these respective beliefs. The relations between the prevalent belief and faculty age (survey question two), job title (survey question four), and self-reported teaching ability (survey question 14) are then tabulated. Also, the relation between the prevalent belief and the way faculty expect students to gather information (survey question 22) is explored. This gives insight into factors that might possibly influence the theoretical beliefs towards teaching.

Correlations showing comparison between the scores of the theoretical belief and the scale items

In the analysis of this research question, participants were divided by prevalent belief into constructivists, behaviorists and undetermined depending on their constructivist and behaviorist scores. These scores were determined by adding their scores for each of the six item scales, thus creating a behaviorist and constructivist score. The individual item scales were borrowed from Grasha (2002) who developed the test questions for constructivist and behaviorist beliefs. The behaviorist scores were then subtracted from the constructivist scores. A positive score higher than .5 indicated a constructivist score. A negative score indicated a behaviorist score. The scores between 0 and .5 were considered to be undetermined.

Since the above score will be used in many crosstabulations, correlations are presented first between the total score and the individual items used to construct it. The researcher's purpose here is to show that answers to questions that test constructivism are more correlated with the constructivist score than answers to questions that test behaviorism and vice versa. Note, in particular, that it is not the researcher's expectation to show that answers to questions that test constructivism correlate *negatively* with the behaviorist score and vice versa. Grasha (2002) emphasizes that instructors do not focus on only one theory and that their practices often reflect more than one belief. Hence, some constructivists, for example, may answer in a manner consistent with some behaviorist beliefs as well. A small positive correlation between the constructivist score and questions that test behaviorism is therefore acceptable as long as a larger positive correlation exists with questions that test constructivism (and vice versa for behaviorist scores).

Grasha's questions help determine the *prevalent* belief of a person holding mixed beliefs, as opposed to identify the sole belief of a person held to the exclusion of other beliefs. In Chapter III, the mixed belief nature of the population was demonstrated when reliability was computed for scale items measuring constructivist and behaviorist beliefs (separately) using Cronbach's Alpha and found to be low for both groups. A low Cronbach's Alpha indicates that participants "mixed and matched" elements of different beliefs as opposed to falling squarely in one or another. The crosstabulations below help understand the degree to which such "mixing and matching" occurred.

Table 20.

Correlations between the Theoretical Belief Scores for Behaviorism and Constructivism of the Participants and the Behaviorist Scale

Correlations

		Construct_belief	behav_belief	discrete_steps	Grade_motivation	Organization_structure	Students_learn_pace	retake_exams	Extrinsically_rewarded
construct_belief	Pearson Correlation	1	.335(**)	.270(**)	-.018	.235(**)	.295(**)	.220(**)	.033
	Sig. (2-tailed)		.000	.000	.756	.000	.000	.000	.577
	N	291	283	290	289	289	289	291	288
behav_belief	Pearson Correlation	.335(**)	1	.504(**)	.461(**)	.429(**)	.403(**)	.494(**)	.595(**)
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000
	N	283	287	287	287	287	287	287	287

Table 21.

Correlations between the Theoretical Belief Scores for Behaviorism and Constructivism of the Participants and the Constructivist Scale Items

Correlations

		Construct belief	Behave belief	Problem solving	Teach Problem solving	Coursework Critical thinking abilities	limitations of processing abilities	Present Info. Different contexts	Develop Organizing For themselves
construct_belief	Pearson Correlation	1	.335(**)	.389(**)	.699(**)	.572(**)	.479(**)	.527(**)	.408(**)
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000
	N	291	283	291	290	291	291	291	291
behav_belief	Pearson Correlation	.335(**)	1	.042	.300(**)	.149(*)	.291(**)	.051	.106
	Sig. (2-tailed)	.000		.480	.000	.012	.000	.393	.074
	N	283	287	285	286	285	287	286	286

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

The Pearson's correlation between the scores for the theoretical beliefs of participants and the scale items for behaviorism is presented in Table 20. The correlation between the scores for the theoretical beliefs of participants and the scale items for constructivism is presented in Table 21. The Pearson's correlation suggests that there is a significant ($p<.05$ or greater) positive correlation between the behaviorist scores of the participants and the behaviorist scale items (Table 20) and between the constructivist scores and the constructivist scale items (Table 21). As expected (due to the mixed-belief nature of the faculty, as pointed out by Grasha), there is also a significant, but *lower*, positive correlation between the behaviorist scores and the constructivist scale items, as well as between the constructivist scores and behaviorist score items. The above data give a better understanding of the mixed-belief nature of the population. With that understanding in mind, this section proceeds with the presentation of results based on prevalent belief.

Frequencies and crosstabulations for the beliefs of the participants

Table 22.

Frequency Table Showing the Prevalent Beliefs of the Participants

prevalent_belief

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	behaviorist	1	.3	.4	.4
	undetermined	59	18.7	20.8	21.2
	constructivist	223	70.8	78.8	100.0
	Total	283	89.8	100.0	
Missing	System	32	10.2		
Total		315	100.0		

As described earlier, participants were divided by prevalent belief into constructivists, behaviorists and undetermined depending on their constructivist and behaviorist scores. As seen in Table 22, the frequencies of the prevalent beliefs of the participants were primarily constructivist. The number of participants who scored in the constructivist category was 223 out of 283. There were 59 participants labeled as undetermined. Only one participant had a score that placed him/her definitively in the behaviorist belief.

Table 23.

Percentages Showing Ages of the Participants Based on the Prevalent Theoretical Belief

Age * prevalent_belief Crosstabulation

			prevalent_belief			
			behaviorist	undetermined	constructivist	Total
Age	25-30	Count	0	2	8	10
		% within Age	.0%	20.0%	80.0%	100.0%
	31-35	Count	1	17	29	47
		% within Age	2.1%	36.2%	61.7%	100.0%
	36-40	Count	0	8	33	41
		% within Age	.0%	19.5%	80.5%	100.0%
	41-45	Count	0	6	43	49
		% within Age	.0%	12.2%	87.8%	100.0%
	46-50	Count	0	9	32	41
		% within Age	.0%	22.0%	78.0%	100.0%
	50+	Count	0	16	77	93
		% within Age	.0%	17.2%	82.8%	100.0%
Total		Count	1	58	222	281
		% within Age	.4%	20.6%	79.0%	100.0%

Table 23 shows the crosstabulations of age based on the prevalent belief of the participants. The data suggests that the faculty members who are around the stage of receiving tenure (between the ages of 31 and 35) tended to be less inclined toward constructivism than other faculty members. The sole behaviorist also fell within this age category. Other than this observation, the breakdown of participants by belief was quite similar for the different age categories.

Table 24.

Percentages Showing Job Titles of the Participants Based on the Prevalent Theoretical Belief

Job_title * prevalent_belief Crosstabulation

			prevalent_belief			Total
			behaviorist	undetermined	constructivist	
Job_title	Instructor	Count	0	5	11	16
		% within Job_title	.0%	31.3%	68.8%	100.0%
	Asst Prof	Count	1	12	43	56
		% within Job_title	1.8%	21.4%	76.8%	100.0%
	Assoc	Count	0	16	54	70
		% within Job_title	.0%	22.9%	77.1%	100.0%
	Full Prof	Count	0	25	94	119
		% within Job_title	.0%	21.0%	79.0%	100.0%
	other	Count	0	1	19	20
		% within Job_title	.0%	5.0%	95.0%	100.0%
Total		Count	1	59	221	281
		% within Job_title	.4%	21.0%	78.6%	100.0%

Table 24 shows the crosstabulation of job title based on the prevalent belief of the participants. The table shows that Assistant Professors, Associate Professors and Full Professors seem to show very little difference in breakdown by belief. Interestingly, the largest percentage of faculty members who were undetermined was for Instructors (31%) despite the fact that they are the category with the most training according to Table 14. The faculty members who listed their job title as "Other" had the largest percentage of constructivist scores (95%) while Instructors had the lowest percentage of constructivists (69%). Faculty members who listed their job title as Full, Associate or Assistant Professors all had similar percentages of constructivists (76.8-79%).

Table 25.

Percentages Showing Teaching Ability of the Participants Based on the Prevalent Theoretical Belief

Teaching_ability * prevalent_belief Crosstabulation

			prevalent_belief			
			behaviorist	undetermined	constructivist	Total
Teaching_ability	novice	Count	0	1	1	2
		% within Teaching_abil	.0%	50.0%	50.0%	100.0%
	Average	Count	1	27	92	120
		% within Teaching_abil	.8%	22.5%	76.7%	100.0%
	Expert	Count	0	31	130	161
		% within Teaching_abil	.0%	19.3%	80.7%	100.0%
Total		Count	1	59	223	283
		% within Teaching_abil	.4%	20.8%	78.8%	100.0%

Table 25 shows the crosstabulations of self-reported teaching ability based on the prevalent belief of the participants. Excluding the novice category, where the number of samples is clearly inadequate, the table suggests that self-reported experience with teaching in itself does not appear to be strongly related to belief, as the beliefs of self-reported average and expert teachers where very similarly-distributed between constructivist, behaviorist and undetermined.

Table 26.

Percentages Showing the Ways Participants Expect Students to Gather Information based on the Prevalent Theoretical Belief

Gather_information * prevalent_belief Crosstabulation

			prevalent_belief			Total
			behaviorist	undetermined	constructivist	
Gather_informatior	Instructor prim textbok second	Count	1	37	87	125
		% within Gather_information	.8%	29.6%	69.6%	100.0%
	textboks/self	Count	0	4	12	16
		% within Gather_information	.0%	25.0%	75.0%	100.0%
	problem-solving	Count	0	15	109	124
		% within Gather_information	.0%	12.1%	87.9%	100.0%
	class discussion	Count	0	2	12	14
		% within Gather_information	.0%	14.3%	85.7%	100.0%
Total		Count	1	58	220	279
		% within Gather_information	.4%	20.8%	78.9%	100.0%

Table 27 shows the crosstabulations of the way participants expect students to gather information based on the prevalent belief of the participants. According to the table, the two most prevalent ways faculty members expect students to gather information are first through the combination of instructor and textbook, then through the use of problem-solving and homework problems to build additional knowledge. However, the fraction of those who marked each method varied between constructivists and those undetermined. Of those who stated that they primarily expected their students to gather information from the instructor and textbooks, 29.6% were "undetermined" and 69.6% were constructivists. In contrast, of those who stated that they expected their students to gather information through the use of problem-solving and homework problems only 12.1% were undetermined, while 87.9% were constructivists.

Table 27.

Percentages Showing the Relation between the Teacher Training Services Used at the Current Institution based of the Prevalent Belief

teachertraining * prevalent_belief Crosstabulation

			prevalent_belief			
			behaviorist	undetermined	constructivist	Total
teachertraining	none	Count	0	28	92	120
		% within teachertraining	.0%	23.3%	76.7%	100.0%
	one tpye	Count	1	16	49	66
		% within teachertraining	1.5%	24.2%	74.2%	100.0%
	two types	Count	0	11	51	62
		% within teachertraining	.0%	17.7%	82.3%	100.0%
	three types	Count	0	1	18	19
		% within teachertraining	.0%	5.3%	94.7%	100.0%
	four types	Count	0	2	10	12
		% within teachertraining	.0%	16.7%	83.3%	100.0%
	five types	Count	0	1	2	3
		% within teachertraining	.0%	33.3%	66.7%	100.0%
	six types	Count	0	0	1	1
		% within teachertraining	.0%	.0%	100.0%	100.0%
Total		Count	1	59	223	283
		% within teachertraining	.4%	20.8%	78.8%	100.0%

Table 28.

Correlations of Prevalent Belief with the Amount of Teacher Training Services Used

Correlations

		prevalent_ belief	teacher training
prevalent_belief	Pearson Correlation	1	.082
	Sig. (2-tailed)		.168
	N	283	283
teachertraining	Pearson Correlation	.082	1
	Sig. (2-tailed)	.168	
	N	283	315

The crosstabulation of the amount of teacher training services used based on the prevalent belief is presented in Table 27. As shown in Table 27 the largest percentages of participants are constructivist. The largest number of constructivists (92 out of 223) said that they had not used any teacher training services at their institution, this is also true of those who were undetermined (28 out of 59). The sole behaviorist stated he had used one type of teacher training service. Table 28 shows the correlation between the use of teacher training services and the prevalent belief of the participants. As can be seen in Table 28, there is not a significant correlation between the amount of teacher training services used and the prevalent belief of the participant. In fact the correlation is so small as to be non-existent. This indicates that the use of teacher training services does not have an influence on the prevalent beliefs of the participants.

Teaching Practices and Influences

Research question four investigates the teaching practices of the participants and the factors that influence those practices. This research question uses data on job title (survey question five) class size (survey question 18), hours spent on class preparation (survey question 19), undergraduate office hours (survey question 20), selected instructional methods (survey question 23), knowing students by name (survey question 24), use of class projects (survey question 25), likelihood to experiment (survey question 29) and tenure status (survey question eight).

Unlike all other survey questions used so far, which were multiple choice questions, some questions used in this section asked for numeric answers that were to be chosen by the participants. To summarize such numeric responses, boxplots are used. Boxplots are convenient for summarizing data sets whose distributions are not accurately known. They show the mean, the 25th percentile, the 75th percentile, the maximum and the minimum of a data set, as well as outliers. For questions not involving open-ended numeric scores, crosstabulations are used for data summarizations.

The section has three main parts. First, descriptives, boxplots and crosstabulations are shown to describe common relations between faculty categories and their practices. Second, ANOVA analyses are presented to determine significant differences. Third, correlations are found between variables of interest. More specifically, in order to describe prevalent practices, this section first summarizes numeric data in the form of means tables and boxplot graphs showing, for each job title, the data involving the average number of students in the participants' undergraduate computer science classes (survey question 18), the average number of hours spent each week on class preparation (survey question 19), the average number of office hours dedicated to undergraduate students (survey question 20) and the average number of hours spent each week advising undergraduate students outside of office hours. Observe that the word "average" above refers to the average reported by the participant. This reported average changes from one participant to another. Hence, relevant statistics over a population are presented in the means tables and boxplots. For questions not involving (open ended) numeric answers, crosstabulations are reported showing the use of selected instructional methods (survey question 23) based on job title (survey question five), how well the participants know their students by name (survey question 24) based on job title, and the use of team projects (survey question 25) based on job title.

Following the means tables, boxplots and crosstabulations, ANOVAs are presented to examine any significant differences based on job title. Where significant differences are found, Tukey's posthoc tests are presented. In addition to these ANOVAs, crosstabulations and an ANOVA to examine the differences in the likelihood to experiment (survey question 29) based on tenure status (survey question eight) is presented.

Finally, in order to examine the possible influences that affect teaching practices, Pearson's correlations are presented that show the relations between theoretical beliefs and selected instructional methods used; as well the relations between the amount of teacher training received and selected instructional methods used.

Means, N's, Standard Deviations and Medians and Boxplots

Table 29.

Means, Ns, Standard Deviations, and Medians for the Average Number of Students in Undergraduate Classes

Report

Number_of_students

Job_title	Mean	N	Std. Deviation	Median
Instructor	57.35	17	35.669	60.00
Asst Prof	38.24	58	23.166	30.00
Assoc	39.21	73	18.404	40.00
Full Prof	43.87	127	34.156	35.00
other	41.86	21	20.036	40.00
Total	42.25	296	28.295	40.00

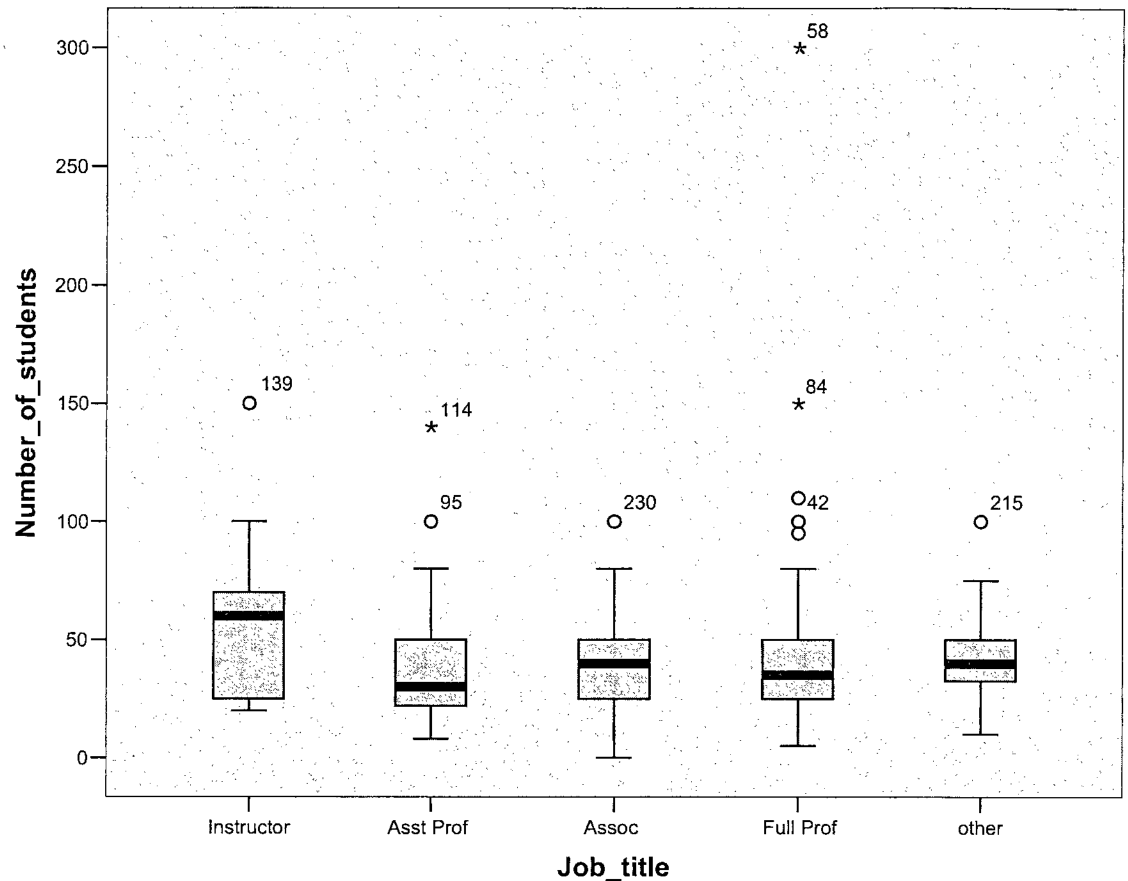


Figure 10. Boxplot graph for the average number of students in undergraduate classes based on job title.

Table 29 shows the means, Ns, standard deviations, and medians for the number of students in undergraduate classes taught by instructors, Assistant Professors, Associate Professors, Full Professors and "Other" participants. Figure 10 shows a box plot of the data, comparing the medians, the first and third quartiles (i.e., the 25th and the 75th percentiles), the minimum and maximum numbers of students, as well as individual outliers. As might be expected, Assistant Professors, who are often shielded by their departments from large classroom duties, have the smallest mean (38.24 students) and median (30 students). In contrast, instructors, who are typically hired specifically to teach larger classes, have the highest mean (57.35) and median (60). The mean numbers of students in classes taught by Associate Professors, Full Professors and other categories are 39.21 students, 43.87 students, and 41.86 students, respectively. These numbers might be skewed by outliers. The medians are a much more robust measure with respect to outliers. The median numbers of students in classes taught by Associate Professors, Full Professors and "Other" faculty are 40 students, 35 students, and 40 students, respectively. It is interesting to see that the quartile range, defined as the difference between the 75th and the 25th percentiles, is largest for instructors.

Table 30.

Means, Ns, Standard Deviations, and Medians for the Average Number of Hours Per Week Spent on Class Preparation

Report

Hours_for_class

Job_title	Mean	N	Std. Deviation	Median
Instructor	14.82	17	8.435	12.00
Asst Prof	8.88	57	3.813	10.00
Assoc	9.01	73	5.410	8.00
Full Prof	9.38	125	5.986	9.00
other	8.10	20	5.098	6.00
Total	9.42	292	5.731	9.00

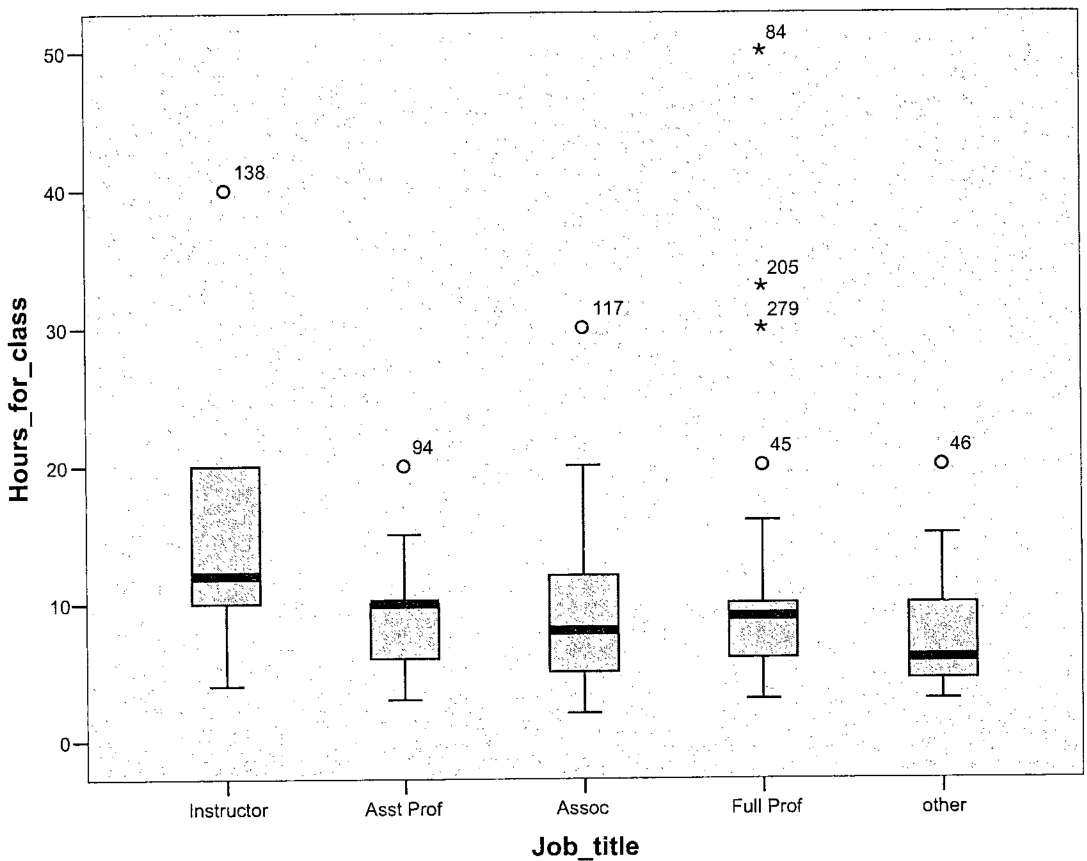


Figure 11. Boxplot Graph showing the average number of hours per week spent on class preparation based on job title

Table 30 shows the means, Ns, standard deviations, and medians for the average number of hours per week spent by instructors, Assistant Professors, Associate Professors, Full Professors and "Other" participants on class preparation. Figure 11 shows a boxplot comparing the medians, the first and third quartiles, the maximum and minimum numbers, and some outliers. An interesting observation is that while Assistant Professors had the smallest classes, according to data from Table 28, they report the second largest median of hours spent on class preparation (10 hours/week), exceeded, unsurprisingly, only by instructors whose median is 12 hours/week. The respective averages for Assistant Professors and instructors are 8.88 hours/week and 14.82 hours/week respectively. The mean number of hours reported by Associate Professors, Full Professors, and "Others" are 9.01 hours/week, 8.38 hours/week and 8.1 hours/week. The corresponding medians are 8 hours/week, 9 hours/week and 6 hours/week, respectively. The median statistics are more robust with respect to outliers and are therefore more telling of workload for comparison purposes.

Table 31.

Means, Ns, Standard Deviations, and Medians for the Average Number of Hours Spent on Office Hours Based on Job Title

Report

Ofice_hours

Job_title	Mean	N	Std. Deviation	Median
Instructor	3.82	17	2.298	3.00
Asst Prof	2.79	58	1.662	2.00
Assoc	2.97	73	3.476	3.00
Full Prof	2.75	128	1.474	3.00
other	3.52	21	2.562	3.00
Total	2.93	297	2.285	3.00

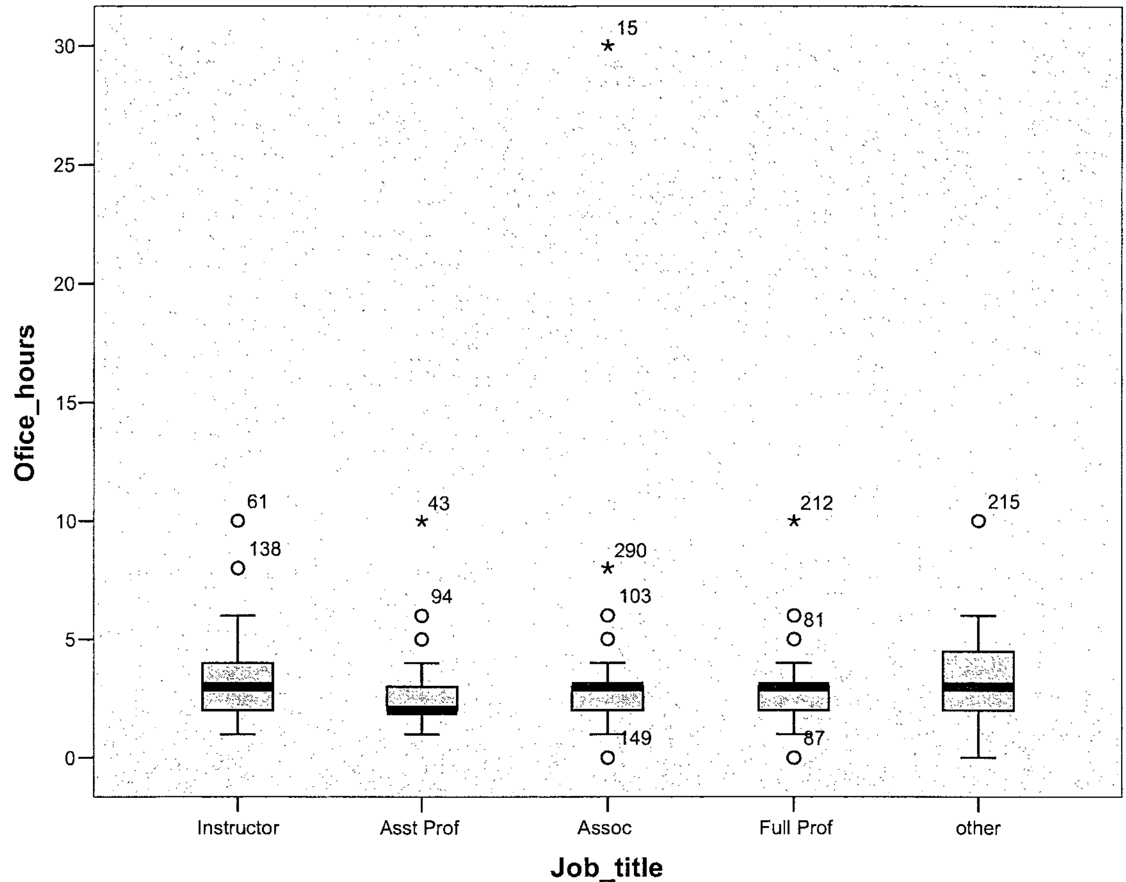


Figure 12. Boxplot graph showing the average number of hours spent on office hours based on job title.

Table 31 shows the means, Ns, standard deviations, and medians of the average number of office hours offered based on job title. It shows that instructors have the highest mean (3.82 hours/week) compared to 2.79 hours/week for Assistant Professors, 2.97 for Associate Professors, 2.75 hours/week for Full Professors, and 3.52 for "Other" participants. The medians of reported office hours for the different job titles are the same

(3 hours/week), except for Assistant Professors, whose median is 2 hours/week. This is consistent with expectations, since Assistant Professors are often given one less course to teach per year, compared to other faculty. Figure 12 shows the boxplot for these data. An immediate observation is that the quartile range for office hours offered is low for Assistant, Associate and Full Professors, showing only one hour difference between the 25th percentile and 75th percentile. The quartile range for instructors and "Other" participants is a bit higher, showing a difference of 2 and 2.5 hours respectively.

Table 32.

Means, Ns, Standard Deviations, Median Showing the Average Number of Hours Spent on Undergraduate Advising Outside of Office Hours Based on Job Title

Report

Student_advising

Job_title	Mean	N	Std. Deviation	Median
Instructor	4.29	17	3.118	4.00
Asst Prof	2.28	54	2.013	2.00
Assoc	3.12	73	3.366	2.00
Full Prof	3.15	128	3.667	2.00
other	3.55	20	4.442	3.00
Total	3.08	292	3.385	2.00

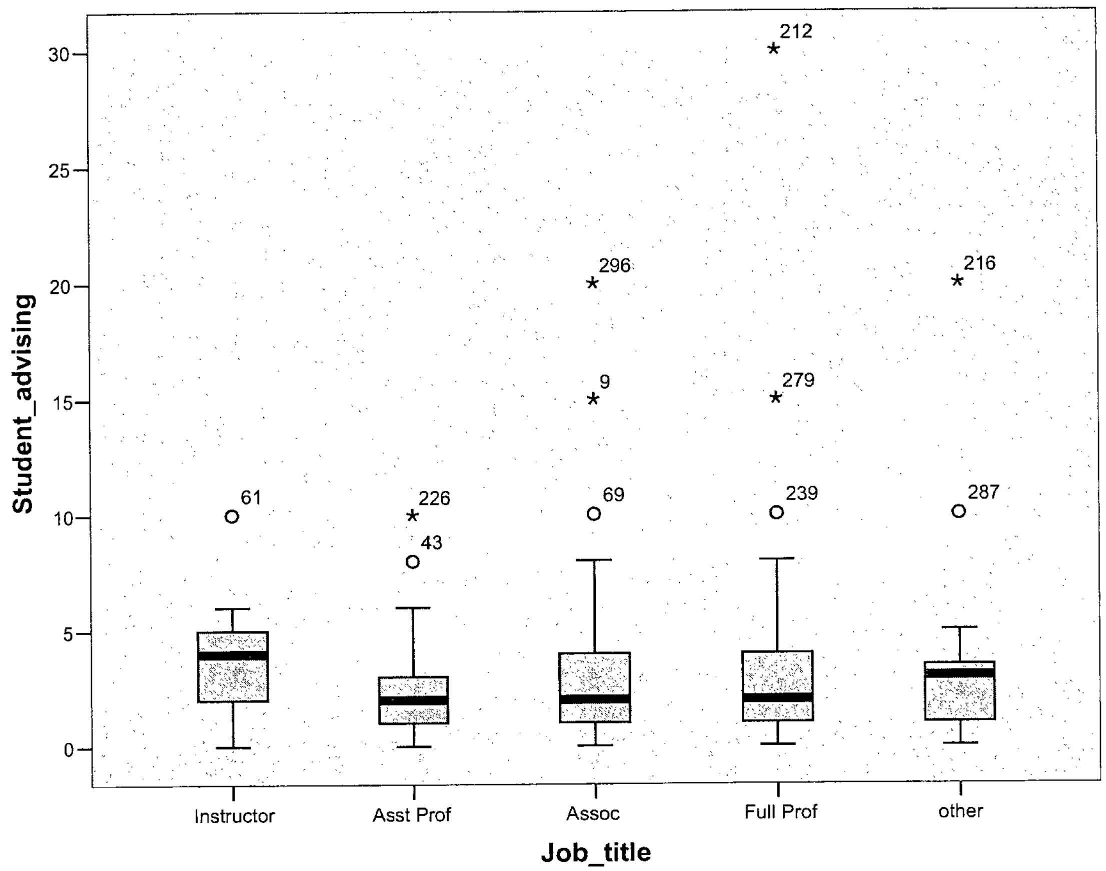


Figure 13. Boxplot graph showing the average number of hours spent on undergraduate advising outside of office hours based on job title.

Finally, Table 32 shows the means, Ns, standard deviations, and medians for the average number of hours spent on undergraduate advising outside of office hours based on job title. Unsurprisingly, instructors have the highest mean (4.29 hours/week) and median (4 hours/week). Assistant Professors have the lowest mean (2.28 hours/week), but tie on median with Associate and Full Professors (2 hours/week) whose means are somewhat higher (3.12 hours/week and 3.15 hours/week, respectively). Faculty, who identified their job title as "Other," have a mean of 3.55 hours/week and a median of 3 hours/week. Figure 13 shows the box plot. The box plot indicates that the quartile range for advising is a bit larger than that for office hours. Assistant Professors have a quartile range of 2 hours/week, whereas most other categories of faculty have a quartile range of 3 hours/week.

Crosstabulations for the use of selected instructional methods based on job title

Table 33.

Crosstabulation Showing Percentages the Use of the Lecture Method Based on Job Title

Job_title * Lecture Crosstabulation

			Lecture					Total
			Never	< 1time per week	at least once per week	at least 2 out of three classes	Every class	
Job_title	Instructor	Count	2	2	3	4	6	17
		% within Job_title	12%	11.8%	17.6%	23.5%	35.3%	100%
	Asst Prof	Count	3	2	1	21	29	56
		% within Job_title	5.4%	3.6%	1.8%	37.5%	51.8%	100%
	Assoc	Count	1	4	5	20	44	74
		% within Job_title	1.4%	5.4%	6.8%	27.0%	59.5%	100%
	Full Prof	Count	5	2	14	40	67	128
		% within Job_title	3.9%	1.6%	10.9%	31.3%	52.3%	100%
	other	Count	1	1	4	7	8	21
		% within Job_title	4.8%	4.8%	19.0%	33.3%	38.1%	100%
Total		Count	12	11	27	92	154	296
		% within Job_title	4.1%	3.7%	9.1%	31.1%	52.0%	100%

Next, crosstabulations are presented that determine the relation between job title and use of specific teaching methods. As seen in Table 33, when grouped by job title, the data indicate that 51.8% of Assistant Professors, 59.9% of Associate Professors and 52.3% of Full Professors tend to use lecture in every class. These percentages are much higher than the percentages for Instructors (35.3%) and those listed as "Other" (38.1%). The data indicate that Associate Professors are the most likely group to use the instructional method of lecture in every class.

Table 34.

Crosstabulation of Percentages for the use of Small Groups to Problem-solving based on Job Title

Job_title * small groups to problem_solve Crosstabulation

			Problem_solve					
			Never	< 1time per week	at least once per week	at least 2 out of three classes	Every class	Total
Job_title	Instructor	Count	2	5	6	1	3	17
		% within Job_title	12%	29.4%	35.3%	5.9%	17.6%	100%
	Asst Prof	Count	18	18	13	3	5	57
		% within Job_title	32%	31.6%	22.8%	5.3%	8.8%	100%
	Assoc	Count	21	31	12	4	3	71
		% within Job_title	30%	43.7%	16.9%	5.6%	4.2%	100%
	Full Prof	Count	40	48	19	12	7	126
		% within Job_title	32%	38.1%	15.1%	9.5%	5.6%	100%
	other	Count	3	6	9	2	1	21
		% within Job_title	14%	28.6%	42.9%	9.5%	4.8%	100%
Total		Count	84	108	59	22	19	292
		% within Job_title	29%	37.0%	20.2%	7.5%	6.5%	100%

Table 34 shows the percentages of faculty members who use small groups to problem-solve and the frequency with which they choose to use this method. Adding the percentages in the column labeled "at least once a week" and those columns labeled by higher frequencies, the data indicate that 58.8% of Instructors use small groups once a week or more frequently to problem solve. This percentage is to be contrasted with 36.9% of Assistant Professors, 26.7% of Associate Professors, 30.2% of Full Professors and 57.2% of "Other" faculty. The data indicate that Associate Professors are least likely to use small groups to problem solve. The largest percentage of Instructors (35.3%) and "Others" (42.9%) indicate that they use small groups once a week, while the largest percentages of Associate (43.7%) and Full Professors (38.1%) indicate that they use small groups less than once a week. Assistant Professors were equally likely to never use small groups (32%) or to use it less than one time per week (31.6%) and somewhat less likely to use small groups at least once a week (22.8%).

Table 35.

Crosstabulation of Percentages for the Use of Whole Class Discussion Based on Job Title

Job_title * Whole_class_disc Crosstabulation

			Whole_class_disc					
			Never	< 1time per week	at least once per week	at least 2 out of three classes	Every class	Total
Job_title	Instructor	Count	2	6	4	2	2	16
		% within Job_title	13%	37.5%	25.0%	12.5%	12.5%	100%
	Asst Prof	Count	15	20	10	4	8	57
		% within Job_title	26%	35.1%	17.5%	7.0%	14.0%	100%
	Assoc	Count	15	27	16	4	10	72
		% within Job_title	21%	37.5%	22.2%	5.6%	13.9%	100%
	Full Prof	Count	25	48	24	16	14	127
		% within Job_title	20%	37.8%	18.9%	12.6%	11.0%	100%
	other	Count	1	6	7	3	4	21
		% within Job_title	4.8%	28.6%	33.3%	14.3%	19.0%	100%
Total		Count	58	107	61	29	38	293
		% within Job_title	20%	36.5%	20.8%	9.9%	13.0%	100%

Table 35 shows the percentages of faculty members who use whole class discussion, and the frequency of that use based on job title. The data indicate that the faculty members who listed their job title as "Other" are more likely to use whole class discussion than their colleagues (95.2%). The data also indicate that Assistant Professors are least likely to use whole class discussion (74%). The largest percentage of "Others" (33.3%) indicate that they use whole class discussion at least once a week, while the largest percentages of Assistant (35.1%), Associate (37.5%) and Full Professors (37.8%) indicate that they use whole class discussion less than once a week.

Table 36.

Crosstabulation of Percentages for the use of Demonstration, Hands-on or Role play Activities based on Job Title

Job_title * Demonstrations Crosstabulation

			Demonstrations					
			Never	< 1time per week	at least once per week	at least 2 out of three classes	Every class	Total
Job_title	Instructor	Count	0	7	4	2	4	17
		% within Job_title	.0%	41.2%	23.5%	11.8%	23.5%	100%
	Asst Prof	Count	19	19	11	5	3	57
		% within Job_title	33%	33.3%	19.3%	8.8%	5.3%	100%
	Assoc	Count	16	23	17	12	3	71
		% within Job_title	23%	32.4%	23.9%	16.9%	4.2%	100%
	Full Prof	Count	31	46	28	13	7	125
		% within Job_title	25%	36.8%	22.4%	10.4%	5.6%	100%
	other	Count	3	11	4	0	3	21
		% within Job_title	14%	52.4%	19.0%	.0%	14.3%	100%
Total		Count	69	106	64	32	20	291
		% within Job_title	24%	36.4%	22.0%	11.0%	6.9%	100%

Table 36 shows the percentages of faculty members who use demonstrations, hands-on and role-play activities, and the frequencies with which they use them. The data indicate that Instructors are more likely to use demonstration, hands-on and role play activities than their colleagues as all Instructors said that they use them some time. The data also indicate that Assistant Professors (67%) would be least likely to use demonstration, hands-on and role play activities. The largest percentage of "Others" (52.4%), Instructors (41.2%), Associate (32.4%) and Full Professors (36.8%) indicate that they demonstration, hands-on and role play activities less than once a week. Assistant Professors had equal numbers of participants whom answered that they use demonstration, hands-on and role play activities less than one time per week or not at all (33%).

Table 37.

Crosstabulation of Percentages for the use of Student Led Discussions based on Job Title

Job_title * Student_led_Disc Crosstabulation

			Student_led_Disc					
			Never	< 1time per week	at least once per week	at least 2 out of three classes	Every class	Total
Job_title	Instructor	Count	8	8	0	0	1	17
		% within Job_title	47%	47.1%	.0%	.0%	5.9%	100%
	Asst Prof	Count	32	19	4	1	1	57
		% within Job_title	56%	33.3%	7.0%	1.8%	1.8%	100%
	Assoc	Count	36	26	8	2	0	72
		% within Job_title	50%	36.1%	11.1%	2.8%	.0%	100%
	Full Prof	Count	81	33	7	5	1	127
		% within Job_title	64%	26.0%	5.5%	3.9%	.8%	100%
	other	Count	8	10	3	0	0	21
		% within Job_title	38%	47.6%	14.3%	.0%	.0%	100%
Total		Count	165	96	22	8	3	294
		% within Job_title	56%	32.7%	7.5%	2.7%	1.0%	100%

Table 37 shows the percentages of faculty members who use whole class discussion and the frequencies with which they use them. The data indicate that the faculty members who listed their job title as "Other" (62%) are more likely to use student led discussion than their colleagues. The data also indicate that Full Professors (64%) are least likely to use student led discussion. The largest percentage of Instructors (67.1%) and "Others" (47.6%) indicate that they use student led discussion less than once a week, while the largest percentages of Assistant (56%), Associate (50%) and Full Professors (64%) indicate that they never use student led discussion.

Table 38.

Crosstabulation of Percentages for the Use of Relating Material to Real World Contexts based on Job Title

Job_title * real_world_contexts Crosstabulation

			real_world_contexts					
			Never	< 1time per week	at least once per week	at least 2 out of three classes	Every class	Total
Job_title	Instructor	Count	0	1	5	3	8	17
		% within Job_title	.0%	5.9%	29.4%	17.6%	47.1%	100%
	Asst Prof	Count	0	5	16	19	17	57
		% within Job_title	.0%	8.8%	28.1%	33.3%	29.8%	100%
	Assoc	Count	0	6	24	21	22	73
		% within Job_title	.0%	8.2%	32.9%	28.8%	30.1%	100%
	Full Prof	Count	1	13	32	34	48	128
		% within Job_title	.8%	10.2%	25.0%	26.6%	37.5%	100%
	other	Count	0	1	4	9	7	21
		% within Job_title	.0%	4.8%	19.0%	42.9%	33.3%	100%
Total		Count	1	26	81	86	102	296
		% within Job_title	.3%	8.8%	27.4%	29.1%	34.5%	100%

Table 38 shows the percentages of faculty members who relate materials to real world contexts and the frequencies with which they use them. The data indicate that Instructors (47.1%) and Full Professors (37.5%) tend to relate materials to real world contexts during every class more than all other groups. The data also indicate that almost all the participants relate materials to real world context at least once a week. Only one participant in the Full Professor group (.8%) indicated that they never relate materials to real world contexts.

Table 39.

Crosstabulation for Percentages of How Well Faculty Members Know their Students by Name Based on Job Title

Job_title * Student_names Crosstabulation

			Student_names				
			no	more active ones	most	all	Total
Job_title	Instructor	Count	1	7	6	3	17
		% within Job_title	5.9%	41.2%	35%	18%	100%
	Asst Prof	Count	0	14	19	25	58
		% within Job_title	.0%	24.1%	33%	43%	100%
	Assoc	Count	1	29	25	19	74
		% within Job_title	1.4%	39.2%	34%	26%	100%
	Full Prof	Count	3	57	45	23	128
		% within Job_title	2.3%	44.5%	35%	18%	100%
	other	Count	2	5	8	6	21
		% within Job_title	9.5%	23.8%	38%	29%	100%
Total		Count	7	112	103	76	298
		% within Job_title	2.3%	37.6%	35%	26%	100%

Table 39 shows the percentages of faculty members who know their students by name and to what extent. The data indicate that 43% of Assistant Professors responded that they knew all their students by name, topping all other categories in that respect. Full Professors, Associate Professors and Instructors predominantly reported knowing only the more active students, ranging in percentage for that answer between 39.2% and 44.5%. For the "Other" faculty, the most popular answer was that they know most (but not all) of the students by name (38%). Looking at the numbers of students taught by the different categories (shown in Table 29), it may be expected that assistant professors who teach smaller classes should indeed know their students better, whereas instructors who teach larger classes would not know their students as well. The explanation is less obvious for the relative lack of involvement of Associate and Full Professors.

Table 40.

Crosstabulation for Percentages of How Often Faculty Members Use a Team Project in Their Classes Based on Job Title

Job_title * Team_project Crosstabulation

			Team_project				
			Never	Some Courses	Most courses	Every Course	Total
Job_title	Instructor	Count	0	10	4	3	17
		% within Job_title	.0%	58.8%	23.5%	17.6%	100%
	Asst Prof	Count	9	17	11	21	58
		% within Job_title	16%	29.3%	19.0%	36.2%	100%
	Assoc	Count	7	21	19	27	74
		% within Job_title	9.5%	28.4%	25.7%	36.5%	100%
	Full Prof	Count	16	46	29	36	127
		% within Job_title	13%	36.2%	22.8%	28.3%	100%
	other	Count	3	6	6	6	21
		% within Job_title	14%	28.6%	28.6%	28.6%	100%
Total		Count	35	100	69	93	297
		% within Job_title	12%	33.7%	23.2%	31.3%	100%

Table 40 shows the percentages of faculty members who use team projects in their courses and the frequencies with which they use them. The data indicate that all Instructors who responded used projects in their courses. Of Instructors, 58.8% said they used projects in some courses, 23.5% said they used them in most courses, and only 17.6% used them in every course. Full professors popularly reported using projects in some courses (36.2%). Only 22.8% reported using projects in most courses and 28.3% reported using them in every course. This was in contrast with Assistant and Associate Professors whose most popular answer was using projects in every course (36.2% and 36.5%, respectively). The "Other" faculty had a more equal distribution, with 28.6% reporting that they used projects in some, most, and all courses, respectively. Assistant, and Associate Professors are more likely to assign a team project in their courses, Instructors are most likely to only assign a team project in some courses. Assistant and Associate Professors had the highest percentages for assigning a team project in every course they teach.

Descriptives, ANOVAs and Tukey's Posthoc tests for the use of selected instructional methods

Table 41.

Means, Ns, and Standard Deviations for the Use of Lecture, Small Group Problem-Solving, and Whole Class Discussion Based on Job Title

Descriptives

		N	Mean	Std. Deviation
Lecture	Instructor	17	3.59	1.417
	Asst Prof	56	4.27	1.053
	Assoc	74	4.38	.932
	Full Prof	128	4.27	.992
	other	21	3.95	1.117
	Total	296	4.23	1.036
Problem_solve	Instructor	17	2.88	1.269
	Asst Prof	57	2.28	1.221
	Assoc	71	2.11	1.036
	Full Prof	126	2.19	1.150
	other	21	2.62	1.024
	Total	292	2.26	1.146
Whole_class_disc	Instructor	16	2.75	1.238
	Asst Prof	57	2.47	1.338
	Assoc	72	2.54	1.278
	Full Prof	127	2.57	1.251
	other	21	3.14	1.195
	Total	293	2.60	1.272

Table 42.

Means, Ns, and Standard Deviations for the Use of Demonstrations, Hands-on, and Role Play Activities, Student Led Discussion and Relating Materials to Real World Contexts Based on Job Title

Descriptives

		N	Mean	Std. Deviation
Demonstrations	Instructor	17	3.18	1.237
	Asst Prof	57	2.19	1.156
	Assoc	71	2.48	1.145
	Full Prof	125	2.35	1.131
	other	21	2.48	1.209
	Total	291	2.41	1.163
Student_led_Disc	Instructor	17	1.71	.985
	Asst Prof	57	1.60	.842
	Assoc	72	1.67	.787
	Full Prof	127	1.52	.834
	other	21	1.76	.700
	Total	294	1.60	.823
real_world_contexts	Instructor	17	4.06	1.029
	Asst Prof	57	3.84	.960
	Assoc	73	3.81	.967
	Full Prof	128	3.90	1.049
	other	21	4.05	.865
	Total	296	3.89	.995

Table 43.

Summary of ANOVA to Determine Whether There is a Difference in the Use of Lecture, Small Group Problem-Solving, and Whole Class Discussion Based on Job Title

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Lecture	Between Groups	10.489	4	2.622	2.490	.043
	Within Groups	306.426	291	1.053		
	Total	316.916	295			
Problem_solve	Between Groups	11.466	4	2.867	2.219	.067
	Within Groups	370.753	287	1.292		
	Total	382.219	291			
Whole_class_disc	Between Groups	7.781	4	1.945	1.206	.309
	Within Groups	464.696	288	1.614		
	Total	472.478	292			

Table 44.

Tukey's Posthoc Tests for the Use of Lecture Based on Job Title

Multiple Comparisons

Dependent Variable: Lecture
Tukey HSD

(I) Job_title	(J) Job_title	Mean Difference (I-J)	Std. Error	Sig.
Instructor	Asst Prof	-.680	.284	.120
	Assoc	-.790(*)	.276	.036
	Full Prof	-.677	.265	.081
	other	-.364	.335	.813
Asst Prof	Instructor	.680	.284	.120
	Assoc	-.111	.182	.974
	Full Prof	.002	.164	1.000
	other	.315	.263	.751
Assoc	Instructor	.790(*)	.276	.036
	Asst Prof	.111	.182	.974
	Full Prof	.113	.150	.944
	other	.426	.254	.449
Full Prof	Instructor	.677	.265	.081
	Asst Prof	-.002	.164	1.000
	Assoc	-.113	.150	.944
	other	.313	.242	.694
other	Instructor	.364	.335	.813
	Asst Prof	-.315	.263	.751
	Assoc	-.426	.254	.449
	Full Prof	-.313	.242	.694

* The mean difference is significant at the .05 level.

Table 45.

Summary of ANOVA to Determine Whether There is a Difference in the Use of Demonstrations, Hands-on, and Role Play Activities, Student Led Discussion and Relating Materials to Real World Contexts Based on Job Title

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Demonstrations	Between Groups	13.521	4	3.380	2.552	.039
	Within Groups	378.816	286	1.325		
	Total	392.337	290			
Student_led_Disc	Between Groups	1.880	4	.470	.690	.599
	Within Groups	196.759	289	.681		
	Total	198.639	293			
real_world_contexts	Between Groups	1.627	4	.407	.408	.803
	Within Groups	290.467	291	.998		
	Total	292.095	295			

Table 46.

Tukey's Posthoc Test for the Use of Demonstrations, Hands-on and Role Play Activities Based on Job Title

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) Job_title	(J) Job_title	Mean Difference (I-J)	Std. Error	Sig.
Demonstrations	Instructor	Asst Prof	.983(*)	.318	.018
		Assoc	.698	.311	.166
		Full Prof	.824(*)	.298	.047
		other	.700	.375	.339
	Asst Prof	Instructor	-.983(*)	.318	.018
		Assoc	-.286	.205	.630
		Full Prof	-.159	.184	.910
		other	-.283	.294	.871
	Assoc	Instructor	-.698	.311	.166
		Asst Prof	.286	.205	.630
		Full Prof	.127	.171	.946
		other	.003	.286	1.000
	Full Prof	Instructor	-.824(*)	.298	.047
		Asst Prof	.159	.184	.910
		Assoc	-.127	.171	.946
		other	-.124	.271	.991
	other	Instructor	-.700	.375	.339
		Asst Prof	.283	.294	.871
		Assoc	-.003	.286	1.000
		Full Prof	.124	.271	.991

* The mean difference is significant at the .05 level.

Faculty members were asked to answer how often they used certain instructional methods in their undergraduate courses. The descriptives for the use of lecture, small groups to problem-solve and whole class discussions are presented in Table 41, while the descriptives for the use of demonstrations, student led discussion and relating materials to real world contexts are presented in Table 42. The descriptives suggest that student led discussions is the instructional method that is used the least (means between 1.5 and 1.7) while the use of lecture and relating material to real world contexts are used the most (means between 3.5 and 4.2). Associate Professors had the highest mean (4.38) for the use of lecture while Instructors (3.59) had the lowest. In contrast, Instructors and "Other" had the highest mean (1.76) for the use of student led discussion while Full Professors had the lowest (1.52).

As can be seen in Table 43 and Table 45, there were significant differences in the use of lecture (Table 43) with p=.043 and the use of demonstration (Table 45) with p=.039 based on job title. In order to determine where the differences were, Tukey's posthoc tests were run on the data for lecture as seen in

Table 44, and the use of demonstration as seen in Table 46. The Tukey posthoc test for lecture shows that significant differences were evident between Instructors and the Associate Professors. Instructors rated almost a full point lower in the use of lecture than did Associate Professors (-.790). The Descriptives for the use of lecture (Table 41) show that Instructors answered that they use lecture method for at least 1 class a week (3.59 out of 5), whereas the means for Associate Professors (4.38 out of 5) show that they use lecture method at least 2 out of every 3 classes. The Tukey posthoc tests for the use of demonstrations, hands-on and role play activities (Table 46) show that Instructors scored almost a full point higher for the use of demonstration, hands-on and role play activities than did Assistant (.983 higher) or Full Professors (.824 higher). The means for these groups indicate that Instructors (3.18) use demonstration, hands-on and role play activities at least one class a week and Assistant (2.18) and Full Professors (2.35) use them less than one class a week.

Descriptives, ANOVAs and Tukey's Posthoc tests for how well faculty members know their students by name

Table 47.

Means, Ns, and Standard Deviations for How Well Faculty Members Know their Students by Name

Descriptives

Student_names

	N	Mean	Std. Deviation
Instructor	17	2.65	.862
Asst Prof	58	3.19	.805
Assoc	74	2.84	.828
Full Prof	128	2.69	.791
other	21	2.86	.964
Total	298	2.83	.836

Table 48.

Summary of ANOVA to Determine Whether There is a Difference in How Well Faculty Members know their Students by Name Based on Job Title

ANOVA

Student_names

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10.689	4	2.672	3.976	.004
Within Groups	196.922	293	.672		
Total	207.611	297			

Table 49.

Tukey's Posthoc Test for the How Well Faculty Members know their Students by Name Based on Job Title

Multiple Comparisons

Dependent Variable: Student_names
Tukey HSD

(I) Job_title	(J) Job_title	Mean Difference (I-J)	Std. Error	Sig.
Instructor	Asst Prof	-.543	.226	.118
	Assoc	-.191	.220	.909
	Full Prof	-.040	.212	1.000
	other	-.210	.267	.935
Asst Prof	Instructor	.543	.226	.118
	Assoc	.352	.144	.106
	Full Prof	.502(*)	.130	.001
	other	.333	.209	.503
Assoc	Instructor	.191	.220	.909
	Asst Prof	-.352	.144	.106
	Full Prof	.150	.120	.718
	other	-.019	.203	1.000
Full Prof	Instructor	.040	.212	1.000
	Asst Prof	-.502(*)	.130	.001
	Assoc	-.150	.120	.718
	other	-.170	.193	.905
other	Instructor	.210	.267	.935
	Asst Prof	-.333	.209	.503
	Assoc	.019	.203	1.000
	Full Prof	.170	.193	.905

* The mean difference is significant at the .05 level.

Faculty members were asked to answer how well they knew their students by name in their undergraduate courses. The descriptives for their answers are presented in Table 47. The descriptives show that Assistant Professors are most likely to know their students by name. The mean for Assistant Professors is 3.19 which indicate that Assistant Professors know most of their students by name. Whereas Instructors, Associate and Full Professors as well as "Others" indicated that they only know the more active students in their classes.

As can be seen in Table 48, there were significant differences in how well faculty members know their students by name with p=.004 based on job title. In order to determine where the differences were, Tukey's posthoc tests were run on the data as seen in Table 49. The Tukey posthoc test shows that significant differences were evident between Assistant and Full Professors in that Assistant Professors scored .5 points higher than did Full Professors. Based on the Descriptives for the how well faculty members know their students by name (Table 47) show that Assistant Professors answered that they know most of their students by name (3.19 out of 4), whereas the means for Full Professors (2.69 out of 4) show that they only know the more active students in their classes.

Descriptives and ANOVA for the use of team projects in courses

Table 50.

Means, Ns, and Standard Deviations for the Use of Team Projects in Their Courses Based on Job Title

Descriptives

Team_project

	N	Mean	Std. Deviation
Instructor	17	2.59	.795
Asst Prof	58	2.76	1.113
Assoc	74	2.89	1.015
Full Prof	127	2.67	1.024
other	21	2.71	1.056
Total	297	2.74	1.028

Table 51.

Summary of ANOVA to Determine Whether There is a Difference in of Team Projects in Their Courses Based on Job Title

ANOVA

Team_project

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.768	4	.692	.651	.626
Within Groups	310.269	292	1.063		
Total	313.037	296			

As can be seen in Table 51 there were no significant differences (p>.05) in the use of team projects in courses with p=.626 based on job title. The means for all job titles were between 2.59 and 2.89 with Instructors having the lowest mean and Associate Professors have the highest with a mean of 2.89. These data indicate that faculty members use team projects in some to most of their classes.

Crosstabulation for Likelihood to Experiment based on Tenure Status

Table 52.

Crosstabulation of the Likelihood to Experiment with New Teaching Methods Based on Tenure Status.

Tenure_current * likely_to_experiment Crosstabulation

			likely_to_experiment				
			very unlikely	somewhat unlikely	somewhat likely	very likely	Total
Tenure_curren	yes	Count	7	46	102	45	200
		% within Tenure_curr	3.5%	23.0%	51.0%	22.5%	100.0%
	no	Count	1	12	51	32	96
		% within Tenure_curr	1.0%	12.5%	53.1%	33.3%	100.0%
Total		Count	8	58	153	77	296
		% within Tenure_curr	2.7%	19.6%	51.7%	26.0%	100.0%

As seen in Table 52, the largest percentage of faculty members who said they were very likely to experiment with alternative methods was those faculty members who do not have tenure (33%). However more than 50% of faculty members in each group said they were somewhat likely to experiment. Faculty members with tenure had the highest percentages of members who said they were somewhat unlikely (23%) and very unlikely to experiment (3.5%)

Analysis of the Likelihood of experimentation based on tenure status

Table 53.

Means, Ns, and Standard Deviations for Likelihood to Experiment Based on Current Tenure Status.

Have tenure	N	Mean	Std. Deviation
yes	200	2.93	.770
no	96	3.19	.685
Total	296	3.01	.752

Table 54.

Summary of ANOVA to Determine whether there is a Difference Between Faculty Members likelihood to Experiment with Alternative Methods Based on Job Title.

Tenure Status	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.470	1	4.470	8.087	.005
Within Groups	162.500	294	.553		
Total	166.970	295			

Faculty members were asked to answer questions about their current tenure status and how likely they would be to experiment with alternative methods. As can be seen in Table 53 the mean scores for the likelihood of experimenting were dissimilar for faculty members who have tenure (2.93) and those who don't (3.19). There were twice as many faculty members with tenure than there were without tenure.

There were significant differences (p <.05 or greater) between faculty members with tenure and faculty members without tenure as it pertains to their likelihood to experiment with alternative teaching methods (Table 54). The means in Table 53 suggest that those without tenure are more likely to experiment with alternative methods with a difference in means of .26 points.

Data Analysis for teacher training and teaching methods

Table 55.

Correlations between Faculty Members' Amount of Teacher Training and Their Use of Selected Instructional Methods

Correlations

		Lecture	Problem solve	Whole class disc	Demon-strations	Student Led Disc	real world contexts
teacher training	Pearson Correlation	-.235(**)	.271(**)	.030	.124(*)	.191(**)	.095
	Sig. (2-tailed)	.000	.000	.612	.034	.001	.102
		298	294	295	293	296	298

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

The Pearson's correlation between teacher training and the use of different teaching methods is presented in Table 55. The Pearson's correlations suggest that there is a significant (p<.05 or greater) negative correlation between teacher training and the use of the lecture method (-.235). There were significant positive correlations between teacher training and the use of problem solving (.271), student led discussion (.191) and demonstration (.124). There were positive but non-significant correlations between teacher training and the use of whole class discussions and real world contexts. These correlations indicated that some of the faculty members who engaged in additional teacher training activities tended to use more student-oriented teaching methods.

Behaviorist and Constructivist beliefs and teaching method

Table 56.

Correlation between Faculty Members' Instructional Beliefs and Their Reported Use of Selected Instructional Methods

Correlations

		Lecture	Problem -solve	Whole class disc	Demon-strations	Student led Disc	real world contexts
construct_belief	Pearson Correlation	-.073	.098	.148(*)	.229(**)	.152(**)	.086
	Sig. (2-tailed)	.214	.100	.012	.000	.010	.145
	N	288	285	286	284	287	288
behav_belief	Pearson Correlation	.083	.088	-.106	.105	.071	-.072
	Sig. (2-tailed)	.161	.139	.077	.079	.231	.224
	N	284	281	282	280	283	284

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 57.

Correlation among Reported use of Selected Instructional Methods.

Correlations

		Lecture	Problem_solve	Whole_class_disc	Demonstrations	Student_led_Disc	real_world_contexts
Lecture	Pearson Correlation	1	-.461(**)	-.226(**)	-.190(**)	-.306(**)	-.111
	Sig. (2-tailed)		.000	.000	.001	.000	.058
	N	298	293	294	292	295	296
Problem_solve	Pearson Correlation	-.461(**)	1	.239(**)	.286(**)	.250(**)	.100
	Sig. (2-tailed)	.000		.000	.000	.000	.088
	N	293	294	293	291	294	294
Whole_class_disc	Pearson Correlation	-.226(**)	.239(**)	1	.196(**)	.398(**)	.286(**)
	Sig. (2-tailed)	.000	.000		.001	.000	.000
	N	294	293	295	292	295	295
Demonstrations	Pearson Correlation	-.190(**)	.286(**)	.196(**)	1	.228(**)	.154(**)
	Sig. (2-tailed)	.001	.000	.001		.000	.008
	N	292	291	292	293	293	293
Student_led_Disc	Pearson Correlation	-.306(**)	.250(**)	.398(**)	.228(**)	1	.177(**)
	Sig. (2-tailed)	.000	.000	.000	.000		.002
	N	295	294	295	293	296	296
real_world_contexts	Pearson Correlation	-.111	.100	.286(**)	.154(**)	.177(**)	1
	Sig. (2-tailed)	.058	.088	.000	.008	.002	
	N	296	294	295	293	296	298

The Pearson's correlation table between teaching methods and constructivist and behaviorist beliefs is given in Table 56. As can be seen in Table 56, the results of Pearson's correlation show that faculty members who scored higher in the constructivist beliefs tended to use the instructional methods of whole class discussion, demonstration, and student led discussion. The faculty members who scored higher in behaviorist beliefs did not show any correlation with specific instructional methods. In Table 57, the data shows that there is a negative correlation between the use of the more teacher-oriented lecture method and selected student-oriented teaching methods. This negative correlation indicates that faculty members, who use the more teacher-oriented lecture method frequently, are less likely to use the selected student-oriented teaching methods. The data also shows that there are significant positive correlations between the more student-oriented teaching methods. This positive correlation suggests that if faculty members use one of the selected student-oriented methods, they are more likely to use the others. Real-world contexts did not show significance when correlated with the lecture method or problem-solving.

Teaching methods and age and years experience

Table 58.

Correlations between Faculty Members' Years Experience and Their use of Selected Instructional Methods.

Correlations

		Lecture	Problem_solve	Whole_class_disc	Demonstrations	Student_led_Disc	real_world_contexts
Years_teaching	Pearson Correlation	-.037	.046	.066	.003	-.028	.047
	Sig. (2-tailed)	.523	.437	.259	.958	.635	.418
	N	297	293	294	292	295	297

** Correlation is significant at the 0.01 level (2-tailed).

Table 59.

Correlations between Faculty Members' Age and Their Use of Selected Instructional Methods.

Correlations

		Lecture	Problem solve	Whole class disc	Demon-strations	Student led Disc	real world contexts
Age	Pearson Correlation	-.065	.037	.081	.041	-.037	.027
	Sig. (2-tailed)	.263	.524	.168	.491	.522	.645
	N	296	292	293	291	294	296

** Correlation is significant at the 0.01 level (2-tailed).

Faculty members were asked to enter their ages and years experience given in five year ranges and were asked to answer how often they used each of six methods in their classes. As can be seen in Table 58, there are no significant correlations between the years of experience and teaching method. There were negative correlations between the years of experience and the use of the lecture method and the use of student led discussion. Additionally, as seen in Table 59, there was also this same negative correlation between age and the lecture method and student led discussions. The small correlations show that there is little variation in the answers given by faculty members despite the large range of ages and years of experience.

Teaching Incentives, Rewards and Deterrents

Research question five investigates the incentives and rewards available to faculty members for innovation in teaching. In addition to the incentives and rewards this section investigates the deterrents that influence why faculty members choose to use the instructional methods they use. In order to investigate the rewards and incentives available to faculty members, the following section contains crosstabulation tables showing the frequencies and percentages of rewards and incentives based on job title. The data in this section involve the rewards and incentives available (survey question 35), the rewards and incentives desired by faculty members (survey question 36) and the deterrents to experimenting with new teaching methods (survey question 30).

Crosstabulations of Rewards and Incentives Available and Desired for Teaching

Rewards and Incentives Available for Teaching

Table 60.

Crosstabulation for Percentages of Rewards and Incentives Available to Faculty Members for Teaching Based on Job Title

Job_title * Incentives Available Crosstabulation

			Student evals_	Money	Grants	Exemption From Activites	None
Job_title	Instructor	Count	6	6	7	0	6
		% within Job_title	33.3%	33.3%	39.9%	0%	33.3%
	Asst Prof	Count	25	6	10	0	25
		% within Job_title	41.0%	9.8%	16.4%	0%	41%
	Assoc	Count	42	13	19	2	23
		% within Job_title	54.5%	16.9%	24.7%	2.6%	29.9%
	Full Prof	Count	77	40	39	10	35
		% within Job_title	57.5%	29.9%	29.1%	7.5%	26.1%
	other	Count	9	3	7	3	6
		% within Job_title	40.9%	13.6%	31.8%	13.6%	27.3%
Total		Count	159	68	82	15	95
		% within Job_title	51.0%	21.8%	26.3%	4.8%	30.4%

The percentages of different rewards and incentives that faculty members say are available for teaching are available in Table 60. The percentages show the percentage of the total number of participants of each job title which means that the percentages will not add up to 100%. Surprisingly, a large percentage of all participants (51%) said that student evaluations were used as an incentive for teaching. The second largest percentage of all participants (30.4%) said that there were not any rewards or incentives available for teaching. The largest percentage of faculty members who said there were not any rewards or incentives were Assistant Professors (41%), though Instructors were close with 33.3%. Faculty members of all job titles said that student evaluations, grants, and monetary awards were available. However, Assistant (41%), Associate (54.5%), Full Professors (57.5%) and "Others" (40.9%) had high percentages that said student evaluations were a reward or incentive for teaching. Instructors also said student evaluations were used for an incentive but only 33.3% listed this as an incentive. The use of student evaluations as an incentive for teaching was not unexpected as many schools tend to use them to help determine raises and promotions and are often instrumental in determining tenure. However, it is interesting that so many faculty members stated that monetary awards (21.8%) and grants (26.3%) were available as incentives.

Crosstabulations of Rewards and Incentives Desired for Teaching

Table 61.

Crosstabulation for Percentages of Rewards and Incentives Desired by Faculty Members for Teaching Based on Job Title

Job_title * Incentives Desired Crosstabulation

			Student evals_	Money	Grants	Exemption From Activites
Job_title	Instructor	Count	7	10	12	7
		% within Job_title	38.9%	55.6%	66.7%	38.9%
	Asst Prof	Count	23	21	21	30
		% within Job_title	37.7%	34.4%	34.4%	49.2%
	Assoc	Count	27	33	34	37
		% within Job_title	35.1%	42.9%	44.2%	48.1%
	Full Prof	Count	46	51	43	53
		% within Job_title	34.3%	38.1%	32.1%	39.6%
	other	Count	8	7	8	8
		% within Job_title	36.4%	31.8%	36.4%	36.4%
Total		Count	111	122	118	135
		% within Job_title	35.6%	39.1%	37.8%	43.3%

The rewards or incentives desired by faculty members for teaching are presented in Table 61. The percentages presented show the percentage of total participants who answered for each of the incentives desired. This means that percentages will not add up to 100%. The percentages indicate that faculty members tended to choose more than one incentive. Of Full Professors 39.6% answered that they would like exemption from certain activities, 38.1% said they would like monetary awards and 32.1% said they would like competitive grants. Surprisingly 34.4% of Full Professors said they wanted student evaluations to be used as an incentive for teaching. Instructors had the highest percentage of faculty members answer what they desired for rewards and incentives. The highest percentages of Instructors answered that they desired monetary awards (55.6%) and competitive grants (66.7%). When looking at what Instructors desired for rewards, 67% of them said they wanted competitive grants, 55.6% of them said they wanted monetary rewards, and 38.9% said they wanted exemption from certain activities. Surprisingly 38.9% also said they wanted student evaluations to be used as an incentive. The highest percentages of Associate (49.1%) and Assistant (49.2%) Professors said that they desired to have exemptions from research and service activities. However Associate Professors also had large percentages of participants who said they wanted Monetary awards (42.9%) and Competitive Grants (44.2%). Full Professors and "Others" had similar percentages across all of the desired incentives. Assistant Professors had similar percentages across the desired incentives of student evaluation, monetary awards and competitive grants.

Deterrents to experimenting with new methods

Table 62.

Crosstabulation for Percentages of the First Six Deterrents to Experimentation Based on Job Title

Job_title * Deterrents Crosstabulation

			Lack of knowledge	Lack of Support	Method not proven	Current methods work	Better with more experience	Lack of Time
Job title	Instructor	Count	4	0	3	9	9	7
		% within Job_title	22.2%	.0%	16.7%	50.0%	50.0%	38.9%
	Asst Prof	Count	20	11	11	28	22	26
		% within Job_title	32.8%	18.0%	18.0%	45.9%	36.1%	42.6%
	Assoc	Count	31	12	10	27	27	32
		% within Job_title	40.3%	15.6%	13.0%	35.1%	35.1%	41.6%
	Full Prof	Count	31	19	15	52	34	59
		% within Job_title	23.1%	14.2%	11.2%	38.8%	25.4%	44.0%
	other	Count	4	4	2	10	5	9
		% within Job_title	18.2%	18.2%	9.1%	45.5%	22.7%	40.9%
Total		Count	90	46	41	97	126	133
		% within Job_title	28.8%	14.7%	13.1%	40.4%	31.1%	42.6%

Table 63.

Crosstabulation for Percentages of the Second Six Deterrents to Experimentation Based on Job Title

Job_title * Deterrents part 2 Crosstabulation

			Obligation not to alter	Lack of Support	Class Size	Subject matter	Not encouraged	Tenure
Job title	Instructor	Count	2	0	2	2	1	1
		% within Job_title	11.8%	.0%	11.8%	11.8%	5.9%	5.9%
	Asst Prof	Count	1	11	10	18	10	3
		% within Job_title	1.6%	18.0%	16.4%	29.5%	16.4%	4.9%
	Assoc	Count	3	12	5	13	18	8
		% within Job_title	3.9%	15.6%	6.5%	16.9%	23.4%	10.4%
	Full Prof	Count	2	19	15	21	20	12
		% within Job_title	1.5%	14.2%	11.2%	15.7%	14.9%	9.0%
	other	Count	0	4	5	7	5	1
		% within Job_title	.0%	18.2%	22.7%	31.8%	22.7%	4.5%
Total		Count	8	8	37	61	54	25
	Job_title	% within	2.6 %	14.7%	11.9%	19.6%	17.4%%	8%

Tables 62 and 63 show the crosstabulation for percentages of the deterrents to experimentation based on job title. The percentages indicate the percentage of the total number of participants for each job title; therefore the percentages do not add up to 100%. For example, 11.8% of all Instructors said that they felt an obligation not to alter the delivery method of the course. Faculty members were asked to indicate which factors deter them from experimenting with new methods. Instructors had the highest percentages for any of the deterrents. Of those participants who indicated deterrents to experimenting, 50% of Instructors answered that their current methods work well for their students and they do better with the methods they have more experience with using. As Instructors are more likely to have more teacher training (Table 14) this could mean that the methods they use work well for their students because they use more methods in their classes. Assistant Professors (45.9%) also stated that their current methods work well for their students, the "Other" group also had a similar percentage of participants (45.5%) answer that their methods work well for their students. A total of 40.4% of all participants said that their methods work well for their students. However, 42.6% of all participants answered that lack of time was a main deterrent to experimenting with new methods. Those who stated lack of time as a deterrent were as follows: 38.9% of Instructors, 42.6% of Assistant Professors, 41.6% of Associate Professors, 44% of Full Professors and 40.9% of "Other." Besides the lack of time and their methods working well for their students the third largest percentage (31.1%) of all participants stated that they are better with the methods they have more experience with using. As already stated 50% of Instructors stated this as a deterrent, 36.1% of Assistant Professors, 35.1% of Associate Professors, 25.4% of Full Professors and 22.7% of "Other" states that they are better with the methods they have more experience using. The final of the largest deterrents was the lack of knowledge of new methods, 28.8% stated this was a deterrent. A total of 22.2% of Instructors, 32.8% of Assistant Professors, 40.3% of Associate Professors, 23.1% of Full Professors and 18.2% of "Others" stated this as a deterrent to experimenting with new methods.

Further Analysis

RapidMiner data mining software (http://rapid-i.com/) was used to look at all the data collected in order to discover connections, if any, between answers given by the respondents. The researcher verified the results found by the data mining software through examining the data herself if a connection was found.

Perceptions. Participants who were between the ages of 36 and 40 were more likely to answer that teaching and service were not an important part of their job responsibilities. Participants who answered that teaching was unimportant to their institution were more likely to answer that time was not a consideration when choosing a teaching method. Also participants who answered that teaching and service were not important to the institution tended to say that their research obligations and knowledge of different methods factored very little in the choice of teaching method.

Many participants thought that effective teaching was not important to the institution despite the fact that their institution had two or more methods of teacher training available to faculty members. There was a connection between those who felt that teaching was not important to the institution and those who strongly disagreed with the behaviorist method of extrinsically rewarding students and felt that knowledge of methodology was not a deterrent to the choice of method.

Summary

This chapter presented the analysis of the data as collected from the survey hosted on Survey Monkey. This chapter examined the data as it related to the research questions: 1) How important is effective teaching to computer science faculty members at the undergraduate level and how important do they perceive effective teaching to be to their institution? 2) How much teacher training have computer science faculty members received? 3) What do computer science faculty members believe about teaching? 4) What are the current teaching practices of computer science faculty members and what influences those practices? 5) What incentives or rewards are offered to faculty members who try innovative teaching methods or receive additional training? The data analysis in this chapter will be used to answer these research questions based on the population surveyed, and will be discussed in the next chapter.

Chapter V

Discussion

Summary

Dissatisfaction among undergraduate students is not a new problem nor is the occurrence of computer science departments looking at teaching as a source of the problem. As shown in chapter two of this study, there is a lot of information about how students look at the teaching methods used in the undergraduate computer science programs (Barker et al. 2005, Baxter-Magolda, 1992, Felder, 1993, Lee, 2001, McConnell, 1996). There are also a lot of studies that indicate what faculty members should do to improve their teaching and help improve student satisfaction (Felder, 1993, 1998, Prey, 2001, Chase & Okie, 2000). However, there are few studies that ask the faculty members how they feel about teaching and why they teach the way they do (Brawner et al., 2002, Felder 1993, Huang et al. 2005), and there are none that look only at computer science. This study was designed to investigate the way computer science faculty members looked at teaching. This study addressed the importance of teaching to computer science faculty, the perceived importance of teaching to their institutions, the teacher training that computer science faculty received, their beliefs regarding effective teaching methods, their actual teaching practices, the incentives offered by their institutions for effective teaching, and the deterrents that keep faculty members from trying new methods.

The rest of this chapter is organized into 1) a discussion of each of the research questions, 2) recommendations made to computer science faculty regarding teaching in view of this study, and 3) a summary of the main conclusions of this study.

Discussion

The discussion in this section is organized by research question, followed by a general discussion of additional factors and issues observed in this study.

Importance of Teaching as a Job Responsibility

Several interesting observations were uncovered from the survey regarding the importance of teaching to faculty members in computer science. These observations are discussed in the subsections below.

Importance of teaching depends on the perceived priorities of the institution. As shown in Table 12, the importance of teaching to computer science faculty was shown to be significantly correlated (at both the 0.05 and 0.01 levels) with the perceived importance of teaching to the institution. This is contrary to the findings of Brawner et al. (2002) which found that the importance of teaching to the faculty member is independent of the perceived importance of teaching to the institution. However, the idea that faculty members will perceive the importance of teaching in direct relation to that of the school is not surprising because faculty members will most likely prefer to spend the most time on the aspects of their job that are stressed by the institution. This observation is consistent with previous studies, not necessarily specific to computer science. Tenure-track and research faculty tend to have a lot of pressure placed on them to write proposals and get funding for their research and increase revenues as well as the number of graduate students for the department (Lee, 2001).

Along with the pressure to perform well in the research area is the pressure to take on a lot of service obligations, both inside and outside the university. Service ranges from committees within the department such as admissions committees and problem solving committees to publications and conferences. If research and service are emphasized by the institution, the faculty members typically try to spend more time on those areas because these things typically influence raises (Felder & Brent, 1999). Focusing more on teaching reduces the amount of time that could be spent on the research aspect of their jobs. Felder and Brent (1999) pointed out that while the school may publicly state their mission as one purpose they internally state a true mission that does not necessarily match the stated mission.

The researcher had access to many different computer science faculty members during the course of this study and had the opportunity to conduct some personal interviews based the idea that faculty members will rate teaching importance in relation to the importance placed on teaching by the institution. The faculty members interviewed all worked at public universities. Some of the faculty members interviewed worked for universities that placed a high importance on teaching performance as part of promotion and reward systems such as raises. Many of the faculty members worked for "research institutions" in which research and service were of the highest importance as part of promotion and reward systems (Anonymity Requested, personal communication, August 22, 2007).

Upon the promise of anonymity, several faculty members of research institutions admitted that they didn't worry about how well they did teaching because it wasn't as important to their department. They felt spending too much time on preparing their classes took away from the time they could be doing research and earning acknowledgements from the university. Many of these faculty members admitted that their teaching evaluations were rated as average or below average (Anonymity Requested, personal communication, August 22, 2007). A few of the faculty members from research institutions felt that teaching was very important despite the fact that research and service were seen as more important by their department and had an above average rating on teaching evaluations.

Faculty members from schools that put high emphasis on teaching were questioned as well. These were not solely teaching institutions. Research was considered to be important as well, although perhaps slightly less important than teaching (Anonymity Requested, personal communication, August 22, 2007). The majority of these faculty members rated teaching as highly important because good teaching evaluations were part of the promotion and rewards processes. Additionally, the majority of these faculty members admitted to average or highly above average teaching evaluations (Anonymity Requested, personal communication, August 22, 2007). There were a few faculty members who rated teaching as lower importance (Anonymity Requested, personal communication, August 22, 2007).

The trend expressed by these personal interviews seemed to be consistent with the data obtained from the study, showing a significant correlation between the personal importance of teaching and the perceived importance of teaching to the institution, as demonstrated in Table 12.

What is most interesting is that the primary research study on this topic, which was conducted by Brawner, et al. (2002) found that faculty members almost always rated effective teaching as high in importance regardless of the importance placed on teaching by the institution. Hence, a correlation was not present. It is unclear why there was such a marked difference between the results of this study and the results of the Brawner, et al. (2002) study. One reason for this difference could be the fact that in the Brawner, et al. study, only four percent of the participants were actually from computer science departments, whereas, in this study all 321 participants were from computer science departments. It could be that computer science, being among the fastest moving fields in the engineering profession (Tucker, 1996), offers a sharper tradeoff between focusing on teaching excellence and focusing on other aspects of the job, as it is harder to reconcile the two.

The perceived teaching priority of the institution is lower than faculty's own. An interesting observation was that faculty generally appeared to believe that teaching was less important to their institution than it was to them personally. This observation is supported by the comparison between personal and (perceived) institutional priorities presented in Table 3, as well as by the descriptives shown in Table 6 and Table 9 that summarize personal and (perceived) institutional priorities, respectively. The disparity between the personal and (perceived) institutional priority of teaching was seen for all ranks of surveyed faculty, regardless of job title. However, it was most acute for Instructors, as can be seen by comparing Table 6 and Table 9. It appears that those faculty members whose primary responsibility was teaching were the most "dissatisfied" with institutional priorities.

The above observation has deep implications as it suggests that computer science faculty members are generally disappointed with the level of importance their institutions attribute to teaching, considering it inferior to their own. In other words, they appear to externalize the blame, if blame may be cast, attributing it more to their institutions than to themselves. The juxtaposition of this externalization with the correlation between personal and (perceived) institutional priorities, discussed earlier, predicts a motivation problem. Teaching quality may deteriorate if 1) the personal importance of teaching is correlated with perceived institutional priorities, and 2) the perceived institutional priority of teaching is lower than the faculty's own.

Teaching is negatively impacted by research. Another interesting observation is one that relates the priorities of teaching, research, and service. Table 13 showed a significant negative correlation between the priorities of teaching and research. This is reminiscent of a zero sum game where one can only win in one area at the expense of another. It could be symptomatic of the fact that computer science is a very rapidly evolving field (Tucker, 1996). If there is no time for faculty to achieve excellence in both research and teaching, one job responsibility has to win at the expense of the other. The winner tends to be consistent with institutional priorities. Table 62 supports the notion of a zero sum game. Indeed, the top reason that faculty gave for not experimenting with new teaching methods was lack of time. This time, the researcher conjectures, is taken up by other responsibilities such as research and service.

Teaching is disconnected from student career goals. It is very interesting to observe that there was no correlation (according to Table 13) between the importance of teaching and the importance of student placement to the respondents. This lack of correlation implies that faculty in computer science have a disconnection between effective teaching and the preparation of students for success in their careers. One might expect that effective teaching is not an end goal in itself. Rather it is a means to a goal; the goal being one of preparing students for success as useful contributors to tomorrow's society. This view is not expressed in the data collected from faculty taking the survey. The disconnection was especially prevalent in the answers of Instructors, according to Table 6. While Instructors had the highest average rating for the importance of teaching (giving it a full 4.0 out of 4.0 with zero variance), they also reported the lowest mean (of only 2.06 or "somewhat unimportant") for the importance of student placement. This disconnect is perhaps part of the teaching problem in computer science, where teaching may have become increasingly disassociated from the goal of addressing real-world concerns (that make the students of more interest to prospective employers).

Interestingly, it appears that the disconnection between teaching and placement becomes stronger with seniority of faculty members. According to Table 6, the gap is lowest for Assistant Professors, whose mean ranks for the importance of teaching and the importance of student placement were 3.46 and 3.13, respectively. The difference between the two scores was only 0.33 points, putting both between very important and important. The gap widened for Associate Professors, who ranked teaching higher than Assistant Professors (at 3.49), but ranked student placement lower (at only 3.07). A gap of 0.42 was observed. This gap widened again for Full Professors, who ranked teaching even higher than Associate Professors (at 3.72), but ranked student placement even lower (2.8). A non-trivial gap of 0.92 points (on a 4 point scale) was observed. This gap was exceeded only by Instructors who ranked teaching at 4.0 and student placement at 2.06.

The above data shows an important trend in the teaching process. While Assistant Professors appear to regard both teaching and placement as important responsibilities of their profession, this view is held progressively less strongly with seniority. Two conjectures can possibly explain this trend. One potential explanation is that time on the job desensitizes faculty to the importance of student placement. Presumably, Assistant Professors are closer to having been students themselves and hence share the concerns of their students more strongly. Another potential explanation is that more junior faculty come from educational backgrounds that attribute more value to the utilitarian relevance of teaching to society than their senior colleagues who appear to view computer science education, in the spirit of liberal arts, as more of an end goal of independent value itself. A longitudinal study could be of interest to tell which dominant factor is responsible for the observed trend. Either way, the trend demonstrates a current problem. If classes are not expressly linked to student career goals, student satisfaction is negatively affected.

Further evidence suggests that the second possible explanation (that explains the trend by differences in educational background) is not likely to be the right one. If differences in educational backgrounds of junior and senior faculty had such a profound effect on their views regarding the goals of teaching and its relation to student careers, one might expect that junior faculty (who, presumably, lean more strongly towards practical relevance because of their increased exposure to constructivism), would also show a larger percentage of constructivists. Unfortunately, Table 24, which presents the relation between job title and prevalent belief, does not support this observation. According to Table 24, 76.8% of Assistant Professors are predominantly constructivists while 21.4% are undetermined. The breakdown for Associate and Full Professors is almost the same. Of Associate Professors, 77.1% are constructivist and 22.9% are undetermined. Of Full Professors, 79% are constructivist and 21% are undetermined. The differences between these categories are not significant, suggesting that the differences in preparation for junior and senior faculty do not seem to have affected their views about teaching. This leaves the explanation that faculty become increasingly desensitized to the placement concerns of their students over time. This, if true, appears to be a significant problem that needs to be remedied.

Another observation regarding teaching and placement is that student placement was correlated with research and service according to Table 13. Research and Service (especially external service such as serving on editorial boards of journals and on technical program committees of peer-reviewed conferences) are important job priorities of research institutions. One may therefore conclude that faculty at research institutions worry more about student placement than those at teaching institutions. Indeed, this seems to be the graduate school culture of research institutions, and it may be affecting undergraduates as well. Placement of doctoral students in high ranking job locations brings prestige to the advisor. Many faculty members in computer science, for example, maintain "family trees" of student-advisor lineage relations. Faculty members take pride in such trees. There is no equivalent to this phenomenon in undergraduate education.

Teacher training

Teacher training is usually left as an optional activity for faculty. There are two important questions that come to mind where optional teacher training is concerned. The first question is whether the optional training classes offered are actually taken advantage of by the faculty. The second question is whether taking advantage of these classes makes a difference in faculty beliefs and practices. This section investigates the first of the two questions. The second question will be addressed later, in the context of investigating faculty beliefs about teaching and faculty teaching practices. In relation to the first question, the investigation shows that there is "good news" and "bad news". These are discussed below, respectively.

The "good news" is that teacher training services are indeed taken advantage of by faculty. The study shows that the amount of teacher training services offered and the amount of teacher training services used are highly correlated. The data in Table 16 show that the more types of teacher training services are offered by an institution the more likely faculty members are to use at least one type of teacher training service. Schools were categorized by the number of teacher training services they offered into six categories, offering one, two, three, four, five and six services, respectively. . In schools offering only one service, 33% of the faculty reported using it. In schools that offered more services, the percentages of faculty who reported using at least one service were 60% (for schools with two or three services), 69% (for schools with four services), 76% (for schools with five services) and 84% (for schools with six services).

Note that, while offering more services increased the odds that faculty used at least *one*; the overall faculty turnout generally seemed to decline with each additional service offered. This observation is clearly demonstrated by looking, in Table 16, for the fraction of faculty who used *all* services offered by the school. In schools offering one or two services the percentage of faculty who took them was 33% and 30%, respectively. In schools offering, three, four, five and six services, the percentage dropped abruptly to 7.5%, 8.2%, 6.9% and 4%, respectively. This suggests the need for cost-benefit analysis to determine the right trade-off between having more faculty members try at least one service and having services be generally well-utilized. It also suggests the need to further investigate which types of teacher training services were most popular.

The "bad news," revealed by this study, is that the offered teacher training services were in part "preaching to the choir." This observation can be made from Table 18 that shows a significant positive correlation between teacher training services received by faculty members at their current institution and teacher training services received previously elsewhere. In other words, faculty members who chose to attend such services previously, tended to continue to do so. Faculty who opted out previously, also tended to continue to do so. For example, Table 15 shows that over half of those who received no prior teacher training used no teacher training services at their current institution. In contrast, this ratio was less than 30% for those who received prior training.

One might argue that a more encouraging result would have been to see no correlation between attending services at the present institution and attending previous services, meaning that everyone is equally likely to take advantage of offered services. This, unfortunately, was not the case.

Teacher beliefs

Based on their answers to survey question 17, faculty members were divided in this study by prevalent belief into constructivists (223), behaviorists (1), and undetermined (59). Ignoring the single behaviorist for the time being, as there was no statistical significance to this one sample, the faculty classification was into constructivists and undetermined. Two key observations were made regarding faculty beliefs.

A faculty with mixed beliefs. The first observation was that computer science faculty did not fall cleanly into constructivists and behaviorists. Their answers, in fact, mixed elements of both theories. The most telling statistic that revealed this issue was the very low Cronbach alpha obtained for the reliability of the behaviorist and constructivist scales used, which were borrowed from Grasha (2002). Reliability is measured by the degree of correlations between scale items that are supposed to measure the same belief. When respondents have mixed beliefs, the correlation between such items becomes low, resulting in a lower scale reliability measure. Hence, the scale used in this study merely measured the prevalent belief in a mixed belief scenario. Accordingly, a constructivist label, for example, indicated that a person answered more consistently with constructivism than behaviorism. It did not mean that the person followed the constructivist belief to the exclusion of others.

The researcher conjectures that the low reliability, and hence low correlation between answers that measure the same behaviorist or constructivist scale, is attributed to the respondents general lack of knowledge of those theories creating an inconsistency between their goals (e.g., teaching problem solving, which is a constructivist goal) and means (e.g., allowing student to retake exams until mastery is achieved, which is a behaviorist method).

A uniform distribution of belief across faculty categories. The second observation is one regarding the uniformity of the ratio of constructivists to those undermined across faculty categories. Table 23, Table 24, and Table 25 indicate that a ratio of approximately 4:1 prevailed robustly across different ages, job titles, and self-reported levels of teaching ability. In other words, age, job title, and teaching ability did not correlate significantly with beliefs (actual correlation tables are removed for brevity). The observation is counter-intuitive. One might expect, for example, that Assistant Professors and Full Professors may disagree on beliefs about effective teaching, mixing different degrees of behaviorist and constructivist beliefs. This expectation was not supported by the data.

Also of interest is to note that the amount of teacher training services received did not correlate with belief, as shown in Table 28. This was especially surprising at first, considering that teacher training services typically have the express goal of altering the beliefs of faculty by promoting those beliefs that are more consistent with effective teaching. In a way, this lack of correlation between teacher training services received and faculty beliefs about teaching may, in principle, be interpreted as an efficacy problem with the training services offered at current institutions. Later, this issue shall be revisited, showing that while training did not affect faculty beliefs, it did affect their practices.

The lack of correlation between teacher training and beliefs has another possible explanation. Grasha's question focused on what faculty believed were the *goals* most consistent with effective teaching. It did not inquire about the *methods* faculty believed were best to achieve such goals. It appeared that the population had a clear and consistent idea regarding teaching goals, leaning more on the constructivist side. The real question was whether their practices actually matched these goals. This question is addressed next as faculty practices are investigated together with factors that affect such practices.

Teaching practices

In this subsection, a general picture is presented of average teaching obligations of different categories of computer science faculty, followed by observations regarding their teaching practices and the factors that affect them.

Average teaching obligations. The survey data (in Table 29) indicated that faculty, with the exception of Instructors, generally taught classes of about 40 students (ranging from approximately 38 students for Assistant Professors to approximately 44 students for Full Professors). Instructors' classes were larger with a mean of approximately 57 students. The medians showed a slightly bigger variation, ranging from 30 students for Assistant Professors to 60 for Instructors. Other categories reported medians of either 35 or 40 students. Not surprisingly, Assistant Professors also reported the highest instances of knowing their students by name (Table 47). The average number of hours spent on class preparation was approximately nine hours for all faculty members except Instructors, who reported spending approximately 15 hours per week (according to Table 30). This is consistent with their larger class size. The reported medians were 12 hours for Instructors, 10 for Assistant Professors, and six to nine for the remaining categories. It was interesting to observe that Assistant Professors, who taught the smallest classes, reported the largest median for class preparation time, with the exception of Instructors. All faculty members also reported having an average of just under three office hours per week, according to Table 31, with the exception of Instructors, who reported an average closer to four office hours, and "other" faculty who reported an average of approximately 3.5 hours. The medians showed less variation, being three office hours per week for all categories except Assistant Professors, who reported a median of two office hours per week. The means and medians for undergraduate advising showed similar trends to office hours, according to Table 32.

Adding up the medians of class preparation, office hours, and undergraduate advising, the total time spent on teaching-related responsibilities outside the classroom was 19 hours for Instructors, 14 hours for Assistant and Full Professors, 13 hours for Associate Professors, and 12 hours for "other" faculty. While this might appear like low numbers, an interesting observation is that faculty whose responsibilities included teaching, research and service spent on teaching alone a substantial fraction of the time spent on teaching by Instructors. This is significant because Instructors, by their own admission in Table 6, had no other job responsibilities that they considered at least "somewhat important".

Teaching methods used in class. The next interesting question is regarding the teaching methods that faculty members used in their classrooms. Overall, roughly half the respondents reported using lecture every class (Table 33). As far as other regular activities, where by "regular" the researcher means "performed every week" (meaning either once a week, twice a week or every class), 43.5% reported weekly use of whole class discussion (Table 35), 40% reported weekly use of hands-on demonstrations or role-play (Table 36), 33% reported weekly use of small groups for problem solving every week (Table 34), and 11% reported use of weekly student-led discussions (Table 37). In addition 91% of the faculty reported relating material to real-world context on weekly basis (Table 38) and 88% reported use of a class project (Table 40). Breaking the data by job title, according to Table 41, Associate Professors reported the highest use of the lecture method as well as team projects, whereas Instructors reported the highest use of problem-solving, whole-class discussion, demonstrations, and relation to real-world contexts. Interestingly, faculty who identified themselves as "Other" reported the highest use of student-led discussions.

When correlated with the amount of teacher training received, the lecture method showed a significant negative correlation, whereas student-centered techniques such as problem solving and student-led discussions showed a significant positive correlation (Table 55). This could be interpreted to mean that teacher training does encourage more effective teaching practices that are more consistent with the beliefs that computer science faulty were shown to have regarding education goals. According to Table 56, demonstrations, whole class discussions and student lead discussions were all significantly correlated with constructivist beliefs. They were also negatively correlated with use of lecture (Table 57). Another interpretation might be that those who choose to take teacher training courses are a self-selected subset of faculty who are already more predisposed to the use of constructivist methods in the classroom. In short, the correlation is significant, but does not necessarily suggest the presence and direction of a cause-and-effect relation.

Interestingly, no significant correlations were found between years of experience and the choice of teaching methods (Table 58). Also, no significant correlations were found between age and the choice of teaching methods (Table 59). One may therefore conclude that experience alone does not necessarily correct teaching shortcomings. Training may be a more reliable way to effect behavior change. These results support what Lee (2001), Huang, et al. (2005), and Felder (1993) have noted, that most faculty members teach the way they, themselves, were taught.

Finally, when asked about their willingness to experiment with new teaching methods, faculty without tenure reported being more willing to experiment on average than those with tenure, as shown in Table 53. The difference was statistically significant, as demonstrated in the analysis in Table 54. The overall average answer was 3.01 on a 4.0 scale, indicating that faculty were generally “somewhat willing” to experiment.

Putting observations from this and the previous research question together, a clear picture emerges regarding faculty beliefs, practices and factors that affect them. Namely, the majority of faculty members in computer science tend to share the constructivist goals (beliefs) of teaching, although not to the exclusion of behaviorist beliefs. They are generally willing to experiment with new teaching methods, but apparently they do not do so. According to Table 62and Table 63, the most significant deterrents to experimentation were the lack of time (expressed by 42% of the faculty) and the belief that current methods work well (expressed by 40% of the faculty). This is consistent with the lack of correlation between years teaching and methods used. If faculty do not mind experimenting but either cannot afford it or find it unnecessary, their preferred teaching methods will not evolve over time. Teacher training was found correlated with the use of student-centered (constructivist) teaching practices. However, there was also a strong correlation between the use of teacher training services at the current institution and their previous use elsewhere. Hence, it may be that the subset of faculty members, who chose to avail themselves of these services, are a self-selected group who are already predisposed to the use of more effective teaching methods. It is therefore not clear whether use of teacher training services results in better practices or is caused by a predisposition to practice better teaching.

In relation to the use of "better" teaching practices the use of student-oriented teaching practices and the attrition of women should be examined. Chase and Okie (2000) noted that there was a high withdrawal or fail rate within typical computer science courses, but once more student-oriented approaches were tried, the rates dropped. Chase and Okie (2000) also remarked upon the reduced rate of failure or withdrawal of women once the student-oriented approaches were used within the classroom. Barker, et al. (2005) also showed in their study, that there was more satisfaction among students when more student-oriented approaches were used. They also noted that women in particular felt less isolated in the student-oriented approach. The current study suggests that teacher training services might be an effective tool in improving student retention in computer science, especially when it comes to retention of women.

Faculty incentives

The final research question investigated what rewards and incentives are offered to faculty members for innovation in teaching. As a subsection of this question is the question of what do faculty wish to have as incentives. While this was, in part, essential to understand the data surrounding research question one, it is also essential to figuring out what would best help faculty members currently. Many faculty members stated that there were very few rewards offered and as many as 30.4% (according to Table 60) did not even know of any rewards that their institution offered, which supports Lee's (2001) and Felder's (1993) belief that many faculty members who choose to try innovative teaching methods do so with little or no reward. Overall, approximately half of the respondents reported student evaluations as the used incentive. Grants were second with 26.3% of the faculty reporting having such an option at their institution. Monetary awards were next with 21.8%, and only 4.8% of the faculty reported exemption from other activities as an offered incentive for teaching excellence at their institution. Observe that answers to the incentives question were non-exclusive, meaning that faculty were allowed to state more than one incentive.

In contrast to the distribution of available incentives, the top incentive that faculty cited as desired to encourage teaching excellence (according to Table 61) was exemption from some of the other responsibilities. As much as 43.3% of the faculty mentioned it as a desired incentive. Assistant Professors were the highest supporters of this reward with 49.2% stating that it was desired. This is consistent with lack of time being the top reported impediment to experimenting with new teaching methods as well as with the negative correlation between teaching and research importance, as discussed earlier. Given that the number of hours in a day is fixed, to improve one aspect of their job performance, faculty members simply need relief from some other responsibilities.

The next reported incentive in the order of desirability was monetary awards (39.1%). Instructors were the largest supporter of this incentive with 55.6% indicating that they wanted it. Grants were the next incentive (37.8%), also greatly supported by Instructors (66.7%). Student evaluations as an incentive were the least popular overall. The above results can be contrasted with Lee (2001) and Felder (1993). Both of those studies noted that most faculty members who choose alternative methods or attempt innovation in teaching do so with little or no reward. While this appears to be true of the respondents in this study as well, when asked if they would like to be rewarded, grants and monetary awards were close to the top of the list.

The top deterrents to experimentation were lack of time (expressed by 42.6%) and the perception that current methods worked well (expressed by 40.4%). The perception that faculty were better at those methods they had more experience with (31.1%), and the lack of knowledge of alternative methods (28.8%) were the next largest reported deterrents. These were followed by the perception that class subject matter was not well suited for certain delivery methods (19.6%) as well as the perception that faculty were not encouraged to experiment with new teaching methods by their institution (17.4%). Deterrents that were not as widely cited included class size (11.9%), lack of institutional support (14.7%), the perception that alternative methods were not proven good (13.1%), lack of motivation due to tenure status (8%), and the perception of an obligation not to change the current method (2.6%).

Further discussion

In the literature of chapter two, extensive evidence was presented that showed students are expecting more than a passive approach to learning in the undergraduate curriculum (Barker et al., 2005, Baxter Magolda, 1992, DeBard, 2004). DeBard (2004) mentions the distinct difference in the millennial generation of students, who are just beginning to enter post-secondary education. These students have grown accustomed to relying more on their peers and other sources of knowledge rather than on the instructor (DeBard, 2004, Baxter-Magolda, 1992). Meanwhile Baxter-Magolda (1992) points out that at the undergraduate level, men and women have different ways of knowing and thus different ways of learning or processing information. It is because of these higher expectations that students are becoming more dissatisfied with the undergraduate curriculums.

Baxter-Magolda's research is especially pertinent to computer science education because of their desire to recruit and retain women. The Epistemological Reflection Model that resulted from Baxter Magolda's longitudinal study contains four stages;

gender-related patterns are reflected in the first three of those stages. The four stages are *absolute knowing, transitional knowing, independent knowing,* and *contextual knowing* (Evans et al., 1998, Baxter Magolda, 1992). Each of the four stages has two different patterns of knowing contained within the stage (Evans et al., 1998). In each of the first three stages of Baxter-Magolda's theory she discusses the differences that tend to occur between the way men and women learn and know. These differences could help computer science faculty understand how to better accommodate the female population of students in their classes.

Tucker (1996) noted that computer science is a rapidly changing field. Unlike more mature sciences faculty members find it harder to develop materials and activities that can be amortized (Felder, 1993). The technology and knowledge surrounding computer science is always evolving and thus much of the material changes from year to year (Lee, 2001). While it is possible that eventually the field will become more stable in its evolution, it is unlikely. New technologies are being invented daily and as such, computer science faculty members need to keep abreast of these changes and pass them on to their students, which make it harder to focus on the content delivery method (Felder, 1993). Unfortunately, this lack of focus on content delivery leads to increased student dissatisfaction. However, researchers began to look at alternative methods in the undergraduate classroom and how they can be used.

Prey (1995) was among the first computer science researchers to look at alternative methods in the undergraduate classroom. During the time that generation x students were entering post-secondary education, she had begun to notice an increasing gap in the curriculum offerings and what was needed or expected by students and future employers. She introduced the idea of cooperative learning in beginning computer science courses, pointing out that in the job field most jobs were done cooperatively rather than individually. To better understand what is meant by cooperative learning Chase and Okie (2000) defined it as a strategy that uses "student peer groups as orchestrated learning environments" (p. 374). Chase and Okie (2000) have noted that group work is an important aspect of computer science education because software development is undertaken in industry by teams of experts, not just an individual. Therefore, it makes sense to allow students to work cooperatively in their classes rather than on an individual basis.

Later, Lee (2001) and McConnell (1996) both discussed the use of active learning in the classroom. Active learning gets students involved in activity rather than sitting passively listening to lecture. Activity can include, but is not limited to, reading, writing, class discussion, responding to thought provoking questions and problem solving (McConnell, 1996). They offered suggestions for incorporating active learning into the classroom. Lee (2001) recognizes that many faculty members may have found that a downside of active learning is that one cannot cover as much content in class, requires too much time for class preparation and seems impossible to use in a large classes. However, active learning can be something as simple as asking students to discuss a question or concept with a neighbor or as complex as physically acting out a concept in the course such as token passing, such as McConnell mentions.

McConnell (1996) offers some suggestions for active learning techniques that can work for many computer science courses, whether they are small or large. He suggests a form of modified lecture that helps alleviate the problem of declining attention spans. A way to do this is to lecture for ten minutes then take a five minute discussion break where students can discuss notes and correct misunderstandings with their neighbors (McConnell, 1996). He also recommends using a think-pair-share technique in which a question is posed, students write an answer for the question then pair up with someone next to them and share their answers. McConnell (1996) suggests after the think-pair-share the instructor could possibly demonstrate some topics, like algorithms, in real-time.

As an example of discussing algorithms in real-time, McConnell suggests that for algorithm tracing; rather than having the instructor tracing the algorithm in a lecture, have the students trace the algorithm in groups (McConnell, 1996). Assign each member of the group a role and have them do the tracing on transparencies which allows for the transparencies to be shared with the rest of the class (McConnell, 1996). McConnell also suggests using demonstration software so that students can interact with the ideas of computer science.

Pollard and Duvall (2006) also felt that by expanding the teaching styles used in the computer science classroom the audience of students that enjoy and succeed in technology related classes would increase. They discuss the use of games and manipulatives in the undergraduate classroom. Pollard and Duvall (2006) integrated the use of games, toys, stories, and play into their regular computer science classes rather than relegating these techniques solely to labs. Although a long range effect of this use of play in the classroom is not yet known, the immediately evident effect was a more fun environment in the classroom. Additionally, they noticed an increased interest in the material and by using manipulatives they noticed that students had an easier time solving a complex proof.

Stamm (2004) suggested that faculty members not limit themselves to just one method but to use multiple methods. Additionally he suggests the use of something jarring to shock the students into awareness. For example he uses the example of a professor that walked to the front of the room and yelled loudly. While this was an unusual experience for the students and got their attention it does not have to be anything quite so loud. The researcher has had personal experience with a professor who enjoyed shocking his students. The first day of classes the researcher was waiting for class to begin when a guy with pink hair, black trench coat and pink shoelaces walked into the room. He then sat cross-legged on the table in the front of the room. All the students slowly quieted and wondered who this weird character was. It turned out he was the professor, and over the course of the semester he would come in with something different and shocking that professors normally wouldn't or shouldn't do. The effect was that students very rarely missed a class and all eagerly awaited the arrival of the professor.

An important aspect of choosing a teaching method for undergraduate courses is that faculty members need to be comfortable with the method they choose. This is why Lee (2001) believes most faulty members choose to fall back on the lecture method. In order to help faculty members choose methods that they are comfortable with, Grasha (2002) includes a series of questionnaires and surveys in his book *Teaching with Style* which helps faculty members determine their conceptual base, and teaching style. Once discovering their teaching style they can look to Grasha's suggestions for teaching methods that they can use in the classroom.

In order to help computer science faculty members increase student satisfaction and help faculty members with their teaching, the literature presented in chapter two and the discussions presented in this chapter has been used to develop some recommendations.

Limitations and Recommendations

In making recommendations to help computer science departments and their faculty members there are a few limitations that must be considered before one tries to implement the recommendations.

Limitations

There are some limitations with this study that need to be addressed. This study does not look at some factors that might impact the results of the data. The first limitation of note is that this study did not look at gender. Gender could have shown major differences if it had been considered. However, one of the main reasons gender was not looked at is the large discrepancy in numbers between males and females in the field. Even given the large number of possible participants it would have been difficult to get a significant number of female participants to make accurate conclusions based on gender differences.

Another limitation of this study is that it did not look very closely at the effects of a person's country of origin. Due to a desire to refrain from anything that could be socially or politically incorrect, the factors such as cultural differences, language barriers and/or religious implications were not explored. For example, it could be very possible that the main reason a faculty member teaches the way he or she does is that it is a cultural norm. One participant approached the researcher socially and said that a lot of time he resorts to lecture because, his professors in his native country taught like that and no one had problems with learning. However, he also noted that he has begun to use other methods because he realized that his undergraduate students "tune out" during the class (Anonymity Requested, personal communication, September 22, 2007).

Another limitation of this study is that a majority (67%) of the participants were native-born Americans. Therefore there was not as many of the non-native American faculty members participating. This can significantly limit the generalization to computer science departments that have a large population of faculty that are naturalized American citizens. Additionally, 67% of the participants were from large state universities. This could have serious complications, because different size schools tend to emphasize different things, but due to the small number of large private and small state colleges and the complete lack of small private colleges it is hard to be sure the data reflects the general population of computer science faculty.

There is also a limitation in the analysis of the data in that involves the theoretical constructs of behaviorism and constructivism. The reliability analysis of the scales for behaviorism and constructivism showed a low reliability. Though these scales were borrowed from Grasha (2002) he did not provide a reliability analysis. The fault could have also lain with the design of the question and the subsequent scoring. Question 17 was adapted from Grasha (2002) and the scoring was completed in a similar manner.

Recommendations

This study has several implications that can provide faculty members with the services they could use to improve teaching quality and thus have an effect on student satisfaction. Faculty members showed little concern for teaching if the institution did not emphasize it or offer sufficient incentives outside of being considered for tenure cases. Additionally, two of the main reasons cited for not trying a different method of teaching in the classroom were lack of time, and lack of knowledge. Two other main deterrents was the idea that faculty members preferred to use methods they were more comfortable with and they also believed that their methods worked well for their students. The biggest problem is helping faculty members get the knowledge they can use without taking up more of their valuable time or without some incentives to make the effort worthwhile. Once the knowledge is acquired the comfort level with other methods should likewise increase.

One way to mitigate the time issue would be to create a database where faculty members can submit their ideas for activities or some pertinent materials for certain classes. Such a database could be similar to the My Teaching Partner program which was created by an interdisciplinary team at the University of Virginia to provide "teachers with high-quality, evidence-based teaching tools and support for their work with children" (Myteachingpartner:, 2006). For example, real-time systems are taught in almost all computer science programs. There are different classes within that discipline, and sometimes two or more professors take turns teaching a given class. If one professor has an activity or project that worked well for his/her group, he/she can submit it to the database and the other professor(s) can look at the submission and use it as is or modify it to suit his/her class, or topic. Faculty members can also go to the database or website to ask for help from faculty members with whom they might normally be unable to consult. Having a database such as this has been helpful for teachers of all subjects and grade levels. The researcher had often found these databases to be helpful in her teaching career. The use of some of these databases could help incorporate more student-oriented teaching practices in the classroom and could possibly help with the attrition of women in computer science as suggested by Barker et al. (2005).

Another factor to consider is the fact that many faculty members are expected to teach without having any teaching experience or teacher training (Lee, 2001, Felder, 1993). These faculty members are often left to fumble their way through a learning process and often do so with concerns over the impact their teaching will have on their future tenure case. The colleges and universities often offer workshops or videotaping services that faculty members could use if they had a desire to, but as the data shows in this study some faculty members are unaware of them. Even if faculty members are aware of the teaching assistance or training availability, few actually take advantage of them, due to the fact that they are not required and take up precious time, which could be devoted elsewhere, and have minimal returns. To help mitigate this problem, while minimizing the impact on the faculty member's already limited time, the university could obtain the services of a confidential consultant that would visit the classes of the newer faculty members at least twice a semester and then would make observations and suggestions for improving the instructor's technique in a brief follow-up meeting. The consultant could also visit the more senior faculty occasionally in order to offer support or suggestions to the faculty member.

To encourage faculty members to utilize the teaching resources or try new techniques the department could institute a points systems that would lead to some kind of reward. For example, for every resource they use or teaching workshop they attend, they earn 2 points (different point values for different resources). Once they accumulate a certain number of points (for example: 10) they get an exemption from a required committee or get a monetary award. This sort of points system would work similar to the points system employed by the Department of Education for the renewal of teaching certificates for k-12 teachers. The point system is designed to ensure that teachers have continuous education in a field that is always changing and growing, much like the field of computer science.

Areas of Future Study

This study provided a basis for how computer science faculty members look at teaching courses in the undergraduate program in order to increase student satisfaction and reduce the student attrition rate, especially of women. This study should be replicated and expanded upon with a larger population spanning more types of schools. Additionally, this study should be further expanded by looking at faculty members' gender and cultural influences on teaching.

This study could also be expanded upon by looking at the ranking of the computer science departments, both in undergraduate education and graduate education. Ranking in the undergraduate and graduate computer science departments could give further clues as to the philosophy of the school and therefore the faculty members as it regards to teaching. Graduate schools focus a lot on research; therefore the higher ranked graduate schools might be more research based and tend to rate teaching as lower in importance. Whereas there is not much research conducted at the undergraduate level and the focus would most likely be on teaching in a school with a high ranking for the undergraduate program.

A qualitative study that looks at both the faculty members and the students at a teaching oriented school and a research oriented school from each size of university might further enlighten researchers as to how to approach the attrition rate of both male and female students; especially if teaching methods turn out to be a consideration in students leaving the program.

In Conclusion

Participants in this study indicated that:

- Faculty members perceive the importance of effective teaching in relation to the importance placed upon teaching by the institution with which they are associated.
- The importance placed on teaching seems to be negatively impacted by the importance of research.

- Faculty members who had received teacher training prior to beginning to teach seemed to show a higher likelihood to continue using teacher training services.
- The beliefs of faculty members tend to reflect the constructivist theory, but often also contain elements of the behaviorist beliefs.
- Faculty members prevalent belief in not necessarily influenced through the use of teacher training services.
- Lack of time and knowledge of teaching methodology coupled with lack of comfort with alternative methods are some of the main deterrents to experimenting with different teaching methods in the undergraduate computer science classrooms.
- This study has also shown that increased teacher training is correlated with more student-oriented teaching methods and less teacher-oriented methods.
- The current incentives beyond tenure are not sufficient for faculty members to choose to invest the time and effort to developing new instructional materials for their classrooms.

Given the quantitative analysis, existing research in the area of effective teaching in undergraduate computer science and the experiences of the researcher with computer science faculty members, this study suggests that time constraints, lack of incentives and lack of knowledge surrounding teaching methods are major factors in choice of teaching methods. The findings from this study indicate that given the right incentives, faculty members would be willing to try new methods provided it could be done with a minimal amount of impact on their already limited time.

Conclusion

This study began with five research questions that were that were the driving forces behind the research. The first research question related to the importance of effective teaching to faculty members teaching undergraduate computer science, this was also looked at in relation to their perception of the priorities of the institution. This question was supported by the data collected through the web-survey and one-factor ANOVAs showed a significant difference between job titles. This was an indication that tenure and job security also impact the way faculty members look at teaching. The data allowed the researcher to confirm the idea that teaching plays little, if any, part in a reward or incentive program. Half of the participants stated that teaching is looked at as part of promotions or raises, but that it is hardly ever considered for any other reason. They also stated that the main sources for evaluating teaching are student evaluations. This idea was supported by Brawner, et al. (2002), who also found that student evaluations were used as part of the reward or incentive program.

Three research questions were looked at in the second set of data analyses. The amount of teacher training faculty members have received and the current practices they use. The third question involved looking into whether faculty members believe more in the constructivist or behaviorist beliefs. Teacher-oriented methods are typically reflected by the behaviorist theories on teaching and learning, while the student-oriented methods are usually reflected by the constructivist theories.

The data did support the idea that more training would lead to more constructivist approaches to teaching. Pearson's correlations were run on the data regarding the teacher training received and the practices of the faculty members. They showed a significant correlation between the amount of teacher training and the use of student-oriented teaching methods, such as whole class discussion, demonstration and student beliefs.. The faculty members that had taken more advantage of training opportunities used more student-oriented teaching approaches. This result of the data was supported by Lee (2001) and Felder (1993) when they discuss the preparation of future engineering faculty members.

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Appendix A

Survey

Agreement of Participation

Welcome.
This 37 question survey is part of a study conducted for a dissertation and focuses on faculty perceptions of teaching in undergraduate computer science (CS) and should take approximately 30 minutes to complete.

The survey focuses on many different aspects of teaching at the undergraduate level. You are able to skip any question that does not apply to you.

Participation is completely voluntary and will be completely anonymous. Due to the anonymous nature of the study submitted surveys will be unable to have the data excluded from the study. While it may be possible to deduce identity through the demographic information provided no attempt will be made to do so. There are no risks involved in this study.

The results of the study can be obtained by contacting: Ann Abdelzaher (217) 722-4712, ampeck@earthlink.net.

Please understand by clicking Next below you are agreeing to take part in this study. There are no direct benefits of this study and information will be kept confidential and anonymous.

Demographics

This section collects general information for comparison purposes and statistical analysis. Information will remain confidential.

1. With what type of university or college are you associated?

- ○ Large state institution (over 5k)
- ○ Large private institution
- ○ Small state institution
- ◉ Small private institution
- ○ Other (please specify)

2. Age:

○ Under 25 ○ 25-30 ○ 31-35 ○ 36-40 ○ 41-45 ○ 46-50 ○ 50+

3. What is your native country?

- ◯ United States
- ◯ Canada
- ◯ China/Taiwan
- ◯ India
- ◯ Italy
- ◯ Sweden
- ◯ France
- ◯ Portugal
- ◯ Other (please specify)

4. What is the highest degree you hold in computer science?

◯ Associates ◯ Bachelors ◯ Masters Doctorate

◯ Other (please specify)

5. What is your job title for this academic school year?

◯ Instructor ◯ Assistant Professor ◯ Associate Professor Full Professor

◯ Other (please specify)

6. What is your focus within computer science?

7. Rate the following areas in importance based on what you consider your primary purpose is as a faculty member.

	Not at all important	Somewhat unimportant	Somewhat important	Extremely important
Research	◯	◯	◯	◯
Teaching	◯	◯	◯	◯
Service (committees, etc)	◯	◯	◯	◯
Student placement	◯	◯	◯	◯

8. Do you have tenure at your current institution?

◯ Yes ◯ No

9. Did you have tenure at a different institution than the one you are currently at?

◯ Yes ◯ No

10. Rate the following areas in importance based on what you would say is of more importance to your institution.

	Not at all important	Somewhat unimportant	Somewhat important	Extremely important
Research	○	○	○	○
Teaching	○	○	○	○
Service	○	○	○	○
Student placement	○	○	○	○

11. How many years have you been teaching undergraduate computer science courses?

○ Never ○ 0-5 ○ 6-10 ○ 11-15 ○ 16-20 ○ 20+

12. On average, how frequently do you teach undergraduate computer science courses?

○ Less than once every two years ○ One semester every two years ○ One semester a year ○ Every semester

○ Other (please specify)

13. Did you receive teacher training or mentoring before beginning to teach classes?

○ No ○ Partially ○ Yes

14. How would you rate your teaching ability in undergraduate classes?

○ Novice ○ Average ○ Expert

Effective Teaching

The following section refer to quality of teaching: setting high but attainable goals, enabling most students to meet or exceed those goals, and elicit high levels of satisfaction. Some of the questions contained in this section are adapted from Brawner, Felder, Allen and Brent (2002).

15. Please rate the importance of teaching quality to the groups below

	Not at all important				Extremely important
You as an instructor	○	○	○	○	○
Department colleagues (faculty)	○	○	○	○	○
Department chair	○	○	○	○	○
The dean	○	○	○	○	○
Students	○	○	○	○	○

16. Other than being an item in promotion and tenure guidelines, is teaching quality recognized as part of an incentive or reward program at your institution (such as a bonus or tangible award)?

○ Yes ○ No

Teaching Practices

The following questions are about teaching practices and beliefs.

17. Rate each of the following statements as to how well they fit your beliefs about the goals of teaching.

Adapted from Grasha(2002)

	Strongly Disagree	Slightly Disagree	Slightly Agree	Strongly Agree
The development of students' capacity to solve problems is most important.	○	○	○	○
Students learn best if material is broken down into small discrete steps rather than giving them a big chunk of information at once.	○	○	○	○
Problem solving must be taught to students rather than assuming that problem solving is already a skill the students possess.	○	○	○	○
The best way to motivate all students is through grades rather than through content or teaching method.	○	○	○	○
Coursework should be used to develop critical thinking abilities.	○	○	○	○
In order for learning to occur, organization and structure are essential.	○	○	○	○
The natural limitations of students' information processing abilities should be taken into account when planning instruction.	○	○	○	○
Instructors should allow time in the course for students to learn at their own pace.	○	○	○	○
Presenting information in several different contexts help students learn the concept thoroughly and help them to generalize the concept to other contexts.	○	○	○	○
Students should be allowed to retake course exams until mastery is achieved.	○	○	○	○
Students need to develop ways of organizing information for themselves.	○	○	○	○
Students need to be extrinsically rewarded for completing course assignments in order to develop and maintain an interest in them rather than be intrinsically motivated by teaching method or course material.	○	○	○	○

18. On average, how many students are in each section of your undergraduate classes?

[ ]

19. On average, how many hours do you spend per week preparing for class?

[ ]

20. On average, how many hours per week do you have set aside for office hours?

[ ]

21. On average, how much time per week, other than office hours, is spent advising or working with undergraduate students outside of class?

[ ]

22. What best describes the primary way you expect students to gather information.

- ◯ Information is explained in class by the instructor. Textbook and homework are means of reinforcing that information.
- ◯ Information comes most comprehensively from textbooks and self-study. The class provides pointers to information sources, summaries, clarifications, and advice on how to gather information.
- ◯ Learning occurs primarily by problem-solving. Homework problems and exercises build knowledge beyond class and textbook.
- ◯ Learning occurs primarily from class discussion and peer activities.

23. How often do you do the following: (assume that a week=3 classes)

	Never	<1 time a week	At least 1 class a week	At least 2 out of 3 classes	Every class
Lecture for most of the class period with or without slides	◯	◯	◯	◯	◯
Have students work in small groups or pairs to solve problems or discuss class material	◯	◯	◯	◯	◯
Have whole class discussions	◯	◯	◯	◯	◯
Use demonstrations, hands-on activities or role-play to address a topic	◯	◯	◯	◯	◯
Have students lead discussions during class periods	◯	◯	◯	◯	◯
Relate material to real world contexts	◯	◯	◯	◯	◯

24. Do you know your students by name?

- ◯ No
- ◯ I know only the few more active ones
- ◯ Yes, I know most of them
- ◯ Yes, I know (almost) all by name

25. How often do you assign at least one major team project to students in courses you teach?

- ◯ Never
- ◯ Some courses
- ◯ Most courses
- ◯ Every course

Teaching Development

This section explores the teaching development services that are available to you as an instructor and which services you use, if any.

Some questions adapted from Brawner et al. (2002)

26. Please check all services that are provided by your institution for teaching development.

- ☐ None
- ☐ Workshops or seminars
- ☐ Teaching consultants (teaching resource center)
- ☐ Meetings (brown bag lunches, discussion groups) to address teaching development
- ☐ Mentoring program
- ☐ Books or example tapes on teaching practices
- ☐ Videotaping of your lectures
- ☐ Other (please specify)

27. Which of the following development services have you used?

- ☐ None
- ☐ Workshops or seminars
- ☐ Teaching consultants (teaching resource center)
- ☐ Meetings (brown bag lunches, discussion groups)to address teaching development
- ☐ Mentoring program
- ☐ Books or example tapes on teaching practices
- ☐ Videotaping of your lectures
- ☐ Other (please specify)

28. How likely are you to attend teaching development workshops, meetings or seminars if offered?

- ◯ Very unlikely
- ◯ Somewhat unlikely
- ◯ Somewhat likely
- ◯ Very likely

29. How likely are you to experiment with new teaching methods in your classes?

- ◯ Very unlikely
- ◯ Somewhat unlikely
- ◯ Somewhat likely
- ◯ Very likely

30. What, in your opinion, are the main deterrents from experimenting with new teaching methods? (Check all that apply):

- ☐ I am not well versed on the latest theories of teaching methods
- ☐ There is no support for me to learn new teaching methods in my institution
- ☐ Most "new" methods I know of are experimental and not yet proven to be better than older well-established methods
- ☐ The methods I use work well for my students
- ☐ I am better at the methods I have more experience with
- ☐ I have no time to develop instructional material that incorporates new methods in my classroom
- ☐ I feel an obligation not to alter the delivery of the course
- ☐ Most "new" methods I know of are inapplicable to the size of my class
- ☐ Most "new" methods I know of are unsuitable for the subject I teach
- ☐ My institution does not encourage me to invest in such experimentation
- ☐ I would rather not risk it because of tenure implications
- ☐ Other (please specify)

31. How often do you discuss teaching methods with your fellow faculty members?

- ◯ A few times a week
- ◯ A few times a month
- ◯ A few times a semester
- ◯ Never

32. How often do you discuss teaching methods with teaching assistants or graduate students?

- ◯ A few times a week
- ◯ A few times a month
- ◯ A few times a semester
- ◯ Never

33. How often do you solicit feedback from your students geared toward improving your teaching during the semester?

- ◯ At the end of the semester only
- ◯ At the middle and end of the semester only
- ◯ Several times a semester
- ◯ Never

Incentive and Reward programs

This section refers to incentive or reward programs that are available at your institution.

34. To what extent is teaching innovation (trying new methods, writing textbooks or software) considered as part of an incentive or reward program at your institution?

- ◯ It is of most importance to the incentive program
- ◯ It is important but other things take precedence
- ◯ It is considered but only minimally
- ◯ It is not considered at all

35. What incentive or reward programs are available to you as a faculty member for innovation in teaching?

- ☐ Student evaluations affect raises/promotion
- ☐ Monetary awards for teaching excellence
- ☐ Competitive grants that sponsor innovative teaching methods
- ☐ Exception from some research- or service-related activities
- ☐ To my knowledge, no worthwhile incentives are available
- ☐ Other (please specify)

36. In your opinion, which of the following incentive or reward programs, if available, would significantly promote innovation in teaching?

- ☐ Student evaluations affect raises/promotion
- ☐ Monetary awards for teaching excellence
- ☐ Competitive grants that sponsor innovative teaching methods
- ☐ Exception from some research- or service-related activities
- ☐ Other (please specify)

Influencing Factors

This section involves factors that influence your choice of teaching method.

37. Please rate how much each of the following influences your choice of teaching method.

	Not at all			Strong influence
Knowledge of different teaching methods	○	○	○	○
Availability of teaching support	○	○	○	○
Class size	○	○	○	○
Course content	○	○	○	○
Time required to prepare for class	○	○	○	○
Research obligations	○	○	○	○
Other commitments (conferences, service)	○	○	○	○

Other (please specify)

38. Comments/suggestions enter them here.

Appendix B

Frequencies and Percentages

Faculty Survey

1. With what type of university or college are you associated?

	Response Percent	Response Count
Large state institution (over 5k)	**66.6%**	**213**
Large private institution	25.9%	83
Small state institution	0.0%	0
Small private institution	6.9%	22
Other (please specify)	0.6%	2
answered question		320
skipped question		2

2. Age:

	Response Percent	Response Count
Under 25	0.0%	0
25-30	3.2%	10
31-35	16.4%	52
36-40	14.5%	46
41-45	16.7%	53
46-50	13.9%	44
50+	**35.3%**	**112**
answered question		317
skipped question		5

3. What is your native country?

	Response Percent	Response Count
United States	**67.4%**	**213**
Canada	0.9%	3
China/Taiwan	3.8%	12
India	8.5%	27
Italy	0.9%	3
Sweden	0.3%	1
France	0.6%	2
Portugal	0.3%	1
Other (please specify)	17.1%	54
	answered question	**316**
	skipped question	**6**

4. What is the highest degree you hold in computer science?

	Response Percent	Response Count
Associates	0.0%	0
Bachelors	1.3%	4
Masters	3.1%	10
Doctorate	**89.3%**	**285**
Other (please specify)	6.3%	20
	answered question	**319**
	skipped question	**3**

5. What is your job title for this academic school year?

	Response Percent	Response Count
Instructor	3.5%	11
Assistant Professor	19.5%	62
Associate Professor	24.2%	77
Full Professor	**42.5%**	**135**
Other (please specify)	10.4%	33
	answered question	**318**
	skipped question	**4**

6. What is your focus within computer science?

	Response Count
	296
answered question	**296**
skipped question	**26**

7. Rate the following areas in importance based on what you consider your primary purpose is as a faculty member.

	Not at all important	Somewhat unimportant	Somewhat important	Extremely important	Rating Average	Response Count
Research	3.1% (10)	2.2% (7)	7.2% (23)	**87.4% (278)**	3.79	318
Teaching	0.0% (0)	2.5% (8)	33.0% (105)	**64.5% (205)**	3.62	318
Service (committees, etc)	3.5% (11)	21.7% (69)	**62.9% (200)**	11.9% (38)	2.83	318
Student placement	7.6% (24)	19.1% (60)	**51.6% (162)**	21.7% (68)	2.87	314
					answered question	**318**
					skipped question	**4**

8. Do you have tenure at your current institution?

	Response Percent	Response Count
Yes	67.0%	211
No	33.0%	104
answered question		315
skipped question		7

9. Did you have tenure at a different institution than the one you are currently at?

	Response Percent	Response Count
Yes	11.8%	37
No	88.2%	277
answered question		314
skipped question		8

10. Rate the following areas in importance based on what you would say is of more importance to your institution.

	Not at all important	Somewhat unimportant	Somewhat important	Extremely important	Rating Average	Response Count
Research	0.0% (0)	0.3% (1)	3.5% (11)	**96.2% (305)**	3.96	317
Teaching	3.2% (10)	10.1% (32)	**60.3% (191)**	26.5% (84)	3.10	317
Service	4.7% (15)	32.5% (103)	**57.7% (183)**	5.0% (16)	2.63	317
Student placement	13.3% (42)	23.4% (74)	**51.9% (164)**	11.4% (36)	2.61	316
				answered question		317
				skipped question		5

11. How many years have you been teaching undergraduate computer science courses?

	Response Percent	Response Count
Never	1.9%	6
0-5	23.1%	73
6-10	21.5%	68
11-15	14.2%	45
16-20	10.4%	33
20+	**28.8%**	**91**
	answered question	316
	skipped question	6

12. On average, how frequently do you teach undergraduate computer science courses?

	Response Percent	Response Count
Less than once every two years	3.8%	12
One semester every two years	7.2%	23
One semester a year	**53.5%**	**170**
Every semester	29.2%	93
Other (please specify)	6.3%	20
	answered question	318
	skipped question	4

13. Did you receive teacher training or mentoring before beginning to teach classes?

	Response Percent	Response Count
No	66.1%	209
Partially	25.9%	82
Yes	7.9%	25
answered question		316
skipped question		6

14. How would you rate your teaching ability in undergraduate classes?

	Response Percent	Response Count
Novice	1.9%	6
Average	42.0%	133
Expert	56.2%	178
answered question		317
skipped question		5

15. Please rate the importance of teaching quality to the groups below

	Not at all important				Extremely important	Rating Average	Response Count
You as an instructor	0.3% (1)	1.0% (3)	3.8% (12)	40.7% (127)	**54.2% (169)**	4.47	312
Department colleagues (faculty)	2.9% (9)	14.1% (44)	34.1% (106)	**40.2% (125)**	8.7% (27)	3.38	311
Department chair	2.3% (7)	10.0% (31)	30.0% (93)	**49.0% (152)**	8.7% (27)	3.52	310
The dean	6.2% (19)	17.0% (52)	30.7% (94)	**37.3% (114)**	8.8% (27)	3.25	306
Students	0.3% (1)	1.0% (3)	2.9% (9)	27.6% (86)	**68.3% (213)**	4.63	312
						answered question	**313**
						skipped question	**9**

16. Other than being an item in promotion and tenure guidelines, is teaching quality recognized as part of an incentive or reward program at your institution (such as a bonus or tangible award)?

	Response Percent	Response Count
Yes	46.7%	141
No	**53.3%**	**161**
answered question		**302**
skipped question		**20**

17. Rate each of the following statements as to how well they fit your beliefs about the goals of teaching. Adapted from Grasha (2002)

	Strongly Disagree	Slightly Disagree	Slightly Agree	Strongly Agree	Rating Average	Response Count
The development of students' capacity to solve problems is most important.	0.3% (1)	0.7% (2)	17.3% (52)	**81.7% (245)**	3.80	300
Students learn best if material is broken down into small discrete steps rather than giving them a big chunk of information at once.	1.7% (5)	10.0% (30)	**50.7% (152)**	37.7% (113)	3.24	300
Problem solving must be taught to students rather than assuming that problem solving is already a skill the students possess.	0.3% (1)	7.3% (22)	42.5% (128)	**49.8% (150)**	3.42	301
The best way to motivate all students is through grades rather than through content or teaching method.	36.8% (110)	**49.5% (148)**	12.4% (37)	1.3% (4)	1.78	299
Coursework should be used to develop critical thinking abilities.	0.3% (1)	2.0% (6)	28.6% (85)	**69.0% (205)**	3.66	297
In order for learning to occur, organization and structure are essential.	1.3% (4)	10.1% (30)	43.3% (129)	**45.3% (135)**	3.33	298
The natural limitations of students' information processing abilities should be taken into account when planning instruction.	0.7% (2)	7.0% (21)	**53.2% (159)**	39.1% (117)	3.31	299
Instructors should allow time in the course for students to learn at their own pace.	2.0% (6)	26.5% (79)	**58.4% (174)**	13.1% (39)	2.83	298
Presenting information in several different contexts help students learn the concept thoroughly and help them to generalize the concept to other contexts.	0.0% (0)	1.3% (4)	39.8% (119)	**58.9% (176)**	3.58	299
Students should be allowed to retake course exams until mastery is achieved.	34.1% (102)	**44.8% (134)**	18.1% (54)	3.0% (9)	1.90	299
Students need to develop ways of organizing information for themselves.	0.3% (1)	5.7% (17)	**58.1% (172)**	35.8% (106)	3.29	296

Students need to be extrinsically rewarded for completing course assignments in order to develop and maintain an interest in them rather than be intrinsically motivated by teaching method or course material.	13.3% (39)	34.5% (101)	**41.0% (120)**	11.3% (33)	2.50	293
					answered question	**302**
					skipped question	**20**

18. On average, how many students are in each section of your undergraduate classes?

	Response Count
	300
answered question	**300**
skipped question	**22**

19. On average, how many hours do you spend per week preparing for class?

	Response Count
	295
answered question	**295**
skipped question	**27**

20. On average, how many hours per week do you have set aside for office hours?

	Response Count
	301
answered question	**301**
skipped question	**21**

21. On average, how much time per week, other than office hours, is spent advising or working with undergraduate students outside of class?

	Response Count
	295
answered question	**295**
skipped question	**27**

22. What best describes the primary way you expect students to gather information.

	Response Percent	Response Count
Information is explained in class by the instructor. Textbook and homework are means of reinforcing that information.	**44.5%**	**133**
Information comes most comprehensively from textbooks and self-study. The class provides pointers to information sources, summaries, clarifications, and advice on how to gather information.	6.4%	19
Learning occurs primarily by problem-solving. Homework problems and exercises build knowledge beyond class and textbook.	43.8%	131
Learning occurs primarily from class discussion and peer activities.	5.4%	16
answered question		**299**
skipped question		**23**

23. How often do you do the following: (assume that a week=3 classes)

	Never	<1 time a week	At least 1 class a week	At least 2 out of 3 classes	Every class	Rating Average	Response Count
Lecture for most of the class period with or without slides	4.0% (12)	3.7% (11)	9.0% (27)	31.0% (93)	**52.3% (157)**	4.24	300
Have students work in small groups or pairs to solve problems or discuss class material	28.7% (85)	**36.8% (109)**	20.6% (61)	7.4% (22)	6.4% (19)	2.26	296
Have whole class discussions	19.9% (59)	**36.7% (109)**	20.5% (61)	9.8% (29)	13.1% (39)	2.60	297
Use demonstrations, hands-on activities or role-play to address a topic	23.4% (69)	**36.3% (107)**	22.4% (66)	10.8% (32)	7.1% (21)	2.42	295
Have students lead discussions during class periods	**55.7% (166)**	32.9% (98)	7.4% (22)	3.0% (9)	1.0% (3)	1.61	298
Relate material to real world contexts	0.3% (1)	8.7% (26)	27.3% (82)	29.3% (88)	**34.3% (103)**	3.89	300
						answered question	**302**
						skipped question	**20**

24. Do you know your students by name?

	Response Percent	Response Count
No	2.3%	7
I know only the few more active ones	**37.7%**	**114**
Yes, I know most of them	34.8%	105
Yes, I know (almost) all by name	25.2%	76
answered question		**302**
skipped question		**20**

25. How often do you assign at least one major team project to students in courses you teach?

	Response Percent	Response Count
Never	12.0%	36
Some courses	**33.2%**	**100**
Most courses	23.3%	70
Every course	31.6%	95
	answered question	**301**
	skipped question	**21**

26. Please check all services that are provided by your institution for teaching development.

	Response Percent	Response Count
None	5.7%	17
Workshops or seminars	**76.0%**	**225**
Teaching consultants (teaching resource center)	69.9%	207
Meetings (brown bag lunches, discussion groups) to address teaching development	47.6%	141
Mentoring program	32.8%	97
Books or example tapes on teaching practices	24.0%	71
Videotaping of your lectures	62.2%	184
Other (please specify)	3.7%	11
	answered question	**296**
	skipped question	**26**

27. Which of the following development services have you used?

	Response Percent	Response Count
None	41.0%	121
Workshops or seminars	**41.7%**	**123**
Teaching consultants (teaching resource center)	17.6%	52
Meetings (brown bag lunches, discussion groups)to address teaching development	19.3%	57
Mentoring program	11.5%	34
Books or example tapes on teaching practices	8.5%	25
Videotaping of your lectures	16.6%	49
Other (please specify)	2.7%	8
	answered question	**295**
	skipped question	**27**

28. How likely are you to attend teaching development workshops, meetings or seminars if offered?

	Response Percent	Response Count
Very unlikely	**35.7%**	**107**
Somewhat unlikely	33.0%	99
Somewhat likely	26.3%	79
Very likely	5.3%	16
	answered question	**300**
	skipped question	**22**

29. How likely are you to experiment with new teaching methods in your classes?

	Response Percent	Response Count
Very unlikely	2.7%	8
Somewhat unlikely	19.7%	59
Somewhat likely	**52.0%**	**156**
Very likely	26.0%	78
answered question		**300**
skipped question		**22**

30. What, in your opinion, are the main deterrents from experimenting with new teaching methods? (Check all that apply):

	Response Percent	Response Count
I am not well versed on the latest theories of teaching methods	32.5%	91
There is no support for me to learn new teaching methods in my institution	16.8%	47
Most "new" methods I know of are experimental and not yet proven to be better than older well-established methods	14.6%	41
The methods I use work well for my students	45.4%	127
I am better at the methods I have more experience with	35.0%	98
I have no time to develop instructional material that incorporates new methods in my classroom	**47.5%**	**133**
I feel an obligation not to alter the delivery of the course	2.9%	8
Most "new" methods I know of are inapplicable to the size of my class	13.2%	37
Most "new" methods I know of are unsuitable for the subject I teach	22.1%	62

My institution does not encourage me to invest in such experimentation		19.6%	55
I would rather not risk it because of tenure implications		8.9%	25
Other (please specify)		10.7%	30
		answered question	**280**
		skipped question	**42**

31. How often do you discuss teaching methods with your fellow faculty members?

		Response Percent	Response Count
A few times a week		6.0%	18
A few times a month		22.5%	67
A few times a semester		**60.7%**	**181**
Never		11.1%	33
		answered question	**298**
		skipped question	**24**

32. How often do you discuss teaching methods with teaching assistants or graduate students?

		Response Percent	Response Count
A few times a week		13.5%	40
A few times a month		35.0%	104
A few times a semester		**40.7%**	**121**
Never		11.1%	33
		answered question	**297**
		skipped question	**25**

33. How often do you solicit feedback from your students geared toward improving your teaching during the semester?

	Response Percent	Response Count
At the end of the semester only	28.0%	84
At the middle and end of the semester only	**44.3%**	**133**
Several times a semester	26.3%	79
Never	1.7%	5
	answered question	**300**
	skipped question	**22**

34. To what extent is teaching innovation (trying new methods, writing textbooks or software) considered as part of an incentive or reward program at your institution?

	Response Percent	Response Count
It is of most importance to the incentive program	1.7%	5
It is important but other things take precedence	29.7%	88
It is considered but only minimally	**43.9%**	**130**
It is not considered at all	24.7%	73
	answered question	**296**
	skipped question	**26**

35. What incentive or reward programs are available to you as a faculty member for innovation in teaching?

	Response Percent	Response Count
Student evaluations affect raises/promotion	**54.2%**	**160**
Monetary awards for teaching excellence	23.7%	70
Competitive grants that sponsor innovative teaching methods	28.5%	84
Exception from some research- or service-related activities	5.1%	15
To my knowledge, no worthwhile incentives are available	32.2%	95
Other (please specify)	13.2%	39
	answered question	**295**
	skipped question	**27**

36. In your opinion, which of the following incentive or reward programs, if available, would significantly promote innovation in teaching?

	Response Percent	Response Count
Student evaluations affect raises/promotion	41.9%	111
Monetary awards for teaching excellence	46.4%	123
Competitive grants that sponsor innovative teaching methods	45.3%	120
Exception from some research- or service-related activities	**51.7%**	**137**
Other (please specify)	14.7%	39
	answered question	**265**
	skipped question	**57**

37. Please rate how much each of the following influences your choice of teaching method.

	Not at all			Strong influence	Rating Average	Response Count
Knowledge of different teaching methods	6.9% (20)	15.8% (46)	**43.3% (126)**	34.0% (99)	3.04	291
Availability of teaching support	12.5% (36)	25.3% (73)	**31.9% (92)**	30.2% (87)	2.80	288
Class size	3.1% (9)	10.5% (31)	37.1% (109)	**49.3% (145)**	3.33	294
Course content	2.4% (7)	9.9% (29)	35.2% (103)	**52.6% (154)**	3.38	293
Time required to prepare for class	6.2% (18)	12.3% (36)	38.7% (113)	**42.8% (125)**	3.18	292
Research obligations	11.8% (34)	15.9% (46)	27.0% (78)	**45.3% (131)**	3.06	289
Other commitments (conferences, service)	11.8% (33)	29.4% (82)	**32.6% (91)**	26.2% (73)	2.73	279
					Other (please specify)	5
					answered question	**295**
					skipped question	**27**

38. Comments/suggestions enter them here.

	Response Count
	130
answered question	**130**
skipped question	**192**