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THE APPLICATION OF EMBODIED CONVERSATIONAL AGENTS FOR MENTORING AFRICAN AMERICAN STEM DOCTORAL STUDENTS

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THE APPLICATION OF EMBODIED CONVERSATIONAL AGENTS FOR MENTORING AFRICAN AMERICAN STEM DOCTORAL STUDENTS

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ABSTRACT

This dissertation presents the design, development and short-term evaluation of an embodied conversational agent designed to mentor human users. An embodied conversational agent (ECA) was created and programmed to mentor African American computer science majors on their decision to pursue graduate study in computing. Before constructing the ECA, previous research in the fields of embodied conversational agents, relational agents, mentorship, telementorship and successful mentoring programs and practices for African American graduate students were reviewed. A survey used to find areas of interest of the sample population. Experts were then interviewed to collect information on those areas of interest and a dialogue for the ECA was constructed based on the interview's transcripts. A between-group, mixed method experiment was conducted with 37 African American male undergraduate computer science majors where one group used the ECA mentor while the other group pursued mentoring advice from a human mentor. Results showed no significant difference between the ECA and human mentor when dealing with career mentoring functions. However, the human mentor was significantly better than the ECA mentor when addressing psychosocial mentoring functions.

DEDICATION

I am especially thankful to my colleagues, family and friends. I could not have done it without you.

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I want to acknowledge all my lab partners, instructors, collaborators and advisors. Special thanks go to my family, especially mom, who has been with me through this long journey. Also, thanks to my Morehouse family, who believed in me, supported me with whatever I needed and stayed patient with me through this whole experience. Much love for my editors, Melvin and Kellye who made sure my grammar was up to par. My sincerest appreciation goes out to Dr. Bryant Marks and Thomas Benjamin for taking time to review my results and help analyze the data. And finally, thanks to a wonderful advisor, Dr. Juan E. Gilbert, who opened my eyes to the world of quality research.

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CHAPTER ONE

INTRODUCTION AND RATIONALE

Motivation

The Need for Minority Participation in Science and Engineering

In a report by the National Academy of Science ("Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future," 2007) the role of the United States as a global leader in science and technology was threatened by other nations due to investments by those nations in research and other educational capacities. The report called for the United States to invest in research, encourage innovation and grow a strong, talented and innovative science and technology workforce in order to maintain its global competiveness. In another report by the National Academy of Science" ("Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads," 2011), the demographic challenge is addressed with regards to its Science and Engineering workforce. The report stated that minorities are critically underrepresented in science and engineering, yet they are the most rapidly growing segment of the American population. And so, although there are many underrepresented groups and many scientific fields, the author has chosen African American males in computer science as the demographic for the subjects in this manuscript.

Underrepresentation in Computing by African Americans

The Taulbee Survey published by the Computing Research Association is the "principle source of information on the enrollment, production and employment of PhDs in computer science and computing engineering (CS and CE) and in providing salary and demographic data for faculty in CS and CE in North America" ("CRA Taulbee Survey," 2011). In the 2010 – 2011

survey, 184 PhD granting universities responded to the survey providing a wide scale view of computing education at the doctoral level. The United States has over 39 million African Americans representing 12.6 percent of the total population (Humes, Jones, & Ramirez, 2011). Unfortunately, African American faculty represents only 1.4% of all computing science faculty (Table 1) and 2.1% of newly hired faculty (Table 2). African American students also have disproportionate numbers with 3.6% of computer science bachelor degrees awarded (Table 3), 1.6% of master's degrees awarded (Table 4) and 1.2% of doctoral degrees (Table 5) awarded in 2011. With so few African Americans with advanced degrees in computing, role models of the same ethnicity for potential African American in these areas remain scarce.

Table 1 - Ethnicity of Computing Science Faculty

	Full		Associate		Assistant		Teaching		Research		Postdoc		Total	
Nonresident Alien	12	0.6%	37	2.5%	97	12.7%	14	2.1%	86	19.1%	205	35.8%	451	7.6%
American Indian / Alaska Native	2	0.1%	4	0.3%	3	0.4%	7	1.1%	0	0.0%	3	0.5%	19	0.3%
Asian	415	21.0%	415	27.8%	196	25.7%	50	7.6%	57	12.7%	111	19.4%	1,244	21.0%
Black or African-American	12	0.6%	21	1.4%	23	3.0%	22	3.3%	3	0.7%	2	0.3%	83	1.4%
Native Hawaiian/ Pacific Islander	1	0.1%	3	0.2%	1	0.1%	0	0.0%	1	0.2%	0	0.0%	6	0.1%
White	1,446	73.2%	924	61.8%	393	51.5%	536	81.5%	262	58.2%	200	35.0%	3,761	63.6%
Multiracial, not Hispanic	3	0.2%	3	0.2%	0	0.0%	1	0.2%	1	0.2%	0	0.0%	8	0.1%
Hispanic, any race	33	1.7%	35	2.3%	25	3.3%	16	2.4%	13	2.9%	15	2.6%	137	2.3%
Resident, race/ ethnic unknown	51	2.6%	52	3.5%	25	3.3%	12	1.8%	27	6.0%	36	6.3%	203	3.4%
Total known residency	1,975	100%	1,494	100%	763	100%	658	100%	450	100%	572	100%	5,912	100%
Residency Unknown	130		128		43		45		43		73		462	
Total	2,105		1,622		806		703		493		645		6,374	

Table 2 - Ethnicity of Computer Science Faculty New Hires

	Tenure-Track		Teaching		Research		Postdoc		Total	
Nonresident Alien	34	13.6%	8	10.0%	11	18.3%	51	35.7%	104	19.5%
American Indian / Alaska Native	2	0.8%	2	2.5%	1	1.7%	0	0.0%	5	0.9%
Asian	40	16.0%	6	7.5%	8	13.3%	29	20.3%	83	15.6%
Black or African-American	6	2.4%	2	2.5%	1	1.7%	2	1.4%	11	2.1%
Native Hawaiian/ Pacific Islander	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
White	98	39.2%	58	72.5%	31	51.7%	41	28.7%	228	42.8%
Multiracial, not Hispanic	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Hispanic, any race	7	2.8%	1	1.3%	2	3.3%	8	5.6%	18	3.4%
Resident, race/ethnic unknown	63	25.2%	3	3.8%	6	10.0%	12	8.4%	84	15.8%
Total known residency	250	100.0%	80	100.0%	60	100.0%	143	100.0%	533	100.0%
Residency Unknown	8		1		0		1		10	
Total	258		81		60		144		543	

Table 3 - Bachelor's Degree Awarded by Ethnicity (2011)

	CS		CE		I		Total	
Nonresident Alien	524	7.0%	179	10.0%	78	3.6%	781	6.8%
Amer Indian or Alaska Native	39	0.5%	8	0.4%	16	0.7%	63	0.5%
Asian	1,115	14.8%	337	18.8%	302	13.9%	1,754	15.3%
Black or African-American	274	3.6%	106	5.9%	151	6.9%	531	4.6%
Native Hawaiian/Pac Islander	22	0.3%	7	0.4%	8	0.4%	37	0.3%
White	5026	66.9%	981	54.7%	1432	65.8%	7,439	64.8%
Multiracial, not Hispanic	104	1.4%	28	1.6%	3	0.1%	135	1.2%
Hispanic, any race	409	5.4%	146	8.1%	187	8.6%	742	6.5%
Total Residency & Ethnicity Known	7,513		1,792		2,177		11,482	
Resident, ethnicity unknown	741		200		99		1,040	
Residency unknown	1032		112		140		1,284	
Grand Total	9,286		2,104		2,416		13,806	

Table 4 - Masters' Degree Awarded by Ethnicity (2011)

	CS		CE		I		Total	
Nonresident Alien	3,332	56.7%	776	72.6%	389	19.6%	4,497	50.4%
Amer Indian or Alaska Native	12	0.2%	0	0.0%	12	0.6%	24	0.3%
Asian	753	12.8%	108	10.1%	245	12.3%	1,106	12.4%
Black or African-American	96	1.6%	13	1.2%	123	6.2%	232	2.6%
Native Hawaiian/Pac Island	19	0.3%	0	0.0%	6	0.3%	25	0.3%
White	1533	26.1%	142	13.3%	1113	56.1%	2,788	31.2%
Multiracial, not Hispanic	8	0.1%	4	0.4%	4	0.2%	16	0.2%
Hispanic, any race	119	2.0%	26	2.4%	92	4.6%	237	2.7%
Total Residency & Ethnicity Known	5,872		1,069		1,984		8,925	
Resident, ethnicity unknown	320		88		205		613	
Residency unknown	419		26		17		462	
Grand Total	6,611		1,183		2,206		10,000	

Table 5 - PhD Degree Awarded by Ethnicity (2011)

	CS		CE		I		Total	
Nonresident Alien	634	48.1%	130	67.4%	44	37.0%	808	49.6%
Amer Indian or Alaska Native	2	0.2%	0	0.0%	2	1.7%	4	0.2%
Asian	171	13.0%	16	8.3%	14	11.8%	201	12.3%
Black or African-American	16	1.2%	1	0.5%	6	5.0%	23	1.4%
Native Hawaiian/Pac Islander	4	0.3%	0	0.0%	0	0.0%	4	0.2%
White	465	35.3%	42	21.8%	52	43.7%	559	34.3%
Multiracial, not Hispanic	3	0.2%	0	0.0%	0	0.0%	3	0.2%
Hispanic, any race	22	1.7%	4	2.1%	1	0.8%	27	1.7%
Total Residency & Ethnicity Known		1,317	193		119		1,629	
Resident, ethnicity unknown	43		4		2		49	
Residency unknown	96		8		0		104	
Grand Total	1,456		205		121		1,782	

According to Gilbert et al. (Gilbert, Seals, & Chang, 2008), seven barriers persist for African American to pursue doctoral degrees. The first barrier is the stereotypes of scientists. A Beadslee and O'Dowd study (Beardslee & O'dowd, 1961) found that college students viewed scientists as radical, individualistic, strange and intelligent individuals that are socially introverted and apathetic to others. Powell 1990 tells us "considerable evidence that today's college students, particularly African-American and Hispanics, avoid majoring in science and mathematics because cultural traits support unfavorable images of scientists and make attainment of a scientific career unrealistic" (Powell, 1990). The second barrier is the lack of role models in STEM. According to Sewell and Martin (1976) African Americans tend to select careers in which they have had contact with successful role models in those careers. Due to the low number of African American faculty (1.4%) in computing sciences faculty positions, finding role models can be a challenging task for African Americans according to Gilbert et al. (Gilbert et al., 2008). The third barrier is the interest in helping professions. A Hagar and Elton (Hager & Elton, 1971) survey of college freshman and a Sewell and Martin (Sewel & Martin, 1976) survey of high school juniors found that African American men were more interested in social service fields

than White men. According to Hall and Post-Kammer (Hall & POST-KAMMER, 1987), the reason African Americans chose these fields was because of a cultural emphasis and expectation to help others. Financial concerns makes up the fourth barrier. In the 2001 Brazziel and Brazzeil study (2001), students indicated that financial concerns were one of the four factors why African American students did not consider pursuit of a doctoral degree in computer science. According to the study by Lewis and Frierson (2005) students feared accumulating more college debt to obtain the doctorate degree. These students were not aware of funding opportunities such as assistantship and fellowships; therefore they did not consider pursuing the doctoral degree. The fifth barrier highlights inadequate advisement. In a study by Ernest Boyer (1983) most African American students choose their future occupations based on advice from their parents and aspirations of their mothers. The sixth barrier is the lack of knowledge in the benefits of having a PhD. In the 2001 study Brazziel and Brazziel (2001) students indicated that they did not pursue the doctoral degree in computing because they did not know the benefits and salary that comes with the degree. The last barrier is surprisingly the fear of unemployment. According to Brazziel and Brazziel (2001), students did not see role models in these fields so they questioned if jobs in these fields even existed. All of these barriers can be demystified by increasing the number of African Americans with terminal degrees in computing. Since African American PhDs in computing are scarce, another solution is needed to leverage the experience and support of this limited group. This dissertation presents the possibility of filing this void with a virtual human or Embodied Conversational Agent.

Embodied Conversational Agents

Embodied Conversational Agents (ECAs) have been defined as “anthropomorphic interface agents which engage a user in real-time dialogue, using speech, gesture, gaze, and

verbal and nonverbal channels to emulate the experience of human face-to-face interaction" (Timothy Bickmore & Cassell, 2001). Since their inception, they have been used for a variety of tasks such as selling real estate (Timothy W. Bickmore, 2004), nursing the sick (Timothy W. Bickmore, Mitchell, et al., 2010; Timothy W. Bickmore, Pfeifer, et al., 2010; Timothy W. Bickmore, Pfeifer, & Paasche-Orlow, 2009), making travel arrangements (Marriott, 2003) and providing museum tours (Timothy W. Bickmore et al., 2008). One major area specifically targeted by ECA researchers is education (Giraffa & Viccari, 1998; Leelawong & Biswas, 2008; Zakharov, Mitrovic, & Johnston, 2007), specifically Intelligent Tutoring Systems (ITS) (Zakharov et al., 2007). These systems have been defined by Joseph Psotka as "any computer system that provides direct customized instruction or feedback to students, i.e. without the intervention of human beings, while performing a task." (Joseph Psotka, 1988) Most educational intelligent tutoring systems and embodied virtual agents concentrate on the academic content areas or curricula (Brusilovsky, 2000; Merrill, Reiser, Ranney, & Trafton, 1992). For example, an ECA may teach a student how to solve a mathematics equation or a mnemonic for remembering elements on the periodic table. However, there is little research conducted on the effectiveness of ECAs and ITSs that focus on covert (or secondary) curriculum items such as academic mentorship, coaching and counseling. These covert curriculum items, involve, as examples, teaching a student how to create a resume, network at a research conference or advising a student on how to handle a conflict with one's research advisor.

In order to begin examining the effectiveness of ECAs with covert curriculum items, a student demographic must be selected. In this case, African American doctoral students majoring in Science, Technology, Engineering and Mathematics are being selected. The rational for selecting this group is the potential impact this research could make in assisting the United

States broadening participation in the STEM areas (Kuenzi, 2006). Additional significance for this study includes the following:

I. The proposed research will provide a model for constructing Virtual Advisors that focus on cognitive as well as covert curricula.

II. The proposed research will yield, for African American STEM doctoral students as well as African Americans who are interested in graduate studies, a working mentoring agent prototype made specifically for them.

III. The proposed research will provide insight on what content is necessary and how that content should be organized when constructing a virtual mentorship agent for doctoral students.

The following section briefly introduces the contributions, approaches and goals of this research.

Overview of Research Goals, Approaches and Contributions

The major goal of this research was to determine how the short-term effectiveness of African American STEM doctoral student mentorship differs when it is provided by an embodied conversational agent compared to that of mentorship provided by a human mentor. Also, the virtual mentorship agent developed in this research was designed to serve as a tool for mentoring African American STEM doctoral students.

There were several challenges that made the measurement of the ECAs effectiveness difficult for this type of application. First, the effectiveness of the mentorship varied depending on whether or not the student successfully utilized the advice given to them. Second, the quality of the ECA was dependent on the quality of advisement that was programmed into the ECA.

After finding solutions to these challenges, the dialogue for the mentorship mediums (including the ECA) was developed. It was important to identify the major topics the application covered.

Organization of the Dissertation

In the chapters that follow, a research agenda is examined. Chapter 2 gives an overview of the areas of research that pertain to a variety of agents – specifically Embodied Conversational Agents and Relational Agents. Also, in the review of literature, mentorship is addressed. Mentorship topics include: mentoring African American graduate students, myths surrounding mentoring students of color, the components of and steps for setting up mentoring programs for ethnic minorities, and telementorship. In Chapter 3, the design and development of the agent is illustrated. Chapter 4 defines the research question and presents the blueprint for the research study. The result of the study is presented in Chapter 5 and the conclusion and future work is included in Chapter 6. The dissertation concludes with a listing of references and appendices.

CHAPTER TWO

LITERATURE REVIEW

The review of literature covers two main research areas: intelligent agents and mentorship. For intelligent agents, the topics addressed consist of virtual agents, embodied virtual agents, relational agents and embodied conversational agents. Each of these agent types is discussed individually; however, Figure 1 presents the relationship that each one has with the other.

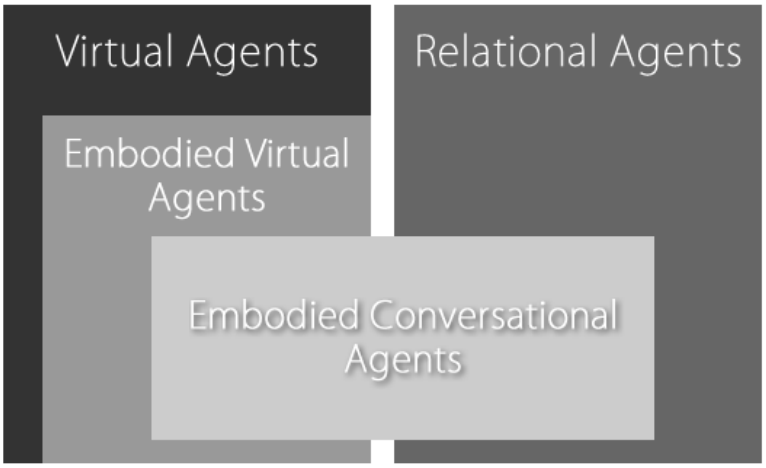

Figure 1 - Relationship Between Agent Types

Embodied Conversational Agents

Timothy Bickmore, renowned researcher in Embodied Conversational Agents (ECAs), discusses below ECAs in the 2001 proceedings for the SIGCHI Conference on Human Factors in Computing:

> "Embodied Conversational Agents (ECAs) are particularly well suited to the task of relationship building. ECAs are anthropomorphic interface agents that engage a user in

real-time dialogue, using speech, gesture, gaze, and other verbal and nonverbal channels to emulate the experience of human face-to-face interaction. The nonverbal channels are important for conveying information, and for regulating the flow of the conversation. These nonverbal channels are also especially crucial for relational conversation, since they can be used to provide such social cues as attentiveness, positive affect, liking and attraction, and to mark shifts into and out of relational activities."(Timothy Bickmore & Cassell, 2001)

From Bickmore's definition, Embodied Conversational Agents are designed to provide an experience similar to interacting with another person as opposed to simply finding text on a website, reading a book or watching a video. This is important when the type of relationship that an ECA designer wishes to establish is a long-term, serious relationship. For example, if ECAs "require users to interact with them for more than a few minutes," or "expect users to take them seriously enough to discuss their medical problems or give out their credit card numbers" the agent must establish trust, which in turn, eases cooperation (Timothy Bickmore & Cassell, 2001).

Commercial Applications of ECAs

While many ECAs have been developed for research purposes, there are also many commercial applications including MyTurboLoan (Iacobelli & Cassell, 2007), Sauna Works (Baylor & Kim, 2003a) and Ikea (Iacobelli & Cassell, 2007).

MyTurboLoan is a product of the Victory Product Group LLC (Iacobelli & Cassell, 2007). At myTurboLoan.com, visitors are encouraged to apply for home mortgages. On their website an embodied conversational agent is used to greet users, explain the services provided on the

website and direct users to the application page. This ECA uses a synthesized female voice and speaks a preconfigured message without accepting input from the user of the system.

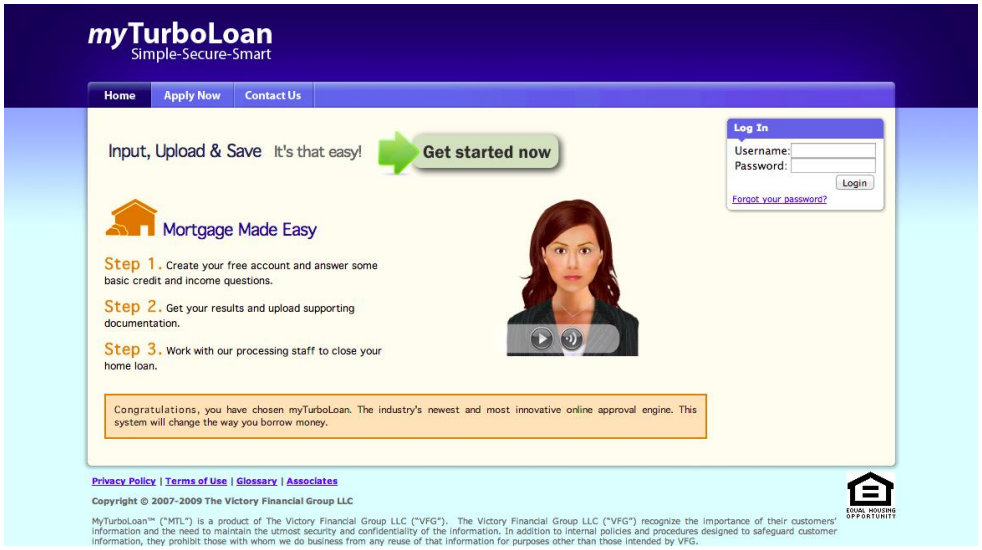

Figure 2 - ECA Greeter from the myTurboLoan Website

Sauna Works is a company that sells a variety of saunas. One of their sauna models, the Clearlight Infrared Sauna, has several testimonies from past and current users. Through their website, Sauna Works has a series of ECAs that personify the past and current users of their products. When one of the ECAs is selected, they provide an audio-recorded testimony about their satisfaction with the product.

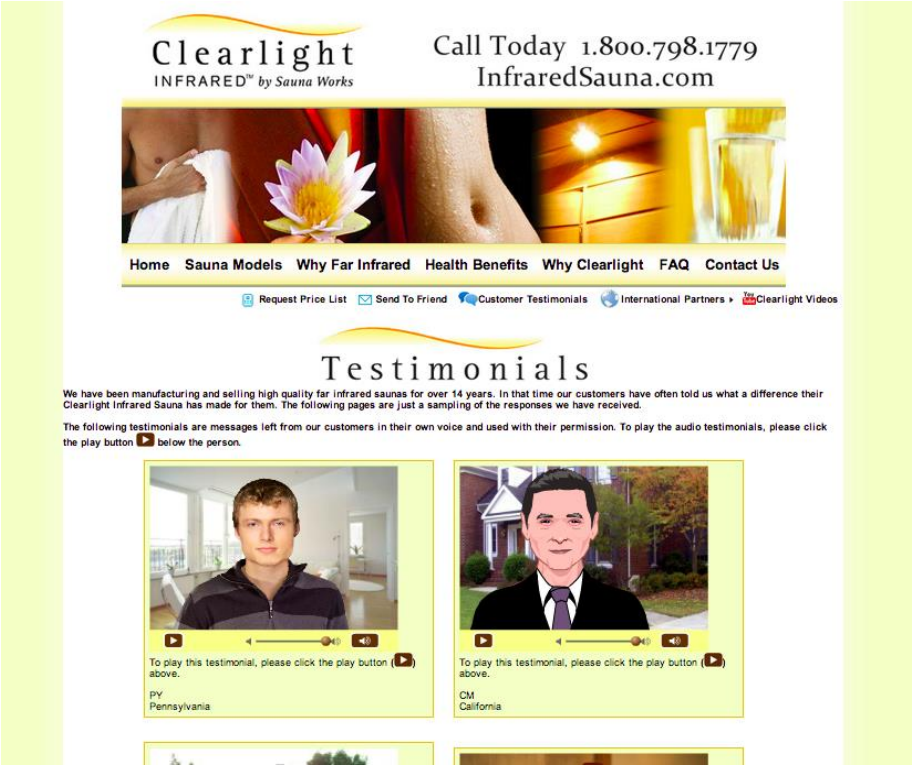

Figure 3 - Virtual Testimonies of the Clearlight Infrared Sauna

Ikea is an international home products company that designs and sells ready-to-assemble furniture appliances, and home accessories. The company has 332 stores in 38 countries (Baylor, Shen, & Huang, 2003) making it the world's largest furniture retailer (Hayes-Roth, Maldonado, & Moraes, 2002). Anna, Ikea USA's Automated Online Assistant is available to answer various Ikea related questions typed in by website visitors. Some of the areas Anna is knowledgeable of include product information, store hours and shipping cost. Anna allows for an open conversation by allowing website visitors to type in their questions in a text box before providing a verbal and printed response.

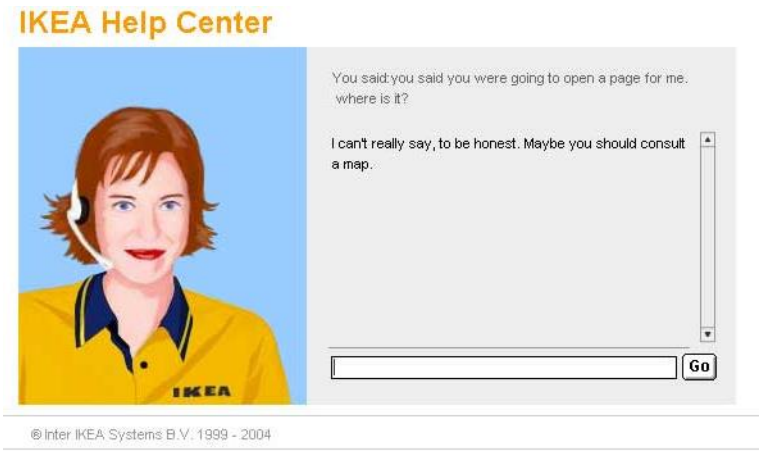

Figure 4 - Anna from Ikea USA Website

These systems vary in their capabilities, appearance, audio type, input and task domains, but all share the common goal of attempting to engage the user in natural, full-bodied (in some sense) conversation.

Experimental Research Techniques with Embodied Conversational Agents

In Nass et al. (Nass, Isbister, & Lee, 2000) the authors discuss best practices for conducting experimental research with embodied conversational agents. It was noted that due to the nature of experimental research, that researchers could not simply show users an ECA and ask them questions about it, but they must compare the ECA to one or more other instantiations of an ECA, an interface without an ECA or an actual person. Additionally, Nass et al. (Nass et al., 2000) notes that virtually all theories concerning ECAs are relative and comparative. For example, a study may suggest that "Agent X was preferred over Agent Y" or that the "natural voice was preferred over the computer generated voice".

In the book "Embodied Conversational Agents" (1998), Sharon Oviatt and Bridget Adams discuss the benefit of simulations studies, also known as Wizard of Oz studies, in designing

systems that are still in the planning stages. These studies "involve proactive and situated data collection for the purpose of system design, which is done in advance of actually building a fully functional system" (E. Lee & Nass, 1998). In a Wizard of Oz study, the participant uses what they believe to be a fully functional system, while research in a remote location secretly provided simulated system responses (James E. Blackwell, 1989). One key benefit of using this research approach is that they are "relatively easy and inexpensive to adapt, compared with actually building and iterating a complete system" (Moreno et al., 2002). Using simulation techniques, according to Oviatt and Adams (2002) allow researchers to collect empirical data that can:

- Reveal undiscovered phenomena of interest, such as landmark features of interactive speech, which will need to be processed by future spoken language and multimodal systems
- Quantify the prevalence of linguistic and other behavioral phenomena observed in users
- Establish their causal basis through isolation and manipulation of the factors that drive them
- Interpret these linguistic and behavioral phenomena in relation to contextual factors that predict and explain them
- Create a solid foundation for next-generation interface design

Another consideration given by Oviatt and Adams (Moreno et al., 2002) is the use of a mobile simulation environment. One limitation of previous simulation environments was that the experimentation occurred in a scientific research laboratory setting rather than a real world environment (Moreno et al., 2002). Utilizing a mobile simulation environment creates a reliable tool to support advance data collection and interface design appropriate for "(1) new media

(e.g., speech, pen, touch) and their multimodal combination, (2) portable technology for use in natural field environments and in situations where users are mobile, (3) diverse user groups (e.g., children or elderly users, accented nonnative speakers), who represent significant market potential, and (4) conversational interfaces that incorporate animated characters and other multimedia output. To further promote these types of future system design, an additional goal of the Mobile Simulation Environment is to develop (5) a toolkit that enables the rapid creation and adaptation of different simulated application" (Moreno et al., 2002).

One application utilizing this environment is Immersive Science Education for Elementary kids-I SEE! This system was studied in a Science Center in Maine with children of age six through ten. The children interacted with the wizard-of-Oz system through a mobile device (Figure 5). This study allowed users of the system to interact with the system in a natural and convenient scenario while still collecting data on how the users interacted with the system.

Figure 5 - Children interacting with I SEE! at the Maine Science Center

Scott W. McQuiggan and James C. Lester created a tool and methodology for evaluating empathy in embodied conversational agents (1989) called CARE. CARE is a "data-driven effective architecture and methodology for learning models of empathy by observing human-human social interactions" (James E Blackwell, 1989). With CARE, during CARE training sessions, a trainer directs the ECA to produce "empathetic behaviors such as spoken language, gesture and posture. Next the CARE software tracks "situational data including locational, intentional and temporal information to induce a model of empathy". Studies conducted using CARE suggest that the CARE paradigm can provide the basis for effective empathetic behavior control in embodied companion agents.

Conversational Models

Conversational models illustrate the process by which agents read input from the user, process the information and generate output to return to the user (Rossen, Lind, & Lok, 2009). ECA researcher, Justine Cassell, discusses conversational models in her article on representation and intelligence in user interfaces (Cassell, 2001). Here she introduces the FMBT (pronounced "fembot") model based on the following four key properties: functions, modalities, behaviors and time. In the FMBT model there is a division between the propositional and interactional functions. In short, interactional discourse functions are responsible for creating and maintaining an open channel of communication between the participants, while propositional functions shape the actual content (Cassell, 2001). Modalities, both verbal and non-verbal are responsible for carrying out the interactional and propositional functions. An example scenario would be an agent telling a user that an object is big while simultaneously using a hand gesture to illustrate how big the item is. As for behaviors, Cassell confirms the difference between behaviors and functions. An observed behavior does not perform the same function when it is

used. An example would be a head nod. It may mean "yes" in one instance and "I agree" in another. Also, behaviors may be different for the same function. An agent may tell a user yes by saying "yes" or by nodding to user. Lastly, time is an important variable in this model. The timing of various behaviors can completely change how the user interprets the agent. For example, a head nod from the agent can signify understanding; however, a delayed head nod can signify a lack of complete understanding. An example of conversational model architecture is shown in Figure 6.

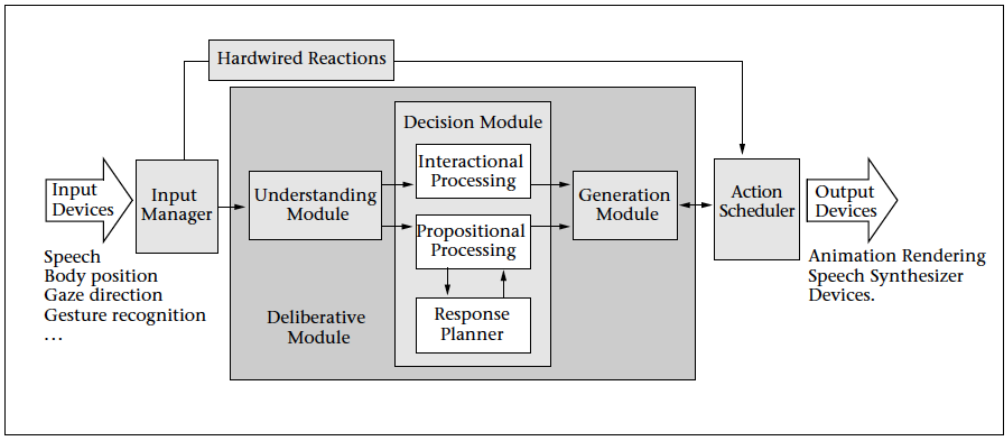

Figure 6 - The Architecture for Justine Cassell's REA Agent (Cassell, 2001)

Gender and Ethnicity in Conversational Agents

If one creates an agent to appear human, a decision must be made about the human characteristics that agent displays. Two obvious characteristics that a user will notice visually are the agent's gender and ethnicity. On the subject of gender, Niculescu et al. (Niculescu, Hofs, van Dijk, & Nijholt, 2010) found that user preferred agents that have an obvious gender to those who gender is ambiguous. Research done by Zimmerman et al. (J. Zimmermann, 2005) concluded that female agents where preferred over male agents, by both male and female end

users. In another study by Baylor et al. (Baylor et al., 2003) college students were not more likely to choose to work with an agent of the same gender. In a between-subjects study the users were more satisfied with their performance and reported that the agent better facilitated self-regulation if it was male (Baylor & Kim, 2003b). Comparably, Moreno et al (Moreno et al., 2002) revealed that learners applied gender stereotypes to animated agents. They also found that this stereotypical expectation affected their ability to learn. With respect to the ethnicity of pedagogical agents, empirical results do not provide consistent results.

When selecting the features of an agent to give the appearance of an ethnicity, studies have shown (Baylor & Kim, 2003b; Campbell, Grimshaw, & Green, 2009; Moldonado, 2004; Nass et al., 2000) that users prefer agents of the same ethnicity to those of different ethnicities. Nass et al. (Nass et al., 2000) found that users found agents of the same ethnicity to be more trustworthy, socially attractive and competent. The gender of agents also has an effect on the type of content spoken by the agent. In a 2003 study (E. J. Lee, 2003), it was found that users more often followed the advice given by a male character when the subject was masculine, such as sports, and by female characters when the topic was feminine, such as cosmetics and fashion. In “Virtual Human Elicit Skin-Tone Bias Consistent with Real-World Skin-Tone Biases” by Rossen et al. (Rossen, Johnsen, Deladisma, Lind, & Lok, 2008) it was shown that dark skin-tone ECAs elicit user behavior consistent with real world skin-tone biases. Results from a study with students in medical school show participant empathy towards a dark skin-tone ECA patient was predicted by their previously recorded bias towards African Americans (Rossen et al., 2008).

When discussing ethnicity, one may think primarily of skin tones. Many studies have occurred to analyze user reactions to culturally diverse ECAs; however, most of these studies feature ECAs with various external features such as skin color or appearance (Baylor & Kim, 2003a; Hayes-

Roth et al., 2002; Nass et al., 2000). “Race” is associated mostly with biology while “ethnicity” is associated with culture (Iacobelli & Cassell, 2007). In “Ethnic Identity and Engagement in Embodied Conversational Agents” (2007), Fransicso Iacobellli and Justine Cassell conducted a study with two ECAs that were developed to mimic the non-verbal cues from African American and Caucasian children. The Caucasian children spoke primarily Standard American English (SAE) while the African American children spoke primarily African American Vernacular English (AAVE). The study showed that an ECA was perceived as an African American when speaking AAVE and was overwhelmingly perceived as a Caucasian when speaking SAE.

Sample ECA Interaction

In order to further illustrate the interaction between an ECA and a user, the following example from REA is used. REA is an embodied conversational agent and stands for Real Estate Agent constructed to interact with users and discuss homes in the Boston area. Below is an excerpt from an actual interaction with REA:

> *Mike approaches the projection screen. Rea is currently turned side on and is gazing idly about. As Mike moves within range of the two cameras mounted above the screen, Rea turns to face him and says:*
>
> REA> Hello. How can I help you?
>
> MIKE> I'm looking to buy a place near MIT.
>
> *Rea nods, indicating that she is following.*
>
> REA> I have a house to show you.
>
> *A picture of a house appears on-screen behind Rea who blinks and looks at the house and then at Mike.*

REA> It's in Somerville.

MIKE> Tell me about it.

Rea looks up and away while she plans what to say

REA> It's big.

Rea makes an expansive gesture with her hands.

Mike brings his hands up as if he is about to speak and so Rea does not continue; instead waiting for him to speak.

MIKE> Tell me more about it

REA> Sure thing. It has a nice garden.

Rea sketches a curved gesture with her hands indicating that the garden extends along two sides of the house

MIKE> How far is it?

REA> It is five minutes to the Porter Square T station.

Rea makes it clear that it is five minutes on foot from the T station by making a walking gesture with her fingers

MIKE> How big is the house?

REA> It has four bedrooms, three bathrooms. . .

Mike interrupts Rea who stops speaking immediately.

MIKE> Wait. Tell me, where is the master bedroom?

REA> I'm sorry, I didn't catch that. What did you ask me?

MIKE> Where is the master bedroom?

REA> It's upstairs.

Rea points up

MIKE> Where is the master bathroom?

REA> It's next to the bedroom.

Rea brings her hands together to indicate the relationship between the bedroom and the bathroom. And the house tour continues.

In this exchange between REA and the user several notable things occur. First, REA was able to ask questions of the user as well as answer questions. Second, REA pointed up when discussing a room upstairs. She was able to show non-verbal communication specific to the verbiage spoken to illustrate her point. Last, REA stopped speaking, similar to a human, when cut off by the user of the system. This example shows the sophistication that is possible for an ECA utilizing motion data from the system users.

Relational Agents

Due to the type of long-term, serious relationships required of the ECA in this work, it is important to define relational agents (Figure 3). Bickmore defines relational agents as "computational artifacts designed to build and maintain long-term, social-emotional relationships with their users" (Timothy Wallace Bickmore, 2003). One would assume that these agents are exclusively software humanoid animated agents, however they can be non-humanoid. An example would be a robot or a hand-held device.

One obvious feature of ECAs (that also serves as a relational agent) is their ability to "remember past history and manage future expectations in their interactions with users"(Timothy Wallace Bickmore, 2003). In a human-to-human relationship, each person remembers important points from previous conversations. This makes the interaction vastly different because there is no need to spend the time and effort to refresh each other on facts gathered from previous conversations.

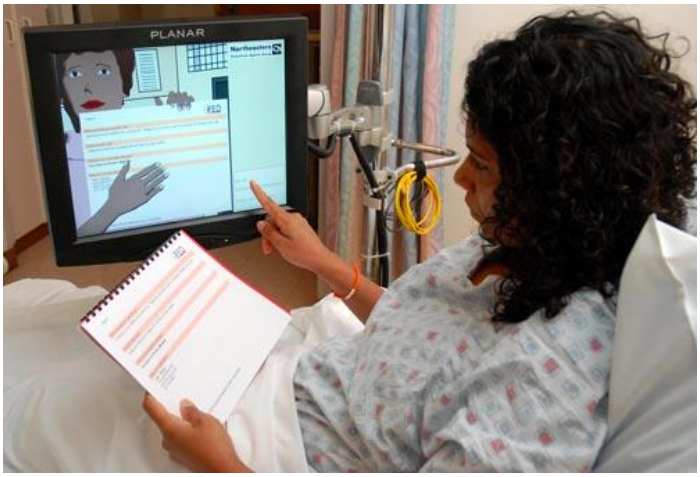

Figure 7 - Patient Communicating with a Relational Agent (Kulbako)

Disadvantages of Relational Agents

Not all feedback about the effectiveness of relational agents has been positive. In the dissertation study of Timothy Bickmore (Timothy Wallace Bickmore, 2003) his relational agent, Laura, was developed to encourage users to increase their exercise activities as a virtual personal trainer. The study has overall positive results, however many subjects did report an annoyance with the relational aspects of the character (small talk, facial expressions, for example) after the initial novelty period wore off. This annoyance was primarily due to the repetitive nature of the interaction (Campbell et al., 2009). In another study (Gultz, 2005) where a relational agent was developed for users between 12 and 15 years, the results were mixed with a marginal majority preferring the relational agent to the control. When summarizing responses, the author is clear that any liked the relational agent while others viewed the small talk, for example, as annoying and unnecessary (Gultz, 2005). It is hypothesized that the key difference could be the age and social mix of the users.

When comparing human-to-human interaction against human-to-relational agent interaction, multiple studies (T. Bickmore, Pfeifer, & Paasche-Orlow, 2007) provide data that suggest users prefer human-to-human interaction when the person needed to converse is viewed as “less important” or “less busy”. In scenarios where the users feel a human would be more busy or important, they preferred the relational agent more often.

Recent studies (Bartneck, Brahnam, De Angeli, & Pelachaud, 2008; Brahnam & De Angeli, 2008; De Angeli & Carpenter, 2005) have investigated the phenomena of “agent abuse”. Empirical evidence indicates that verbal disinhibition and sexual communications occur in 10-50% of anonymous interactions with conversational agents outside the laboratory (Angeli & Brahnam, 2008; De Angeli & Carpenter, 2005; Veletsianos, Scharber, & Doering, 2008).

Mentoring African American Graduate Students

It would be difficult to discuss mentorship among African American graduate students without first defining mentorship. Defining mentoring is challenging due to inconsistent definitions and ungrounded theory (Merriam, 1983). While many definitions exist, Healy and Welchert (Healy & Welchert, 1990) define mentoring to accommodate observations from a compilation of studies of mentoring relationships:

A dynamic, reciprocal relationship in a work environment between an advanced career incumbent (mentor) and a beginner (protégé) aimed at promoting the career development or both. For the protégé, the object of mentoring is the achievement of an identity transformation, a movement from the status of understudy to that of self-directing colleague. For the mentor, the relationship is a vehicle for achieving midlife “generativity” [or passing along a legacy]. (p. 17)

Brown II, Davis and McClendon also define mentoring as “the process by which a novitiate person (student or mentee) is positively socialized by a sagacious person (faculty or mentor) for the purpose of learning the traditions, practices, and frameworks of a profession, association, or organization” (Brown II, Davis, & McClendon, 1999). One could interpret that to mean, in terms of graduate student mentorship, that mentorship applies to those aspects of graduate education outside of the required academic content area.

Mentoring has traditionally been divided into two primary functions, career and psychological (Kathy E. Kram, 1983). A third function, networking help, has been established since Kram’s initial publication (Tenenbaum & Crosby, 2001). The career-related functions include “nominating the protégé for desirable projects, lateral moves, and promotions (sponsorship); providing the protégé with assignments that increased visibility to organizational decision makers and exposure to future opportunities (exposure and visibility); sharing ideas, providing feedback, and suggesting strategies for accomplishing work objectives (coaching); reducing unnecessary risks that might threaten the protégé’s reputation (protection); and providing challenging work assignments (challenging assignments)” (Noe, 1988). Psychosocial functions identified by Kram (1985) include “serving as a role model of appropriate attitudes, values, and behaviors for the protégé (role model); conveying unconditional positive regard (acceptance and confirmation); providing a forum in which the protégé is encouraged to talk openly about anxieties and fears (counseling); and interacting informally with the protégé at work (friendship)” (Noe, 1988). Networking functions include introducing the protégé to future colleagues.

Importance of Mentorship for African American Graduate Students

There have been many papers that have identified mentoring to be a significant influence on the students' professional development (Jacobi, 1991; Merriam, 1983; Phillips, 1979; Rawles, 1980). Specifically, students with effective mentors benefit from academic guidance, career development, exposure that leads to meaningful relationships with future colleagues in their respective professions and honest feedback (Thomas, Willis, & Davis, 2007). Similar responses to mentorship have been mapped to African American doctoral students as well. A study conducted by Katz and Hartnett (Katz & Hartnett, 1976) reported that African American graduate students regarded their relationship with members of the faculty as the single most important aspect of their graduate experience. Unfortunately, these same researchers also found that many students viewed their relationship with faculty as the most disappointing aspect of their graduate experience. The findings by these authors have accentuated the crucial role that faculty have on the graduate experience.

When looking at data on previous cohorts of African American doctorates, Blackwell et al. reported no more than 12% of their respondents had access to a mentor (J. E. Blackwell, 1983; J. W. Holland, 1993; Howard-Vital & Morgan, 1993; Stewart, 1994). However, in a more recent study (Dixon-Reeves, 2003) it was found that 97% of recent PhDs reported having a mentor. In addition, 74% of participants reported having more than one mentor. When multiple mentors were reported, they were classified as providing different functions such as coach (44%) role models (17%) advisers (15%), sponsors (12%) and peer counselors (6%) (Dixon-Reeves, 2003). Another finding from the Dixon –Reeves study was that the participants reported receiving more career-enhancing benefits than emotional and purely advisory academic supports (Dixon-Reeves, 2003). Lastly, it was reported that more than one half of all PhDs were

encouraged by their mentors to submit articles, chapters and book reviews for publication, serve as a research assistant, and present their work at a local or national conference (Dixon-Reeves, 2003).

Relationship Types Between African American Graduate Students and their Advisors

In a study conducted by Jearold Holland (Jearold W. Holland, 1993), the following five relationship types where found between African American graduate students and their faculty advisors: formal academic advisement relationships, academic guidance relationships, quasi-apprenticeship relationships, academic mentoring relationships and career mentoring relationships.

In formal academic relationships, there were three consistent attributes found. First, the advisor provides only basic and routine academic advice to the student. Next, contact is limited between the doctoral student and the advisor and formal in nature. Lastly, the relationships are non-developmental. The scope of the relationship was to give the doctoral student academic advice to successfully matriculate from the program.

More common than the formal academic relationships are academic guidance relationships. Again there are three attributes that characterize academic guidance in doctoral student-advisor relationships. First, these relationships are flexible in nature wherein contact between the student and the advisor is not systematically structured, and communication between the parties is collegial. Next, the major advisors are supportive and understanding of the student and the student's educational needs. Lastly, major advisors basically provide academic- related guidance and advice to the doctoral student.

In quasi-apprenticeship doctoral student-advisor relationships, the student works with the advisor in research-oriented projects. Three attributes characterize these relationships. First,

the advisor provides the student with academic opportunities not available to most doctoral students. Second, students are invited to work in projects that advance the research work of their selected advisor. Lastly, these are academic relationships where the guidance provided by the advisor is primarily related to the student's educational needs.

With academic mentoring relationships, faculty provides students an understanding on scholarly life through in-depth discussions and academic role modeling. Two attributes characterize academic mentoring relationships. First, these relationships are primarily about academic development. Secondly, advisors take a personal interest in the student and in the student's career preparation and success.

The last relationship type is that of career mentoring relationships. These relationships are the most extensive of doctoral student-advisor relationships. Three attributes describe these relationships. First, these are developmental. The advisor takes a clear and purposeful role in preparing the student for faculty employment in higher education. Second, advisors in these relationships are active in socializing the student into a profession. Lastly, the advisor takes a personal interest in the student and his or her career success.

Issues Faced by African American Graduate Students

According to Gasman (2008) there are many issues encountered by African American graduate students (M. Gasman, Hirschfeld, & Vultaggio, 2008). Some of these issues include relationships with faculty, experiences in the classroom, relationships with peers, and both academic and social support systems.

Student Relationships with Faculty

There are multiple studies that highlight the challenges faced by African American graduate students with respect to student-faculty relationships (Walter R Allen, 1992; Walter Recharde Allen, Epps, & Haniff, 1991; Solorzano, Ceja, & Yosso, 2000). Many of these studies place the blame primarily on the low number of African American faculty members who are available to provide mentoring to African American graduate students (Allen-Castellitto, 2001; Cleveland, 2004; Marable, 2002; Smith & Davidson, 1992). At Predominantly White Institutions (PWIs) the proportion of African American faculty members is virtually the same as it was in 1979 at 2.3%. Overall, only 5.1% of all faculty are African Americans (Nelson & Rogers, 2005). Of that total, the overwhelming majority of Black teaching faculty are located in historically Black colleges and universities, in two-year community colleges and at largely underfunded public universities where teaching demands are high and resources for research, laboratories, travel to academic and professional conferences and libraries are modest (Marable, 2002). These challenges leave less time to mentor, less mentorship training and less access to African American graduate students. This lack of representation by African Americans faculty members places an increased importance on the ability of non-African Americans to mentor African American graduate students.

A paper by Davidson and Foster-Johnson (2001) found that cultivating understanding of the experience of students from various cultural backgrounds is challenging for White faculty members due to societal dynamics involving race and ethnicity. In the study conducted by Evelynn Ellis a group of 21 Black and 21 White males and females who graduated within the previous 3 years completed interviews and participated in focus groups. Results of the study showed race and gender affected socialization, commitment to degree completion and the level

of satisfaction. Specifically, the study found that Black doctoral female students are affected more by race than are Black males and White students.

Many researchers blame the general shortage on the lack of African Americans in college and university faculty and administrative positions (Blanchett, 1999; Hood, 1995; Linthicum, 1989). Even though African American students would be naturally drawn to administrators and faculty of the same race, other individuals from different races can serve as effective mentors as well (Brown, 1999; Epps, 1997; R. Steele, 1991). However, African Americans students tend to seek mentorship from African American faculty because they feel as if they understand their unique cultural issues (Patton, 2003).

Student Experiences in the Classroom

According to recent literature, African American graduate students frequently sense that their viewpoints are not valued in the classroom. According to Gasman et al. (M. Gasman, Gerstl-Pepin, C., Anderson-Thompkins, S., Rasheed, L., & Hathaway, K., 2004) African American graduate students "often feel academically isolated in the classroom due to the lack of alignment between their opinions and those of their White professors" (M. Gasman et al., 2008). Additionally, graduate students of color often feel discouraged from participating in class discussions if there are no other minority students in the classroom (Pruitt, 1985). Furthermore, due to sensitive nature of racial topics, faculty members may not feel comfortable addressing these issues within the classroom (M. Gasman, Gerstl-Pepin, C., Anderson-Thompkins, S., Rasheed, L., & Hathaway, K., 2004). In terms of curriculum, many faculty members and institutions have historically privileged Eurocentric knowledge in the classroom (Pruitt, 1985). Due to the lack of inclusion of alternative racial and ethnic perspectives, this prevalent Eurocentrism often creates an unfriendly environment for African American graduate students

(M. Gasman, Gerstl-Pepin, C., Anderson-Thompkins, S., Rasheed, L., & Hathaway, K., 2004). Along these lines, a more modest form of discrimination against African American students is evidenced by the lack of intellectual support for culturally based scholarship (Margolis & Romero, 1998). For instance, dissertation topics that focus on African American issues may be considered "unworthy" by some White faculty (Margolis & Romero, 1998). Lastly, due to scrutiny by colleagues and professors, African American graduate students may feel that it is necessary to "prove themselves" academically above and beyond their classmates (M. Gasman, Gerstl-Pepin, C., Anderson-Thompkins, S., Rasheed, L., & Hathaway, K., 2004; Pruitt, 1985). This finding underscores the reasons why African American graduate students may flounder when their insight and research topics are not valued in the classroom.

Student Relationships with Peers

Even though relationships with faculty and experiences in the classroom are certainly important, the review of literature suggests that peer interactions are also significant in terms of African American students' experiences and perseverance through graduate school (E. M. Ellis, 2001; Golde, 2000; V. Tinto, 1975; V. Tinto, 1993). Specifically Huratdo (1994) suggests that peer interactions influence several aspects of the African American graduate student experience, from scholastic achievement to emotional satisfaction. Some of the negative effects include the claim that African American graduate students feeling unaccepted or out of place at their institutions (Allen-Castellitto, 2001; Cheatham, 1995; Pruitt, 1985; Taylor, Summer, 2000) and experiencing negative stereotyping from their peers (Benton, 2005; C. M. Steele, 1999; Taylor, Summer, 2000). Isolation is a problem as well. Students may feel removed or disconnected from their families, classmates and friends (Golde, 2000). One example in Golde's (2000) study was a participant that described how the emotional distance between her and her

classmates aided her decision to drop out of the doctoral program, stating, “I remember needing to talk to someone, and people just weren't around” (Golde, 2000). In addition to the effects of social isolation, multiple studies have shown that students from underrepresented racial and ethnic backgrounds are typically exposed to negative stereotyping from their peers (Benton, 2005; C. M. Steele, 1999; Taylor, Summer, 2000). As defined by Claude Steele (1999) stereotype threat is “a situational threat… that, in general form, can affect the members of any group about whom a negative stereotype exists.” Based on this definition, one participant in Gasman et al.'s (2004) study spoke about how stereotype threat may cause African American students to question their compatibility with academic life, which could negatively influence their graduate school experience. However, when African American graduate students have been able to experience positive peer interaction, studies have shown that the students have a sense of shared community and a safe space to discuss their experiences (E. M. Ellis, 2001). These positive peer interactions provide students with a “culturally familiar sounding board” (Patton, 2003), and that “helped mitigate social and intellectual isolation” (Taylor, Summer, 2000).

Academic and Social Support Systems

There have been many studies that highlight the impact of on-campus and off-campus programming that provide encouragement for graduate students from underrepresented backgrounds (Cheatham, 1995; Golde, 2000; Patton, 2003; Taylor, Summer, 2000). On campus, underrepresented students utilized resources such as campus psychologists, career services, student affairs professionals and administrators in academic and non-academic departments (Cheatham, 1995; Golde, 2000; Taylor, Summer, 2000). Academic departments at institutions also provide special programs to support minorities – especially in STEM fields. At Clemson

University, the Program for Educational Enrichment and Retention (PEER) Office provides award-winning services to under-represented students including study halls, workshops, test banks, student lounges, scholarships and social activities ("Programs for Educational Enrichment and Retention (PEER),"). At Auburn University the Alabama Power Academic Excellence Program provides summer engineering enrichment programs, scholarships, newsletters, peer tutoring, collaborative learning and an interactive learning lab ("Alabama Power Academic Excellence Program,"). Off campus, underrepresented students opted to converge with religious groups, cultural organizations, and African American faculty employed at other institutions (Cheatham, 1995; Patton, 2003).

Issues Faced by African American Undergraduate Students

Undergraduate African American students also face similar challenges as their graduate counterparts. In a study by Walter R. Allen (Walter R Allen, 1992), findings suggested that undergraduate African American students felt immediate surroundings, social context and interpersonal relationships were the most influential factors of academic achievement. A study by James Blackwell (James E Blackwell, 1989) suggested that mentoring undergraduate African-American students “can foster [in the students] a continuing interest in education and may lead to a decision to undertake graduate work.” In a study by Cabrera et al (Cabrera, Nora, Terenzini, Pascarella, & Hagedorn, 1999) results indicated that perceived discriminatory behavior “ negatively affected minority student academic/intellectual development, social experiences and institutional commitment.” For African American undergraduates at historically Black colleges and universities, a study (Cokley, 2000) found that the best predictor of academic self-concept for students attending HBCUs was the quality of student-faculty interactions. These additional sources of support are particularly vital for underrepresented minorities at selective

predominantly White institutions, as they have fewer same-race peers than their White contemporaries. Although there are several challenges for African American graduate and undergraduate students, several myths also exist.

Myths Surrounding Mentoring Students of Color

A myth is defined as "a collective opinion or belief that is premised on falsehoods or fallacious reasoning"(Brown II et al., 1999). Examined are several falsehoods of effective forms of African American graduate student mentorship provided by Brown II, Davis and McClendon (Brown II et al., 1999). The first myth is the belief that any senior person can mentor a junior person. This myth does not account for "individual personality types and differences"(Brown II et al., 1999). Brown-Wright, Dubick, and Newman state that "Effective mentoring requires the mentor to have some basic understanding of what mentoring is, including its reciprocal benefits"(Brown-Wright, 1997). The second myth is that "engaging with graduate students of color during class and seminars is sufficient mentoring"(Brown II et al., 1999). It would be hard to find truth in "in-class mentorship" due to the manuscript's original definition of what mentorship is and what it focused on – traditions, practices, and frameworks of a profession, association, or organization – all items outside of the academic content area. Additionally, when mentorship efforts occur outside of the classroom, students are able to increase their confidence in their ability to do professional work, learn how to cope with the formal and informal structures of the organization or profession, and encourage the student to enter their selected field (Brown II et al., 1999). The third myth is that only faculty of color can only mentor students of color. This myth was notably addressed by Higher Education researcher Edgar Epps when he stated, "the extent to which all faculty, rather than [faculty of color], are committed to the task of recruiting and nurturing [talented students of color] is an indication of an

institution's commitment to equality for [students of color]"(Epps, 1989). Epps's comment suggests that effective mentorship can come from a faculty member of any ethnicity. In addition, due to disparities between the number of Black faculty members and Black students (Tables 1 and 2) it would be challenging connecting African American students and faculty. The last myth presented is the misconception that the faculty member and the student have to be in the same discipline. Understandably, a mentor who has an intimate knowledge of a mentee's discipline would have an advantage over someone outside of the discipline in discipline specific matters. Unfortunately many faculty members tend to use a mentor-mentee relationships unknowingly as a way to clone or "reproduce themselves"(Brown II et al., 1999). Obviously many mythical barriers exist; however, there are also many examples of successful mentorship to African American graduate students.

Table 6 - 2008 United States Student Race/Ethnicity by Graduate Degree Program

2008 United States Student Race/Ethnicity by Graduate Degree Program						
Race/ethnicity	White	African American	Hispanic or Latino	Asian	Other	Total
Graduate degree program						
Master's degree	66.1%	12.9%	8.5%	10.1%	3.3%	100%
Doctoral degree	62.5%	9.3%	7.1%	17.9%	3.3%	100%
Source: U.S. Department of Education, National Center for Education Statistics NPSAS:2008 Grad Students Computation by NCES QuickStats on 11/18/2011						

Table 7 - 2008 United States Faculty Race/Ethnicity by Institution Level

2008 United States Faculty Race/Ethnicity by Institution Level						
Race/ethnicity	American Indian/Alaska Native	Asian/Pacific Islander	African American	Hispanic	White	Total
Institution: level						
2-year	1.9%	3.4%	7.2%	4.8%	82.6%	100%
4-year non-doctoral granting	1.4%	4.7%	6.3%	2.3%	85.4%	100%

4-year doctoral granting	1.1%	10.2%	4.8%	3.1%	80.9%	100%
Source: U.S. Department of Education, National Center for Education Statistics, and 2004 National Study of Postsecondary Faculty (NSOPF:04). Computation by NCES QuickStats on 11/18/2011						

African American Graduate Student Mentorship Programs

In order to create a virtual mentor it is important to understand the steps needed to create a mentorship program. Miller (Miller, 2002) divides these tasks into two categories, planning and implementation. For planning, Miller offers the following suggestions:

1. "Ensure that individuals and representatives of the minority group targeted are represented on the project steering group.
2. Identify any specific issues of identity, race and racism facing the minority ethnic mentee target group.
3. Ensure that the educational institution has reviewed its policies and practices to counteract institutionalized racism.
4. Ensure the participating schools have an overall strategy for tackling underachievement by student from the target group.
5. Decide whether to target minority ethnic students within a general program or to have an identified minority ethnic program.
6. Consider the need to offer other forms of educational and social support alongside the mentoring. These may include basic skills, residential experience and group mentoring.
7. Recruit a project worker who is from the minority ethnic community and can draw on personal experience to help young people and their mentors tackle issues of behavior management, identity and racism.

8. Ensure that at least one of the project workers can speak the first language of the mentees and their families.
9. Review mentor recruitment and screening policies and practices to see if they have unintentionally excluded potentially valuable mentors.
10. Consider inviting mentors and mentees to choose a name for the program in order to increase the feeling of ownership.
11. Draw up a community map showing where members of the target community gather so that recruitment literature and briefing can be carefully targeted.
12. Allow for the reproduction of recruitment and other scheme literature in the appropriate community language(s).
13. Target community media- newspaper, magazines and local radio – in any mentor recruitment activities" [20].

When it comes to implementing these programs for minority ethnic groups, Miller offers the following suggestions:

1. "Make sure that students are clear about the aims of the mentoring program and can understand the relevance of it to their school career and their life beyond school.
2. Ensure that students are able to raise difficult questions of race, racism and identity in training and review sessions. Make sure that trainers are able to handle these subjects with sensitivity and clarity.
3. Include a discussion of expectations in student preparation covering what they expect from the scheme and what the scheme organizers expect of them.

4. Encourage mentors to think through their personal philosophies for addressing questions of minority underachievement and to consider what it means to be a role model for young people.
5. Make sure that mentor training includes discussion of mentees culture and religion. It might also include: experiences of racism; barriers to education, training and employment; media stereotyping and valuing diversity.
6. Be aware of potential cultural and stoical issues in cross-gender and cross-minority ethnic matching. Ask mentors and mentees about any preferences they might have in cross-cultural matching
7. Include parents in early meeting between mentees and mentors in order to build positive relationships, confidence and trust
8. Ensure that the project worker or scheme coordinator provides close support for mentees and mentors
9. Try to offer some form of accreditation for mentors as people from minority ethnic communities often face additional barriers in their own careers
10. Bring mentors and mentees together for group cultural experience" [20].

All of the suggestions listed will be screened for relevancy with the implementation component of the experimentation in this research.

Components to Mentorship Programs

There are many similar attributes to mentoring programs aimed at African American graduate students across the country. A report from the National Education Association

provides the following list of features that were most frequently listed in annual reports, mentoring pamphlets and external program evaluations:

1. Assignment of a faculty mentor.
2. Assignment of a student or peer advisor.
3. Formally established student or peer network.
4. Academic assistance workshops.
5. Computer skills workshops and assistance.
6. Research, writing, and professional publication guidance.
7. Social activities and programming.
8. Provision of financial assistance.
9. Orientation or welcome programs.
10. Career decision-making and planning workshops.(I. H. Johnson, 1996)

To look for these ten characteristics, a variety of programs that provide mentorship to African American STEM doctoral students were researched. Each of these programs has overlapping, yet unique missions. The Southern Regional Education Board State Doctoral Scholars Program was the largest of the groups researched. Since 1993, the organization has supported more than 1,100 underrepresented minority doctoral students at 83 institutions in 29 states ("SREB State Doctoral Scholars Program,"). The Future Faculty Program at North Carolina State University (by comparison) is used as a recruitment mechanism for the institution as well as a training experience for program participants ("BFF Program,"). A summary of each of the selected programs is provided in Table 8 and Table 9.

Table 8: African American STEM Doctoral Programs I

Program Name	Target Ethnic Group[1]	Target Discipline	Career Focus	Program Length	(Designated) Faculty Mentor	(Designated) Peer Advisors	Formal Peer Network
Southern Regional Education Board	UM	All	Faculty	All Year	No	No	No
African American Researchers in Computer Science	B	CS	All	All Year	No	No	No
NC State Future Faculty Program	UM	All	Faculty	3 Days	No	No	No
National Black Graduate Student Association	B	All	All	All Year	Yes	Yes	No
Empowering Leadership Alliance	UM	CS	All	All Year	Yes	No	No
African American Computer Science Future Faculty Club	B	CS	Faculty	All Year	Yes	No	No
Alliance for Graduate Education and the Professoriate	UM	STEM	Faculty	All Year	No	No	No

[1] UM stands for Underrepresented Minority, B stands for Black

Table 9: African American STEM Doctoral Programs (continued)

Program Name	Academic Assistance Workshops	Computer Workshops/ Assistance	Publication Guidance	Social Activities & Programming	Financial Assistance	Welcome Program	Career Workshops
Southern Regional Education Board	Yes	No	Yes	No	Yes	Yes	Yes
African American Researchers in Computer Science	Yes	No	Yes	Yes	No	Yes	Yes
NC State Future Faculty Program	Yes	No	No	No	No	Yes	Yes
National Black Graduate Student Association	Yes	No	No	Yes	No	Yes	Yes
Empowering Leadership Alliance	No	No	N/A	No	No	Yes	Yes
African American Computer Science Future Faculty Club	No	No	Yes	No	No	No	Yes
Alliance for Graduate Education and the Professoriate	Yes	No	Yes	Yes	Yes	Yes	Yes

Negative Mentoring Experiences

While studying all of benefits of mentoring has demonstrated the importance of these relationships, little research has addressed the long-held contention that mentorships are susceptible to problems (K. E. Kram, 1985; Levinson, Darrow, Levinson, Klein, & McKee, 1978). Even in positive mentoring relationships, only a subset of possible functions are provided by the mentor (K. Kram, 1986). Often, faculty do not always have the competencies or training required to effectively mentor any student (W. B. Johnson & Huwe, 2002). In addition, faculty members are rarely evaluated in regards to the quality of mentoring provided to students (H. Ellis, 1992; Girves, 2005). Two recent theoretical papers discuss dysfunctional mentoring and suggest ideas for future research (Feldman, 1999; Scandura, 1998) and two empirical studies examine protégés reports of negative experiences with mentors (Eby & Allen, 2002; Eby, McManus, Simon, & Russell, 2000). One study (Collins, 1983) reported that a quarter of women in the sample reported had sexual relations with their mentor. Research on interpersonal relationships considers a variety of behaviors that either member may engage in that can lead to relational problems, such as fights, conflicts, jealousy, possessiveness, sabotage, selfishness and deception among others (Duck, 1982; Marshall, 1994). Ten specific dysfunctions, outlined by Eby & McManus (2004), have been found to occur in mentor-protégé relationships include the following: negative relationships, malevolent deception, sabotage, harassment, difficulty, spoiling, benign deception, submissiveness, performance below expectations and unwillingness to learn.

Mentoring Constellations

Traditionally, definitions of mentoring suggest a dyadic relationship in which the more experienced mentor helped guide the career of a younger organizational member as this

protégé learned to “navigate the world of work” (K. E. Kram, 1985). Much of the mentoring research has been conducted within traditional organizational settings with traditional, dyadic mentor-protégé relationships (T. D. Allen, Poteet, & Burroughs, 1997; Chao, 1997; K. E. Kram, 1985; Ragins, 1997). Just in the last five years a new model of mentoring has been emerging that encourages a broader, more flexible network of support, in which no single person is expected to possess the expertise required to help students exclusively (Sorcinelli & Yun, 2007). In this model junior faculty-to-senior faculty relationships as well as doctoral student-to-faculty rely on “mentoring partners” in non-hierarchical, collaborative, cross-cultural partnerships known as multi-mentor networks or mentoring constellations (Sorcinelli & Yun, 2007). In a 2003 article (Mathews, 2003), provides a framework for mentoring that suggest that given the varied components of academic work, mentoring is best undertaken by a number of faculty members, rather than by one individual. Other studies have confirmed the relationship of having a network of mentors compared to just a single mentor will enhance career success and personal well-being (de Janasz, 2004; Girves, 2005; W. B. Johnson, 2007). In a study by I. J. Heety van Emmerik’s (van Emmerick, 2004), it was found that having multiple mentors is not a substitute for a single mentor but should be held in addition to a core relationship. In a 2002 study of formal mentoring programs (Cawyer, Simonds, & Davis, 2002), the authors concluded that the most important feature of mentoring constellations might be accessibility to the mentors in that particular constellation. In studies conducted by Eby (Eby, 1997) and McManus & Russell (McManus & Russell, 1997) it was deduced that, depending on the research perspective, a mentor may not be from within the same organization as the protégé and it is actually optimal if the network of mentors come from different organizations due to a reduction in information redundancy (Higgins & Kram, 2001). In a 2000 study (Peluchette & Jeanquart, 2000), it was

found that multiple mentors where used by early career professionals to seek emotional support. That same study also found that mentoring constellation patterns changed according to the career stage of the protégé (Peluchette & Jeanquart, 2000).

Measuring Mentoring Effectiveness

There have been different methodologies and techniques used to measure mentoring effectiveness in the literature. A qualitative study was conducted by Jearold W. Holland (Jearold W. Holland, 1993) to study the relationships between African American doctoral students and the major advisors. The study consisted of in-depth interviews with 42 current African American doctoral students and recent doctoral graduates from two Midwestern universities. Five types of relationships that African American doctoral students have with their major advisors were identified: 1) formal academic advisement, 2) academic guidance, 3) quasi-apprenticeship, 4) academic mentoring and 5) career mentoring. Of the five types of relationships found the formal academic advisement and academic guidance were identified as the least satisfying, while the quasi-apprenticeship, academic mentoring and career mentoring relationships were found to have the most significant impact on the participants of the study.

Quantitative research methods have also been used to measure mentoring effectiveness (van Eck Peluchette & Jeanquart, 2000; van Emmerik, 2004). In a 2000 study on mentorship sources at various career stages (Peluchette & Jeanquart), a survey was administered to 880 tenure-track faculty members across two universities. Demographic variables such as age, gender, rank, tenure status and length of time at that university were collected with direct, single questions. The remainder of items on the survey represented one of two distinct categories: subjective career success and objective career success. In the study, the subjective career success was measured using a survey instrument with a 5-point Likert scale.

The survey measured how well the subject felt the mentor affected the five facets of subjective career success (work role, interpersonal, financial, hierarchical and life). For objective career success, the study measured non-opinionated things like the number of publications written, instructor's manuals, book chapters, refereed and non-refereed journal articles, conference proceedings, grade point averages and standardized test scores (Green & Bauer, 1995). Since the various items do not weigh equally in decision of tenure and promotion, the authors developed weights for each of the items based on interviews with deans and department chairs at the chosen universities.

Another factor to consider when measuring the effectiveness of mentorship is the phase of the mentor-protégé relationship. In Harings et al Network Mentoring Model (Haring & Welch, 1994) there are four phases in which all mentor-protégé relationships encompass: the Initiation Phase, Cultivation Phase, Separation Phase and Redefinition Phase. Sub phases from Haring's model include educating, role modeling, consulting and coaching, encouraging, sponsoring/providing exposure/visibility, projecting, counseling and moving from transitional figure to friend.

In a 2005 study (Berk, Berg, Mortimer, Walton-Moss, & Yeo, 2005) a review of years of mentoring manuscripts demonstrated several limitations in the context of the mentoring relationship. It was reported that evaluation tools used where designed to evaluate only specific mentoring program, the importance of mentoring functions and/or the frequency of mentoring behaviors. In addition, these instruments rarely related to faculty-student mentoring (Berk et al., 2005).

Telementorship

Telementoring is a version of mentoring that involves the use of distance technology to develop the mentoring relationship (Miller, 2002). With telementoring, the mentee would obtain mentorship using “e-mail, text, audio or video conferencing technology, or a combination of these varied means of communication”(Miller, 2002). Telementoring has been defined also as “the use of e-mail or computer conferencing systems to support a mentoring relationship when a face-to-face relationship is impractical”(O'Neill, 2005).

Telementoring can appear in different forms such as e-mentoring (the mentor – mentee relationship occurs primarily of email) or teletutoring (usually a subject matter expert responds to questions posed by others through a website.

Telementoring Versus Traditional Mentoring

There are many possible advantages for telementoring over conventional in-person, one-on-one mentoring (Harrington, 1999). First, telementoring “offers a means of connecting professionals with students on a much larger scale than would be practicable with traditional mentoring programs”(Miller, 2002). This is possible due to the reduction in travel time or the cost of traveling expenses. Second, telementoring can eliminate the geographic restrictions of a face-to-face relationship. Third, telementoring can reduce “the problems of arranging and/or changing the dates and times of meetings that can beset traditional, external, mentoring programs”(Miller, 2002). Forth, telementoring can allow for more interaction between the mentee and mentor since the overall convenience of the interactions are increased. Fifth, it generates “an archive of communication that can be used to evaluate the success of the program and that can serve as a referenced for all parties”(Miller, 2002). Lastly, telementoring can make it easier for the mentors “to perceive and understand the impact that they are having

on their mentees"(Miller, 2002) To conclude, there are a plethora of advantages to forming telementoring relationships.

Existing Telementoring Platforms

In a report on electronic mentoring practices, Knight & Zheng (2009) researched several exemplar platforms for electronic mentoring and found the majority included the following six components: the pairing of mentors and mentees, communication between the mentors and mentees, management of the program, community development/knowledge sharing, mentoring support and security/privacy. These components where used to compare the following highly visible electronic mentoring platforms: Imentor.org, Insala.com, CSV.org, MentorNet, Mentor Scout and Icouldbe. Table 5 below (P. Knight, Zheng, W., 2009) shows the similarities and differences of the technique feature for the platforms investigated.

Another electronic mentoring platform was created in 2012 for women interested in STEM careers. The Women in Technology Sharing Online, or WitsOn, project has six prominent women as lead mentors including Mae C. Jemison, the first Black female astronaut; Jacqueline K. Barton, the chairwoman of the chemistry department at Caltech; and Padmasree Warrior, Cisco's chief technology officer – as well as nearly 300 other mentors (Lewin, 2012). They will answer questions submitted online by students at any of the universities participating in the project.

Evaluation of Telementoring Programs

There are few eMentoring projects, such as the Electronic Emissary based at the University of Texas and the career-oriented science and engineering project implemented by the Center for Children and Technology (CCT) that have been exposed to extensive and rigorous

research (P. Knight & Zheng, 2009). Saito and Sipe (2003) also conducted an evaluation of the Digital Heroes Campaign (DHC), an eMentoring project administered and sponsored by People Magazine, AOL Time-Warner, PowerUP and the National Mentoring Partnership. Research conducted on other eMentoring programs consist primarily of 1) youths' and/or mentors' post-program reports on their participation in the program, including how they believe they have benefited from participation, and/or 2) summaries based on reports of the frequency of e-mail messages sent (P. Knight, Zheng, W., 2009).

Despite the scarcity of extensive research, some common melodies emerge from the studies that do exist. McDonough, Jastrzab, Sipe, and Rappapport (McDonough, Jastrzab, Sipe, & Rappapport, 2002) reported a few of these. First, both mentors and mentees were most satisfied when the communication occurred often and regularly. Reports from the CCT found that "75 percent of the pairs who agreed they had a positive relationship communicated at least once a week" (P. Knight & Zheng, 2009). Youth participating in these programs indicated that their telementors "influenced them in some way – such as broadening their horizons or positively affective their career aspirations" (P. Knight & Zheng, 2009). Another finding was that the mentors who had the most positive experiences in CCT's Telementoring program usually have relatively flexible expectations about the relationship's activity (P. Knight & Zheng, 2009).

One of the most popular telementoring programs, MentorNet, has a well-documented track record for success (Alapati, Fox, Dockter, & Muller, 2003; C. Muller, 2000; Single, Muller, Cunningham, Single, & Carlsen, 2005). MentorNet (www.MentorNet. net), the E-Mentoring Network for Diversity in Engineering and Science, addresses the underrepresentation of women in science, technology, engineering, and mathematics (STEM) fields (Single et al., 2005). MentorNet offers a multi-institutional, structured, electronic mentoring (e-mentoring) program

that pairs undergraduate and graduate students with professionals and supports them through e-mentoring relationships of specified lengths of time (Single et al., 2005). In the Spring of 2002 (C. B. Muller & Barsion, 2003) a survey was distributed to all the students and mentors that had been matched in the one-on-one program. Of the 2,973 students and 2,749 mentors that were solicited (a few mentors were assigned to two students) 1,101 students and 1,424 successfully completed the survey. It must be also noted that 94% of MentorNet students that responded to the survey were women. A total of 66% of respondents emphasized the value of the encouragement and moral support they received from their assigned mentor. Sample comments included the following:

- "The most valuable aspect is the inspiration from my mentor. Because there are times when you are so stressed out that you don't know what you should do next. My mentor always gives me the encouragement that I need… Sometimes those few words make a big difference to me."
- "I have grown very comfortable sharing difficult issues with my mentor. My mentor is like a friend, except that she has wide knowledge about working and how to succeed."
- "[The most valuable aspect of the MentorNet One-on-One relationship was] Just being able to confide in someone who seems to care, and that I didn't have to worry about sounding dumb.'"
- "Just having someone listen to me and let me know about her life and what it's like. I'm the first in my family to go to college, so my parents can't help me there."

- "Hearing that my worries of going into the 'real world' next year are not unique to me, and that everyone goes through them."

Other feedback provided by student participants in the program included the following:

- 75% of mentors suggested specific strategies for students to achieve their career aspirations
- 69% of students reported learning about their mentor's job and workplace
- 61% of students reported the experience affected their desire to pursue a job in their field
- 45% reported an increased understanding of skills used by engineering, science, or math professionals.
- 94% of students say they would recommend MentorNet to a friend;
- 77% expect to continue communicating with their e-mentor over the summer;
- 70% expect to continue being e-mentored another year.

Program evaluations also established that over 90% of the participants would recommend MentorNet to a friend or colleague (Single et al., 2005).

Mentors participating in the study also had similar positive outcomes. Mentors' rating of their own outcomes varied by racial/ethnic group:

- 40% of mentor respondents who were African American (n=64) said their experience as a MentorNet mentor improved their skills for recruiting new talent as compared to 22% of all other mentors.
- 48% of African American mentors said MentorNet experience gave them renewed commitment to their field as compared to 33% of all other mentors.

- 38% of mentors who are Hispanic (n=63) said the experience increased their own self-confidence as compared to 25% of all other mentors,
- 50% of Hispanic mentors said they experienced renewed commitment to their field as compared to 33% of all other mentors.
- 36% of mentors who are Asian (n=160) said the experience improved their supervisory skills compared to 23% of all other mentors,
- 40% of Asian mentors reported increased self-confidence compared to 24% of all other mentors.

Mentors reported being highly satisfied with their experience of being a telementor, with 96% responding they would recommend to a colleague that s/he volunteers with MentorNet.

Lastly, mentors reported spending an average of 13.7 minutes a week writing and reading MentorNet email.

Table 10 - A Comparison of Major Electronic Mentoring Platforms

EMENTORING PLATFORM		IMENTOR	INSALA	CSV	MENTORNET	MENTOR SCOUT	ICOULDBE
Matching Mentor/Mentee	Database Search	*			*	*	*
	Online Profile Comparison	*			*		
	email or Other Tools		*	*	*		
Communication	Email	*		*	*		*
	Web Post		*		*	*	*
Program/ Curriculum management	Program Management						*
	Curriculum Management.	*					*
Community Development/Knowledge Sharing	Sharing Through Coordinators	*			*		
	Just In Time Learning/Sharing		*			*	*
	e-Forum	*		*	*	*	*
	Advice Board						*
Mentoring Support	Evaluation Report	*	*	*			*
	Activity Checking:	*	*			*	*
Security /Privacy	Volunteer Screening	*				*	*
	Login Control	*	*	*			*
Target user	Teenagers	*					*
	Primary or Secondary School, University students			*	*		
	Young Employees		*		*	*	

Conclusion

The review of literature was very important to establish parameters for the experiment. In the next section, the thesis will highlight the details about the experimentation.

CHAPTER THREE

TOOL CREATION

Overview

Many steps were taken to construct the graduate school mentoring agent. First, the subject areas for the content that would be utilized by the mentor had to be selected. Second, questions from the selected area had to be created and asked to a series of experts. Third, an analysis was done of the answers provided by the experts, and generic responses were created for the list of questions. Fourth, a framework had to be selected or built from scratch to handle the input from the user of the system. Since the decision was made to create the agent from scratch, the code had to be written to process the users' input, compare the processed text with the content stored to the agent and respond to the user. Fifth, the design and construction of the humanoid appearance of the agent was done using the SitePal avatar creation tool on the SitePal website. Sixth, a database was constructed to collect data provided by the participants. Lastly, a website was created to host the agent and the system software. The sections below describe each step in more detail.

Subject Areas Loaded into the Virtual Mentor

Due to the vast amount of data that would have to be compiled and verified for every STEM degree and every single conversational topic, a sample of two topics related to graduate school study for one major, computer science, was collected. In order to identify two areas of interest by the initial users of the system, a survey instrument was constructed and distributed to a group of students from the computer science majors at the institution where the study was conducted. Once the survey instrument was constructed, it was submitted and approved by the

Institutional Review Board (IRB) at both the institution were the study was conducted and the home institution of the author. A total of 60 students were surveyed. One survey was incomplete and discarded leaving a total of 59. The 59 students included 6 freshmen, 16 sophomores, 18 juniors and 19 seniors. Students were solicited using a flyer and given a box of movie-style candy as an incentive. Each student was instructed to rate their interest using a five point Likert scale when answering the following questions:

1. How do I obtain funding to attend graduate school?
2. How should I select a graduate school?
3. How do I select a graduate research advisor?
4. How do I apply for graduate school?
5. Why should I attend graduate school?
6. What are the duties as a graduate student?
7. How do I obtain letters of recommendations?
8. How do I complete an admission essay?
9. What are the differences between a Masters and a PhD?
10. What are the career options with a PhD?
11. What are the salary ranges for PhD graduates?
12. What are graduate courses like?
13. What can I do to start preparing for graduate school now?

Of the 13 questions above, the two highest rated were the questions about funding graduate school and career options with a PhD (See Table 11). Due to the popularity of these topics, questions were asked that fit into these two categories.

Table 11 - Survey Responses from Student Interest Area Survey

Survey Questions	Mean	SD
1. How do I obtaining funding to attend graduate school?	**4.64**	**0.8**
2. How should I select a graduate school?	4.37	1.05
3. How do I select a graduate research advisor?	4.15	1
4. How do I apply to a graduate school?	4.08	1.16
5. What reasons should I attend graduate school?	3.61	1.49
6. What are the duties as a graduate student?	4.17	1.05
7. How do I obtain letters of recommendations?	3.95	1.2
8. How do I complete an admission essays?	4.15	0.93
9. What are the differences between Masters and PhD?	3.69	1.2
10. What are the career options with a PhD?	**4.54**	**0.7**
11. What are the salary ranges for PhD graduates?	4.36	1
12. What are graduate courses like?	4.49	0.82
13. What can I do to start preparing for graduate school now?	4.44	1

Mentorship Content in the Virtual Mentor

Content for the virtual mentor was compiled from a collection of 12 individuals that worked as administrators, faculty members, funding agencies and industry professionals. These "experts" were either African Americans who received their doctoral degree in a computing field or individuals with work experience mentoring African American doctoral students in computing. One-on-one interviews were set up with each expert. Every interview was recorded and later transcribed for accuracy. A list of questions was prepared for each expert before the start of the interview. Each question asked was answered by at least three of the experts.

Questions were asked to each person based on his or her specific experiences and qualifications. For example, questions about faculty career options were asked to those who are currently in tenure-track faculty positions. Answers provided by the experts were transcribed and grouped by question asked. Answers used by the ECA were determined by including fragments by at least two of the three experts.

Scene Creation

To study the effectiveness of the relational agent, the agent must be created first. The virtual agent used in this study was constructed using the SitePal editor tool from SitePal.com. SitePal was chosen due to its popularity, JavaScript API, scalability and price. SitePal's editor tool is designed so that the developer is able to create scenes, which allows for the creation of a new agent or the use of an agent that already exists. The tool gives the developer access to five distinct features. First, the developer can select the model desired from a listing of different male and female models (Figure 8). For this project, a model that appears to be an African American male was chosen. This decision was made due to the sample population of the study (to be discussed in the next chapter) as well as studies that suggest college students' preference to interact with agents of the same gender (Baylor et al., 2003) and trend for African American students to seek mentoring from African American faculty because they feel as if they understand their unique critical issues (Patton, 2003). The developer also had the option to upload his or her own photograph or image, however a life-like model was already included in the software eliminating the need for creating a new model.

Figure 8 - Model Selection

Second, the developer can choose the expression of the agent (Figure 9). The pre-installed expressions (i.e. surprise, thinking, happy, sad, etc.) dictate the overall "mood" of the agent. A neutral mood was chosen for the study to eliminate any participant bias to any of the other optional emotions.

Figure 9 - Facial Expression Selection

Third, the developer can choose the background image for the agent (Figure 10). The pre-installed options include photographs or artist drawings. For this experiment, a pre-installed

office background photograph was chosen due to its resemblance to the location of a traditional mentor-mentee interaction.

Figure 10- Background Selection

Fourth, the developer can add audio to the avatar (Figure 11). SitePal editor (under the Silver package) provides the following five options for adding audio: text-to-speech, microphone, upload, phone and voice talent. Here the text-to-speech version was chosen due to its flexibility and scalability.

Figure 11 - Agent Audio Selection

Once the voice is added, the last step is to choose the player format (Figure 12). Options include wide format, narrow format, etc. The wide format version was selected since it was the largest.

Figure 12 - Agent Player Selection

Conversational Methodology

When a scene is created, up to this point, the agent has the ability to speak information without any input from the user (or mentee). Obviously, this would not be sufficient if replicating a mentor-mentee relationship. In order for an agent to carry out a conversation with a user, there would need to be some type of decision-making process from the agent. To accomplish this, a logical solution must be found before a technical solution can be implemented.

Sample questions were asked by a group of users. A pattern was found from these questions: the questions typically belonged to a particular category and had one word, where in combination with the category, made the question unique. Essentially each question asked by the user contained two keywords. A system had to be utilized to accommodate this finding.

The initial software Artificial Intelligence Markup Language (AIML) was employed to create the agent. AIML is an XML dialect for creating natural language software agents. The XML dialect called AIML was developed by Richard Wallace and a worldwide free software community between the years of 1995 and 2002. It formed the basis for what was initially a highly extended Eliza called "A.L.I.C.E." ("Artificial Linguistic Internet Computer Entity"), which won the annual Loebner Prize Competition in Artificial Intelligence (Loebner, 2013) three times, and was also the Chatterbox Challenge (Chuchran, 2013) Champion in 2004. The following is a sample of AIML code.

```
<category>
 <pattern> PLEASE TELL ME YOUR NAME </pattern>
 <template><![CDATA[My name is <bot name="name"/>.]]></template>
</category>
<category>
 <pattern>WHAT SHOULD I CALL YOU</pattern>
 <template>
  <srai> please tell me your name </srai>
 </template>
</category>
```

In the sample code above, the code in the first category tags answers an input of “please tell me your name” with a statement of the agent’s name. However, in the second set of category tags, the input “what should I call you” will be redirected to the category that matches the input “please tell me your name”. In other words, it is saying that the two phases are equivalent.

The benefits of AIML include its popularity, its ability to be integrated into web-based systems and its pre-established integration with the SitePal avatar creation tool. Due to these benefits, a prototype was developed with this language. Unfortunately, when this system was tested, responses provided to the user did not match the expected responses programmed by the author. Because the author wanted total control of the responses coming from the agent, a tool was created using JavaScript and PHP called VM1.

VM1 is a back-end software application developed in the PHP and JavaScript programming languages that is similar to AIML in that it retrieves responses based on keyword matches. The acronym stands for "Virtual Mentor 1". Steps taken for information retrieval in VM1 are as follows:

1. A user asks a question to the conversational agent by typing their question into a text field.
2. The original question is saved to a variable while a copy of the question is saved for processing.
3. The question copy string is stripped of all punctuation and numbers.
4. The revised question copy string then substitutes words that are in plural or past tense to its base tense.
5. Every word in the question copy string is checked against a list of synonyms and, if found, is replaced with the root word of the synonym.
6. Words that are not keywords are removed from the question copy string and the words remaining in the string are stored individually.
7. If there are three or more words remaining, the remaining words are sequentially compared to sets of **three** keywords that assume a particular question.

8. If there is a match with a three-keyword set, then the highest ranked response from VM1 is returned to the user assuming it has identified the question asked to the system.
9. If there is no match with any of the sets of keywords and at least two words are left, then the remaining words are sequentially compared to sets of **two** keywords that assume a particular question.
10. If there is a match with a two-keyword set, then the highest ranked response from VM1 is returned to the user assuming it has identified the question asked to the system.
11. If there is no match with any of the sets of two keywords, then the question copy string is sequentially compared to individual keywords that assume a question was asked in a particular category.
12. If there is a match with an individual keyword, the highest ranked generic response for that single keyword is returned to the user assuming it has identified the category of the question probed to the system.
13. If there is no category match for the question copy string, the system will give the following response to the user: “I don’t understand your statement”.
14. Once VM1 sends the response to the user through the conversational agent, the original question asked by the user is also shown to the user next to the visual response from VM1 (Figure 13).
15. When the user selects the “Finish Conversation” button, the original question and the response given to the user are inserted into the VM1 database.

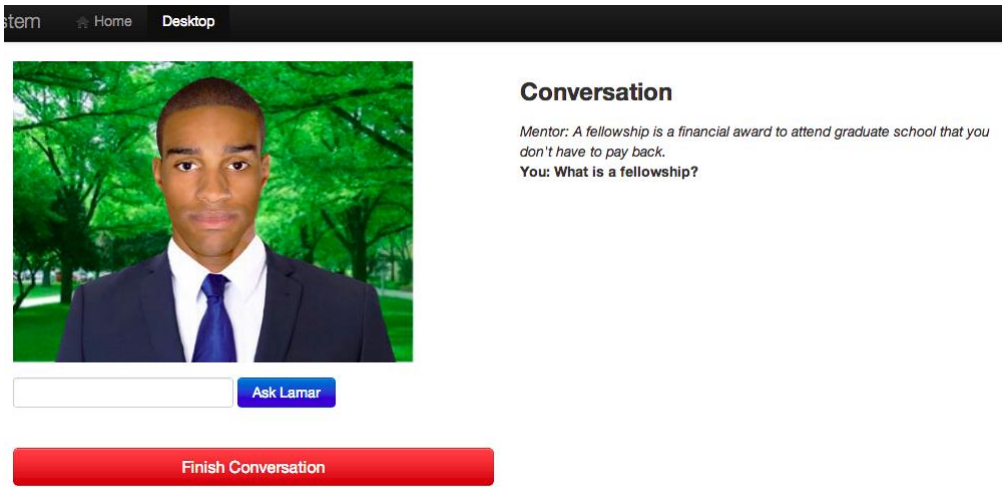

Figure 13 - Screenshot showing response from VM1

Example Question for the VM1 System

In this example, the user wants to know what his overall grade point average needs to be in order to receive a teaching assistantship at a typical university. The user types in the following question to the system to retrieve an accurate response: “What kind of grades should I have to get a TA?” After typing in his question into the text box, he selects the button labeled “Ask Lamar” (Lamar is the name of the virtual mentor). Once the button is submitted, the text is sent to VM1 for processing. VM1 first will copy the string so the original question is saved. Next, the question is stripped of all punctuation leaving the revised question string: “What kind of grades should I have to get a TA”. Now, words that are keywords or synonyms are reverted to the original tense. In this case “grades” is replaced with “grade” to yield the following revised string: “What kind of grade should I have to get a TA”. Then every word in the string is compared against a list of synonyms. The word TA is found in the list and replaced with the word assistantship. The question string now reads the following: “What kind of grade should I have to get a assistantship”. Since the response from virtual mentor provided the same answer for

different types of assistantships, the “teaching” in “teaching assistantship” was no longer needed for processing. With the synonyms changed, all words that were not keywords are now removed. This leaves the following string: “grade assistantship”. The string is now broken up into individual words. Since there are only two words left, the word set is not compared to the sets of three words. The two-word set is then compared to the other two words sets that are saved in VM1 and a single match is found for the words “assistantship” and “grade”. The word match assumes the following question or a similar question was asked of the system: “What does my GPA need to be to get an assistantship?” The response returned to the interface is as follows:

> *“There is no universal answer for every school, but obviously, the higher your GPA the more likely you are to be awarded an assistantship. Many schools like to see at least a 3.0 when applying for a program; however, a school may weight a GPA differently depending on the school the student has graduated from. Sometimes a graduate school will look at specific things in your transcript such as what you made in your major courses or what grades you made after your freshman year.”*

At this point, the user will see and hear the virtual mentor, Lamar, speak the above response as well as see the response on the right-hand side of the screen along with the original question asked. This scenario (Scenario #1) represents the “best-case” scenario because there is exactly one match for the set of keywords found (Figure 14). There are also three other scenarios that exist.

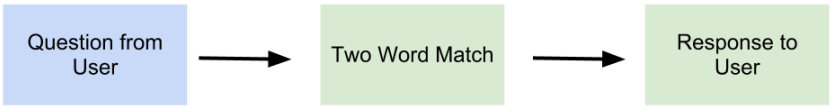

Figure 14 - VM1 Scenario #1

In scenario #2, there are multiple matches based on the keywords found (Figure 15). For example, the user asks Lamar "How can I apply for assistantship funding?" This question will be parsed into three keywords: "apply", "assistantship" and "funding". In this scenario, there is no match for these three words together. However, the following two separate matches for two of the words exist: 1) "apply" and "assistantship" and 2) "funding" + "assistantship". The first word pair ("apply" and "assistantship") is assumed by VM1 to think the user is asking the following question: "How do I **apply** for an **assistantship**?" The second word pair ("funding" + "assistantship") is assumed by VM1 to think the user is asking the following question: "How much **money** could I make doing an **assistantship**?" In this example the word "money" would be exchanged with its synonym, "funding". In scenario #2 two completely different responses are possible. The VM1 system will select the highest ranked set in this scenario. For this initial version of VM1, word sets were randomly ranked, however the system is flexible enough to manually change the rankings based on the accuracy of given responses by the system.

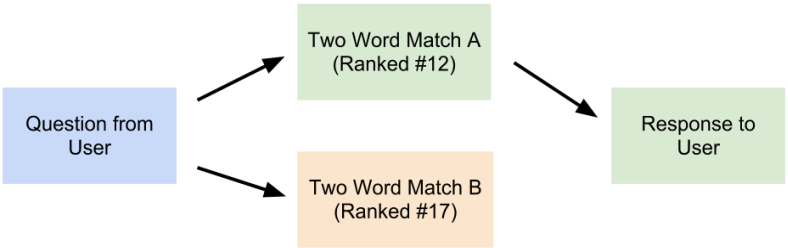

Figure 15 - VM1 Scenario #2

In scenario #3 multiple matches occur and those matches do not consist of the same number of words (Figure 16). An example of this scenario would be if a user asked the following question: “What does my GRE score need to be to gain an assistantship?” In this example the keywords “gre” and “assistantship” would remain after processing the query to the system. Here the following two matches occur: 1) “assistantship” and “grades” and 2) “assistantship”. In this scenario the first match would be chosen over the second match since the first match has more words than the second match. The rankings of each set of words in this scenario is irrelevant.

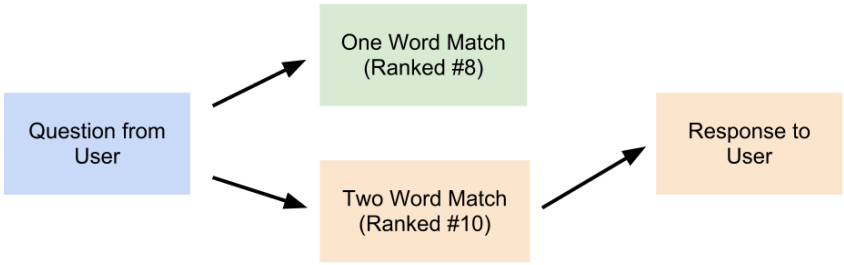

Figure 16 - VM1 Scenario #3

In the last scenario (Figure 17), the user may ask the following question: “So what’s up with Clemson?” In this situation, there are no keyword matches and VM1 will return the following response: “I don’t understand your statement”.

Figure 17 - VM1 Scenario #4

Database Design

The database was designed to serve as the conversation repository for the virtual mentor. The relational database management system used was MySQL. The relational database management system was chosen because of its popularity, compatibility and price (free). In the database, a single table was created to record the interaction between the virtual mentor and the participant in the study. Fields in the table included the following attributes:

- question_ID – int(11) – unique identifier for each statement made by the agent or user
- speaker_ID – varchar(25) – the speaker (agent or human) who made the statement
- question – text – the statements made by the users of the system
- response – text – the statement made by the conversational agent
- datetime - timestamp - the date and time that the statement was recorded in the database

The responses given by the agent and the keywords the agent responded to were not stored in the database. Since there was only a single entity, there were no relationships with the conversation table.

Website Creation

The website was created to host the agent and the VM1 software. The website has three pages. The first page (Figure 18) has an agent named Lamar that explains how the virtual mentoring system works and what topics it is familiar with. The name “Lamar” was chosen from a list of African American names of the largest database directory of African American Baby names ("Black Baby Names "). It was selected for its ease of spelling and pronunciation. It also asks for the user’s ID number and classification before continuing with the next page.

Additionally, Lamar welcomes the user to the system and provides some insight on how the system should be used. Below is the script that is spoken by Lamar when the page is loaded:

> *Welcome to the Virtual Mentorship System. My name is Lamar. I am here to mentor you about your possible decision to attend graduate school. I currently know mostly about funding options for graduate school and career options if you obtain a graduate degree in computing. Please fill out the information on the left and submit to begin.*

Once the user listens (or reads) the welcome by Lamar, enters an ID code and classification, he/she is prompted to start the interaction with Lamar by selecting the green button labeled “Start the Conversation”. The width of the button takes up one third of the page so it is very visible to the user. The welcome message is displayed on the right side of the screen in case the user does not hear something said by Lamar. Lamar is placed in the center of the screen since the embodied conversational agent is the focus of the application.

Figure 19 is comprised of Lamar, the virtual agent, the conversation and the related question list. The conversation section, on the right third of the page, gives a transcript of everything that is said by the user and the agent. The questions by the user and the responses by Lamar are listed in chronological order from the most recent questions and answers to the least recent question and answer. Questions asked by the user of the system are in bold so that the user can easily differentiate between text questions from the user and responses from Lamar. Also on the left-most third of the page is a related question section. This section provides a listing of related questions that relates to one of the keywords of a question asked by the user. Users can then select one of the related questions, listed as hyperlinks, to get a response from

Lamar without asking the question in the text box. The related questions update dynamically after every question that is asked by the user.

The following categories are programmed in the VM1 system: teaching faculty careers, research faculty careers, careers in industry, assistantships and fellowships. In the middle of the page is Lamar, a text box, a button labeled “Ask Lamar” and a red button that spans one third of the page labeled “Finish Conversation”. Lamar is placed in the center column of the page since he is the focus of the page. The text box and button are located immediately under Lamar. The “Finish Conversation” button was colored red since that color is related to stopping (i.e. traffic light, stop sign, etc.). When this button is pressed the conversation is sent to the database and the interaction is over.

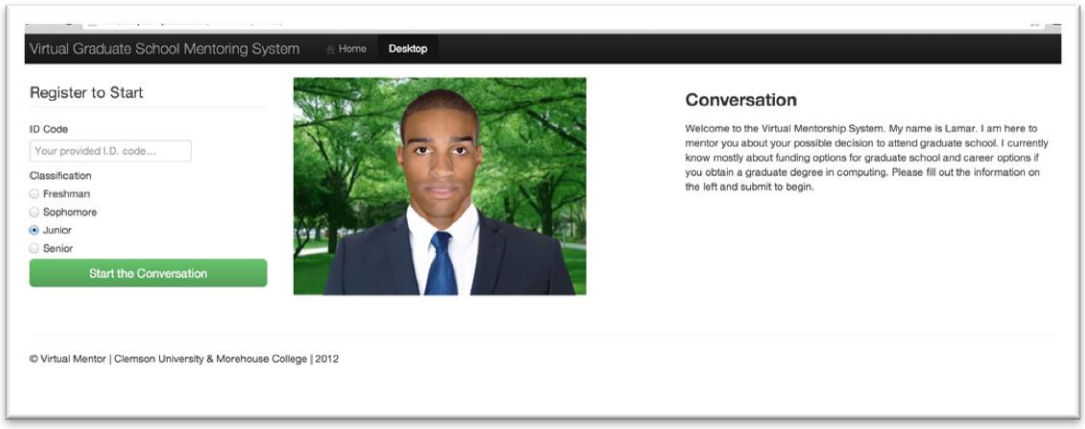

Figure 18 - Screenshot of Virtual Mentor Intro Screen

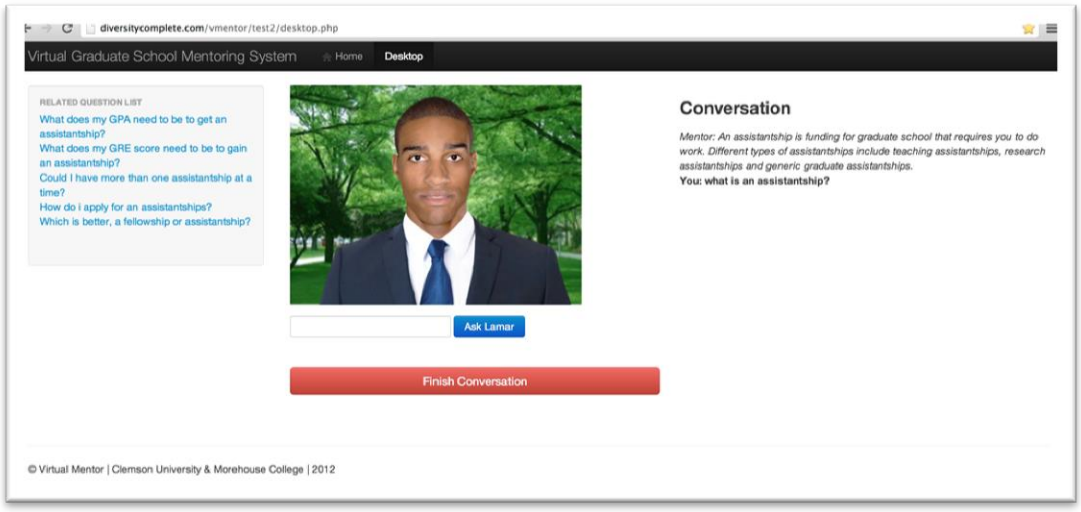

Figure 19 - Screenshot of Virtual Mentor Application Screen

The third and final page of VM1 is the Administrator page (Figure 20). This page was not designed to be accessible to the users of the system. The page has three sections. The first section is the statistics section. At the time of the study, this section only tracked the number of misfires that occurred in the system. A misfire is defined as an occurrence of a user asking a question where this is no three, two or one word match. The section is a single-column table of all the misfires that occurred in the database. Each row in the table has the statement that was submitted by the user to the system and the ID code of that user. These two sections allow the administrator to see what questions are causing misfires and the frequency of misfires.

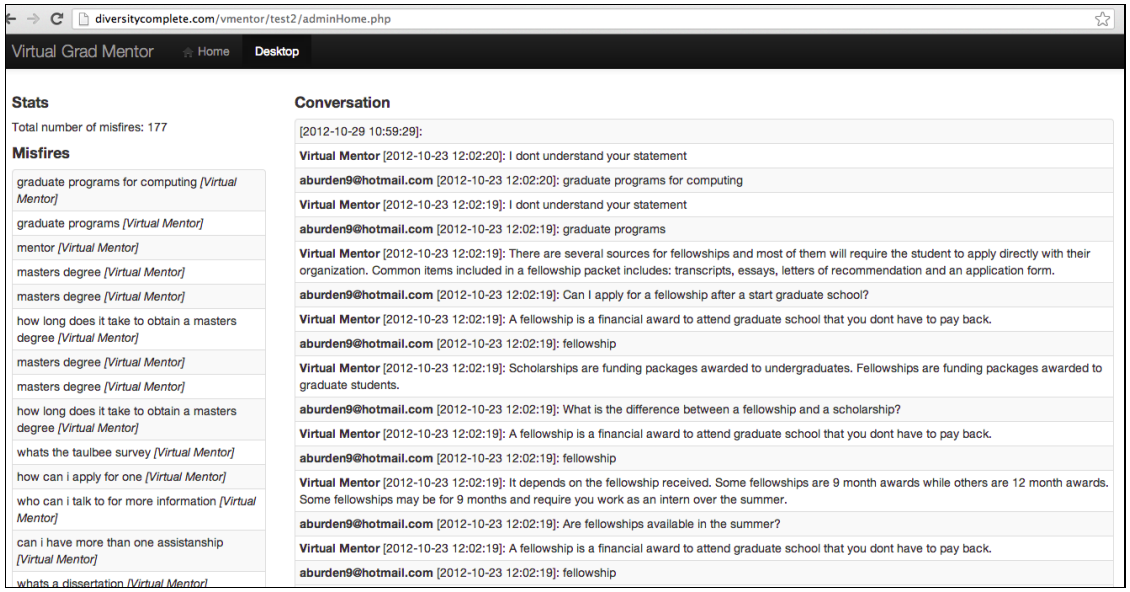

Figure 20 - Screenshot of the VM1 Administrator Page

CHAPTER FOUR

PROBLEMS AND PROPOSED APPROACHES

Research Perspective

It is important to provide scope for this project in order to achieve conclusive results. First, the effectiveness of the experience from the created, autonomous virtual mentor as was compared to that of a human mentor. Second, to replicate how the mentoring process works in the real world, students interacting with a human mentor were given the opportunity to select their mentor and contact them directly. Every student was given a list of individuals on their campus that could serve in a mentoring capacity and give graduate school advice. Third, the mentorship knowledge contained by the virtual mentor comprised of mentorship advice from multiple experts who had first-hand knowledge on those areas and how African Americans interact in those areas. Fourth, undergraduates were studied as opposed to graduate students for two reasons: 1) graduate school mentorship starts as students are completing their bachelor's degree and 2) the potential of the virtual mentor being used as a tool to increase interest in the pursuit of the doctoral degree in computing. Lastly, only the short-term effectiveness of the mentorship was studied.

Research Design

The research conducted in this study used a mixed method methodology. Mixed Methods research is defined by (Tashakkori & Creswell, 2007b) as "research in which the investigator collects and analyzes data, integrates findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or a program of inquiry." This method was chosen to allow for the generalization for exploratory findings (due to the

novelty of virtual mentorship) and an explanation of initial results gathered by the quantitative data collected. The mixed method design utilized was a fixed mixed method design rather than an emergent mixed method design since it was known ahead of time that qualitative and quantitative data needed to be collected. The project contained two strands: a quantitative strand and qualitative strands. The quantitative strand included a pre and post survey instrument. The qualitative strand included interviews of the participants. Both strands will be explained in detail later in the chapter.

Mixed Method Design Type

The research used a major mixed method design: explanatory sequential design. This design starts with quantitative data collection and analysis followed by the qualitative data collection and analysis before the start of the interpretation. This mixed methods design was selected for the following reasons: 1) The researcher and the research problem was more quantitatively oriented, 2) The researcher knew the important variables and had access to quantitative instruments for measuring the constructs of primary interest, 3) The researcher had the ability to return to participants for a second round of qualitative data collection, 4) The researcher had the time to conduct the research in two phases, 5) The researcher had limited resources and needed a design where any one type of data was being collected and analyzed at a time, and 6) The researcher developed new questions based on quantitative results, and those new questions could not be answered with quantitative data.

Additional Details about the Methodology

When choosing the appropriate mixed methods design, four factors were taken into account: 1) the level of interaction between the strands, 2) the relative priority of the strands, 3)

the timing of the strands and 4) the procedures for mixing the stands. An interactive level of interaction occurred in the research between the qualitative strand and the quantitative strand. Individuals chosen for the interview were selected based on results from the survey instrument. The priority of the strands was equal since both the quantitative and qualitative measurements played an important role in addressing the research problem. As for the timing of the strands, the qualitative strand occurred after the quantitative strand. The point of interface between the quantitative and qualitative strand occurred during the data analysis stage of the research. Both strands remained separate during the data collection.

Lastly, this experiment used a between-group (or between-subject) design instead of a within-group design. This means that each participant did not use all of the available interfaces. This approach did not create the most data per participant; however, it was more optimal at preventing user learning effects and user fatigue.

Research Question and Hypothesis

The primary research question for this dissertation is as follows: How does the short-term effectiveness of graduate school mentoring differ for African American STEM students when provided by an embodied conversational agent compared to a human mentor? In this manuscript “short term” is defined as a single interaction and “effectiveness” is used to describe how much the participant learned about graduate school due of the mentoring interaction. The null hypothesis (H_0) is that there will be no significant difference between the agent and the human mentor. The alternative, or research, hypothesis (H_1) is that the participants of the study will, on average, find the virtual mentor more effective in some areas, equal in some areas and less effective in other areas than a human mentor.

Participants and Population

Participants used in the study were selected using convenience sampling since the sampling frame had over 150 elements. Since the content of the relational agent was customized for African American male computer science majors, it was a requirement that each participant be an African American male computer science major. Additionally, every participant had to be somewhat interested in graduate school, be at least 18 years old and enrolled in good standings at the institution where the study was conducted.

Of those who met the criteria above, participants were selected using purposeful sampling, rather than probabilistic or any other sampling method, ensuring that feedback was collected from students who had various experiences from their mentoring experience. Potential participants were informed about the study using a flyer as well as email (See Appendix).

Experiment Location and Source of the Participants

Each participant was enrolled at the same historically Black college. This college is an all-male, liberal arts school in the southeastern United States. The Division of Science and Mathematics, with an enrollment of 799 (Table 13), at this institution has several large grants from funding agencies that promote graduate degree pursuit in STEM such as the National Science Foundation, Department of Defense and National Institute of Health. Unfortunately, these programs have been mostly ineffective in promoting computer science majors to pursue STEM graduate degrees compared to other majors throughout the division.

Table 12 – Student Graduation for Host Institution

	2010-11	2011-12
Applied Physics	6	3
Biology	43	22
Chemistry	4	12
Computer Science	**12**	**8**
General Science	11	7
Mathematics	11	15
Physics	7	5
Psychology	34	43
Science & Mathematics	**128**	**115**

Table 13 - Student Enrollment at Host Institution

	2010-11	2011-12
Applied Physics	54	56
Biology	239	239
Chemistry	60	65
Computer Science	**122**	**129**
General Science	12	7
Mathematics	62	56
Physics	77	79
Psychology	169	168
Science & Mathematics	**795**	**799**

In the last two years only **one** student graduated with a Bachelor's of Science in Computer Science attended graduate school after graduation. According to data from the 2010-2011 Taulbee Survey there are 2,962 students who are first year PhD students in Computer Science, Computer Engineering and Information Science. One student in two years can be viewed as low considering the number of incoming PhD students combined with the fact that the school is ranked in the top five in the nation for graduating African American male students who go on to obtain a PhD in science, technology, engineering, and mathematics (Trawick, 2012). Total, the computer science department at this college has 129 active majors in good standing. This department is unique for a Historically Black College because large companies including IBM, Google, Microsoft and Boeing heavily recruit their graduates. It must be noted that at the time of the study, the author was a faculty member in this department.

Approval for Human Subjects Research

Permission to conduct the study using human subjects was achieved at the home institution of the author as well as the home institution of the participants through both institutions' Internal Review Board (IRB). Copies of the IRB applications are located in the appendix section of the manuscript. The following requirements were met in order to get approval: (1) there were no unnecessary risks to subjects; (2) the risks to subjects were reasonable; (3) the selection of subjects were equitable; (4) informed consent was sought and appropriately documented; (5) adequate provision was made for monitoring data collection to ensure safety of subjects; (6) adequate provision was made to protect the privacy of subjects; and (7) when subjects were likely to be vulnerable to coercion or undue influence, additional safeguards were included. Both institutions accepted this research under the category of exempt, avoiding full board review.

Research Variables

The research variables in this experiment were divided into two groups – independent and dependent variables. The independent variables addressed in this research primarily came from user demographics that included the following: age, major, minor, classification (i.e. freshman, sophomore, etc.), school, grade point average and ethnicity. Other independent variables included the following:

1. The interest in pursuing a graduate degree in computing
2. Confidence in getting accepted into a graduate program
3. Knowledge about the graduate school application process
4. Knowledge of graduate school funding options
5. Knowledge of career options with a graduate degree in computing
6. Knowledge of graduate school terminology
7. The relationship they had with the agent

The primary dependent variables that were addressed in this research consist of the knowledge learned about graduate school in computing and interest in pursuing a graduate degree in computing.

Equipment

The participants using the virtual mentor interacted with the agent using an Apple 21.5-inch iMac computer with a 2.5GHz Quad-Core Intel Core i5 processor and an NVIDIA GeForce GT 640M graphics processor with 512MB of GDDR5 memory. Each participant was given Sony MDR NC40 noise cancelling headphones to hear the virtual mentor and remove noise from the room.

Users navigated the website with the agents using a full-size Apple wireless keyboard and a multi-touch magic mouse.

Selection of Human Mentors

Students who participated in the study were randomly assigned to one of two groups. One group of participants was mentored by the virtual mentoring agent. The other group was asked to get mentoring advice from a qualified human mentor. Minimum qualifications for the mentor included the following:

1. An African American who had completed, or was in the process of completing a terminal degree in a STEM field.
2. Anyone who had worked in a job where a component of the job was to advise African American STEM students on graduate school opportunities.

Students were given the names of five individuals who met the above qualifications and worked at the school where the participants were enrolled. Three of those individuals worked in the same building where the participants currently took courses. Students were not restricted on which mentors to select.

Survey Instrument

The survey instruments were distributed in a quiet classroom at the home institution of the study participants. The surveys were distributed and collected based on the preference of the participant and availability of the author, Monday through Friday of the fall semester of 2012, and between the hours of 10:00 AM and 5:00 PM. Two surveys were given and collected for every participant in the study. The first survey was given and collected before participants began their mentoring interaction and the second survey was given and collected no more than

five days after their mentorship experience. A five day window was used in hopes of limiting any memory loss about the experience. Both survey instruments where distributed and collected solely by the author. Questions on the survey instrument incorporated open-ended as well as closed-ended questions. Additionally, both instruments contained a combination of questionnaire type questions, attitudinal scale questions and achievement questions.

Virtual Mentorship Experimentation Procedure

The group that used the virtual mentor started by completing the pre survey. After the survey they sat at a desktop computer that already had the website loaded with the conversational agent. The virtual mentor, Lamar, told participants that he only knew about graduate school funding options and career options. However, participants were still able to ask questions that did not fit into these categories. Unfortunately, Lamar told the participants that he did not know an answer to their questions. Below is the script that Lamar told participants upon accessing the website:

"Welcome to the Virtual Mentorship System. My name is Lamar. I am here to mentor you about your possible decision to attend graduate school. I currently know mostly about funding options for graduate school and career options if you obtain a graduate degree in computing. Please fill out the information on the left and submit to begin."

Participants were not given a time limit or maximum number of questions that they could ask the virtual mentor. After the single session, each participant immediately completed the post survey.

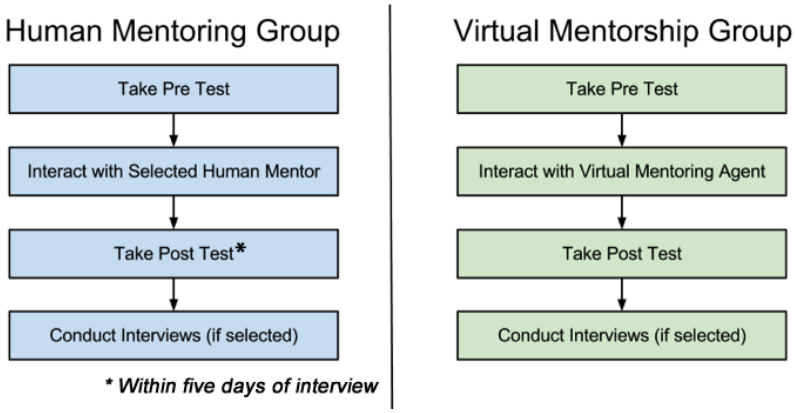

Figure 21 - Experimentation Steps

Human Mentorship Experimentation Procedure

The participants chosen for the human mentorship were provided names of three individuals on campus that they could interact with to learn more about graduate school. All three individuals were told about the experiment in advance. The individuals consisted of two faculty members in the computer science department with terminal degrees and the Director of the Office for Research Careers for the Division of Science and Mathematics. Participants were directed to meet with one of the individuals above or anyone else they feel that could provide quality advice about going to graduate school. In addition, participants were instructed to have only a single graduate school advisement session with this person until they completed their post survey and interview (if selected). There were no time constraints or question limitations between the participant and the mentor. Question topics asked by the participant were not restricted as well. Once the session was complete, the participant was to contact the principal investigator to set up the completion of the post survey.

Interview Procedure

A pool of participants from both groups (those that used the virtual mentor and those who used a human mentor) were interviewed after completing their post study. These participants were selected using a convenience sampling method. Participants were contacted in person, at random and asked if they wanted to participate in a brief interview. Before conducting the interview, each participant was given introductory remarks about the study and was asked again for an informed consent. Each interview was audio recorded and transcribed with an online voice transcription service called Fox Transcribe. In addition to asking for an overview of their experience with their mentor, the following five questions were asked:

1. What did you learn from your experience with your mentor?
2. What could have made your mentorship experience better?
3. What impactful things did you learn from your mentorship experience?
4. What changes will you make after your mentorship experience?
5. How will you describe the relationship between you and your mentor?

Additional questions were then asked depending on the responses of the participant. After the conclusion of the interview, the participant was thanked for their cooperation.

Validity and Reliability

Content-related evidence was collected to ensure validity of both survey instruments based on the content and format of the instrument. A copy of both instruments was given to the research advisor of the author to ensure the content that the instrument contained was an adequate sample of the domain of the content it is supposed to represent. Additionally, the

format of the instrument, to ensure clarity of printing, size of type, appropriateness of language and clarity of directions was examined by the research advisor of the author.

Bias and Error

With this experiment, two types of errors were possible – type I errors and type II errors. A type I (or alpha) error would occur if the information collected from the survey instrument shows that the effectiveness is different, yet it is actually the same. A type II (or beta) error would occur if the information collected from the survey instrument shows the effectiveness is the same, yet the effectiveness of the virtual mentor is actually greater than that of the human mentors.

In terms of bias, the following five types were possible: measurement instrument, experimental procedure, participants, experimental behavior and environment factors. To minimize the potential bias on the survey instrument and experimental procedure, experts in the subject matter reviewed the survey instrument and experimental procedure used by both the virtual mentorship and human mentoring groups. In order to minimize bias from the study participants and the experimenter, they were not informed of the experiment's hypothesis or given any clues as to what would constitute a desirable outcome. To minimize environmental bias, each participant interacted with the system interface in a room facing the wall wearing Sony MDR-NC 40 noise cancelling headphones.

CHAPTER FIVE

RESULTS

Quantitative Analysis

Overview

A power analysis was performed to find a reflective sample size for the study. A total of 41 junior and senior Computer Science majors were enrolled at the college at the time of the study. Results from the power analysis recommended a minimum of 36 of the 41 students participate in the study assuming a 5% margin of error, 90% confidence level and a 50% confidence distribution. Of the participants who participated, 19 used the virtual mentor and 18 interacted with a human mentor.

To test for significant differences in scores from pre-evaluation to post-evaluation, a paired samples t-test for each group (human mentorship and virtual mentorship) was performed. This parametric technique compares sample scores across two time periods (a within-group analysis). In short, this addresses the question: is human or virtual mentorship effective at all? It is important to note that this inquiry must be answered before asking which experience is more effective than the other in the mentorship of undergraduates.

Because no statistical assumptions have been violated in this sample, a similar, yet alternative test, the Wilcoxon Signed Rank test, was not implemented. Also, given that the study only had two groups (human and virtual) a repeated measures analysis of variance was not used. This analysis would have allowed for comparative analysis across three or more groups.

Graduate School Interest and Confidence

The pre and post-survey for both groups of participants included the following four attitudinal questions (Section I) to measure interest in graduate school confidence about graduate school success:

1. I am interested in pursuing a graduate degree in computing.
2. I am interested in pursuing a doctoral degree in computing.
3. I feel confident I can get admitted into a graduate program.
4. I feel confident I will do well as a graduate student.

Participants used a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) to rate the truth of each statement. Tables 14, 15, and 16 below show the statistics for both mentor groups.

Table 14 - Human Condition Graduate School Attitudinal Interest – Paired Samples T-Test (Pre-Post)

Human Condition- Paired Samples T-Test Results (Pre-Post)						
Section 1 Items	**Pre-Test (μ, SD)**	**Post-Test (μ, SD)**	**Mean difference**	**t-statistic**	**Sig. Value**	**Cohen's D**
1. I am interested in pursuing a graduate degree in computing	(4.06, 1.10)	(4.17, .985)	-0.111	-.356	.726	-
2. I am interested in pursuing a doctoral degree in computing	(3.76, 1.20)	(4.12, 1.11)	-0.353	-1.102	.287	-
3. I feel confident I can get admitted into a graduate program	(3.94, 4.39)	(4.39, .698)	-0.444	-1.917	.072	-

4. I feel confident I will do well as a graduate student	(4.22, .938)	(4.33, .686)	-0.111	-.566	.579	-
Interest & Confidence Subscale (Items 1-4)	(4.00, .773)	(4.22, .742)	-0.22	-0.99	.339	-
*Indicates a statistically significant difference from the pre-test score at the p < .05 level.						

Table 15 –Human Condition Interest & Confidence Subscale
for Graduate School Attitudinal Interest

Human Condition- Interest & Confidence Subscale Reliability		
Pre/Post Subscale	**Cronbach's Alpha**	**Number of Items**
Interest & Confidence Subscale (Items 1-4) Pre-Test	.725	4
Interest & Confidence Subscale (Items 1-4) Post-Test	.828	4

Table 16 - Virtual Mentoring Graduate School Attitudinal Interest -
Paired Samples T-Test (Pre-Post)

Virtual Condition- Paired Samples T-Test Results (Pre-Post)						
Section 1 Items	Pre-Test (μ, SD)	Post-Test (μ, SD)	Mean difference	t-statistic	Sig. Value	Cohen's D
1. I am interested in pursuing a graduate degree in computing	(3.83, 1.58)	(4.11, 1.13)	-0.28	-1.57	0.135	-
2. I am interested in pursuing a doctoral degree in computing	**(2.73, 1.91)**	**(3.27, 1.75)**	**-0.53***	**-2.48**	**.027**	**-0.29**
3. I feel confident I can get admitted into a graduate program	(3.65, 1.32)	(4.06, 0.90)	-.412**	-1.95	.069	-0.36
4. I feel confident I will do well as a graduate student	(4.18, 1.07)	(4.12, 1.05)	.060	.324	.750	-
Interest & Confidence Subscale (Items 1-4)	(3.49, 1.10)	(3.86, 0.987)	-0.38*	-2.52	.021	-0.35

Note: The Likert scale ranges from 0 (Strongly Disagree) to 5 (Strongly Agree)
*Indicates a statistically significant difference from the pre-test score at the $p < .05$ level.
** Indicates a difference that is approaching a statistically significant level

Table 17 - Virtual Condition Interest & Confidence Subscale
for Graduate School Attitudinal Interest

Virtual Condition- Interest & Confidence Subscale Reliability		
Pre/Post Subscale	Cronbach's Alpha	Number of Items
Interest & Confidence (Items 1-4) Pre-Test	.551	4
Interest & Confidence Subscale (Items 1-4) Post-Test	.750	4

Paired samples t-tests revealed mixed results across items. For instance, in the human condition (Table 14), there were no statistically significant differences in items 1-4. The lack in significant difference from every item (and ultimately the interest and confidence subscale) suggests that this group may have already had high levels of interest and confidence in pursuing graduate school, to the point where a mentorship intervention would only have marginal positive effects. This is known as a "ceiling effect." Conversely, for the same subscale, students in the virtual mentorship condition (Table 16) did have one occurrence of significant difference. Item 2 did experience significant gains in interest and confidence in pursuing graduate studies in computing. A Chronbach's Alpha of over 0.7 on three of the four subscales (Tables 15 and 17) suggests a satisfactory level of internal consistency of the survey questions.

The difference in means in the virtual group and the insignificant difference in means in the human group was an alert to check for the potential of confounding influence of pre-existing group differences. An independent samples t-test that compared student responses to the "interest and confidence" subscale revealed no statistically significant differences. Additionally a

one-way analysis of covariance also failed to show significant differences in the impact of intervention, while controlling for pre-test scores. If there were initial significant differences in "interest and confidence" between the two groups (at time 1) this would question true random experimental assignment and thus would be considered a type I error. It is inferred that participants in the virtual mentorship group showed significant gains because they so happened to have lower averages at time one (M =3.67) compared to the human mentorship group (M = 3.99). To reiterate, these surface differences have been nullified as indicators of pre-existing, confounding differences.

In the virtual condition, the difference in interest and confidence from time 1 to time 2 had a small effect with a Cohen's D of 0.35 (d = 0.35). Cohen's D is a statistical value that measures effect size and explains the magnitude of a significant difference once one is established. It presents a *standardized* difference between means. For future reference, the strength of different effect sizes tends to reflect the following scale: $d \leq 0.4$ (small effect), $0.5 \leq d < 0.8$ (medium effect), $d \geq 0.8$ (large effect). In summary, human mentorship had no effect on the variance of scores for items relevant to "interest and confidence," whereas virtual mentorship had a small effect. These findings should *not* be interpreted as one mentorship style being more effective than the other. Because virtual mentorship students in the pre-trial yielded less than sufficient scale reliability (a Cronbach's Alpha less than .70) the results should be closely examined item-by-item with marginal emphasis on comparing these particular subscales.

Attitudinal Measure of Knowledge Obtained

The pre and post survey for both groups of participants included the following 10 attitudinal questions to measure how much the participant learned about various items:

1. I am knowledgeable about funding sources for graduate school.

2. I am knowledgeable about graduate fellowships
3. I am familiar with many fellowship opportunities.
4. I understand how to apply for a fellowship.
5. I am knowledgeable about assistantships.
6. I understand how to apply for an assistantship.
7. I know the difference between a fellowship and an assistantship.
8. I am familiar with many graduate school visitation opportunities.
9. I am knowledgeable about other African Americans who have a PhD in computing.
10. I am familiar with organizations that I can join that could provide me with information about pursuing a graduate degree in computing.

Participants used a 5-point Likert scale to rate the truth of each statement. Tables 18, 19, 20 and 21 below show the statistics for both mentor groups.

Table 18 - Human Condition Graduate School Funding Attitudinal Knowledge – Paired Samples T-Test (Pre-Post)

Human Condition- Paired Samples T-Test Results (Pre-Post)						
Section 2 Items	Pre-Test (μ, SD)	Post-Test (μ, SD)	Mean difference	t-statistic	Sig. Value	Cohen's D
5. I am knowledgeable about funding sources for graduate school	(2.76, 1.09)	(3.94, .966)	-1.176*	-5.10	.000	-1.15
6. I am knowledgeable about graduate fellowships	(2.44, 1.30)	(3.94, .873)	-1.50*	-5.30	.000	-1.35
7. I am familiar with many fellowship opportunities	(2.00, 1.24)	(3.50, .985)	-1.50*	-5.53	.000	-1.34
8. I understand how to apply for a fellowship	(2.12, 1.32)	(3.53, 1.33)	-1.41*	-3.67	.002	-1.06
9. I am knowledgeable about assistantships	(1.78, 1.40)	(3.61, 1.46)	-1.83*	-4.43	.000	-1.28
10. I understand how to apply for an assistantship	(1.61, 1.20)	(3.33, 1.50)	-1.72*	-4.19	.001	-1.27
11. I know the difference between a fellowship and an assistantship	(2.06, 1.51)	(3.61, 1.42)	-1.56*	-3.62	.002	-1.06
12. I am familiar with many graduate school visitation opportunities	(2.39, 1.20)	(3.56, 0.98)	-1.17*	-3.58	.002	-1.07
13. I am knowledgeable about other African Americans who have a PhD in computing	(2.67, 1.28)	(3.78, 1.26)	-1.11*	-3.16	.006	-0.87
14. I am familiar with organizations that I join that could provide me with info about pursuing a graduate degree in computing	(2.50, 1.15)	(3.50, 1.20)	-1.00*	-2.58	.020	-0.85
Funding Knowledge Subscale (Items 5-14)	(2.21, 1.00)	(3.63, 0.942)	-1.41*	-5.44	.000	-1.46
Note: The Likert scale ranges from 0 (Strongly Disagree) to 5 (Strongly Agree) *Indicates a statistically significant difference from the pre-test score at the $p < .05$ level. ** Indicates a difference that is approaching a statistically significant level						

Table 19 - Human Condition Funding Attitudinal Knowledge Subscale Reliability

Human Condition- Funding Knowledge Subscale Reliability		
Subscale	Cronbach's Alpha	Number of Items
Funding Knowledge Subscale (Items 5-14) Pre-Test	.930	10
Funding Knowledge Subscale (Items 5-14) Post-Test	.936	10

Table 20 - Virtual Condition Graduate School Funding Attitudinal Knowledge – Paired Samples T-Test (Pre-Post)

Virtual Condition- Paired Samples T-Test Results (Pre-Post)						
Section 2 Items	**Pre-Test (μ, SD)**	**Post-Test (μ, SD)**	**Mean difference**	**t-statistic**	**Sig. Value**	**Cohen's D**
5. I am knowledgeable about funding sources for graduate school	(2.74, 1.56)	(3.68, 1.30)	-0.95*	-2.41	.027	-0.65
6. I am knowledgeable about graduate fellowships	(2.72, 1.81)	(3.61, 1.20)	-0.89*	-2.20	.042	-0.58
7. I am familiar with many fellowship opportunities	(2.11, 1.64)	(3.06, 1.55)	-0.94*	-2.52	.022	-0.60
8. I understand how to apply for a fellowship	(2.25, 1.69)	(3.31, 1.58)	-1.06*	-2.46	.027	-0.65
9. I am knowledgeable about assistantships	(2.13, 1.78)	(3.75, 1.29)	-1.63*	-3.43	.004	-0.76
10. I understand how to apply for an assistantship	(2.13, 1.69)	(3.40, 1.64)	-1.27*	-2.94	.011	-0.76
11. I know the difference between a fellowship and an assistantship	(1.71, 1.90)	(4.18, 1.60)	-2.47*	-4.73	.000	-1.41
12. I am familiar with many graduate school visitation opportunities	(2.75 1.69)	(3.25, 1.34)	-.500*	-2.24	.041	-0.33

13. I am knowledgeable about other African Americans who have a PhD in computing	(2.12, 1.80)	(3.18, 1.38)	-1.06*	-3.14	.006	-0.66
14. I am familiar with organizations that I join that could provide me with info about pursuing a graduate degree in computing	(2.76, 1.75)	(3.35, 1.41)	-.59	-1.71	.106	-
Funding Knowledge Subscale (Items 5-14)	(2.23, 1.40)	(3.40, 1.15)	-1.16*	-4.42	.000	-0.91
Note: The Likert scale ranges from 0 (Strongly Disagree) to 5 (Strongly Agree) *Indicates a statistically significant difference from the pre-test score at the $p < .05$ level. ** Indicates a difference that is approaching a statistically significant level						

Table 21 - Virtual Condition Funding Attitudinal Knowledge Subscale Reliability

Human Condition- Funding Knowledge Subscale Reliability		
Pre/Post Subscale	**Cronbach's Alpha**	**Number of Items**
Funding Knowledge (Items 5-14) Pre-Test	.948	10
Funding Knowledge Subscale (Items 5-14) Post-Test	.896	10

Changes in students' knowledge about graduate school funding (where numerous items were statistically encapsulated in the "funding knowledge" subscale [Tables 19 and 21]) seemed to be more uniformed across both human and virtual groups. Only item 14 (familiarity with organizations) for the virtual condition had a p-value of over 0.05. This suggests the virtual treatment did nothing to significantly change participants' familiarity with organizations that could provide the user more information about pursing a graduate degree in computing. Overall, the human (Table 18) and virtual (Table 20) mentorship groups had statistically

significant differences across time periods ($p < .05$) and large effect sizes where Cohen's $d = 1.46$ and 0.91 respectively. This indicates that gains in "funding knowledge" (see subscale) were largely accounted for by mentorship immersion. In essence, simply engaging with some type of mentor contributed to increases in knowledge about graduate school funding. Lastly, a Chronbach's Alpha of well over 0.7 on all of the four subscales (Tables 19 and 21) suggests a satisfactory level of internal consistency of the survey questions.

Cumulative Graduate School Familiarity Achievement Questions

The pre and post-survey for both groups of participants included the following questions that counted the number of items they learned after their mentoring experience and queried the participant's knowledge of terminology:

1. How many mentors do you have that are knowledgeable about attending graduate school in a computing discipline?
2. How many fellowship opportunities do you know about?
3. How many graduate school visitation events are you familiar with?
4. What is a fellowship?
5. What is an assistantship?
6. What are the different types of assistantships?
7. What career options does one have with a Ph.D. in computing?

Participants gave an integer value to Questions 1-3. For Question 4, participant responses were coded to one of three possible values. A "1" was given if the participant

indicated that the fellowship was money for college that they did not have to pay back. A "0.5" was given if the participant indicated money was received, but mentioned that work was involved or money had to be paid back. No points were given if the response did not mention monies given for graduate school.

Question 5 was similar to Question 4; however, the scale was different. Participants were given a "1" if the response included money for school and some mention of work. A score of "0.5" was given if money for school was mentioned, but work was not mentioned. No points were given if the response did not mention money for school.

In Question 6 above, participants listed the different types of assistantships they were familiar with. A value of "1" was assigned for each type. Possible values were graduate assistantship, teaching assistantship and research assistantship.

For Question 7, a score of "1" was assigned for any indication of each of the following careers: faculty, industry, non-profit, government and entrepreneurship. Tables 22 and 23 below show the results for each group of participants.

Table 22 - Human Condition Graduate School Achievement Knowledge – Paired Samples T-Test (Pre-Post)

Human Condition- Paired Samples T-Test Results (Pre-Post)						
Open Ended Items	Pre-Test (μ, SD)	Post-Test (μ, SD)	Mean difference	t-statistic	Sig. Value	Cohen's D
15. How many mentors do you have that are knowledgeable about attending graduate school in a computing discipline?	(1.72, 1.74)	(2.28, 1.32)	-.56	-1.71	.106	-

16. How many fellowship opportunities do you know about?	**(0.78, 1.22)**	**(1.69, 1.47)**	**-0.92***	**-2.60**	**.019**	**-0.67**
17. How many graduate school visitation events are you familiar with?	(1.17, 1.47)	(1.83, 1.58)	-0.67**	-2.00	.062	-0.43
18. What is a fellowship?	**(.353, .424)**	**(.647, .424)**	**-.294***	**-2.78**	**.013**	**-0.69**
19. What is an assistantship?	**(.118, .219)**	**(.824, .498)**	**-.706***	**-5.80**	**.000**	**-1.84**
20. What are the different types of assistantships?	**(.350, .702)**	**(1.41, 1.18)**	**-1.06***	**-4.85**	**.000**	**-1.09**
21. What career options does one have with a PhD in computing?	(1.59, 1.37)	(1.94, 1.12)	-0.35	-1.46	.163	-
Note. Items 15-17 are cumulative values. Items 18 and 19 are scaled values ranging from 0 to 1 (e.g. 0 = no clue, 0.5 = somewhat know, 1.0 = know). Items 20 and 21 are also cumulative values.						

Table 23 - Virtual Condition Graduate School Achievement Knowledge – Paired Samples T-Test (Pre-Post)

Virtual Condition- Paired Samples T-Test Results (Pre-Post)						
Open Ended Items	Pre (μ, SD)	Post (μ, SD)	Mean difference	t-statistic	Sig. Value	Cohen's D
15. How many mentors do you have that are knowledgeable about attending graduate school in a computing discipline?	(1.37, 1.54)	(1.89, 1.85)	-.53**	-1.96	.066	-0.31
16. How many fellowship opportunities do you know about?	**(1.03, 1.70)**	**(1.53, 1.68)**	**-0.50***	**-2.43**	**.026**	**-0.30**
17. How many graduate school visitation events	(2.71, 3.13)	(1.84, 1.98)	-0.87**	1.34	.197	-

are you familiar with?						
18. What is a fellowship?	**(.447, .497)**	**(.868, .327)**	**-.421***	**-3.44**	**.003**	**-1.00**
19. What is an assistantship?	**(.158, .291)**	**(.605, .427)**	**-.446***	**-5.80**	**.000**	**-1.22**
20. What are the different types of assistantships?	**(0.47, .964)**	**(1.05, 1.27)**	**-0.58***	**-2.48**	**.023**	**-0.51**
21. What career options does one have with a PhD in computing?	(1.42, 1.39)	(1.63, 1.30)	-0.21	-1.00	.331	-
Note: Items 15-17 are cumulative values. Items 18 and 19 are scaled values ranging from 0 to 1 (e.g. 0 = no clue, 0.5 = somewhat know, 1.0 = know). Items 20 and 21 are also cumulative values.						

Finally, with regard to the miscellaneous open-ended items (Tables 22 and 23), there were positive changes (ranging from medium to large effect sizes) amongst various items, presumably due to sheer mentorship engagement. In the human condition (Table 22), items 16, 18, 19 and 20 produced significant changes in the means with p-values all under 0.05. Cohen's D ranging from -0.67 to -1.84 shows an effect size ranging from medium to high. Oddly, the mean for item 21 dropped from 1.59 to 1.37. Since the p-value was 0.163 the difference doesn't have any significant relevance to the study. For the virtual condition (Table 23), the same items (16, 18, 19 and 20) as the human condition showed significant changes in the means. Again, like the human condition the effect size ranged from medium to high. Unlike the human condition, a non-significant yet positive increase in the mean occurred for item 21 for the virtual condition group.

Attitudinal Measure of Mentor Protégée Interaction

In the post survey for both groups, 30 questions were asked to evaluate various mentoring functions. These survey items originated from a 1988 paper (Noe, 1988) entitled "An Investigation of the Determinants of Successful Assigned Mentoring Relationships".

Table 24 - Independent Samples T-Test (Human vs. Virtual Post-Test Means)

Section 1 Items	**Human (μ, SD)**	**Virtual (μ, SD)**	**Mean difference**	**t-statistic**	**Sig. Value**	**Cohen's D**
1. My mentor was accessible	(4.47, .624)	(4.42, .607)	.050	.241	.811	-
2. My mentor demonstrated professional integrity	(4.56, .511)	(4.56, .984)	.000	.000	1.00	-
3. My mentor demonstrated content expertise in my area of need	(4.17, 1.24)	(4.21, 1.42)	.798**	1.94	.061	-0.03
4. My mentor was approachable	(4.67, .59)	(4.21, 1.03)	.456	1.64	.111	-
5. My mentor was supportive and encouraging	(4.56, .620)	(3.71, 1.03)	.841**	2.05	.057	1.00
6. My mentor provided constructive and useful critiques of my work	(3.94, .998)	(3.21, 1.53)	.723	1.55	.131	-
7. My mentor motivated me to improve my work product	(4.57, .514)	(2.92, 1.55)	1.65*	3.76	.001	1.42
8. My mentor was helpful in providing direction and guidance on professional issues (e.g., networking)	(4.50, .730)	(3.56, 1.65)	.944*	2.20	.038	0.74

Section 1 Items	Human (μ, SD)	Virtual (μ, SD)	Mean difference	t- statistic	Sig. Value	Cohen's D
9. My mentor answered my questions satisfactorily	(4.56, .616)	(4.00, 1.05)	.556**	1.94	.060	0.65
10. My mentor acknowledged my contributions appropriately	(4.14, .864)	(2.54, 1.51)	1.60*	3.43	.002	1.30
11. My mentor suggested appropriate resources	(4.19, 0.84)	(3.32, 1.60)	.872*	2.06	.048	0.68
12. My mentor challenged me to extend my abilities	(4.20, 1.01)	(2.60, 1.50)	1.60*	3.42	.002	1.25
13. Mentor has shared history of his/her career with you	(4.33, .840)	(2.00, 1.56)	2.33*	5.48	.000	1.86
14. Mentor has encouraged you to prepare for advancement	(4.50, .707)	(3.28, 1.41)	1.22*	3.30	.003	1.09
15. Mentor has encouraged me to try new ways of behaving in my job	(4.00, .913)	(4.21, 1.59)	1.77*	3.48	.002	-0.16
16. I try to imitate the work behavior of my mentor	(3.87, .920	(2.29, 1.73)	1.58*	3.05	.007	1.14
17. I agree with my mentor's attitudes and values regarding education	(4.06, .900)	(3.27, 1.71)	.792	1.61	.123	-
18. I respect and admire my mentor	(4.12, .860)	(3.15, 1.52)	.964**	2.05	.06	0.79
19. I will try to be like my mentor when I reach a similar position in my career	(4.00, .710)	(2.57, 1.87)	1.43*	2.70	.016	1.01

Section 1 Items	Human (μ, SD)	Virtual (μ, SD)	Mean difference	t- statistic	Sig. Value	Cohen's D
20. My mentor has demonstrated good listening skills in our conversations.	(4.44, .710)	(3.67, 1.41)	.778*	2.09	.047	0.69
21. My mentor has discussed my questions or concerns regarding feeling of competence, commitment to advancement, relationships with peers and supervisors or work/family conflict	(4.13, .806)	(1.75, 1.42)	2.34*	5.19	.000	2.06
22. My mentor has shared personal experiences as an alternative perspective to my problems	(4.17, .790)	(1.83, 1.70)	2.33*	4.46	.001	1.77
23. My mentor has encouraged me to talk openly about anxiety and fears that detract from my work	(4.23, 1.24)	(1.57, 1.74)	2.70*	4.54	.000	1.76
24. My mentor has conveyed empathy for the concerns and feelings I have discussed with him/her	(4.36, .930)	(2.07, 1.82)	2.29*	4.19	.000	1.58
25. My mentor has kept feelings and doubts I shared with him/her in strict confidence	(4.50, .650)	(2.57, 1.70)	1.93*	3.97	.001	1.50
26. My mentor has conveyed feelings of respect for me as an individual	(4.47, .624)	(3.07, 2.06)	1.40*	2.46	.027	0.92

Section 1 Items	Human (μ, SD)	Virtual (μ, SD)	Mean difference	t- statistic	Sig. Value	Cohen's D
27. Mentor reduced unnecessary risks that could threaten the possibility of becoming a graduate student in computing	(3.77, 1.01)	(2.55, 2.16)	1.22	1.72	.107	-
28. Mentor helped you finish assignments/tasks or meet deadlines that otherwise would have been difficult to complete	(4.08, .954)	(1.92, 1.89)	2.15*	3.66	.002	1.44
29. Mentor helped you meet new colleagues	(4.00, 1.11)	(1.46, 1.66)	2.54*	4.70	.000	1.80
30. Mentor gave you assignments that increased written and personal contact with graduate school faculty	(3.85, 1.14)	(1.58, 1.62)	2.26*	4.06	.000	1.62
Overall Psychosocial Scale (Average)	(4.24, 0.50)	(3.05, 1.12)	1.19*	4.19	.000	1.37

Note: The Likert scale ranges from 0 (Strongly Disagree) to 5 (Strongly Agree)

*Indicates a statistically significant difference from the pre-test score at the $p < .05$ level.

** Indicates a difference that is approaching a statistically significant level

Table 25 – Overall Mentoring Scale

Overall Psychosocial Scale	Cronbach's Alpha	Number of Items
	.975	30

Comparison Between Human and Virtual Conditions

At the second step of analyses, an independent samples t-test was conducted to examine differences between the two mentorship modes (Tables 24, 26, 28 and 30). Here is where the question of which type of mentorship is more effective than the other can be appropriately tackled. One would also be able to determine the specific capacities in which human mentorship is more effective than virtual mentorship and vice versa. Actual qualities and characteristics of mentorship were evaluated across both treatment groups. For example, such items included "My mentor challenged me to extend my abilities" and "My mentor was supportive an encouraging." This 30-item scale (Table 24) was assessed item-by-item and as an overall scale, in which the scale was titled "Psychosocial." In regard to this scale (Table 24), human mentorship was overall more effective ($p < .05$, $d = 1.37$) with a large effect size. Only items 3 (4.17/4.21) and 15 (4.00/4.21) had a higher mean for the virtual treatment. Item 2 had a mean of 4.56 for both the human and virtual treatment. This suggest users on average felt the virtual mentor demonstrated professional integrity, demonstrated content expertise in the user's area of need and encouraged the user to try new ways of behaving at their job. It also suggests that users felt that Lamar showed personal integrity on the same level as a human. Interestingly enough, item 3 is approaching a significance difference with a p-value of .061, which suggests that users **may** prefer the virtual agent to human mentoring in the areas that they need help in. With a Cronback's Alpha of .975 the items for the Psychosocial scale showed a very high level of internal consistency. Also, for those that share a difference it is important to peruse the actual survey item and discern the type of variable that was assessed. Consider an item such as, "My mentor has conveyed empathy for the concerns and feelings I have discussed with him/her." One may not expect a student with virtual mentorship to score this item as

highly, because of the affective and psychosocial implications of empathy. This notion should be applied to other items, particularly those that highlight respect and encouragement. Such constructs may have an inherently human element that a virtual mentor would fail to convey, and thus would have less bearing on students inculcated by a virtual mentor. Nonetheless, human mentorship was more effective with respect to the overall mentorship scale.

Table 26 – Graduate School Attitudinal Interest (Human vs. Virtual Post-Test Means)
Independent Samples T-Test

Section 1 Items	**Human (μ, SD)**	**Virtual (μ, SD)**	**Mean difference**	**t-statistic**	**Sig. Value**
1. I am interested in pursuing a graduate degree in computing	(4.17, .985)	(4.11, 1.13)	.056	.157	.876
2. I am interested in pursuing a doctoral degree in computing	(4.00, 1.19)	(3.06, 1.82)	.941	1.82	.077
3. I feel confident I can get admitted into a graduate program	(4.39, .70)	(3.95, .97)	.442	1.58	.123
4. I feel confident I will do well as a graduate student	(4.33, .69)	(4.11, 1.05)	.228	.778	.442
Interest & Confidence Subscale (Items 1-4)	(4.22,0.74)	(3.86, .987)	.358	1.24	.22
Note: The Likert scale ranges from 0 (Strongly Disagree) to 5 (Strongly Agree) *Indicates a statistically significant difference from the pre-test score at the $p < .05$ level. ** Indicates a difference that is approaching a statistically significant level					

Table 27 - Graduate School Attitudinal Interest (Human vs. Virtual Post-Test Means)
Subscale Reliability

Interest & Confidence Subscale (Items 1-4)	**Cronbach's Alpha**	**Number of Items**
	.785	4

Table 28 - Graduate School Funding Attitudinal Knowledge
(Human vs. Virtual Post-Test Means) Independent Samples T-Test

Section 2 Items **Items**	**Human (μ, SD)**	**Virtual (μ, SD)**	**Mean difference**	**t-statistic**	**Sig. Value**
5. I am knowledgeable about funding sources for graduate school	(3.94, .966)	(3.68, 1.29)	.257	.669	.508
6. I am knowledgeable about graduate fellowships	(3.94, .873)	(3.61, 1.20)	.333	.956	.346
7. I am familiar with many fellowship opportunities	(3.50, .99)	(3.06, 1.55)	.444	1.03	.312
8. I understand how to apply for a fellowship	(3.53, 1.33)	(3.31, 1.58)	.217	.428	.672
9. I am knowledgeable about assistantships	(3.61, 1.46)	(3.76, 1.25)	-0.154	-0.333	.741
10. I understand how to apply for an assistantship	(3.33, 1.50)	(3.40, 1.64)	-0.067	-0.122	.904
11. I know the difference between a fellowship and an assistantship	(3.61, 1.42)	(4.18, 1.55)	-0.57	-1.13	.268
12. I am familiar with many graduate school visitation opportunities	(3.56, .984)	(3.25, 1.34)	.306	.763	.451
13. I am knowledgeable about other African Americans who have a PhD in computing	(3.78, 1.26)	(3.18, 1.38)	.601	1.35	.187
14. I am familiar with organizations that I join that could provide me with info about pursuing a graduate degree in computing	(3.50, 1.20)	(3.35, 1.41)	.147	0.333	.741
Funding Knowledge Subscale (Items 5-14)	(3.63, .942)	(3.40, 1.15)	0.23	0.66	.512
Note: The Likert scale ranges from 0 (Strongly Disagree) to 5 (Strongly Agree) *Indicates a statistically significant difference from the pre-test score at the $p < .05$ level. ** Indicates a difference that is approaching a statistically significant level					

Table 29- Graduate School Funding Attitudinal Knowledge
(Human vs. Virtual Post-Test Means) Subscale Reliability

Funding Knowledge Subscale (Items 5-14)	**Cronbach's Alpha**	**Number of Items**
	.913	10

Table 30 - Human Condition Graduate School Achievement Knowledge
Independent Samples T-Test

Open Ended Items	**Human (μ, SD)**	**Virtual (μ, SD)**	**Mean difference**	**t-statistic**	**Sig. Value**
15. How many mentors do you have that are knowledgeable about attending graduate school in a computing discipline?	(2.28, 1.32)	(1.89, 1.85)	.383	.721	.476
16. How many fellowship opportunities do you know about?	(1.69, 1.47)	(1.53, 1.68)	.168	.324	.748
17. How many graduate school visitation events are you familiar with?	(1.83, 1.58)	(1.84, 1.98)	-.009	-.015	.988
18. What is a fellowship?	(0.647, 0.424)	(0.868, 0.327)	-.221	-1.74	.092
19. What is an assistantship?	(.824, .498)	(.605, .428)	.218	1.42	.166
20. What are the different types of assistantships?	(1.41, 1.18)	(1.05, 1.27)	.359	.878	.386
21. What career options does one have with a PhD in computing?	(1.94, 1.20)	(1.63, 1.30)	.310	.740	.464
Note: Items 15-17 are cumulative values. Items 18 and 19 are scaled values ranging from 0 to 1 (e.g. 0 = no clue, 0.5 = somewhat know, 1.0 = know). Items 20 and 21 are also cumulative values.					

Lastly, by looking at Tables 28, 30 and 32 there were no significant differences between the virtual mentoring experience and the human mentoring experience. In all but five items (items 9, 10 and 11 in Table 28 and items 17 and 18 in Table 32) the average mean for the human mentoring was slightly higher than the virtual mentoring. When asking about the participants' knowledge of assistantships (item 9), understanding of how to apply for an assistantship (item 10), knowledge of the differences between an assistantship and fellowship (item 11), knowledge of graduate school visitation events (item 17) and knowledge of what a fellowship was (item 18) the virtual treatment slightly outperformed the human treatment. Items 9, 10, 11 and 18 were questions that the virtual mentor had specific answers for. Again, these differences in the mean were not significant, thus not a single item had or even approached a significant difference in the means. A Chronbach's Alpha of 0.713 in Table 27 and 0.913 in Table 29 suggest an acceptable and strong internal consistency of the Funding Knowledge and Interest and Confidence subscales, respectively.

Results Conclusion

Considering there is pre and post-test data for each group in the experimental design, an analysis of covariance (which controls for pre-existing differences at the pre-test onset) is deemed appropriate for comparing experimental and control groups (Chen, Lien, Annetta & Lu, 2010). An analysis of covariance was not run because another independent samples t-test (which compared pre-test scores on the graduate funding scale) detected no significant pre-existing differences.

Conversation Analysis from the Virtual Mentor

The conversational agent mentor was asked a total of 450 questions throughout the entire study. Students asked an average of 23.7 questions. VM1 provided the user with an answer 71% of the time. There were 130 instances where a question was asked or statement provided and the conversational agent did not understand and provided the user with a default response. Of those 130 instances, 54 were repeat statements, 17 were incomplete questions, and 17 questions did not fit the categories in which the agent was trained. All but 6 of the repeat spellings came from misspellings of a keyword by the user. Another 17 questions were completely irrelevant to the study. Six of the questions were follow-up questions to a response given by the agent. Blank input was provided six times as well. No question was asked to the agent (on the subject of career options and funding opportunities) that resulted in a lack of response back to the user. These results means that 1) users asked questions outside of the scope of the conversational agent even though Lamar informed them of the limitations of his knowledge, 2) VM1 had no spelling verification which created more misfires than necessary, 3) questions asked outside of the scope of the system provided insight on future areas that should be addressed and 4) M1 performed exactly as designed under the conditions of the study.

Qualitative Study

Qualitative data was collected in part to enhance the validity of the data recorded from the survey instruments, commonly known as triangulation. This data was collected in the study using semi-structured, retrospective interviews. Individual interviews were used instead of focus groups to eliminate any bias amongst participants. A total of 17 participants participated in the interviews. The total time spent conducting the interviews was 100 minutes and 26 seconds. Nine participants that interacted with a human mentor and eight participants that interacted

with the virtual mentor were selected. The interviewees who interacted with the virtual mentor spent an average of 5:07 in their interviews with a minimum of 3:13 and a maximum of 6:07. In addition, the interviewees who interacted with the human mentors spent an average of 6:36 in their interviews with a minimum of 3:17 and a maximum of 9:27. Every participant in the study was asked verbaly to be interviewed and all of those who agreed to be interviewed were interviewed.

Questions asked fell into the categories of experience questions, opinion questions or feelings questions. Interviews with the participants that used either a human mentor or the virtual mentor started with the following initial questions:

- How was your interaction with your selected mentor?
- What did you learn from your experience with your mentor?
- What could have made your mentoring experience better?
- What impactful things did you learn from your mentoring experience?
- What changes will you make as a result of your mentorship experience?

Additionally, participants who had a human mentor were asked to describe the relationship they had with their mentor. Since all participants, with the exception of two, selected mentors outside of the department, the following questions were added to the interviews of these participants:

- What is the background of the mentors selected?
- What is the relationship between the participants and their mentors?
- Why the participants chose mentors from outside of the school and department?

- Overall, how accessible where members of the department?
- What is the relationship between the participant and members of the department overall?
- What questions where asked to the mentor?
- What future interactions do you see between you and your mentor?

Additional questions were added based on the direction of the conversation between the author and the participant. Next is a summary of each interview.

Enumerative Summary of Interview Participants using Human Mentors

A total of nine students who received the human mentoring treatment participated in an interview within seven days of completing the study. Of the nine students, two were unsuccessful in speaking with their selected mentors. One of the two students already had a mentor and could not get a meeting with them due to the student's work schedule. However, both students did have individuals they wanted to contact.

Of those students who did make contact with a mentor, a wide range of topics were discussed. All the topics fit under the categories of either career advice, funding opportunities and application assistance. Of the seven students who met with mentors, two of the students were in funded, undergraduate research programs. Both of those students asked all the questions concerning application assistance but did not ask about career options or funding opportunities. A listing of mentioned topics is found below in Table 31.

Table 31 - Mentioned Topics

Category	Subcategory	Mentions
Career Advice	Career Opportunities	2

Career Advice	Job Security	1
Funding Opportunities	Undergraduate Funding Opportunities	1
Funding Opportunities	Graduate Funding Opportunities	3
Application Assistance	Finding a Research Area	2
Application Assistance	Application Process	1
Application Assistance	Picking an Advisor	1
Application Assistance	GRE Preparation	1
Application Assistance	Recommendation Letters	1
Application Assistance	Planning Ahead	1
Application Assistance	Success in Coursework	1

The source of mentors selected by the participants varied as well. Two of the mentors were family members, two were former classmates at their undergraduate institution (now in graduate school), one was referred by another mentor, one was a co-worker of the participant, two were faculty in the participants' department and two were staff members at the participants' institution. In total, five of the mentors had ties to the participants' undergraduate institution and two did not. In terms of computing experience, four of the mentors had work

experience in computing and five did not. Two of the students used a previous mentor as a way to find more information from another mentor.

Several items were consistent in the interviews. All the participants stated that their faculty, overall, were accessible if they needed them (even though one faculty member was mentioned for being inaccessible). Every mentorship experience was done in person. All participants stated they had a positive mentorship experience. Both students in the undergraduate research programs stated the learning in their mentorship meeting was limited. One of the nine selected mentors was a female. Lastly, not a single participant was told about a specific funding opportunity.

As indicated in the list below, several of the interviews had intriguing statements.

- Participant A had scheduling conflicts with his selected mentor; however, he stated that his work schedule, not the mentor's, was the problem.
- Participant B said he had no mentor overall.
- Participant C stated he met his grad school mentor from his normal mentor who was the faculty advisor for his fraternity.
- Participant D had a mentor who worked on campus, who was also his uncle. He also stated he was somewhat uncomfortable talking to faculty about things that would expose his "faults".
- Participant E selected his mentor based on the network of people she knew, rather than what she knew. Also, he received information about undergraduate funding opportunities rather than graduate opportunities.

- Participant F chose his long-time and graduate school mentor based on his professional demeanor as an undergraduate student.
- Participant G is a member of the NROTC and chose his mentor based on his experience with opportunities with the US Navy.
- Participant H is a member of an undergraduate research program and although he has complete trust that his mentor had his best interest in mind, the information given to him may not be completely accurate.
- Participant I, another student in an undergraduate research program, stated his mentor (a member of the faculty) gave him encouragement in addition to advice. Unfortunately, this participant stated they did not learn anything novel from the interaction.

Network Diagram of Human-to-Human Mentoring Experience

Figure 22 below is a network diagram for the participants assigned to get mentoring experience from a human mentor. The diagram shows that protégé's have many differences even though they all are enrolled in the same major at the same school. Also, there are many attributes to the human mentors that were selected in the study. Lastly, there are several relationships between the protégé and the mentor that they selected.

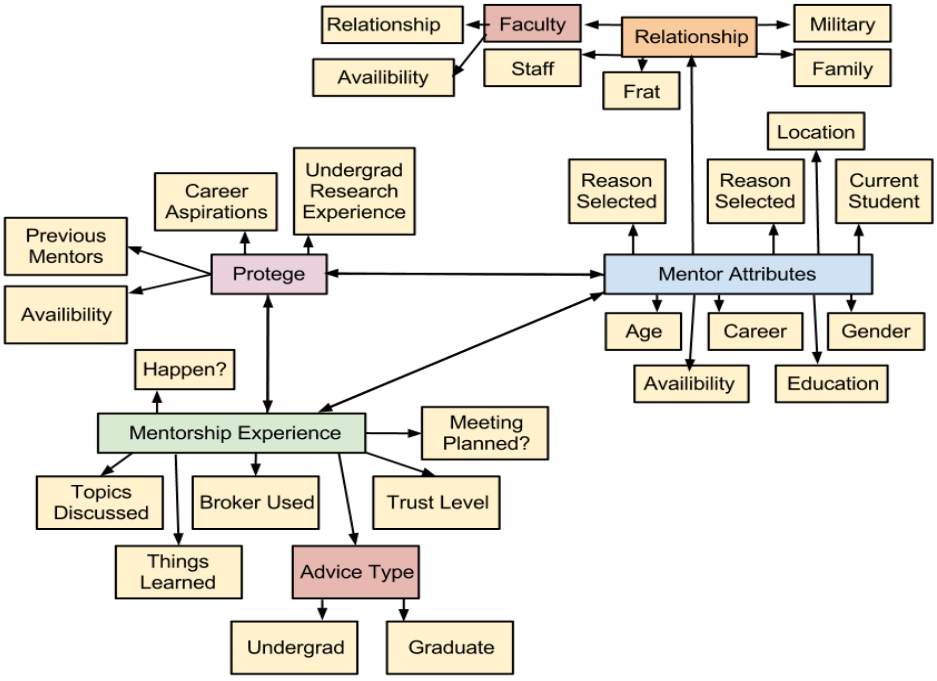

Figure 22 - Participant Network Diagram

Interview Summaries for Participants using the Virtual Mentor

A total of eight participants who interacted with the virtual mentor were interviewed. Participants mentioned how the agent answered basic questions, but struggled to answer questions dealing with specific funding options, school rankings, specific graduate programs and personal experiences. There were eight positive and three negative references to the accuracy of the virtual mentor in answering questions that were asked. There were six positive references to trust they had with the content given by the agent and four of the participants indicated they would want to use it again. One of the participants preferred the virtual mentor to a human mentor, another participant preferred a human mentor to the virtual mentor and four

participants mentioned they would prefer the virtual mentor depending on the situation or question asked.

Table 32 below lists positive and negative comments about the virtual mentor (items reference multiple times in parentheses).

Table 32 - Positive and Negative Comments about the Virtual Mentor

Positive Comments	Negative Comments
● Increased interest in pursuing graduate school ● Likes availability ● Likes concept of virtual mentor ● Informative ● Gives terminology ● Gives in-depth answers ● Broad, not school specific (2) ● More honest than grad school representative ● Good when questions were forgotten in person (2) ● Convenient ● Can offer info regardless of prerequisite knowledge of graduate school ● Corrected false info ● Didn't show bias ● Answers were clear	● Didn't answer in-depth questions ● Felt knowledge was limited ● Wasn't a phone app ● Didn't provide real life examples ● Confusing to use ● Didn't know what expertise the mentor had ● Wanted to see related questions

Qualitative Survey Instrument Results

Open-ended attitudinal questions were included in both the pre and post survey instruments. The pre survey asked participants what questions they had about pursuing a graduate degree in a computing field. The post survey included the following three questions:

1. What additional things would you like to know about graduate school?
2. How did you benefit the most from your mentoring session?
3. How could your mentoring session be better?

When asked about the items they wanted to know about the three most popular responses included those about funding, potential research areas and quality of particular graduate programs. Table 33 below shows a listing of the topic references made by the participants in the open ended attitudinal questions on both the pre and post surveys. Outside of funding questions, school rankings and research areas were popular topics that Lamar was not able to answer.

Table 33 - Category References from Pre and Post Open-Ended Attitudinal Questions

Topics of Interest	Pre Virtual Mentor	Post Virtual Mentor	Pre Human Mentor	Post Human Mentor
Application Process	1	2	1	2
Benefits of Grad Degree	1	1	0	0
Career Info	2	1	2	0
Difference in Degrees	1	1	1	0
Funding	7	6	3	2
General Info	3	1	0	0
GRE	0	3	0	1
Personal Life	0	1	0	2
Qualifications	0	1	0	0
Research Areas	3	3	2	0
School Rankings	4	5	3	0
Nothing	9	7	3	1

When asked how the participant benefited the most from the mentoring experience, most mentioned more information about funding or they provided a generic response such as “motivation”, “knowledge” or “much more opportunities than I believed”. Table 34 below

provides a listing of all the responses to this question by category. Noticeable is the large number of comments indicating how the participants benefited from learning about funding options (15) and the small number of remarks about career opportunities (1).

Table 34 - Participant Benefits

Benefits	Virtual Mentor	Human Mentor
General Comments	8	3
GRE	1	0
Funding	15	0
Career	1	2
Application Info	0	1
Did Not Benefit	3	0
Other	0	1

In the post survey participants were asked about ways to improve their mentoring sessions. For the participants using the virtual mentor, answers given by the participants were suggested improvements to the virtual agent, while answers given by those participants utilizing the human mentor were more abstract. Overwhelmingly, most individuals who used the virtual mentor suggested the mentor should have more responses to different questions or that the virtual mentor was sufficient and did not need improvements. A table with categories of improvements along with the frequency of responses is found in Table 35 below.

Table 35 - Suggested Additions to Virtual Mentor

Suggested Additions (Virtual Mentor)	Frequency
More Answers	9
Fellowship List	2
Link to Additional Info	1
More Specific Answers	3
Technical Improvements	4
Positive Comment	5
None	3
Specific Schools	1
Specific Companies	1
More Accurate	3
Fellowship listing	2
Nothing	1
More interactive	1
More knowledge	1
Wish asked questions earlier on	1

CHAPTER SIX

CONCLUSIONS AND FUTURE WORK

Overview

The study set out to explore the use of embodied conversational agents as virtual mentors compared to current human-to-human mentoring. The population of the study was African American computer science majors at a historically Black college. The agent's purpose was to mentor the students on the pursuit of a graduate degree in computing. Success of this study could call for the need of additional studies that are longer in term, at different institutions on students with different majors, genders and ethnicities. The study sought to answer three primary questions:

1. How effective is organic, short-term, human-to-human mentoring in this environment?
2. How effective is short-term mentoring using an embodied conversational agent in this environment?
3. How effective was the virtual mentoring interaction compared to the human-to-human interaction in this environment?

Human-to-Human Mentoring

Quantitative Analysis

The quantitative data gathered in the survey showed no significant difference between the virtual and human treatment in increasing student interest in attending graduate school, becoming admitted into a graduate program or doing well in a graduate program. When testing the participants' **attitudinal** knowledge of graduate school infrastructure, terminology and

opportunities such as fellowships and assistantships, there was a significant difference in each of the ten questions. This was deducted due to mean differences for those ten questions ranging from -1.00 to -1.83. When asked to **demonstrate** knowledge they achieved during their experience, the results were consistent. There was a significant difference between their knowledge of the definitions for fellowship and assistantship and what various assistantship types existed after the human mentoring intervention. Overall, the qualitative data suggested human mentoring provided a significant difference in the knowledge the participants had about graduate school.

One observation about the data collected for the interest and confidence subscale (items 1-4) was high overall interest in attending graduate school and doctoral program. In an effort to study the effects of both the human and virtual treatment on those who were not already convinced that they wanted to pursue a doctoral degree in computing, those participants were removed from the sample. These participants indicated that they "strongly agree" that they were interested in pursuing a doctoral degree in computing. Strongly Agree was determined as the cutoff point. Since only one graduate from this department successfully entered a doctoral program in computing in the last two years, it would be less than likely that an upperclassman who had reservations in their interest about graduate school would actually apply, get accepted and decide to attend. For the human treatment group, a total of six participants rated "Strongly Agree" to having an interest in a doctoral program in computing and were omitted from the additional analysis. Of those six participants 4 participate in a sponsored research program at the institution and one participant had already applied to at least one doctoral program for the Fall 2013. This left 11 participants from the human treatment group.

When asked about their knowledge of funding (Funding Knowledge subscale) the mean of these increased from 2.29 to 3.50 on a scale of 1 through 5 (Table 36).

Table 36 - Human Mentoring Subgroup: Funding Knowledge Subscale I

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	FundingKnowledge	2.2909	11	1.16572	.35148
	FundingKnowledge_Post	3.5000	11	.94021	.28348

a. Human vs. Virtual = Human

A significant difference in the means could not be established due to the revised number of participants (N = 11), yet the mean difference of 1.2 suggests an effective treatment consistent with the entire group of participants who received the human mentoring treatment (Tables 37 and 38).

Table 37 - Human Mentoring Subgroup: Funding Knowledge Subscale II

Paired Samples Correlations[a]

		N	Correlation	Sig.
Pair 1	FundingKnowledge & FundingKnowledge_Post	11	.326	.328

a. Human vs. Virtual = Human

Table 38 - Human Mentoring Subgroup: Funding Knowledge Subscale III

Paired Samples Test[a]

		Paired Differences				
					95% Confidence Interval of the Difference	
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper
Pair 1	FundingKnowledge – FundingKnowledge_Post	-1.20909	1.23649	.37282	-2.03978	-.37841

When asked about their knowledge of the definition of a fellowship the difference in means increased by 0.30 (Table 41) from a 0.35 to a 0.65 on a scale from 0 to 1 (Table 39). Again a significant difference (Table 40) was unable to be accomplished due to the small number of participants (n = 10). It should be noted that one participant in this subgroup did not answer this question.

Table 39 - Human Mentoring Subgroup: Fellowship Definition I

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	What is a fellowship?	.350	10	.4743	.1500
	What is a fellowship?	.650	10	.4116	.1302

a. Human vs. Virtual = Human

Table 40 - Human Mentoring Subgroup: Fellowship Definition II

Paired Samples Correlations[a]

		N	Correlation	Sig.
Pair 1	What is a fellowship? & What is a fellowship?	10	.413	.236

a. Human vs. Virtual = Human

Table 41 - Human Mentoring Subgroup: Fellowship Definition III

Paired Samples Test[a]

		Paired Differences				
					95% Confidence Interval of the Difference	
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper
Pair 1	What is a fellowship? – What is a fellowship?	-.3000	.4830	.1528	-.6456	.0456

Regarding the question asking about the definition of an assistantship, the mean difference was massive with 0.15 in the pre survey and a 0.85 (Table 42) in the post survey resulting in a mean difference of 0.70 (Table 43). As with the question on fellowship knowledge,

one participant from the subgroup failed to answer the question on both the pre and post surveys.

Table 42 - Human Mentoring Subgroup: Assistantship Definition I

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	What is an assistantship?	.150	10	.2415	.0764
	What is an assistantship?	.850	10	.5798	.1833

a. Human vs. Virtual = Human

Table 43 - Human Mentoring Subgroup: Assistantship Definition II

Paired Samples Test[a]

		Paired Differences				
					95% Confidence Interval of the Difference	
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper
Pair 1	What is an assistantship? – What is an assistantship?	-.7000	.5869	.1856	-1.1198	-.2802

Lastly, when asked about the participants' knowledge of assistantship types, the mean increased from 0.50 assistantship types known on the pre survey to 1.30 types known on the post survey (Table 44). This represents an increase in the mean of 0.80 (Table 45) with a p-value of 0.007 representing a significant change.

Table 44 - Human Mentoring Subgroup: Assistantship Types I

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	What are the different types of assistantships?	.50	10	.850	.269
	What are the different types of assistantships?	1.30	10	1.252	.396

a. Human vs. Virtual = Human

Table 45 - Human Mentoring Subgroup: Assistantship Types II

Paired Samples Test[a]

		Paired Differences				
					95% Confidence Interval of the Difference	
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper
Pair 1	What are the different types of assistantships? – What are the different types of assistantships?	-.800	.789	.249	-1.364	-.236

Table 46 - Human Mentoring Subgroup: Assistantship Types III

Paired Samples Correlations[a]

		N	Correlation	Sig.
Pair 1	What are the different types of assistantships? & What are the different types of assistantships?	10	.783	.007

a. Human vs. Virtual = Human

Qualitative Analysis on Human-to-Human Mentoring

More interesting is the qualitative analysis gathered by the interviews. All of the interviewees recorded a positive mentoring experience. Seven of the nine selected mentors were African American and only two out of nine of the selected mentors were women. The following conclusions were deducted from using enumeration and network diagrams on the interview transcription data:

1. **Students' schedules can become a barrier to gaining human mentoring in addition to the schedule of the prospective mentor.** Students may be overwhelmed with classes, coursework, on and off-campus jobs, involvement in student organizations and other responsibilities.

2. **Knowledge sought by students may differ when students are involved in sponsored graduate research programs.** The two students involved in

undergraduate research programs asked questions that were less general than those participants that do not participate in a sponsored graduate school preparation program.

3. **Student grade point average and/or participation in an undergraduate research program could affect the choice of mentors.** The two students that chose a computing faculty member as their mentor were involved in an undergraduate research program. Additionally, those two students had the highest grade point average of all participants that sought human mentoring.

4. **Mentors come from a variety of sources.** Of the nine participants interviewed, their selected mentors included an officer in the school NROTC program, two current graduate students that attended the participants' university while the participant was enrolled, a real estate agent and an admissions director in addition to current computing faculty in the participants' department.

5. **Selected mentors typically have ties to the protégé or the protégé's school.** In the study, most of the mentors' knew the protégé from interactions on or off campus. Participants indicated they had a level of trust (their opinions were genuine as well as accurate) with these individuals and these individuals could give them "custom" information and guidance.

6. **Brokers can be used to find human mentorship.** Two of the interviewees went to a trusted person whom they already had a relationship with, but was

unknowledgeable about graduate studies in computing to find a mentor with the traits they desired.

7. **Student aspirations affected their choice of mentor.** This was consistent in almost every case. Many of the student's lack of interest in becoming a faculty member was given as the primary reason students sought mentoring from others outside of their department. These students instead sought mentors whose professions were more closely aligned with their career goals or those that they had more intimate, long-term relationships with.

8. **Having non-faculty mentors available in dedicated time periods increases the likelihood for mentoring to occur.** After students in the human mentoring group completed their pre-surveys, they were given the names of faculty and staff members on their campus who they could seek mentoring from. Unknowingly, when asked for an update of their status after two weeks, seven of the students had completed their interviews with mentors off-campus yet only two students chose to connect with faculty or staff for their mentoring. Many participants had trouble connecting with their selected mentors even though they had access to faculty and staff members. In order to finish the data collection another mentor was made available for the students to interact with. This mentor was an African American male PhD student in Human Centered Computing and a graduate of a historically Black university. Once available, the remaining students conducted their mentoring session with him over a two-day

period. It is hypothesized that his availability attributed to the throughput of interactions in that time period.

Mentoring from the Virtual Agent

Before analyzing the effects of the agent, it had to be confirmed that the knowledge base of the agent was sufficient to give an accurate critique of the system. Of the over 400 questions asked to the virtual agent, none were asked that fit into the two subject areas that did not receive a response. The quality of the responses provided was an obvious issue; however, feedback from the interviews and survey instruments justified the overall quality of the responses.

Quantitative Analysis on the Virtual Agent

The quantitative data collected with the pre and post-surveys show no significant difference in the responses for increasing student interest in graduate school, becoming admitted in a graduate program and doing well in a graduate program. Oddly, there was a significant difference (0.027) when asked about the interest in pursuing a doctoral degree in computing; however, due to an unusually low mean in the pre-test compared to the same question in the other group, this difference was not conclusive. Overall, based on the numbers the virtual agent did not change student's interest since they were already interested.

When testing the students' attitudinal knowledge of graduate school infrastructure, terminology and opportunities, similar to the human mentoring, there was a significant difference in almost all of the items (nine out of a possible ten). When asked to demonstrate knowledge they learned from interacting with the mentor, the results were very similar to those of the human mentoring treatment. There was a significant difference between their knowledge

of the definitions for fellowship and assistantship and what various assistantship types existed. Overall, like the human mentoring, the qualitative data suggested a significant difference in the knowledge the participants knew about graduate school.

Similar to the human mentoring treatment, a question could be asked of the impact of the virtual mentoring treatment for those students who are not already convinced that they would want to pursue a doctoral degree in computing. To answer this question the data for participants who indicated that they "strongly agreed" to have an interest in a doctoral program were removed from the subgroup. Unfortunately, three of the participants of the virtual treatment group did not answer this question item on either the pre or post survey so their data was removed as well. Of the remaining 12 participants in the subgroup the mean increased from 1.98 to 3.41 when asked the questions on the Funding Knowledge subscale (Table 47). This increase of 1.43 (Table 48) is much larger than the 0.38 difference recorded from the entire virtual mentoring group.

Table 47 – Virtual Mentoring Subgroup: Funding Knowledge Subscale I

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	FundingKnowledge	1.9824	12	1.23798	.35738
	FundingKnowledge_Post	3.4123	12	.90467	.26116

a. Human vs. Virtual = Virtual

Table 48 - Virtual Mentoring Subgroup: Funding Knowledge Subscale II

Paired Samples Test[a]

		Paired Differences				
					95% Confidence Interval of the Difference	
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper
Pair 1	FundingKnowledge – FundingKnowledge_Post	-1.42989	1.21488	.35071	-2.20179	-.65800

When asked about the participants knowledge of a fellowship (item 18) the mean increased by 0.50 from 0.375 to 0.875 (Table 49) on a scale from 0.0 to 1.0. For the entire virtual mentoring group the difference was similar, but less at 0.421.

Table 49 - Virtual Mentoring Subgroup: Fellowship Definition I

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	What is a fellowship?	.375	12	.4827	.1393
	What is a fellowship?	.875	12	.3108	.0897

a. Human vs. Virtual = Virtual

Table 50 - Virtual Mentoring Subgroup: Fellowship Definition II

Paired Samples Correlations[a]

		N	Correlation	Sig.
Pair 1	What is a fellowship? & What is a fellowship?	12	.038	.907

a. Human vs. Virtual = Virtual

When asked about knowledge of what an assistantship is, there was a mean difference of 0.42 (Table 52) from 0.167 to 0.583 (Table 51) on a scale from 0.0 to 1.0. Similar to the comparison made in the human mentoring group and subgroup, the impact of the virtual mentoring treatment was consistent for the virtual mentoring subgroup as it was for the entire virtual mentoring group.

Table 51 – Virtual Mentoring Subgroup: Assistantship Definition I

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	What is an assistantship?	.167	12	.3257	.0940
	What is an assistantship?	.583	12	.4174	.1205

a. Human vs. Virtual = Virtual

Table 52 - Virtual Mentoring Subgroup: Assistantship Definition II

Paired Samples Test[a]

		Paired Differences				
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference	
					Lower	Upper
Pair 1	What is an assistantship? – What is an assistantship?	-.4167	.4174	.1205	-.6819	-.1514

Qualitative Analysis on Virtual Mentoring

Consistent with the human mentoring analysis, the qualitative data supported the quantitative data yet gave more insight into the participants' experience with the virtual mentor. Eight participants who used the virtual mentor were interviewed. There were some suggestions and feedback given about the agent, but no negative reactions to the agent overall. Below is a list of conclusions based on the comments made during the interviews:

1. **Students liked the concept of using a virtual mentor in addition to having human mentors.** Only one participant mentioned having a negative experience with the virtual mentor; however, that was due to the detail of the responses provided rather than the concept of the virtual mentor itself.

2. **Virtual mentoring can be beneficial when questions are not asked with human mentoring.** Two of the participants stated that they sometimes forget to ask

people questions when they meet with them in person, and the virtual mentor can assist in answering those types of questions.

3. **Virtual mentors can introduce basic concepts and terminology.** Many of the participants stated how they learned about funding opportunities and the terminology to go with it.

4. **Virtual mentoring may give detailed responses to some and broad responses to others.** Participants stated the level of in-depth answers was strength of the system while another participant stated the agent should have more in-depth answers.

5. **Virtual mentoring can appear to be non-biased compared to human mentoring.** Two of the participants mentioned that they felt no pressure from the virtual agent to go a particular graduate school or graduate school in general. It simply gave them unbiased answers to questions they had. The two students indicated exposure to graduate school and industry recruiters who come to their institution.

6. **Virtual mentoring can assist students at different usage levels.** The virtual mentor had positive feedback from students that were in sponsored undergraduate research programs as well as those who weren't exposed to prospects of graduate school at all.

Human Mentoring Compared to Mentoring by the Virtual Agent

Overall, the majority of the survey elements showed no significant difference when using the virtual mentor compared to the human mentor, excluding the survey items that evaluated various psychosocial mentoring functions. In those 18 questions, there was a significant difference after the mentoring experience for 15 of the 18 questions. For human mentoring participants, the mean values for the post survey responses ranged from a 3.85 to a 4.47, suggesting that the participants felt the human mentor had a positive effect in terms of mentoring functions. The absence of a significant difference in the other questions suggests the career functions can be obtained using an embodied conversational agent.

Future Work

The findings of this research provide multiple directions to expand. The following goals contain the primary targets for future studies into mentorship using embodied conversational agents:

1. The content stored in the virtual mentor should be expanded to include other areas of expertise other than career options and funding opportunities.
2. Information about particular graduate schools such as diversity, ranking, size, location, minimum GPA, minimum GRE scores, and application deadlines should be added to the agent.
3. A database of graduate school fellowships, description of current research areas and graduate school rankings can be merged with the virtual agent.
4. Custom responses from the agent should be delivered to the user based on user preferences and attributes such as GPA, REU experience, major,

5. Functionality of the agent should be expanded to enhance the delivery of psychosocial mentoring functions to users.
6. The study should be expanded to include other colleges and universities.
7. The long-term effects of using the agent should be measured in addition to the short-term effects.
8. The accuracy of VM1 should continue to be measure as the corpus of mentorship content and the number of interactions with the system increases.
9. More data should be collected on the current career interest of the participants to see how to adapt the system to provide more beneficial career advice.

Funding from various funding agencies including the National Science Foundation and the United Negro College Fund will be proposed to fund this work.

Limitations

There were several limitations to this research that should be noted. First, the knowledge utilized by the virtual mentor only consisted of two areas, career options and funding opportunities. Second, the study was conducted at one school. Third, that school was an all-male institution and the study didn't show how effective virtual mentorship would be with African American females. Lastly, the school chosen for the study only offers bachelor's degrees and no graduate degrees.

Final Thoughts

This research was successful in justifying the need for more research being conducted on the option of offering virtual mentoring in addition to human mentorship for African American computer science students. In addition, the impact of human mentorship was

confirmed as well. Findings from the study suggest the expansion of this research to include other ethnicities as well as other STEM disciplines. It is the opinion of the author that this manuscript adds virtual mentorship as an effective tool when used independent of or in collaboration with human mentoring in the effort to broaden participation in STEM fields. Thus, the mentoring constellation of the user will include virtual mentors in addition to human mentors.

APPENDICES

Appendix A

Graduate Study Interest Survey Documentation

GRADUATE STUDY INTEREST SURVEY

Major: _____ | Classification: FR SO JR SR | Current GPA: _____

View the following topics below and indicate **how interested you are** in learning more about the following graduate school related topics. Thank you for taking this survey.

Not Interested = 1
Somewhat Interested = 2
Moderately Interested = 3
Interested = 4
Very Interested = 5

How do I obtaining funding to attend graduate school?	1	2	3	4	5
How should I select a graduate school?	1	2	3	4	5
How do I select a graduate research advisor?	1	2	3	4	5
How do I apply to a graduate school?	1	2	3	4	5
Why should I attend graduate school?	1	2	3	4	5
What are the duties as a graduate student?	1	2	3	4	5
How do I obtain letters of recommendations?	1	2	3	4	5
How do I complete an admission essays?	1	2	3	4	5
What are the differences between Masters and PhD?	1	2	3	4	5
What are the career options with a PhD?	1	2	3	4	5
What are the salary ranges for PhD graduates?	1	2	3	4	5
What are graduate courses like?	1	2	3	4	5
What can I do to start preparing for graduate school now?	1	2	3	4	5
Please add up to three additional areas that you would like to know more about that is not listed above.					
1.	1	2	3	4	5
2.	1	2	3	4	5
3.	1	2	3	4	5

Information about Being in a Morehouse College Research Study

Graduate School Area of Interest Study

Description of the Study and Your Part in It
Instructor Kinnis Gosha is inviting you to take part in a voluntary research study. Instructor Gosha is a faculty member in the Department of Computer Science at Morehouse College. The purpose of this research is to gauge student interest in areas related to pursuing advanced degrees in STEM majors. Your part in the study will be to complete the survey. The entire survey should take less than five minutes to complete.

Risks and Discomforts
I do not know of any risks or discomforts to you in this research study.

Possible Benefits
I do not know of any way you would benefit directly from taking part in this study. However, this research may help me to understand what areas undergraduate STEM majors would like more information about when it comes to graduate study.

Incentives
For participating in this study you will be given a choice of movie-sized candy item or popcorn.

Protection of Privacy and Confidentiality
I will do everything we can to protect your privacy and confidentiality. I will not tell anybody that you were in this study or what information I collected about you in particular.

Choosing to Be in the Study
You do not have to be in this study. You may choose not to take part and you may choose to stop taking part at any time. You will not be punished in any way if you decide not to be in the study or to stop taking part in the study.

Contact Information
If you have any questions or concerns about this study or if any problems arise, please contact Kinnis Gosha at Morehouse College at kgosha@morehouse.edu. If you have any questions or concerns about your rights in this research study, please contact the Morehouse College Human Subjects Administrator, Ms. Alana Veal, at aveal@morehouse.edu.

I have read this form and have been allowed to ask any questions I might have. I agree to take part in this study.

Participant's signature: _____ Date: _____

A copy of this form will be given to you.

FREE CANDY!
FREE POPCORN!

If you are a Morehouse STEM Major, you are invited to fill out a quick, one page survey about graduate school interest.

Movie Theater Box Candy or Freshly Popped Popcorn will be provided to those who participate!

Contact Instructor Kinnis Gosha in Technology Tower Room 127 for more information.

Appendix B

Graduate School Mentoring Effectiveness Study Documentation

Graduate School Mentoring Effectiveness Pre Study

Overview: We are conducting a survey, under the supervision of Instructor Kinnis Gosha, on the effectiveness of mentorship in pursuing graduate degrees in computing. Your voluntary participation is requested so that we may learn more about the mentoring styles and techniques associated with successfully mentorship for underrepresented students to pursue a graduate degree in a computing field.

This pre survey will take approximately 10 minutes. Your name will not be recorded on the questionnaire and your responses will be anonymous. Again, your participation is voluntary and you may choose to not answer all of the questions on the questionnaire. After the conclusion of the pre survey, you will be assigned to a mentor to discuss options about graduate school.

Code Number: _____ Major: _____ Gender: _____ Age: _____

Ethnicity: _____ Current GPA: _____ Classification: _____

Directions: Indicate the extent to which you agree or disagree with each statement listed below. Circle the number that corresponds to your response. Your responses will be kept confidential.

0 = Strongly Disagree (SD)
1 = Disagree (D)
2 = Slightly Disagree (SlD)
3 = Slightly Agree (SlA)
4 = Agree (A)
5 = Strongly Agree (SA)
6 = Not Applicable (NA)

Section I	**SD**	**D**	**SlD**	**SlA**	**A**	**SA**	**N/A**
1. I am interested in pursuing a graduate degree in computing.	0	1	2	3	4	5	6
2. I am interested in pursuing a doctoral degree in computing.	0	1	2	3	4	5	6
3. I feel confident I can get admitted into a graduate program.	0	1	2	3	4	5	6
4. I feel confident I will do well as a graduate student.	0	1	2	3	4	5	6
Section II	SD	D	SlD	SlA	A	SA	N/A
5. I am knowledgeable about funding sources for graduate school.	0	1	2	3	4	5	6
6. I am knowledgeable about graduate fellowships.	0	1	2	3	4	5	6
7. I am familiar with many fellowship opportunities	0	1	2	3	4	5	6
I understand how to apply for a fellowship	0	1	2	3	4	5	6
8. I am knowledgeable about assistantships.	0	1	2	3	4	5	6
9. I understand how to apply for an assistantship	0	1	2	3	4	5	6
10. I know the difference between a fellowship and an assistantship.	0	1	2	3	4	5	6
11. I am familiar with many graduate school visitation opportunities.	0	1	2	3	4	5	6
12. I am knowledgeable about other African Americans who have a Ph.D. in computing.	0	1	2	3	4	5	6
13. I am familiar with organizations that I join that could provide me with info about pursuing a graduate degree in computing.	0	1	2	3	4	5	6

Graduate School Mentoring Effectiveness Pre Study

14. How many mentors do you have that are knowledge about attending graduate school in a computing discipline? _____

15. How many fellowship opportunities do you know about? _____

16. How many graduate school visitation events are you familiar with? _____

17. What is a fellowship? _____

_____

18. What is an assistantship? _____

_____

19. What are the different types of assistantships? _____

_____

20. What career options does one have with a PhD in computing? _____

_____

21. What questions do you have about pursuing a graduate degree in a computing field? _____

_____

Graduate School Mentoring Effectiveness Post Study

Overview: This is the final survey for the research project measuring the effectiveness of mentorship in pursuing graduate degrees in computing. Your voluntary participation is requested once more so that we may learn more about your mentorship experience with your assigned mentor.

This survey will take approximately 10 minutes to complete. As before, your name will not be recorded on the questionnaire and your responses will be anonymous. Again, your participation is voluntary and you may choose to not answer all of the questions on the questionnaire.

Code Number: _____ Assigned Mentor: _____

Directions: Indicate the extent to which you agree or disagree with each statement listed below. Circle the number that corresponds to your response. Your responses will be kept confidential.

0 = Strongly Disagree (SD)
1 = Disagree (D)
2 = Slightly Disagree (SlD)
3 = Slightly Agree (SlA)
4 = Agree (A)
5 = Strongly Agree (SA)
6 = Not Applicable (NA)

	0	1	2	3	4	5	6
Section I	SD	D	SlD	SlA	A	SA	N/A
1. My mentor was accessible.	0	1	2	3	4	5	6
2. My mentor demonstrated professional integrity.	0	1	2	3	4	5	6
3. My mentor demonstrated content expertise in my area of need.	0	1	2	3	4	5	6
4. My mentor was approachable.	0	1	2	3	4	5	6
5. My mentor was supportive and encouraging.	0	1	2	3	4	5	6
6. My mentor provided constructive and useful critiques of my work.	0	1	2	3	4	5	6
7. My mentor motivated me to improve my work product.	0	1	2	3	4	5	6
8. My mentor was helpful in providing direction and guidance on professional issues (e.g., networking).	0	1	2	3	4	5	6
9. My mentor answered my questions satisfactorily (e.g., timely response, clear, comprehensive).	0	1	2	3	4	5	6
10. My mentor acknowledged my contributions appropriately (e.g., committee contributions, awards).	0	1	2	3	4	5	6
11. My mentor suggested appropriate resources (e.g., experts, electronic contacts, source materials).	0	1	2	3	4	5	6
12. My mentor challenged me to extend my abilities (e.g., risk taking, try a new professional activity, draft a section of an article).	0	1	2	3	4	5	6
Section II	SD	D	SlD	SlA	A	SA	N/A
13. Mentor has shared history of his/her career with you.	0	1	2	3	4	5	6
14. Mentor has encouraged you to prepare for advancement.	0	1	2	3	4	5	6

Graduate School Mentoring Effectiveness Post Study

15. Mentor has encouraged me to try new ways of behaving in my job.	0	1	2	3	4	5	6
16. I try to imitate the work behavior of my mentor.	0	1	2	3	4	5	6
17. I agree with my mentor's attitudes and values regarding education.	0	1	2	3	4	5	6
18. I respect and admire my mentor.	0	1	2	3	4	5	6
19. I will try to be like my mentor when I reach a similar position in my career.	0	1	2	3	4	5	6
20. My mentor has demonstrated good listening skills in our conversations.	0	1	2	3	4	5	6
21. My mentor has discussed my questions or concerns regarding feelings of competence, commitment to advancement, relationships with peers and supervisors or work/family conflicts.	0	1	2	3	4	5	6
22. My mentor has shared personal experiences as an alternative perspective to my problems.	0	1	2	3	4	5	6
23. My mentor has encouraged me to talk openly about anxiety and fears that detract from my work.	0	1	2	3	4	5	6
24. My mentor has conveyed empathy for the concerns and feelings I have discussed with him/her.	0	1	2	3	4	5	6
25. My mentor has kept feelings and doubts I shared with him/her in strict confidence.	0	1	2	3	4	5	6
26. My mentor has conveyed feelings of respect for me as an individual.	0	1	2	3	4	5	6
27. Mentor reduced unnecessary risks that could threaten the possibility of becoming a school principal or receiving a promotion.	0	1	2	3	4	5	6
28. Mentor helped you finish assignments/tasks or meet deadlines that otherwise would have been difficult to complete.	0	1	2	3	4	5	6
29. Mentor helped you meet new colleagues.	0	1	2	3	4	5	6
30. Mentor gave you assignments that increased written and personal contact with school administrators.	0	1	2	3	4	5	6
Section III	SD	D	SlD	SlA	A	SA	N/A
31. I am interested in pursuing a graduate degree in computing.	0	1	2	3	4	5	6
32. I am interested in pursuing a doctoral degree in computing.	0	1	2	3	4	5	6
33. I feel confident I can get admitted into a graduate program.	0	1	2	3	4	5	6
34. I feel confident I will do well as a graduate student.	0	1	2	3	4	5	6
Section IV	SD	D	SlD	SlA	A	SA	N/A
5. I am knowledgeable about funding sources for graduate school.	0	1	2	3	4	5	6
6. I am knowledgeable about graduate fellowships.	0	1	2	3	4	5	6
7. I am familiar with many fellowship opportunities	0	1	2	3	4	5	6

Graduate School Mentoring Effectiveness Post Study

I understand how to apply for a fellowship	0	1	2	3	4	5	6
8. I am knowledgeable about assistantships.	0	1	2	3	4	5	6
9. I understand how to apply for an assistantship	0	1	2	3	4	5	6
10. I know the difference between a fellowship and an assistantship.	0	1	2	3	4	5	6
11. I am familiar with many graduate school visitation opportunities.	0	1	2	3	4	5	6
12. I am knowledgeable about other African Americans who have a Ph.D. in computing.	0	1	2	3	4	5	6
13. I am familiar with organizations that I join that could provide me with info about pursuing a graduate degree in computing.	0	1	2	3	4	5	6

14. How many mentors do you have that are knowledge about attending graduate school in a computing discipline? _____

15. How many fellowship opportunities do you know about? _____

16. How many graduate school visitation events are you familiar with? _____

17. What is a fellowship? _____

_____

18. What is an assistantship? _____

_____

19. What are the different types of assistantships? _____

_____

20. What career options does one have with a PhD in computing? _____

_____

21. What additional things would you like to know about graduate school? _____

_____

22. How did you benefit the most from your mentoring session? _____

_____

23. How could your mentoring session be better? _____

Information about Being in a Research Study
Morehouse College

Measuring the Short Term Effectiveness of Graduate School Mentorship of African American Computer Science Majors

Description of the Study and Your Part in It

Mr. Kinnis Gosha is inviting you to take part in a research study. Mr. Gosha is an Instructor in the Computer Science Department at Morehouse College. The purpose of this research is to measure the effectiveness of short-term graduate school mentorship for African American Computer Science majors.

Your part in the study will be to take a pre-survey, interact with a graduate school mentor and take a post-survey. Some participants will be asked for an interview after the post-survey. The entire study will take you from one to two hours to participate depending on the time you spend with your mentor.

Risks and Discomforts

We do not know of any obvious risks or discomforts to you in this research study, however your mentor may ask you personal questions about your educational status (i.e. your GPA). You do NOT have to answer any question you do not feel comfortable answering. Feel free to quit the study at anytime.

Possible Benefits

This research seeks to improve the graduate school mentorship for African American computing majors. The information provided during this study could turn out to be beneficial for any participant interested in pursuing a graduate degree in computing.

Incentives

There will be no incentive for participating in this study other than obtaining free information about pursuing a graduate degree in computing.

Protection of Privacy and Confidentiality

We will do everything we can to protect your privacy and confidentiality. We will not tell anybody outside of the research team that you were in this study or what information we collected about you in particular. You will be given a special code that only the principal investigator will know. This code will be used in any situation where you will need to be identified.

Choosing to Be in the Study

You do not have to be in this study. You may choose not to take part and you may choose to stop taking part at any time. You will not be punished in any way if you decide not to be in the study or to stop taking part in the study.

Contact Information

If you have any questions or concerns about this study or if any problems arise, please contact Kinnis Gosha at Morehouse College at 404-215-6268.

If you have any questions or concerns about your rights in this research study, please contact the Morehouse College Office of Research and Sponsored Programs.

Consent

I have read this form and have been allowed to ask any questions I might have. I agree to take part in this study.

Participant's signature: _____ Date: _____

A copy of this form will be given to you.

Student Interview Protocol

Introductory Remarks:
Good (morning/afternoon), my name is Kinnis Gosha and I am a researcher working at Morehouse College and I am conducting interviews of students who participated in the graduate school mentoring project research study. All identifying information will be changed so you are not recognizable in any reporting. During the interview I will ask you questions about your experience with your mentor.

Informed Consent:
The interview will last approximately 30 minutes. We would like to record your responses in order to facilitate future analyses. Do you give us permission to record your interview? Your participation in the interview is completely voluntary, which means that you can refuse to answer any question for any reason, or discontinue your participation at any time.

Please give me a brief summary of your interaction with your selected mentor.

What did you learn from your experience with your mentor?

What could have made your mentorship experience better?

What impactful things did you learn from your mentorship experience?

What changes will you make after your mentorship experience?

How will you describe the relationship between you and your mentor?

Conclusion:
Thank you for participating in today's interview. The results of the interview study will provide feedback for the study. Have a great day!

INTERESTED IN GRAD SCHOOL?

If you are a Morehouse Computer Science Major and are interested in graduate school, you are invited to participate in a research study.

Contact Professor Kinnis Gosha in Technology Tower Room 222 at **kgosha@morehouse.edu** for more information.

Appendix C

Mentorship Content Documentation for the Virtual Mentor

Synonym List for Virtual Mentor

- academics = grade
- aid = federal, fafsa, loan, financial aid
- apply = get, obtain, receive, land
- assistantship = RA, GA, TA
- attend = go, appear, show, visit
- balance =
- bachelors = undergrad, undergraduate
- benefit = advantage, edge, convenience, bonus
- best = attractive, great, perfect, fine, better, top
- career = job, field, work, employment, business, occupation, profession, position
- cost = expense, amount, make, earn, price, how much,
- course =
- computing = computer science, comp sci, cs
- challenge = suffer, downside, withstand
- company = industry, corporation, corporate
- decide = choose, conclude, guess, select
- degree =
- difference = compare, compared, distinction, change
- difficult = hard, tough, crucial, heavy, lofty, severe
- do = achieve, accomplish, complete, produce,
- doctorate = doctoral, phd
- eligible = considered, consider
- faculty = professor, teach, teacher
- fellowship = scholarship
- find = look, search,
- flexible = adaptive, adaptable, variable
- funding = pay, stipend, tuition, money, fund, award
- give = administer, allow, deliver, donate, part, provide, permit
- grade = gpa, academics
- graduate = grad
- gre = test score, test, score
- important = relevant, needed, required, essential, fundamental, prominent, major
- include = cover, contain, involve, have
- live = living,
- many = multiple, two, several, another, more than one
- most = highest, limit, more, greatest, maximum, much, very, full
- options = choices, opportunities
- prepare = learn, become
- program = division, degree, department, major
- publication = papers, manuscript

- responsibility = task, duty, requirement
- school = grad school, place, institution, college, university
- salary = wage, earning, income,
- start = begin, outset
- subject = area, research, niche, specialization, track
- view = interpreted
- whole = entire, all, total, every

Assistantship Questions

assistantship [1]
What is an **assistantship**?
An assistantship is funding for graduate school that requires you to do work. Different types of assistantships include teaching assistantships, research assistantships and generic graduate assistantships.

assistantship AND grades
What does my **GPA** need to be to get an **assistantship**?
There is no universal answer for every school, but obviously, the higher your GPA the more likely you are to be awarded an assistantship. Many schools like to see at least a 3.0 when applying for a program, however a school may weight a GPA differently depending on the school the student has graduated from. Sometimes a graduate school will look at specific things in your transcript such as what you made in your major courses or what grades you made after your freshman year.

gre AND assistantship
What does my **GRE** score need to be to gain an **assistantship**?
I can not give you a specific score; however, aim for a high GRE score because it makes you more competitive compared to other applicants. With that being said, some schools will not accept you into their program as a doctoral student in a STEM field without offering you an award. In those cases, you would just need to have a high enough GRE to get into the program.

many AND assistantship
Could I have **more** than one **assistantship** at a time?
You can have more than one assistantship. A school will have a maximum number of hours a week you can work at the institution; so as long as your total number of hours worked does not exceed that amount, then it should be okay from the institution's perspective.

apply AND assistantship
How do i **apply** for an **assistantships**?
It will differ from school to school. It also matters what type of assistantship you are seeking. A faculty member that has funding for a research assistant position would be able to tell you how to apply for that position. For a teaching assistantship, the graduate program director may be able to give you more information.

career AND assistantship
Could I have a full or part time **job** in addition to an **assistantship**?
You should check with the guidelines of that institution. Keep in mind that some faculty frown upon working an outside job if they award you with an assistantship in that same semester.

funding AND assistantship
How much **money** could I make doing an **assistantship**?
It depends on the department for teaching assistantships since there is a typically a standard pay scale for graduate students. For research assistantships, the pay is typically set by the faculty member who is funding the student.

include AND assistantship
What is **included** with an **assistantship**?
Tuition is normally included. Health insurance may be included as well; however, health coverage may vary for each institution.

summer AND assistantship
Are **assistantships** offered over the **summer**?
If funds are available from that faculty member or department, you will be provided with an assistantship.

Entrepreneurship Questions

(do OR duties OR responsibilities) AND (entrepreneur)
What would I **do** as an **entrepreneur**?
Your job responsibilities as an entrepreneur would depend on the opportunity you are seeking. Various job responsibilities are among the following: developing a product or application, finding funding, marketing your product, pay employees and selling the company.

(benefit OR reason OR advantage OR upside) AND (entrepreneur OR business owner OR start up)
What are some of the **benefits** of becoming an **entrepreneur**?
First you have the potential to make a lot of money as an entrepreneur. You also have full control over decisions made throughout your company.

(challenge OR downside OR bad) AND (entrepreneur OR business owner OR start up)
What would be some of the **challenges** of becoming an **entrepreneur**?
Some of the challenges of becoming an entrepreneur are among the following: raising capital, the amount of time needed, having to invest portions of your income back into the company.

Fellowship Questions

fellowship
What is a **fellowship**?
A fellowship is a financial award to attend graduate school that you don't have to pay back.

apply AND fellowship
How do you **apply** for a **fellowship**?
There are several sources for fellowships; most of them will require the student to apply directly with their organization. Common items included in a fellowship packet includes: transcripts, essays, letters of recommendation and an application form.

gre AND fellowship
What does my **GRE** score have to be to get a **fellowship**?
Typically your GRE score needs to be high enough to get into the graduate program that you want to enter. A minimum GRE score for the fellowship itself is not common.

gpa AND fellowship
What does my **GPA** score have to be in order to receive a **fellowship**?
Different awards have different criteria; however the better the GPA, the more competitive your application becomes. Typically, a 3.0 is the minimum since that is usually required to enter a graduate school program.

tuition AND fellowship
Is **tuition** covered by a **fellowship**?
Some fellowships do cover tuition and some do not. Many times a fellowship will provide a stipend for living expenses and other support while asking the institution to help cover tuition.

books AND fellowship
Are **books** included in the **fellowship**?
It depends on the fellowship program. Keep in mind that some fellowships provide a stipend for living expenses, where the purchase of textbooks would be factored into among other things.

best AND fellowship
Which **fellowship** is the **best**?
Different fellowships are better for different students depending on their situation. Some offer more money, some may be more prestigious, some may have conference travel support or research equipment support. Some may come with mentoring and advisement. It is also important to factor in when you need the fellowship. For example, one fellowship may be better for a student working on their dissertation, *but not when they are just starting their graduate program.*

job AND fellowship
Can you have a part time **job** with a **fellowship**?
Ultimately, it depends on the stipulations of that fellowship. The purpose of many fellowships is to support you while you complete your degree so they may frown upon a recipient working too many hours outside of their department. If you do decide to work an additional job outside your department, let it be because you really need the money and not just because you can.

fellowship AND summer
Are **fellowships** available in the **summer**?
It depends on the fellowship received. Some fellowships are 9 month awards while others are 12 month awards. Some fellowships may be for 9 months and require you work as an intern over the summer.

fellowship AND difference
What is the **difference** between a **fellowship** and a scholarship?
Scholarships are funding packages awarded to undergraduates. Fellowships are funding packages awarded to graduate students.

fellowship AND eligible
What must I do to be **considered** for a **fellowship**?
You will need to make sure that you fit the criteria for that fellowship. For example, you may need to belong to a particular ethnic group, be attending a specific institution or working towards a degree in a particular field. If you find that you meet all the qualifications for a particular fellowship, you just apply.

fellowship AND start
Can I apply for a **fellowship** after I **start** graduate school?
Some fellowships permit applying after you have started graduate school and some do not. You must check with that particular program prior to applying.

fellowship AND spring
Can I apply for a **fellowship** in the **spring** semester??
Check with the program/fellowship coordinator about applying for fellowships during the spring semester. That person should be able to provide you with dates relating to applying during the Spring semester.

fellowships AND give
Who **gives** out **fellowships**? (School? Agencies?) ?
Universities, companies, non-profits, and governmental agencies are among some of the sources for fellowships.

(cost AND fellowship) OR (most AND fellowship)

How **much** can I **make** with a **fellowship**??
Different fellowships provide different award amounts. An approximate average for annual graduate stipends in STEM disciplines is $30,000.

fellowship AND most
Can I have **more** than one **fellowship** at a time?
There is a possibility that you can have more than one fellowship; however, you just need to check the rules and regulations of that particular fellowship and your current fellowship.

Industry Career Questions

company AND prepare
What Would I do to **prepare** for an **industry** position?
There are many strategies that you can take. You could get an internship with the company you want to work for or you can do research in graduate school that is relevant to the company you want to work at. When you encounter individuals that could help you get a job in a company, it is good to keep in contact with them and keep them updated on your accomplishments and current status.

(company AND cost) OR (company AND salary) OR (company AND funding)
How much would you **make** in **industry** positions?
You should expect to start out no lower than ninety thousand dollars a year depending on your location. A six-figure salary is very common when starting out.

company AND benefit
What are the **benefits** of obtaining an **industry** position?
Some of the benefits in working in industry include flexible work hours, high salary, and corporate benefits. Compared to academia, companies can take ideas to the marketplace faster; you don't have to bring in grants to fund your research and companies do not put employees through a formal tenure process.

company AND challenge
What are some of the **challenges** of having an **industry** position?
Some of the challenges of working in industry are among the following: abrupt changes in direction from management, number of hours needed to work, performance evaluation, retraction of funding for a project and the restrictiveness of the research that you work on.

company AND responsibility
What are your job **responsibilities** at a **corporate** position?
Job responsibilities will vary depending on the specific project or product worked on. Potential tasks include working in teams, gathering data, presenting findings, develop prototypes and collect feedback from users.

Round 2

company AND school
How does the choice of school effect hiring in industry?
Your choice of school matters a lot. Companies usually have a list of school they recuit at. Exceptions are made, however those candidates usually have extremely strong grades and resumes.

company AND salary
How much money would you make in an industry position?

With a Ph.D you would start out making a six figure salary. In cities with a higher cost of living you could start off making one-hundred twenty thousand to one-hundred forty thousand.

company AND difficult
How difficult is it to get a job in an industry position?
If you go to a prominent school, know someone at that company, and have a strong research background in an area of interest to that company, it is not very difficult at all.

(career OR company) AND (apply OR prepare)
What would I do to prepare for an industry position?
There are many strategies that you can take. You could get an internship with the company you want to work for or you can do research in graduate school that is relevant to the company you want to work at. When you encounter individuals that could help you get a job in a company, it is good to keep in contact with them and keep them updated on your accomplishments and current status.

Teaching and Research Faculty Careers

faculty AND (do OR responsibilities)

What are my job responsibilities as a research faculty member?

Job responsibilities of a faculty member include teaching, research and service. When conducting research you must generate grant funding to fund your students and equipment. You will also conduct research and publish your results. Different service activities to provide to your institution could the following: advising graduate students, administer qualifying exams and serving on committees like department committees or dissertation committees. If you are faculty at a teaching institution, you will spend a lot more time teaching classes and less expectations conducting research.

faculty AND (difficult OR career)

How difficult is it to obtain a job as a research faculty member?

It is very difficult process attempting to obtain a position as a research faculty member. One needs a lot of publications of high quality. However, depending on how qualified a candidate is, your relationship with the people you are applying to and the climate of the academic market, it may be less difficult. It is probably easier to get a teaching faculty position, but you will typically have a lower salary and heavier teaching load.

faculty AND benefit

What are the benefits of becoming a research faculty member?

You get to make your own decision about the type of research that you one to do. You also get the satisfaction in mentoring students. Other benefits include traveling, salary, flexible work schedule, and the access to resources as an entrepreneur.

faculty AND prepare

How do I prepare if I want to become a research faculty member?

A strong publication record is required. Other ways to prepare are among the following: helping to write a grant proposal, getting some experience as a teaching assistant, develop oral and written communication skills, take on leadership positions, and take as many courses as you can in your perspective research area.

faculty AND challenge

What are some of the challenges of becoming a teaching faculty member?

Overall, the toughest obstacle for faculty members is getting tenure and promotion. For teaching faculty you have more teaching responsibilities and typically less resources than a faculty member at a research institution, so your research expectations will be less than at a research institution. Research faculty will have to publish consistently in the top journals and conferences.

faculty AND teach AND research

How much teaching would you do as a research faculty member?

The amount of teaching you would have to do may vary. Some institutions tends to teach one class a semester, some institutions teach three classes a year across two semesters, some institutions teach four. It just depends on the department and the level of research.

faculty AND flexible
How flexible is a job as a faculty member?
You have complete flexibility. You work at your own time, at your own pace. All you have to do is be there in class, now you have some control over that but the most part you do what you want to do. You decide what trips to take, where to go, and what trips not to take.

faculty AND school
How is the choice of school important for becoming a faculty member?
Because there's still such a lack of diversity with African-American men or women in computer sciences, the choice of school is not as big of a factor for teaching faculty. For a research faculty member, choice of school is very important.

faculty AND publications
Are publications important in obtaining a faculty position?
It depends on the institution; there are no universal requirement for a tenure or universal requirement for hiring. Each institution's perspective on a candidate may vary. However, if you want to increase your chances of getting a position then you should have some publications. The more you have the better off you will be.

faculty AND (search OR apply)
How would you find a job as a faculty member?
To get a faculty position you have to identify when a position is available and then apply. You should look at the job announcements. Make sure you have the appropriate credentials and can meet that institution's criteria. Talking to other faculty in that department or someone in Human Resources at that school could also give you some insight on a particular school.

faculty AND (funding OR salary)
How much money could I make as a faculty member?
For a new tenure track teaching faculty member your nine month salary may start out between sixty and seventy thousand dollars. For a research faculty member you may earn between eighty-five and one-hundred thousand for nine months of work. This amount does not account for any money made on or off campus during the summer terms.

Other Questions

degree AND (best OR benefit OR difference)
school [60] AND company [94]
What are the benefits for getting a graduate degree in computing?
There are many benefits for pursuing a doctoral degree in computing versus a bachelors or masters degree. Some benefits include an increased salary, less supervision, and more say in decisions about the projects you would work on. Additionally, having PhD says you are able to do independent research and you made a contribution to the field and you are an expert over that area. Having a Master's degree indicates that you have the capability to master a general area like computer science; and a Bachelor's degree indicates that you have some capacity to perform using fundamental computer science techniques and theories.

(bachelors [105] OR graduate [106] OR masters [107] OR doctorate [108]) AND (career [56] OR option [54] OR do [4] OR decide [95])
What are my career options with a graduate degree in computing?
A master’s degree will typically provide you with a learning experience in a particular area of computing. Finding a job with a company, non-profit or government agency is common. A doctoral degree will give you the same opportunities, however it is a research degree that will prepare you to be successful in a research career such as industry, government, policy or higher education.

(subject [102] OR options [54]) AND (career [56] OR computing [55])
How does my research area affected my career options?
Often companies, government agencies, research labs, and colleges will look for someone with a particular expertise. They may also look for someone who has a strong background in research. It would be wise to work in an hot area to ensure yourself more employment opportunities.

Other Funding Questions

funding AND (best OR assistantship OR fellowship)
Which is better, a fellowship or assistantship?
Both assistantships and fellowships are great sources of graduate school funding since you don’t have to pay them back; however, they have their pros and cons. Fellowships are more beneficial if you still engaged in research and are active in your department.

(live AND funding) OR (live AND cost)
How does **cost** of **living** affect one's choice of graduate school?
You have to consider the cost of living in an area when you are deciding between institutions.

Some schools may offer more money with a fellowship or assistantship, but the cost of living may be so high that it would not make a difference.

funding [63]
What ways can I get **funding** to attend graduate school?
Two prominent ways to get free money to pay for graduate school are fellowship awards and an assistantships.

(funding [63] OR assistantship [1] OR fellowship [2]) AND (whole [90])
How long will a fellowship or assistantship funding last?
Typically, an assistantship is assigned for one year, but can be renewed yearly. A fellowship is typically a year long or multiple year award.

aid [77]
How do I get financial aid to pay for school?
Two prominent ways are fellowship awards and an assistantships. It is advise you pursue these options before considering student loans or any other source you have to pay back.

funding [63] AND most [69]
How much can I make with a fellowship or assistantship??
Different fellowships provide different award amounts. An approximate average for annual graduate stipends in STEM disciplines is $30,000.

GRE Questions

gre [3]
What is the **GRE**?
The Graduate Record Examinations (GRE) is a standardized test created and administered by Educational Testing Service that is an admissions requirement for many graduate schools in the United States.

gre [3] AND cost [86]
How much does the GRE cost?
As of October of 2012, the price of the GRE is $175. Go to the Educational Testing Service website to see if the price has changed. The website address is w w w dot e t s dot com.

gre [3] and school [60]
Which graduate and business school institutions accept GRE scores?
See the complete list of institutions (PDF) using *GRE*® scores and their official ETS code number.

Other Questions

(important [100] OR view [101]) AND (grade [109])
How important are grades in graduate school?
Graduate schools typically require you to maintain at least a B average to remain in good standing with the program. However, employers may not weigh your GPA as heavily as they would coming out of undergrad. Thing common things employers look at is who you worked with, what school did you attend and what research did you conduct while you were there.

(many [52]) AND (program [96])
Can I work on two graduate degrees at the same time?
It is common and sometimes advantageous to do interdisciplinary work across departments; however, it is uncommon to work on two degrees at the same time.

(decide) AND (career)
What things should I consider when deciding a career path with a graduate degree?
Some things you should consider are the type of work you would do, how much research you want to do, if you enjoy teaching, how much money do you want to make and what type of location do you want to live at. It is crucial that you also consider if you want to chose your own research to work on or are you comfortable working on an assigned research project.

career AND program
How does your choice of school affect your chances to obtain a corporate research position?
When many companies hire someone with a Ph.D. in computing, they will usually stick with graduates of a few select institutions. Attending a graduate school that has a good reputation with companies will increase your chances of obtaining a job with one of these companies.

balance AND (school OR course)
What ways can I find balance in graduate school?
Time management and self-organization is very crucial in graduate school. It is easy to schedule personal time for yourself when you schedule work time for yourself.

research [48]
What type of **research** activities would I do in graduate school?
Computer Science research can include such diverse activities as designing and building new computer systems, proving mathematical theorems, writing computer software, measuring the performance of a computer system, using analytical tools to assess a design, or studying the errors programmers make as they build a large software system. Because a researcher chooses the activities appropriate to answer each question that arises in a research investigation, and because new questions arise as an investigation proceeds, research activities vary from project to project and over time in a single project. A researcher must be prepared to use a variety of approaches and tools.

government [104]
Can I have a career in government with a PhD?
The government offers career options with a Ph.D. in computing. There are jobs in different governmental agencies as well as jobs working in national research labs.

school [60]
How do I select a graduate **school**?
When selecting a graduate school, some factors for choosing a graduate school include a relationship with one of the faculty, research at that school you are interested in, ranking and reputation of the school or department and funding. You can find a list of schools with doctorate programs in computing using the Taulbee Survey [link to the survey: http://cra.org/resources/taulbee/].

phd [57]
What is a **phd**
A Doctor of Philosophy degree, abbreviated Ph.D., is the highest academic degree anyone can earn. Because earning a Ph.D. requires extended study and intense intellectual effort, less than one percent of the population attains the degree. Society shows respect for a person who holds a Ph.D. by addressing them with the title, Doctor. To earn a Ph.D., one must accomplish two things. First, one must master a specific subject completely. Second, one must extend the body of knowledge about that subject.

(best [13] and school [60]) or attend
What is the **best school** for me to attend?
You can find a list of schools with doctorate programs in computing using the Taulbee Survey [link to the survey: http://cra.org/resources/taulbee/]. The Taulbee Survey is the principal source of information on the enrollment, production, and employment of Ph.D.s in computer science and computer engineering. An additional resource is the Computer Science rankings of the US News and World Reports [enter link: http://grad-schools.usnews.rankingsandreviews.com/best-graduate-schools/top-science-schools/computer-science-rankings].

cost [86]
What is the **cost** of graduate school?
The cost of graduate will depend on the school and potentially your state of residency. If you get accepted into a Ph.D. program and some masters programs you have a strong chance of receiving free tuition from either a fellowship award or assistantship from the university.

Appendix D

Virtual Mentoring Conversation Log

quid	response
144	What is an assistantship?
145	I dont understand your statement
146	Which is better, a fellowship or assistantship?
	Different fellowships are better for different students depending on their situation. Some offer more money, some may be more prestigious, some may have conference travel support or research equipment support. Some may come with mentoring and
147	advisement. I
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150	Why should I get a doctoral degree?
151	I dont understand your statement
152	Why should I get a masters degree?
153	I dont understand your statement
154	Which school should I go to for graduate school ?
155	I dont understand your statement
156	What fellowships should I apply to
	There are several sources for fellowships and most of them will require the student to apply directly with their organization. Common items included in a fellowship packet
157	includes: transcripts, essays, letters of recommendation and an application form.
158	Why should I get a doctoral degree
159	I dont understand your statement
160	What is a researcher
161	I dont understand your statement
162	Are you familiar with Google
163	I dont understand your statement
164	Are you familiar with government positions
165	I dont understand your statement
166	Where can I go to graduate school
167	I dont understand your statement
168	what graduate schools offer computer science?
169	I dont understand your statement
170	what graduate school offers a track in video games?
171	I dont understand your statement
172	is video games a good career path?
173	I dont understand your statement
174	how can i get money for graduate school
175	I dont understand your statement
176	how can i apply for graduate school
177	I dont understand your statement

what schools provide scholarships?
I dont understand your statement
what graduate schools give fellowships?
Universities, companies, non-profits and governmental agencies are some of the sources for fellowships.
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230 What are the benefits of attending grad school

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You can find a list of schools with doctorate programs in computing using the Taulbee Survey. The Taulbee Survey is the principal source of information on the enrollment, production, and employment of Ph.D.s in computer science and computer engineering. An additional resource is the Computer Science rankings of the US News and World Reports.

What is the point of graduate school

When selecting a graduate school, some factors for choosing a graduate school include a relationship with one of the faculty, research at that school you are interested in, ranking and reputation of the school or department and funding. You can find a list of schools with doctorate programs in computing using the Taulbee Survey.

What will I learn in graduate school

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How can i get more funding for school?

Different fellowships provide different award amounts. The highest award amount I have heard of for a students yearly stipend is about $30,000.

What is a fellowship

A fellowship is a financial award to attend graduate school that you dont have to pay back.

what is an assistanship

I dont understand your statement

What is an assistanship?

I dont understand your statement

How do I apply for a fellowship

There are several sources for fellowships and most of them will require the student to apply directly with their organization. Common items included in a fellowship packet includes: transcripts, essays, letters of recommendation and an application form.

Any tips for applications

I dont understand your statement

How do i strengthen my application

305 I dont understand your statement
306 what is an assitanship
307 I dont understand your statement
308 what is an assistanship
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363 or higher education.
364 why is research important
Computer Science research can include such diverse activities as designing and building new computer systems, proving mathematical theorems, writing computer software, measuring the performance of a computer system, using analytical tools to assess a design, or studying the errors programmers make as they build a large software system. Because a researcher chooses the activities appropriate to answer each question that arises in a research investigation, and because new questions arise as an investigation proceeds, research activities vary from project to project and over time in a single project.
365 A researcher must be prepared to use a variety of approaches and tools.
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417 one must extend the body of knowledge about that subject.
418 what can you tell me about fellowships
A fellowship is a financial award to attend graduate school that you dont have to pay
419 back.
420 how many fellowships do you know
421 Possibly. You just need to check the rules and regulations of all of the funding sources.
422 what are the differences between a masters and phd program
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427 one must extend the body of knowledge about that subject.
428 what are some funding sources for a phd in STEM
Two popular ways to get free money to pay for graduate school are fellowship awards
429 and an assistantships.
430 where can I apply for a fellowship
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431 includes: transcripts, essays, letters of recommendation and an application form.
432 name one funding source i can apply to
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434 thanks for talking Lamar
435 I dont understand your statement
436 what is an assistantship?
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437 generic graduate assistantships.
438 how will a graduate degree benefit me?
439 I dont understand your statement
440 how do i apply for graduate school?
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441 or higher education.
442 Why is obtaining a graduate degree beneficial?
443 I dont understand your statement
444 what are some fields of study?
445 I dont understand your statement
446 How can i fund my graduate studies?
Two popular ways to get free money to pay for graduate school are fellowship awards
447 and an assistantships.
448 what is a fellowship award?
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449 back.
450 what are some ways to get money for graduate school

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451 and an assistantships.
452 how do i prepare for the GRE
The Graduate Record Examinations (GRE) is a standardized test created and
administered by Educational Testing Service that is an admissions requirement for many
453 graduate schools in the United States.
454 what are some good programs
455 I dont understand your statement
456 what type of work correlates with an assistantship
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482 What is the difference between a fellowship and a scholarship?
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489 I dont understand your statement
490 Wheres the closest liquor store?
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492 You drank?
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565 I dont understand your statement
566 You must not be into hip hop..
567 I dont understand your statement
568 Assistant?
569 I dont understand your statement
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what are my career options if i obtain a graduate degree in computing?
When many companies hire someone with a Ph.D. in computing, they will usually stick with graduates of a few select institutions. Attending a graduate school that has a good reputation with companies will increase your chances of obtaining a job with one of these companies.
which graduate schools have good reputations?
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652 Who gives out fellowships? Where do fellowships come from?
Universities, companies, non-profits and governmental agencies are some of the sources
653 for fellowships.
654 fellowship
A fellowship is a financial award to attend graduate school that you dont have to pay
655 back.
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661 includes: transcripts, essays, letters of recommendation and an application form.
662
test
663 I dont understand your statement
664
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667 I dont understand your statement
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669 I dont understand your statement
670 What opportunities are provided with getting a ph.d?
A Doctor of Philosophy degree, abbreviated Ph.D., is the highest academic degree anyone can earn. Because earning a Ph.D. requires extended study and intense intellectual effort, less than one percent of the population attains the degree. Society shows respect for a person who holds a Ph.D. by addressing them with the title, Doctor. To earn a Ph.D., one must accomplish two things. First, one must master a specific subject completely. Second,
671 one must extend the body of knowledge about that subject.
672 What is the best way to go about getting a ph.d?

You can find a list of schools with doctorate programs in computing using the Taulbee Survey. The Taulbee Survey is the principal source of information on the enrollment, production, and employment of Ph.D.s in computer science and computer engineering. An
673 additional resource is the Computer Science rankings of the US News and World Reports.
674 What is good about a ph.d?
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675 one must extend the body of knowledge about that subject.
676 What salary can i get with a ph.d in computer science?
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679 additional resource is the Computer Science rankings of the US News and World Reports.
680 What should I do to get into graduate school?
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681 or higher education.
682 why is it important to attend graduate school?

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689 or higher education.
690 How do I decide which graduate school is best for me?
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How hard is it to get into graduate school?

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How hard is it to get a fellowship?

There are several sources for fellowships and most of them will require the student to apply directly with their organization. Common items included in a fellowship packet includes: transcripts, essays, letters of recommendation and an application form.

Is it hard to study abroad for graduate school?

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Is it best to stay in state or go out of state for graduate school?

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What is the Taulbee Survey?
I dont understand your statement
Do you think that cyber security is a good field to go into for graduate school?
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Is the GRE hard?
The Graduate Record Examinations (GRE) is a standardized test created and administered by Educational Testing Service that is an admissions requirement for many graduate schools in the United States.
Is the GRE highly weighted when applying to graduate school?
See the complete list of institutions PDF using GRE scores and their official ETS code number.
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I dont understand your statement
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Who gives out fellowships? Where do fellowships come from?
Universities, companies, non-profits and governmental agencies are some of the sources for fellowships.
apprentiship
I dont understand your statement
tell me about graduate school
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744 gpa
745 I dont understand your statement
746 GRE
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747 graduate schools in the United States.
748 what is your name
749 I dont understand your statement
750 what are the leading schools in the computer science field?
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751 or higher education.
752 What are some good schools?
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753 with doctorate programs in computing using the Taulbee Survey.
754 What can you tell me about the GRE?
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755 graduate schools in the United States.
756 What is a good score for the GRE?
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785 includes: transcripts, essays, letters of recommendation and an application form.
786 For computer engineering, what types of degrees can be obtained?
787 I dont understand your statement
788 What is Computer Engineering?
789 I dont understand your statement
790 What is a fellowship?
A fellowship is a financial award to attend graduate school that you dont have to pay
791 back.
792 What is an assistantship?
An assistantship is funding for graduate school that requires you to do work. Different types of assistantships include teaching assistantships, research assistantships and
793 generic graduate assistantships.
794 Are you a mentor?
795 I dont understand your statement
796 The top graduate schools
When selecting a graduate school, some factors for choosing a graduate school include a relationship with one of the faculty, research at that school you are interested in, ranking and reputation of the school or department and funding. You can find a list of schools
797 with doctorate programs in computing using the Taulbee Survey.
798 Computer Engineering
799 I dont understand your statement
800 Computer Science
801 I dont understand your statement
802 Research and Development
Computer Science research can include such diverse activities as designing and building new computer systems, proving mathematical theorems, writing computer software, measuring the performance of a computer system, using analytical tools to assess a design, or studying the errors programmers make as they build a large software system. Because a researcher chooses the activities appropriate to answer each question that arises in a research investigation, and because new questions arise as an investigation proceeds, research activities vary from project to project and over time in a single project.
803 A researcher must be prepared to use a variety of approaches and tools.
804 Engineering
805 I dont understand your statement
806 Morehouse College

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807 with doctorate programs in computing using the Taulbee Survey.
808 What is the Taulbee Survey?
809 I dont understand your statement
810 What is a Masters Degree in Computer Science
811 I dont understand your statement
812 M.S.
813 I dont understand your statement
814 Ph.D
A Doctor of Philosophy degree, abbreviated Ph.D., is the highest academic degree anyone can earn. Because earning a Ph.D. requires extended study and intense intellectual effort, less than one percent of the population attains the degree. Society shows respect for a person who holds a Ph.D. by addressing them with the title, Doctor. To earn a Ph.D., one must accomplish two things. First, one must master a specific subject completely. Second,
815 one must extend the body of knowledge about that subject.
816 MS
817 I dont understand your statement
818 Inventor
819 I dont understand your statement
820 Invent
821 I dont understand your statement
822 B.S.
823 I dont understand your statement
824 Software Engineering
825 I dont understand your statement
826 Software
827 I dont understand your statement
828 Programming
829 I dont understand your statement
830 Lamar
831 I dont understand your statement
832 what is a fellowship?
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833 back.
834 what is an assistantship
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835 generic graduate assistantships.
836 what is the gre

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how do you apply for a fellowship?

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what are the different kinda of assistantships?

An assistantship is funding for graduate school that requires you to do work. Different types of assistantships include teaching assistantships, research assistantships and generic graduate assistantships.

Could I have more than one assistantship at a time?

An assistantship is funding for graduate school that requires you to do work. Different types of assistantships include teaching assistantships, research assistantships and generic graduate assistantships.

what types of assistantships are available?

An assistantship is funding for graduate school that requires you to do work. Different types of assistantships include teaching assistantships, research assistantships and generic graduate assistantships.

Which is better, a fellowship or assistantship?

Different fellowships are better for different students depending on their situation. Some offer more money, some may be more prestigious, some may have conference travel support or research equipment support. Some may come with mentoring and advisement. It is also important to factor in when you need it. For example, one fellowship may be better for a student working on their dissertation, but not when they are just starting their graduate program.

how likely is it that I will get a fellowship I apply for?

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What is a fellowship

A fellowship is a financial award to attend graduate school that you dont have to pay back.

What does my GRE score have to be to get a fellowship?

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What are some different kinds of fellowships

A fellowship is a financial award to attend graduate school that you dont have to pay back.

Who gives out fellowships? Where do fellowships come from?

Universities, companies, non-profits and governmental agencies are some of the sources
857 for fellowships.
858 Can you name some fellowships?
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859 back.
860 What is an assistantship
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861 generic graduate assistantships.
862 What does my GRE score need to be to gain an assistantship?
I can not give you a specific score, however a high GRE score is a good thing because it makes you more competitive compared to other applicants. With that being said, some schools will not accept you into their program as a doctoral student in a STEM field without offering you an award. In those cases you would just need to have a high enough
863 GRE to get into the program.
864 how do I apply for an assistantship
It will differ from school to school. It also matters what type of assistantship you are seeking. A faculty member that has funding for a research assistant position would be able to tell you how to apply for that position. For a teaching assistantship, the graduate
865 program director may be able to give you more information.
866 how long does it take to complete graduate school studies
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867 or higher education.
868 What funding programs exist for international affairs graduate programs?
Two popular ways to get free money to pay for graduate school are fellowship awards
869 and an assistantships.
870 How can I get free money
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881 includes: transcripts, essays, letters of recommendation and an application form.
882 who are you?
883 I dont understand your statement
884 what is graduate school?
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891 with doctorate programs in computing using the Taulbee Survey.
892 What is the Taulbee Survey?
893 I dont understand your statement
894 How do I conduct research at a graduate school?
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895 or higher education.
896 How difficult is it to obtain a job as a research faculty member?

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898 How flexible is a job as a research faculty member?
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899 or higher education.
900 What funding programs exist for international affairs graduate programs?
Two popular ways to get free money to pay for graduate school are fellowship awards
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902 How can I get free money
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913 mentorship
914 I dont understand your statement
915 schools

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949 Keywords?
950 I dont understand your statement
951 Questions?
952 I dont understand your statement
953 Graduate school?
When selecting a graduate school, some factors for choosing a graduate school include a relationship with one of the faculty, research at that school you are interested in, ranking and reputation of the school or department and funding. You can find a list of schools
954 with doctorate programs in computing using the Taulbee Survey.
955 Best graduate schools in computing
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956 with doctorate programs in computing using the Taulbee Survey.
957 What are funding options for Graduate school

A masters degree will typically provide you with a learning experience in a particular area of computing. Finding a job with a company, non-profit or government agency is common. A doctoral degree will give you the same opportunities, however it is a research degree and will prepare you to take up a research career in industry, government, policy
958 or higher education.
959 What is an assistantship
An assistantship is funding for graduate school that requires you to do work. Different types of assistantships include teaching assistantships, research assistantships and
960 generic graduate assistantships.
961 How do i apply for an assistantships?
It will differ from school to school. It also matters what type of assistantship you are seeking. A faculty member that has funding for a research assistant position would be able to tell you how to apply for that position. For a teaching assistantship, the graduate
962 program director may be able to give you more information.
963 What is a fellowship?
A fellowship is a financial award to attend graduate school that you dont have to pay
964 back.
965 What is the difference between and assistantship and a fellowship
Scholarships are funding packages awarded to undergraduates. Fellowships are funding
966 packages awarded to graduate students.
967 how do i get funding for graduate school
A masters degree will typically provide you with a learning experience in a particular area of computing. Finding a job with a company, non-profit or government agency is common. A doctoral degree will give you the same opportunities, however it is a research degree and will prepare you to take up a research career in industry, government, policy
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972 I dont understand your statement
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974 generic graduate assistantships.
975 Which is better, a fellowship or assistantship?
Different fellowships are better for different students depending on their situation. Some offer more money, some may be more prestigious, some may have conference travel support or research equipment support. Some may come with mentoring and advisement. It is also important to factor in when you need it. For example, one fellowship may be better for a student working on their dissertation, but not when they
976 are just starting their graduate program.

977 whats a dissertation
978 I dont understand your statement
979 can i have more than one assistanship
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982 generic graduate assistantships.
983 who can i talk to for more information
984 I dont understand your statement
985 how can i apply for one
986 I dont understand your statement
987 whats graduate school
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997 back.
998 What are the types of research you can conduct in computing?
Computer Science research can include such diverse activities as designing and building new computer systems, proving mathematical theorems, writing computer software, measuring the performance of a computer system, using analytical tools to assess a design, or studying the errors programmers make as they build a large software system. Because a researcher chooses the activities appropriate to answer each question that arises in a research investigation, and because new questions arise as an investigation proceeds, research activities vary from project to project and over time in a single project.
999 A researcher must be prepared to use a variety of approaches and tools.
1000 Is there an area of gaming or virtual reality in computer science research?

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1021 A researcher must be prepared to use a variety of approaches and tools.
1022 why should i attend graduate school

You can find a list of schools with doctorate programs in computing using the Taulbee Survey. The Taulbee Survey is the principal source of information on the enrollment, production, and employment of Ph.D.s in computer science and computer engineering. An
1023 additional resource is the Computer Science rankings of the US News and World Reports.
1024 how long does it take to obtain a doctorate degree
A Doctor of Philosophy degree, abbreviated Ph.D., is the highest academic degree anyone can earn. Because earning a Ph.D. requires extended study and intense intellectual effort, less than one percent of the population attains the degree. Society shows respect for a person who holds a Ph.D. by addressing them with the title, Doctor. To earn a Ph.D., one must accomplish two things. First, one must master a specific subject completely. Second,
1025 one must extend the body of knowledge about that subject.
1026 how long does it take to obtain a masters degree
1027 I dont understand your statement
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fellowship?

A fellowship is a financial award to attend graduate school that you dont have to pay back.

Are fellowships available in the summer?

It depends on the fellowship received. Some fellowships are 9 month awards while others are 12 month awards. Some fellowships may be for 9 months and require you work as an intern over the summer.

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1067 are just starting their graduate program.
1068 what is a fellowship
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1069 back.
1070 Who gives out fellowships? Where do fellowships come from?
Universities, companies, non-profits and governmental agencies are some of the sources
1071 for fellowships.
1072 what is a fellowship
A fellowship is a financial award to attend graduate school that you dont have to pay
1073 back.
1074 Can I apply for a fellowship after a start graduate school?
There are several sources for fellowships and most of them will require the student to apply directly with their organization. Common items included in a fellowship packet
1075 includes: transcripts, essays, letters of recommendation and an application form.
1076 What must I do to be considered for a fellowship?

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1102 graduate programs for computing
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