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Learning Strategies of Digital Forensics Examiners and Students Studying Digital Forensics

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Rachael F. Elliott

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Learning Strategies of Digital Forensics Examiners and Students Studying Digital Forensics

By: Rachael Falynn Elliott

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By _____

Dr. Mark R. McCoy Committee Chair

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Dr. Wayne D. Lord Committee Member

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Dr. John P. Mabry Committee Member

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Abstract

Digital Forensics, also known as Computer Forensics, is the investigation of any digital media in order to find evidence. This media can include computer hard drives, flash drives, cell phones, etc… This discipline is relatively new compared to the other forensic disciplines, and is evolving at an exponential rate to keep up with changing technology. Digital forensics investigators often come from different backgrounds. Some have computer science backgrounds and are trained to be investigators while others come from the investigator side and are trained in computer forensics. Some examiners do not have a background in either area, but are being trained in both. There have been many studies concerning the learning strategies of adults. However, no studies have been done to find a common learning strategy among this group. This study determined the predominant learning strategy of a convenience sample of this diverse group to be Problem Solvers using the Assessing The Learning Strategies of AdultS (ATLAS) tool. This allows educators in this field to have a better understanding of how these students learn, and make the process more meaningful. Also, the educators of the on-going training in digital forensics will be more successful in presenting new material to experienced investigators already in the field.

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Introduction

Evidence of forensic science exists as far back as prehistoric human paintings and rock carvings (Rudin & Keith, 2002). As forensic science has evolved with advances in science and technology, more specified areas of forensics have emerged. Ballistics, DNA, psychology, entomology, toxicology, and digital forensics, are a few examples of these evolutions. Digital forensics is one of the disciplines that has recently developed in forensics science in the last 30 years (Computer Forensics Recruiter, 2010). In its early years, it was referred to as computer forensics because all it entailed was the examination of computers. With the advent of different types of digital storage media the name has been changed to digital forensics to better fit the scope of the discipline. The need for digital forensics has become increasingly important with the rapid technological advances we are seeing with computers, cell phones, and other electronic devices and their use in crime. Haley (2003) defines digital forensics as:

> The preservation, identification, extraction, interpretation, and documentation of computer evidence, to include the rules of evidence, legal processes, integrity of evidence, factual reporting of the information found, and providing expert opinion in a court of law or other legal and/or administrative proceeding as to what was found (p.1).

Simply, it is the investigation of digital media devices that store essential evidence. Digital forensics can be used for a multitude of reasons such as finding out why a system is not operating properly, if a system was used inappropriately, or if a computer system has been used as a resource to commit a crime. There are different kinds of devices that can contain digital evidence. Some of those devices are computers, laptops, cell phones, flash drives, floppy disks, compact disks, DVDs, MP3 players, and even some of the new gaming systems. With the

portability and flexibility of so many devices, digital evidence can be found at almost any crime scene today. There are three main types of investigations in digital forensics. The first is when the computer was used as an instrument to commit the crime, for example, when a computer is used to gather information and stalk someone. The second is when the computer itself is the target of the crime (Hailey, 2003). When a computer system is hacked in order to gather useful information is an instance of a computer being the target of the crime. The third is when the computer is used as a repository of evidence. An example of this kind of investigation is when child pornography is stored on the computer. As a result of these different uses of digital media in crimes, as well as their flexibility and increasing ease of use, the area of digital forensics has become one of the more diverse and functional areas of forensic science.

Several problem areas exist for digital forensics. The discipline suffers from a lack of funding, cross-jurisdictional legal struggles, and a lack of qualified professionals, but all of these problems can be linked to the need for an agreement on curriculum and education within the discipline (Baggil & Kiley, 2007). Digital forensics must use education as its foundation in determining what constitutes a digital forensics' expert to be a legitimate discipline in the scientific community and in the legal system.

Much of the literature in the field discusses how to legitimize digital forensics in the scientific community; one of the main themes that continues to reappear is the need to improve the education and training of digital forensics examiners. In other areas of forensic science, there are educational standards that have been set for many years. Many of them involve traditional classes where the students sit and listen to an instructor teach fundamentals essential to each professional in that area. Specialized classes conducted in laboratories with hands-on, interactive

methods of learning are also included in the curriculum, but not typically until the later part of these programs. These forensic science disciplines tend to put more emphasis on the interactive classes. However, no standard curriculum exists for digital forensics. In addition to the formal educational programs that lead to degrees in forensic science, continuing education is required to ensure the examiners' skills are up to date with evolving technology and new techniques. Continuing education training also lacks a standardized curriculum. Most of the time, it is left up to each individual laboratory to decide on the necessary training for their examiners. There seems to be no agreement on curriculum content or instructional methods.

Another obstacle, adding to the difficulty of coming to a common agreement is the fact that so many digital forensics examiners come from such diverse backgrounds. Some of the examiners have degrees in computer science while other examiners are criminal investigators trained to be digital examiners. Others have no background in either computer science or criminal investigation, but are now going to school to become digital forensics examiners. Educational institutions have a similar problem when attempting to teach students at the graduate level. Many of the graduate students are not required by the institution to have a degree in computer science in order to be accepted into their digital forensics programs. Some students will have a background in computers or criminal justice while others have a degree that is not related to either field. This dilemma poses several questions: How can we best educate this diverse group of people? What methods of instruction would best serve them? To answer these questions we needed to first figure out how students learn, and what learning strategies they employ.

Learning strategies of adults have been studied in other fields such as sales and therapy in an effort to determine the best way to teach their constituencies in order to promote effective learning. Although there have been many studies focused on the learning strategies of adults, there have been no studies describing the learning strategies of digital forensics examiners or those studying to become digital forensics examiners. Investigating the learning strategies of digital forensics examiners is important to help build the discipline's validity in the scientific community. Studying the learning strategies of digital forensics examiners and those studying digital forensics would open the door for building a curriculum geared towards those students. There would be a description of what instructional methods work best for these types of students, increasing the probability for learner success. Learning would be more efficient and meaningful. When these students graduate and pursue careers they will be more successful in the workforce since they will have a better understanding of the skills and expertise expected of them. In addition, the continuing education process would equally benefit from the understanding of learning strategies employed by those already working in the field.

Statement of the Problem

Digital forensics is a new discipline in comparison to other areas of forensic science. Forensic science education in these areas has become more established as a result. There has been more research on other types of forensic science curriculum. Although there are many different programs and methods of teaching digital forensics by multiple institutions and organizations, there is no agreement on what is important and what should be taught in each curriculum. Research is lacking in digital forensics that would fill this gap in knowledge. The learning strategies of adults have been studies in other areas to help understand what methods of

teaching are best for diverse groups of learners. Digital forensics examiners and students studying digital forensics come from such diverse backgrounds as computer science, criminal justice, chemistry, mathematics, and others. While some examiners have undergraduate degrees in these various areas, others have no degree at all and have obtained professional certifications in digital forensics. It is important to study the learning strategies of these groups to see if there is a commonality among these diverse backgrounds that would help identify the best instructional methods.

Forensic Science Education

As forensic science has evolved with advances in science and technology, more specified areas of forensics have emerged. Ballistics, DNA, psychology, entomology, toxicology, and digital forensics, are a few examples of these evolutions. As a result, there are already standardized curriculums for many of the "older" areas. In June 2004, the U.S. Department of Justice (DOJ) published "Education and Training in Forensic Science: A Guide for Forensics Science Laboratories, Educational Institutions, and Students." In this publication, the Department of Justice describes how educational institutions should set up their curriculum and structure their forensic science programs. They report that the increased demand for forensic scientists has placed more responsibility on these institutions. The report details requirements for all levels of education (undergraduate and graduate) and training and continuing education in forensics science. The undergraduate requirements include a list of classes that are traditionally taught through instructor lectures and note-taking. There are also laboratory courses that cover natural sciences as well as forensic sciences. The DOJ stresses extensive laboratory experience in both natural and forensic sciences. This program is not meant to produce case-ready forensics

scientists, but there should be a strong relationship between the institutions and forensic science laboratories in order to provide meaningful internships, employment opportunities, guest lecturers, adjunct faculty, direct interaction with forensic scientists, and cooperative research. The graduate program emphasizes interactive type classes. Students earning this degree are expected to be prepared for employment in operational forensic science laboratories. There is emphasis on the institution having interaction with operational laboratories at this level, as well, for many of the same reasons noted previously. The training instruction requirements also include a mix of traditional instructor led classes as well as student led classes. These classes are designed to achieve and maintain professional competency in forensic sciences. The model training criteria includes many topics to be covered including the history of the discipline, relevant literature, methodologies and validation studies, instrumentation, statistics, knowledge of related fields, and testimony. The DOJ report does not recommend instructional methods to be utilized in training or continuing education. They do, however, mention the usage of assessments. Assessment of learning can be done using oral exams, written exams, laboratory practicals and laboratory exercises, mock trials, and assessments by senior staff. (Department of Justice Office of Justice Programs, 2004)

Pennsylvania State University has developed an undergraduate program in forensic science. They report that building knowledge through practical training is the best approach. They stress that vocational programs lasting only two years are not adequate and universities should not build a forensics program around this kind of model. They also report a balanced undergraduate program should contain three components, “1) teach foundational scientific principles; 2) expand a student’s knowledge base through focused advanced casework and laboratory classes; and 3) allow students to sharpen their skills through aggressive, hands-on

instruction and practical experience" (Holland, Sykes, & Shaler, 2006, p. 3). This program also contains resources to help students identify their talents. "The sooner students identify their strengths, the sooner they can develop them and find career paths that are complimentary" (Holland, Sykes, & Shaler, 2006, p. 6). However, there are no studies testing the effectiveness of these programs.

A study in the area of forensic psychiatry used Problem-Based Learning (PBL) to determine if the students' level of comfort with different aspects of forensic psychiatry would increase. PBL is a method of teaching that uses hypothetical clinical cases, individual investigation, and group process instead of lectures. In this process the group leader's role is simply to assist the process rather than simply give answers. To evaluate its effectiveness, PBL was used in a pilot project to teach forensic psychiatry to psychiatric residents. The evaluation measures consist of four Likert-type scales measuring subjective individual comfort with forensic issues of violence, testimony, liability and competence on an ordinal scale - 1 = none and 5 = high. A similar five-point Likert-type scale was used to measure forensic knowledge base and another five point Likert-type scale to measure resident satisfaction with the educational program. The residents' comfort levels with testimony, liability and competence increased significantly. They also reported an increase in comfort with issues of violence. The ratings of the residents' knowledge base in forensic psychiatry also increased significantly at the end of the PBL course. The students worried that all topics were not covered in the PBL course, but appeared to be engaged and interested. They also gave the program moderately high ratings. PBL rated higher in the areas of student evaluations and clinical performances, and about the same in clinical and factual knowledge; showing the ability to apply their knowledge was increased more so than those who simply studied cases in books (Schultz-Ross & Kline, 1999).

Digital Forensics Education

Digital forensics is such a new discipline students are having a hard time finding research topics, and advances in this field are typically done as a reaction to a problem that has already been revealed (Nance, Hay, & Bishop, Digital Forensics: Defining a Research Agenda, 2009). In June 2008, a group of digital forensic researchers, educators, and practitioners met as a Digital Forensics Working Group in order to gather ideas for research topics, and research problems in digital forensics. They were able to come up with many ideas and organized them into categories/subcategories. One of the ideas discussed was "the challenges associated with educating the diverse constituencies who need digital forensics education and training" (Nance, Hay, & Bishop, Digital Forensics: Defining a Research Agenda, 2009, p. 4). The group goes on to report that research in education for digital forensics would help us to identify the educational methodologies, materials, and environments that would help educators in meeting the needs of the digital forensic examiners with such diverse backgrounds.

Another issue discussed in the literature is the need for digital forensics to be legitimized is the area of education and certification. Education is the foundation for defining what an "expert" should be. Experts should be well versed in the legal process, investigation techniques, psychological behavior and computer science. A common body of knowledge must be developed to establish what is generally accepted as common practice in digital forensics to further validate digital forensic evidence in the court system according to *Daubert v. Merrell Dow Pharmaceuticals, Inc* (Daubert v. Merrell Dow Pharmaceuticals, Inc, 1993). Since no common body of knowledge exists, there are few commonly accepted practice in digital forensics. This common body of knowledge must be driven by the applied experience of the

professional in the digital forensics field. The foundation is education; it must be continually supported by certification (Baggil & Kiley, 2007).

Certification should build off education and ensure the level of proficiency needed to investigate digital crimes. Proficiency exams would add to the credibility of an expert and the courts would be better satisfied at an expert's level of competency in the field. Certification tests must be administered at least every couple of years to guarantee they are keeping up with current technologies. A report in 2007, described what should be included in the digital forensic curriculum at the Associate, Baccalaureate, Graduate, Certificate, and Training and Continuing Education levels. At each level they describe a mix of traditional, instructor led type classes as well as hands-on, laboratory type classes. At the Associate, Baccalaureate, and Graduate levels they stress the importance of interaction with operational laboratories and suggestions for training and certification should extend learning opportunities and promote high standards of professional practices (West Virginia University Forensic Science Initiative, 2007). In the United States, a working group has convened to try to establish an essential body of knowledge in digital forensics. The CDFS's (Council of Digital Forensics Specialists) goal is to promote interest and protect the reliability of the digital forensics industry through standardization and self-regulation by doing five things: "1) uniting digital forensic specialists and industry leading organizations, 2) developing and compiling an essential body of knowledge from existing resources, to provide guidance and direction to educational and certification programs, 3) Identifying minimal qualifications, standards of practice, competencies, and background requirements, 4) creating a model code of professional conduct, and 5) representing the profession to federal and state regulators and other bodies" (Casey, 2009, p. 2). Developing a

standard will also help fulfill the need for digital forensics to have a stronger scientific foundation.

Champlain College, in Burlington, Vermont, did a study in 2005 of on-line classes in digital forensics verses traditional on campus courses. In this study, both types of classes had the same test and assignments. Students were allowed to freely register in each type of class, so there were different types of students in each class. The data showed that there was no significant difference in the course outcomes between the two types of classes. However, the average grades in the on-line classes were slightly higher. There were aspects of the on-line courses that certainly appealed to adult learners. The ability to work at their own pace or feeling more comfortable to have input in required class discussions are a few of these. However, there are some things, such as some hands-on exercises, that cannot be done in an on-line class. This study concluded that on-line learning is not for all students, but works well for some (Kessler, 2007).

Adult Learning Strategies

Significant research has been done on the learning strategies of adult learners. One of the leading studies was the Self-Knowledge Inventory Lifelong Learning Strategy (SKILLS) test developed by Gary J. Conti and Robert A. Fellenz in 1990. This test used 12 scenarios representing a real life learning situation. The subject's response to these scenarios puts them into different categories determining their learning strategies (Conti & Fellenz, 1991). This test, however, proved time consuming to take, and difficult to score. Each respondent had to answer questions concerning twelve real-life scenarios and then total the numbered answers in a box at the end to see their classification (Conti & Fellenz, 1991). As a result, in 1999, Conti and

Kolody developed another test called Assessing The Learning Strategies of AdultS (ATLAS) based off SKILLS that only included five test items organized in a flow chart, and the subject would only answer two to three of them, to determine their learning strategy. This test proved to be much more user friendly. ATLAS has been used in many studies, but it was initially developed for a study at Montana State University. It "undertook a long-range research and development project related to adult learning strategies" (Conti, 2009, p. 888). The learning strategies were separated into three groups, Problem-Solvers, Navigators, and Engagers.

The learning strategies of adults have been used in different areas. One study researched the relationship between learning strategies of patients and proper perception of the home exercise program with non-specific low back pain. Pivotal treatments of lower back pain are different exercises that are often presented to patients in a variety of forms. Cognitive factors can limit patients from learning the exercises correctly, however. The assessment of learning strategies of each patient was able to determine which method of instruction, whether it is face-to-face or use of media, was most effective. By specifying the instructional method to the type of learning strategy patients show significant increases in their ability to learn the exercises correctly (Yildirim & Soyunov, 2010).

Another study reported the connection of learning strategies with the cultural aspects of American Indian HIV/AIDS prevention. This study used a 10 point scale to determine acculturation in conjunction with Assessing the Learning Strategies of Adults (ATLAS) to identify the learning strategies of the respondents. It was discovered that the younger people in the study were less acculturated than their older counterparts. It was also revealed that those classified as Problem-Solvers or Navigators scored higher in Traditional Ways than those that

were classifies as Engagers. The study concluded that including cultural beliefs in teaching HIV/AIDS prevention was important to some, but it was not important to everyone. So it is imperative that each health care practitioner assess each client individually when providing education about HIV/AIDS to maximize patient understanding in the prevention and decrease the spread of HIV/AIDS in the American Indian people (McIntosh & Eschiti, Cultural Aspects of American Indian HIV/AIDS Prevention, 2009).

The literature studies of the learning strategies of adults using ATLAS has been useful to other groups; however, no studies have described the learning strategies of digital forensics examiners or students studying digital forensics. The descriptions of curriculum for the different areas of forensic sciences detailed all the classes that should be included, however, none of them studied which classes were more effective and why. All of the research concerning digital forensics detailed what the discipline lacked in order to make it more legitimate. Some even had suggestions on what needed to be done to establish legitimacy, yet none of them studied what types of classes were most effective for the learning strategies of the digital examiners or students studying digital forensics.

Purpose of the Study

The purpose of this study was to provide a description of the learning strategies of digital forensics examiners and digital forensic students in order to improve digital forensics education and training. Further, it examined the relationship between learning strategies and several demographic variables for digital forensic examiners and digital forensic students. The study also looked at the relationship between learning strategies of digital forensic examiners and digital forensic students.

Research Questions

1. What were the learning strategy preferences of digital forensic examiners as determined by Assessing The Learning Strategies of AdultS (ATLAS)?
2. What were the learning strategy preferences of students studying digital forensics as determined by Assessing The Learning Strategies of AdultS (ATLAS)?
3. To what extent was there a relationship between learning strategies and demographic variables of age, sex, race, education, major, and experience in the field?
4. Was there a difference in learning strategies between digital forensic examiners and students studying digital forensics as determined by Assessing The Learning Strategies of AdultS (ATLAS)?

Significance in the Field

This study will give educators of digital forensics examiners an idea of what methods will be more meaningful to the learners in their classrooms by providing a description of learning strategies employed by digital forensics examiners and those studying digital forensics. If the examiners prove to be mostly in one specific group, their training can be specifically geared towards that style and, as a result, enhance learning. This can also produce more successful professionals in the workplace by keeping them up to date on the most current methods and procedures in digital forensics.

Each learning strategy group develops different relationships with their instructors and puts different weights on different aspects of the learning process. If we can identify which group digital forensics students fall into, educators could develop their teaching strategies to

support the learning strategies of the students. This would engage the learners in the classroom and increase the probability for success in the programs. Also, if the students feel more engaged in the learning process the material will be more meaningful to them and they will be more productive professionals. In addition, if students are aware of their learning strategies, they can use this to their advantage. They will know where their strengths lie in the learning process and become aware of weaknesses. This would allow adjustments to be made easier, and help them understand why they are able to understand one task while another is so difficult. Then they can put together the necessary changes to be more successful at the task at hand.

Limitations

This study did not discuss what specific content should be included in a standardized curriculum. It simply described how digital forensics examiners/students approach problems using their learning strategies and what methods will best serve them in a learning environment. The number of participants in this study was limited to a convenience sample, broadening the study to include a broader sample should be done later. Therefore, the descriptions of the learning strategies of digital forensics examiners and students studying digital forensics were limited to those participants in this study. There were also the known limitations of survey research and self reported data. It was impossible to determine how accurate the responses to the survey items were for each examiner/students.

Review of Literature

Introduction

There are many diverse disciplines in the area of forensic science. Digital forensics is a more recent addition that has shown increasing importance with the evolution of technology. The other, more established, areas of forensic science have standardized curricula that are taught in educational institutions. The field of digital forensics lacks agreement on a standard curriculum. Each organization and laboratory has a different idea of what should be taught, and how it should be presented. Adult learning strategies have been used in studies to determine what method of instruction is best for a specific group. The use of the Assessing the Learning Strategies of Adults (ATLAS) test has made identifying these groups in each study less complicated. The need to identify these groups in the area of digital forensics is imperative to improve education and training programs.

The literature review will address three areas of research related to the study of the learning strategies of digital forensic examiners and students studying digital forensics. The first area will address research related to the area of forensic science education. The second section will focus on research in digital forensics. Finally, the third section will discuss research related to adult learning strategies.

Forensic Science Education

In June 2004 the National Institute of Justice published a report describing the best practices for educating and training forensic scientists. In the report's description of undergraduate and graduate programs it emphasizes a scientific core with additional hours devoted to the student's specific area of expertise. In the graduate program, the report also adds

laboratory experience. The undergraduate program is intended to produce graduates that are ready to enter a graduate program or traditional forensic science laboratory employment while students graduating with a Master of Science degree from the graduate programs are expected to be equipped to enter positions in operational forensic science laboratories. The report goes on to explain requirements for training and continuing education in forensic science. Exemplary programs should include periodic competency testing, laboratory practicals, and laboratory exercises (Department of Justice Office of Justice Programs, 2004). This report is generic in its description of each of these programs. It does not include details for any specific areas of forensic science, and it does not specify any curriculum for digital forensics.

A forensic science program offered at Pennsylvania State University is intended to produce graduates that are more prepared to handle the challenges faced in the forensic science field. The program emphasizes practical crime scene and laboratory education as well as instruction in the legal system. The program views the education of future forensic scientists in a more vocational approach, because of the many skills needed to be successful in the field such as how to identify and collect evidence, how it should be processed in the laboratory, and how the results are to be used in the legal system. Students are required to complete the typical basic education courses in mathematics and science, and when they graduate are seen as science professionals. Students experience their first hands-on type classes in their sophomore year. It is an intensive course that covers a plethora of investigative roles from the first responding officer to the collection and evaluation of different types of evidence. A cottage on campus is used to set up and act out mock crimes that are recorded on camera by faculty and friends. The students then process the scene to make their conclusions as to what happened based on the evidence. Then the students review the video to compare their results. The next series of courses in this

program are laboratory classes intended to duplicate an actual forensic lab. There are three labs, criminalistics, forensic biology, and forensic chemistry laboratories. The program hopes to help students to identify their strengths and weaknesses so they may pursue careers to emphasize these strengths and learn from their weaknesses (Holland, Sykes, & Shaler, 2006). There are no studies, however, that show these students are more successful in the workforce once they have graduated or that this method of teaching is more effective.

Problem based learning is a method that has been growing in the medical field. Problem based learning curriculum replaces typical teacher lead classes with group lead meetings where clinical problems are examined and discussed among the students. A study of this method of teaching was done in forensic psychiatry using residents in psychiatry. The purpose of the study was to determine if problem based learning was an effective method of teaching. The problem based learning program was offered over 2 years. Four hypothetical cases were written and used in the program. The residents attended 3 sessions where the scenarios were analyzed and each resident attempted to solve problems presented in each case. A Likert-type scale was used for the evaluations of student comfort level with the forensic issues in each case such as violence, testimony, liability, and competence on an ordinal scale from 1, no comfort, to 5, high comfort level. In addition, a similar scale was used to measure forensic knowledge base and student satisfaction with the course. The tests were given pre-program and again at the end of the program. The data was analyzed using Statistical Program for Social Scientists (SPSS). The comfort level with forensic issues among the students increased significantly by the end of the study starting with an average of 2.28 on the scale to a 3.3. The ratings of the student knowledge base also increased to a 3.06 from a starting value of a 2.5. The level of satisfaction with the course was also high, scoring 4.33 out of 5 (Schultz-Ross & Kline, 1999). The results show that

student competency increased as well as their comfort level with forensic psychiatry issues. The students appeared more engaged with the learning process, and more enthusiastic when discussing the cases. However, this study did not compare problem based learning with traditional learning. The program was also given in addition to traditional lecture based course that were offered at different times, not during the problem based program. More research was suggested to further investigate stand alone problem based learning programs in comparison to traditional programs (Schultz-Ross & Kline, 1999). This study was also limited to the area of forensic psychiatry, and did not explore the effectiveness of the program in other forensic science areas such as digital forensics. It also did no explore what learning strategies were more successful with this teaching method.

Animation has been used as a teaching tool to make material more interesting to students and to help them gain a better understanding of the subject matter being presented. In forensic pathology the use of different animation is used mainly to teach juries. The use of medical animation proves useful in this case since many jury members are not experts in the field. These animations can be anything from a scientific animation showing the processes of the human body to a forensic reconstruction of a crime scene. Animation used in the classroom can do more harm than good if not used properly. While the use of animations can prove to be more engaging to the students when learning a topic, the wrong lessons can be picked up from the animations. For instance, students who viewed animations about the diffusion of molecules in solution in one study learned incorrect ideas about molecular motion because the material in the animation had been simplified (Fisk, 2008). It was reported that the animations were more successful when students had more background knowledge prior to the animation being presented, and the animation is used as a supplement to the textbook material. Students with less spatial ability also

reported to benefit more from he animations. In addition, it is important for teachers to watch the animations to determine if they are simply entertaining rather than educational. This report did not, however, investigate the different learning strategies and how they benefited from the animations.

Digital Forensics Education

In June 2008, a group of digital forensics researchers, educators, and practitioners met as a Digital Forensics Working Group to develop ideas for research topics in digital forensics. The meeting focused on four main topic areas. The first was Process Control Systems, which are the systems often used in the corporate world. An area of concern in this topic was that the security community recognizes this as a threat, but it is not perceived as much of a threat by industry. As a result of this lack of recognition, this area is behind in most areas of security and is more vulnerable to attack. In addition to being vulnerable to attack, the systems were designed to control the processes but not to track them leaving a large gap in digital forensics evidence in these systems. The second area discussed was the challenges of educating the diverse constituencies needing digital forensics education and training. The third area was the overarching legal issues, both domestic and international, associated with digital forensics. Finally, the fourth topic is the need to improve the digital forensics collection and analysis processes through parallelization. Each topic leads back to the challenges in educating digital forensics examiners, which is the focus of this study. Research in education will help identify methodologies, materials, and environments that will assist educators in meeting the educational and training needs of the diverse students in their classrooms (Nance, Hay, & Bishop, Digital Forensics: Defining a Research Agenda, 2009). The Digital Forensic Working Group (DFWG)

did not discuss how to approach the issue of education, or if these constituencies possibly shared a common learning strategy.

The lack of qualified experts is another problem area in digital forensics. This is mainly due to a disagreement as to how we should define a digital forensics expert. Some argue that it should be based on knowledge, skills, and ability while others believe these criteria must be furthered by a formal degree program. Others argue that education should serve as the primary foundation for qualifying an expert. However, in order to do this there must be some agreement in the digital forensics community about what should be included in a standardized digital forensics curriculum. A major issue adding to this problem is that the digital forensics community has not established what basic knowledge, skills, and abilities each practitioner should have (Kasey, 2009). Since there is no common body of knowledge, there are few common standards and practices accepted by the digital forensics community (Baggil & Kiley, 2007). A group called the Council of Digital Forensic Specialists (CDFS) has begun to meet to discuss what should be considered an essential part of this body of knowledge, but are complicated by the multitude of specializations in the field and their varying needs (Kasey, 2009). This is made even more complicated by the exponential growth of technology and the inability of the digital forensics community to stay ahead of the changes. None of this discussion describes how a common body of knowledge could be based on the learning strategies of digital forensic examiners or students studying digital forensics.

A study was conducted in early 2006 to compare student performance in four different online and on-campus computer and digital forensics courses. The tests and assignments used in these courses were standardized instead of having assessments in each course made by the professors. The students enrolled in both types of courses consist of both traditional, full time

undergraduates and non-traditional continuing education adult learners. The study's results are based on a set of eight final grades, four from online courses and four from the on-campus courses, with no distinctions between the individual courses or instructors. Final grades from 176 students provided the data for this study. A factorial analysis of variance was used to measure the interaction between the course and instructional delivery mode (Kessler, 2007). The data showed that there was no significant difference in the outcome of each type of course, but the average grades in the online courses were slightly higher. One limitation of this study was that the students were not randomly selected for each course, the simply enrolled in the course they preferred. This may have had an affect on the overall grades since the students may have enrolled in the course that provoked the least anxiety, and, therefore, increased their performance (Kessler, 2007). It also did not account for any differences in the students such as age, race, gender, or learning strategies.

In 2007, the West Virginia University Forensic Science Initiative published a research report on the education and training in digital forensics. This report describes different curriculum requirements for each degree level for digital forensics. It stated that graduates of a two year program should have a basic understanding of the justice system, forensic processes, familiarity of common computer systems, understanding of electronic crime scenes and how to identify, document, and protect potential evidence, understanding of the principles of forensic acquisition, and of the forensic analysis of digital data (West Virginia University Forensic Science Initiative, 2007). It was suggested that students demonstrate their abilities in hands-on laboratory and field exercises included in the curriculum. The model curriculum for a Baccalaureate degree program emphasizes a strong foundation is computing as well as the non-technical skills needed to prepare students for successful work in the digital forensics field. It

should include the university's basic education courses in addition to courses in computing and information and a forensic science core. An internship was also strongly recommended to aid in student preparation for casework readiness upon completion of the program. Curriculum considerations for a Master's degree level program are Digital Forensics Methodology Development, Advanced Operating Systems Analysis, Digital Forensics Administration, Preservation of Evidence, Criminal and Civil Legal Issues, Complex Data Analysis, Complex Case Studies/Simulations, and Data Communications and Network Systems (West Virginia University Forensic Science Initiative, 2007). In addition to the coursework, students are expected to complete a research project that will be presented in a public forum prior to graduation. Training and continuing education curriculums should be designed to include both discipline specific and core elements. Core elements include standards of conduct, safety, policies, legal, evidence handling, etc. Discipline specific topics are the history of the discipline, relevant literature, methodologies and validation studies, hardware, software, and other digital media, knowledge of related fields, testimony, training specific to particular types of crime, and knowledge of legal aspects. Assessment mechanisms may include oral exams, written exams, scenario-based practical exercises, mock trials, and assessments of technical performance by senior staff (West Virginia University Forensic Science Initiative, 2007). Each of these programs have suggested requirements, but none of these describe what teaching methodologies should be utilized or which would be more successful in teaching the material.

Adult Learning Strategies

The Self-Knowledge Inventory of Lifelong Learning Strategies (SKILLS) was developed in 1990 to measure adult learning strategies in real-life learning situations (Conti & Fellenz, Assessing Adult Learning Strategies, 1991). This test consisted of twelve real world

scenarios that necessitate different levels and types of learning. It could be completed in less than twenty minutes and then self scored. Since its development, SKILLS has been used in numerous studies with diverse populations with different ages, races, and educational backgrounds. These studies found that selected demographic variables were not a factor in determining the learning strategy (Conti, 2009). The same studies were also able to show different types of learning groups were identified when they are identified by the types of learning strategies they use. With this information the tool Assessing The Learning Strategies of AdultS (ATLAS) was developed as an assessment tool that would be quickly administered and easily scored. Using the ATLAS tool a participant is placed into one of three main categories. The first group was identified as the Engagers. People in this group will decide whether a task is worth finishing based on their feeling that they will enjoy doing so. The other two groups identified were Navigators and Problem solvers. These groups will both approach a problem by looking for resources that will help them accomplish a task. The difference between Navigators and Problem Solvers is that Navigators are more concerned with identifying what needs to be learned while Problem Solvers are more concerned with identifying a variety of solutions for the problem. The knowledge of these groups, and their differences, can be helpful to both the learners and their teachers in that being aware of how they approach a learning task can allow for design and implementation of curriculum to be more specific to these learning strategies (Conti, 2009).

Adult learning strategies have been examined and utilized in many different studies. One study looked at how learning strategies could be utilized to improve education of HIV/AIDS prevention among American Indians. "The purpose of this study was to describe what cultural strategies are important in HIV prevention for American Indians who live in Oklahoma"

(McIntosh & Eschiti, Cultural Aspects of American Indian HIV/AIDS Prevention, 2009, p. 71). Even though American Indians share many inherent philosophies and cultural values they are one of the most culturally diverse ethnic groups in the United States. To gather information in the American Indian community permission must be granted through elders. In this study 11 elders, or gatekeepers, were recognized in tribes across Oklahoma in order to identify participants for the study. They were representative of the Association of American Indian Physicians in Oklahoma City, Bacone College in Muskogee, Cherokee Nation, HIV/AIDS Department in Tahlequah, Claremore Indian Hospital, College of Nursing at University of Oklahoma in Lawton, Eufala Indian Hospital, Indian Health Care Resource Center, an urban Indian health clinic in Tulsa, Kaw Nation Health Center in Kaw City, Lawton Indian Hospital, an Indian Service Facility, Muscogee/Creek Nation in Okmulgee, and Western Oklahoma AIDS Task Force in Oklahoma City (McIntosh & Eschiti, Cultural Aspects of American Indian HIV/AIDS Prevention, 2009). There were 471 participants ranging in age from 18 to 89 years of age. The results showed an unusually low number of Navigators (29%) and an increased number of Problem Solvers (35%) and Engagers (34%) (McIntosh & Eschiti, Cultural Aspects of American Indian HIV/AIDS Prevention, 2009). It was determined that health care professionals will need to assess each client individually when providing education for the prevention of HIV/AIDS. In order to increase understanding, the teaching methods will need to be approached with the needs and cultural practices of each client in mind. This study addressed many other aspects besides just the learning strategies in order to increase the success of educating American Indians for the prevention of HIV/AIDS. The study did not address how other demographic variables, such as levels of education, may influence the type of learning strategy. The study was also limited the study to the American Indian community.

Another study examined learning strategies of patients with lower back pain. Low back pain is a major cause for increased health care costs, working and functional disability. Being able to correctly perform the prescribed exercises is very important. A theory for the failure of the patients' ability to perform these exercises is that some cognitive factors may be limiting the correct learning of these exercises. It is important to address the methods of instruction for these exercises and patient motivation in order to successfully teach them and have patients be able to repeat them correctly. There were a total of 26 participants in this study that were referred to therapy fro non-specific low back pain. Each subject was randomly assigned to the control group or the experimental group. ATLAS was conducted manually in order to determine each patient's learning strategy. Patients in the control group were then taught the exercises using the traditional methods. Patients in the experimental group were taught using the method with a specified describing style in accordance with ATLAS. The instructors assisted patients in the navigator groups with assessing schedules and deadlines, outlining specific learning objectives, summarizing main points and giving feedback, and previewing instructional goals for subsequent instructional exercise sessions. The instructor role in the Problem Solver group was to provide an environment of practical experimentation, give examples from personal experience, assess learning with open-ended questions and problem-solving actions. Instructors in the Engager group would find it more helpful to focus on the task rather than the evaluation while encouraging personal exploration or learning. Group work may also be beneficial and would help to create a positive environment (Yildirim & Soyunov, 2010). Each exercise was presented to the patients for the first two days and were then asked to repeat them at home for a week. To compare the groups Mann-Whitney U-test, chi-square tests were used. Spearmann correlation tests were also used to investigate relationships between proper perception and various personal

factors. When functionality levels were compared in each group at the beginning of the study there were no significant differences. At the end of the study, Exercise Assessment Scales were compared in both groups and a significant superiority in the experimental group was shown. After analyzing the data, the study determined that the typical method of teaching the exercises was not adequate, and collaborating the teaching methodology with the learning strategies as determined by ATLAS was more successful.

There is solid theory and research that relates "adult learning and an awareness that blended learning that combines online and face-to-face components can produce unique and effective learning experiences" (Ausburn, Course Design Elements Most Valued by Adult Learners in Blended Online Education Environments: An American Perspective, 2004, p. 328). Sixty-seven subjects enrolled in a large state university in the United States were involved in a study whose purpose was "to identify the instructional features selected as the most important by this group and to compare the group rankings with those of various sub-groups based on learner variables frequently identified in the literature as related to preference and performance in distance learning" (Ausburn, Course Design Elements Most Valued by Adult Learners in Blended Online Education Environments: An American Perspective, 2004, p. 329). The data for this study was obtained using a questionnaire developed by the author and the ATLAS test. The results showed a fairly even distribution among the learning strategies as determined by ATLAS. The results of the study suggest that the principles of adult learning should be considered when designing courses that will attract and retain adult students (Ausburn, Course Design Elements Most Valued by Adult Learners in Blended Online Education Environments: An American Perspective, 2004).

Summary

In order to move digital forensics in the direction of becoming legitimized in the scientific community, as well as the forensic science community, it needs to have a common body of knowledge. When we examine studies in forensic science education we see that hands-on, problem based learning is a more effective method of teaching then traditional lecture-based teaching. There are no studies that examine which methods are more effective in digital forensics. Literature in the field of digital forensics discusses the importance of establishing a common body of knowledge in order to better define a digital forensics expert and further the discipline in the scientific community. There are no studies that address how this common body of knowledge should be developed and what design this methodology should be based on. Studies about adult learning strategies show that when learning strategies are examined and used as a basis for designing a course, learning is more valuable to the students. Again, there are no studies examining the learning strategies of students studying digital forensics or individuals already working the field as digital forensics examiners. This study determined what learning strategies are predominant in digital forensics examiners and students studying digital forensics allowing educators to better design courses geared towards their students providing a way for educators and trainers can make courses more meaningful to digital forensics examiners.

Methods

Introduction

The purpose of this study was to provide a description of the learning strategies of digital forensics examiners and digital forensic students in order to improve digital forensics education and training. Further, it examined the relationship between learning strategies and several demographic variables for digital forensic examiners and digital forensic students. The study also looked at the relationship between learning strategies of digital forensic examiners and digital forensic students.

The following research questions were addressed in this study:

1. What were the learning strategy preferences of digital forensic examiners as determined by Assessing The Learning Strategies of AdultS (ATLAS)?

2. What were the learning strategy preferences of students studying digital forensics as determined by Assessing The Learning Strategies of AdultS (ATLAS)?

3. To what extent was there a relationship between learning strategies and demographic variables of age, sex, race, education, major, and experience in the field?

4. Was there a difference in learning strategies between digital forensic examiners and students studying digital forensics as determined by Assessing The Learning Strategies of AdultS (ATLAS)?

The data for this descriptive study was gathered using an online survey. The survey collected demographic data and then each participant completed the Assessing the Learning Strategies of AdultS (ATLAS) instrument.

Sample/Participants

Participants in this study were students studying digital forensics and digital forensics examiners. The student participants were part of a convenience sample chosen because of their enrollments in digital forensics courses. Digital forensics examiners were recruited as the remaining part of the convenience sample from the International Association of Computer Investigation Specialists (IACIS) via the IACIS list serve, iacis-l@ops.org, where a link to the survey was posted for the digital forensics examiners to take if they so choose. The announcement posted read:

"Dear IACIS List Serve Members,

The purpose of this survey is to collect data about digital forensics examiners and students studying digital forensics in Oklahoma in order to identify specific demographic information (age, sex, years of experience, etc...), and identify the learning strategies of each individual. The survey will take approximately 10 minutes to complete. All submissions will be completely anonymous. Participation in this survey is voluntary. The information will be gathered in aggregate, data combined from several measurements, and at the end of this study the data collected will be destroyed.

Rachael Elliott is the Principal Investigator on this study and it has been approved by the UCO Institutional Review Board. If you have any further questions, please feel free to contact Rachael by email at relliott@uco.edu. You must be 18 years of age or older to participate in this study."

Professors at universities offering digital forensics' programs were contacted and asked to provide the survey's link to their students so they could choose to participate in this study. The announcement used for the students was:

"Dear Students,

The purpose of this survey is to collect data about digital forensics examiners and students studying digital forensics in Oklahoma in order to identify specific demographic information (age, sex, years of experience, etc...), and identify the learning strategies of each individual. The survey will take approximately 10 minutes to complete. All submissions will be completely anonymous. Participation in this survey is voluntary. The information will be gathered in aggregate, data combined from several measurements, and at the end of this study the data collected will be destroyed.

Rachael Elliott is the Principal Investigator on this study and it has been approved by the UCO Institutional Review Board. If you have any further questions, please feel free to contact Rachael by email at relliott@uco.edu. You must be 18 years of age or older to participate in this study."

The student sample of participants was limited to those students at educational institutions that offered digital forensics courses in Oklahoma. As a result of the different number of enrollments in each course and the inability to determine the number of participants from each institution, the sample was not an even distribution of all digital forensics students.

The examiner sample was limited to those who are members of International Association of Computer Investigation Specialists. Since not all digital forensics examiners are

members of this organization the sample was limited to those examiners that participated in the study.

Data Collection Procedures

Data collection for this study began in spring of 2011. Participants in the study were given the link to the online survey where they first encountered an informed consent page for them to read and agree to. If they indicated they did not want to be a part of the survey, it did not allow them to go any further into the survey. When they agreed to the informed consent they then entered the survey and were asked demographic questions followed by the ATLAS test items. The data collected was kept anonymous. None of the questions asked in the survey could be used to identify the participants. The responses were saved in the online database that was password protected.

This study used an online survey to collect demographic information of digital forensics examiners and students studying digital forensics and administer the Assessing The Learning Strategies of AdultS (ATLAS) instrument to determine their learning strategies. Online surveys share the same strengths as their paper versions, but online surveys are better at addressing sensitive issues because of their anonymity. They are cost efficient in that administrators do not have to travel or use paper to give the surveys. The results are received faster and are easily accessed. They are easily designed and there are unlimited design options. When designing surveys that use skip logic online surveys minimize confusion for the participants. They also have the ability to offer immediate statistical results. There are some disadvantages to using online surveys, however. The participants can experience technical difficulties while completing

the surveys and no interviewer is present to clarify any questions on the test items. The online surveys also do not prevent multiple survey submissions by the same respondent.

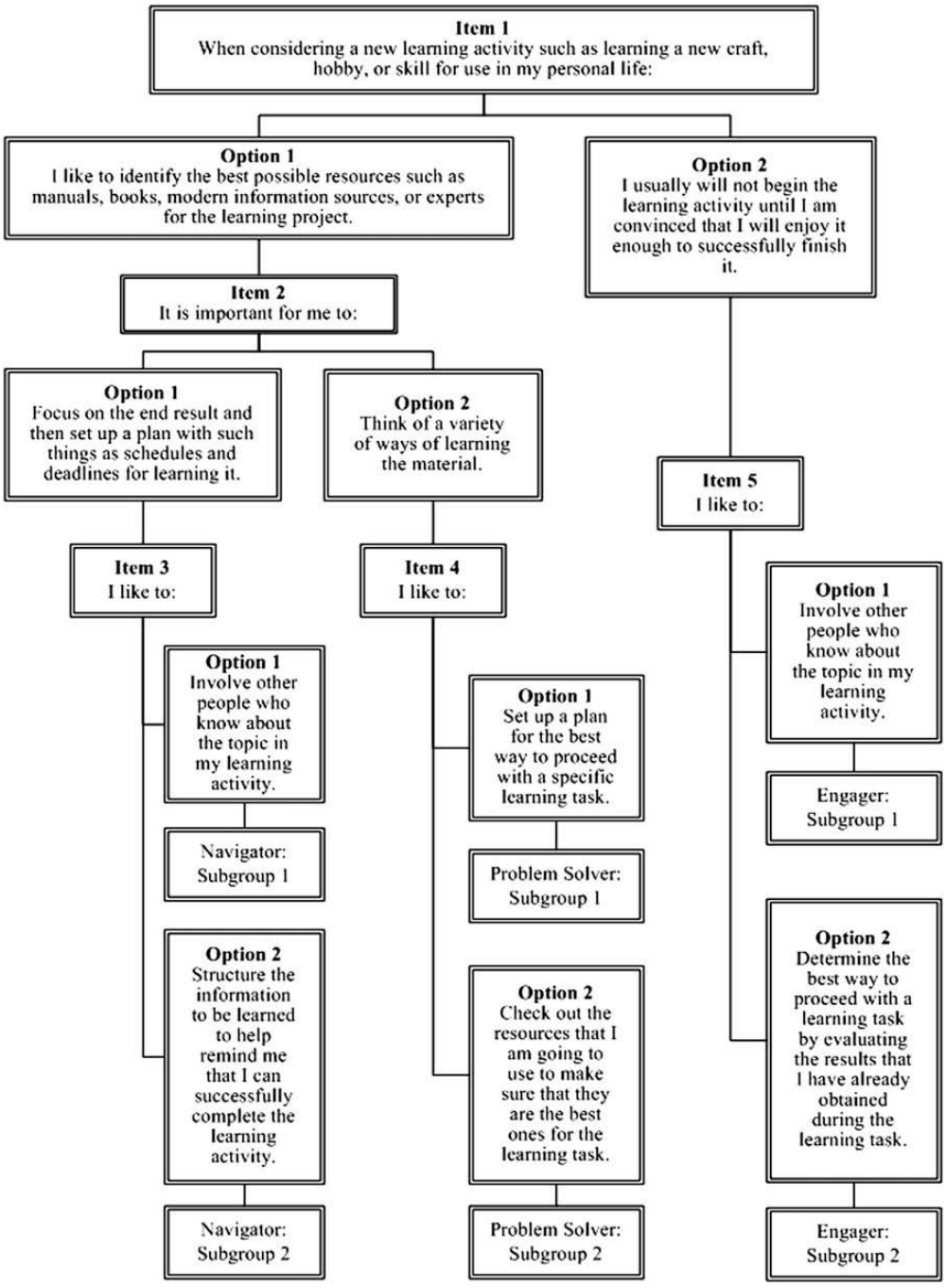
The program Survey Monkey was used to administer the survey to each of the participants. The survey design began with a group of demographic questions, such as age and sex. The participants who identified themselves as digital forensics examiners were then asked how many years of experience they have, what their education background is, and what type of agency they work for. The participants who identified themselves as students were separated into graduate and undergraduate students. The graduate students were asked what type of undergraduate degree they hold while the undergraduates were asked what their major course of study. All student participants were asked how many hours of digital forensics courses they have taken/will take in their program. Then all the participants are guided through the five test items of Assessing The Learning Strategies of AdultS (ATLAS).

Measurement Instrument

The Assessing the Learning Strategies of AdultS (ATLAS) instrument was used to place each participant into their primary learning strategy. The groups were Engagers, Problem Solvers, and Navigators. The five items that identify the learning strategies were as follows: Item 1- When considering a new learning activity such as learning a new craft, hobby, or skill for use in your personal life: Option 1- I like to identify the best possible resources such as manuals, books, modern information sources, or experts for the learning project. Option 2- I usually will not begin the learning activity until I am convinced that I will enjoy it enough to successfully finish it. Item 2- It is important for me to: Option 1- Focus on the end result and then set up a plan with such things as schedules and deadlines for learning it. Option 2- Think of a variety of

ways of learning the material. Item 3- I like to: Option 1- Involve other people who know about the topic in my learning activity. Option 2- Structure the information to be learned to help remind me that I can successfully complete the learning activity. Item 4- I like to: Option 1- Set up a plan for the best way to proceed with a specific task. Option 2- Check out the resources that I am going to use to make sure that they are the best ones for the learning task. Item 5- I like to: Option 1- Involve other people who know about the topic in my learning activity. Option 2- Determine the best way to proceed with a learning task by evaluating the results that I have already obtained during the learning task (Conti, 2009). (See Figure 1)

Figure 1 - Flowchart of ATLAS



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The results of the survey were analyzed to find the predominant learning strategy of digital forensics examiners, as well as, the leading learning strategy among the students. The responses were also analyzed to determine if any differences appeared between the examiners

and the students. The results were also looked at to find out if there was a relationship between the demographic information and the learning strategies.

Validity and Reliability of ATLAS

Assessing the Learning Strategies of AdultS (ATLAS) was developed from the Self-Knowledge Inventory Lifelong Learning Strategy (SKILLS) test (Conti, 2009). The ATLAS reliability and validity was tested and proven in previous studies. The order of the question items was determined by what characteristics differentiated each learning strategy. The learning strategies associated with identification of resources, finding books, manuals, or experts that would help with a project, and critical use of those resources, versus confidence and reward for completing the project proved to be 96.1% accurate in discriminating between Navigators and Problem Solvers in one group and Engagers as another group (Conti, 2009). So the first item in ATLAS requires the respondent to choose between these concepts. Navigators prove to be more concerned with identifying what exactly needs to be learned and developing a plan for learning it while Problem Solvers are more concerned with identifying a variety of solutions. This process proved 98.3% accurate in discriminating between Navigators and Problem Solvers (Conti, Development of a User-Friendly Instrument for Identifying the Learning Strategy Preferences of Adults, 2009). In the Problem Solver group there were two subgroups. The first subgroup has a stronger preference for Planning while the other subgroup relies more on Critical Use of Resources, identifying the members of the two subgroups proves 79.3% accurate (Conti, Development of a User-Friendly Instrument for Identifying the Learning Strategy Preferences of Adults, 2009). The Engager group also has two subgroups. The first subgroup has a stronger preference for the Use of Human Resources while the other group relies more on Planning and Conditional Acceptance. The accuracy of discriminating between these subgroups was 82.2%

(Conti, 2009). The two subgroups of Navigators are discriminated by one subgroup's strong preference for Human Resources while the other subgroup is more concerned with the Organization of material into meaningful patterns. This process proves 80.2% accurate in discriminating between these subgroups (Conti, 2009). ATLAS' criterion-related validity was established in three ways. The first was by comparing the response of the ATLAS preference groups and the specific items from the SKILLS hat were used to identify them. Second, subjects completed four scenarios from SKILLS that were modified to have two items that reflected the learning strategies from the discriminant analysis results that were used for forming the preference groups in ATLAS. Third, the subjects were asked to read the descriptions of the ATLAS group they had been placed in and report on how accurate they felt the description was. Finally, the reliability of ATLAS was established by the test-re-test method which shows the extent to which the scores on the same test stay constant over time (Conti, 2009). The three learning strategy groups have been consistent among most adult populations with 36.5% classified as Navigators, 31.7% as Problem Solvers, and 31.8% as Engagers. However, there was a study that found that among adults that did not complete high school returning to education, first-generation American community college students, adult learners at a two-year technical college, and at-risk urban youths the distribution differed significantly than that of the general population. These groups are more commonly known as "non traditional learners". In this study, Engagers were the predominant group, needing more "hands on" type classes (Ausburn & Brown, Learning Strategy Patterns and Instructional Preferences of Career and Technical Education Students, 2005). These studies are helpful by knowing that separating different types of groups may result in different learning strategies. Using the ATLAS

instrument to determine the learning strategies of digital forensics examiners provided a valid and reliable instrument for this study.

Data Analysis

Descriptive statistics were used to report the results of the demographic data collected and preferred learning strategies. The results were examined to determine which learning strategy was predominant among examiners, which learning strategy was predominant in students, if the demographics had a relationship with the learning strategies, and if the learning strategies of examiners differed from the learning strategies of the students. A chi-square test was used to compare the groups learning strategy responses in the study to the normal distribution of learning strategies according to Assessing the Learning Strategies of AdultS (ATLAS).

Findings

The findings in this study were based on information collected from 26 digital forensics examiners and 23 students studying digital forensics (N = 49). These participants from a convenience sample completed an online survey using the web-based program Survey Monkey. They answered questions related to demographics and then completed the Assessing The Learning Strategies of AdultS (ATLAS) instrument.

Research Questions

This study attempted to answer the following research questions:

1. What were the learning strategy preferences of digital forensic examiners as determined by Assessing The Learning Strategies of AdultS (ATLAS)?
2. What were the learning strategy preferences of students studying digital forensics as determined by Assessing The Learning Strategies of AdultS (ATLAS)?
3. To what extent was there a relationship between learning strategies and demographic variables of age, gender, race, education, major, and experience in the field?
4. Was there a difference in learning strategies between digital forensic examiners and students studying digital forensics as determined by Assessing The Learning Strategies of AdultS (ATLAS)?

Analysis

The demographic questions in the survey revealed that 37.3% of the participants were ages 18 to 29, 19.6% were between the ages of 30 to 39, 27.5% were between 40 and 49, and 15.7% were 50 to 59. (See Figure 2) There were no participants above the age of 59. 56.9% of

respondents were male while 43.1% were female. This was not far from the percentages of males and females from Oklahoma, 49.5% male and 50.5% female, and the United States, 49.2% males and 50.8% female (2010 Census, 2010). (See Figure 3)

Figure 2 - Age Ranges of Participants

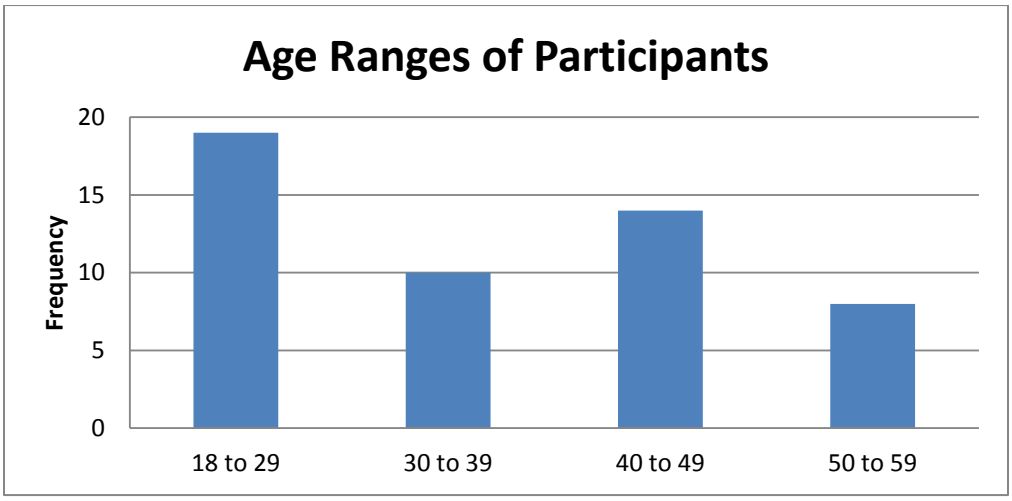
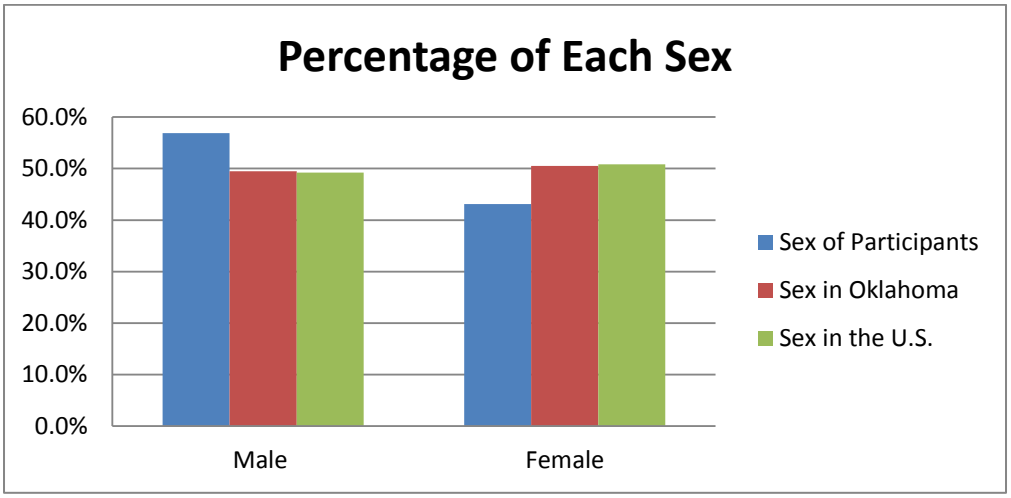


Figure 3 – Comparison of Sex of Participants and General Population



The respondents were evenly distributed between examiners and students with 53.1% of the participants classified as digital forensics examiners and 46.9% being students. The survey

found that 88.5% of those digital forensics examiners worked in law enforcement agencies and 11.5% worked in a private industry. The digital forensics examiners identified as working for law enforcement agencies were 26.1% local agents, 26.1% county, 30.4% state, and 21.7% federal. In the group of digital forensics examiners, 30.8% completed some college while 38.5% held a Bachelor's degree, 23.1% held a Master's degree, and 7.7% held a Doctorate. (See Figure 4) 38.5% (10 of 26) had a major in Criminal Justice, 7.7% (2 out of 26) majored in Forensics Science, 7.7% (2 out of 26) majored in Computer Science, and 46.2% (12 out of 26) majored in an area that was different than the three previous areas. (See Figure 5) Some of the other majors listed by this group were: Video, Radio TV and Film, Psychology, English, Business Administration, Political Science and History, and Sociology. The majority of the examiners, 50.0%, had 6 to 10 years of experience in the field. 23.1% had 1 to 5 years of experience, 19.2% had 11 to 15 years, and 7.7% had 16 to 20 years of experience. None of the respondents had less than one year of experience or more than 20 years of experience.

Figure 4 - Education Level of Digital Forensics Examiners

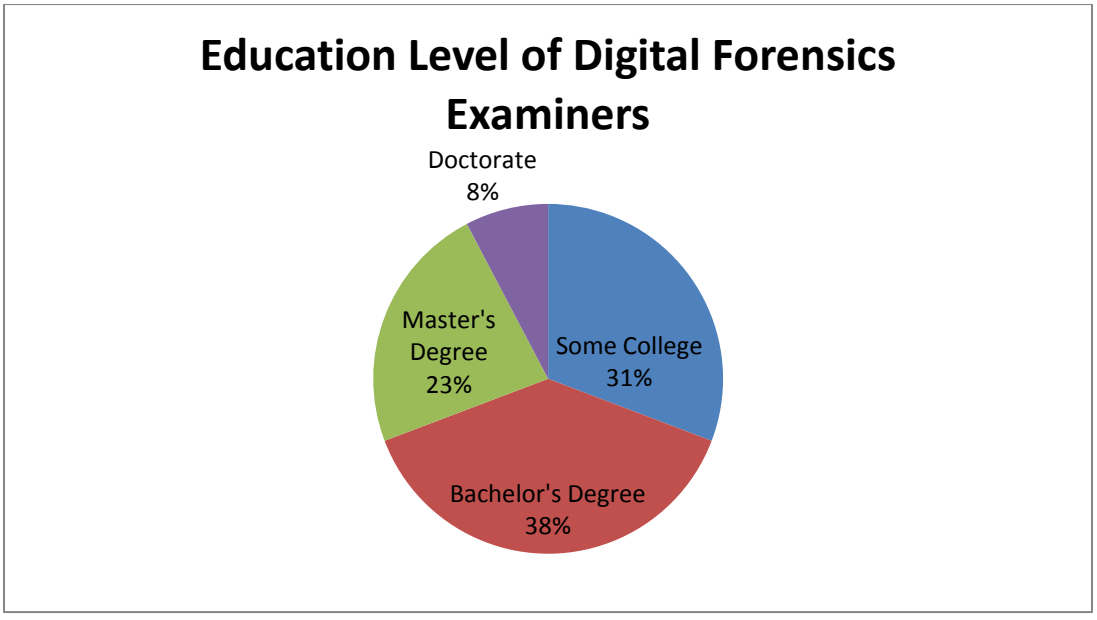
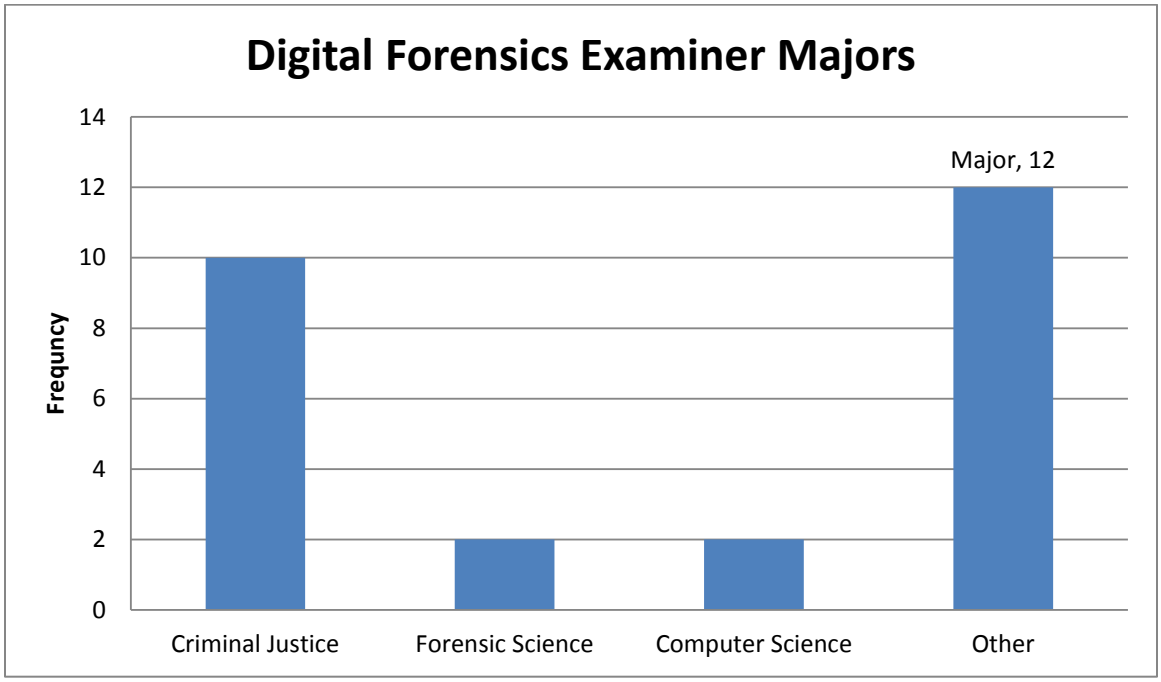


Figure 5 - Digital Forensics Examiners Majors



Students that participated in this study were 46.9% of respondents. In this group, 60.9% of them were undergraduate students and 39.1% of them were graduate students. (See Figure 6) The undergraduate students' major was predominantly Forensic Science at 92.9%. The Criminal Justice majors represented 14.3% of this group, and 21.4% were Computer Science majors. (See Figure 7) Other undergraduate majors listed were Psychology, Political Science, and Nursing. 11.1% of graduate students held an undergraduate degree in Criminal Justice, 11.1% held an undergraduate degree in Computer Science, and 33.3% held a degree in Forensic Science. The majority of graduate students held an undergraduate degree in an area other than Criminal Justice, Computer Science, or Forensic Science. (See Figure 8) 44.4% of graduate students listed they held degrees in areas such as Mathematics, Chemistry, and Criminology. Students studying digital forensics will take or had taken a wide range of hours in digital forensics. The majority of students, 39.1%, will have taken 0 to 3 credit hours while 34.8% will have taken 4 to

6 hours, 4.3% will have taken 7 to 9 hours, and 13.0% will have taken 10 to 12 hours. There were no students that participated in this study that will take 13 to 15 hours, but 8.7% will have taken more than 16 hours.

Figure 6 - Student Level

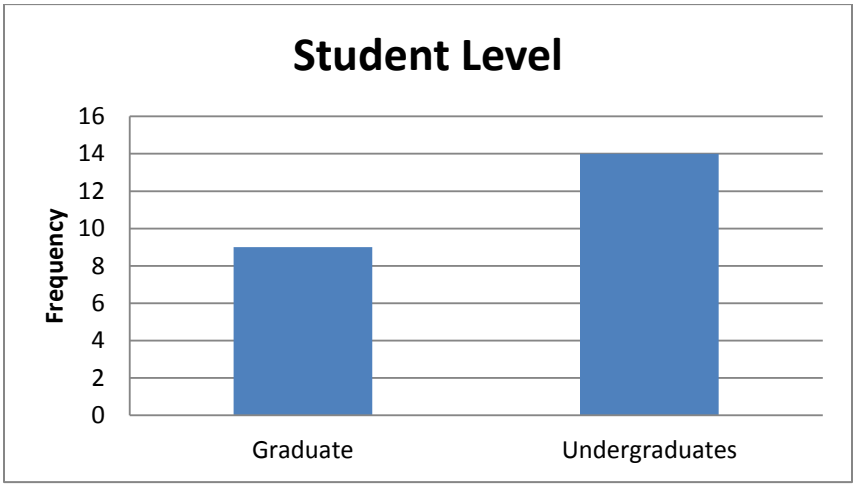


Figure 7 - Majors of Undergraduate Students

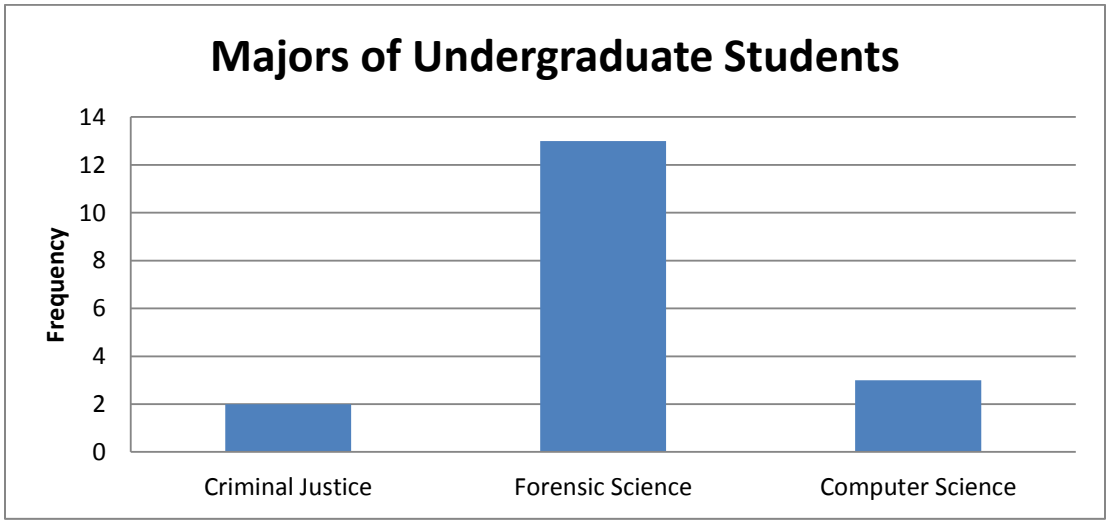
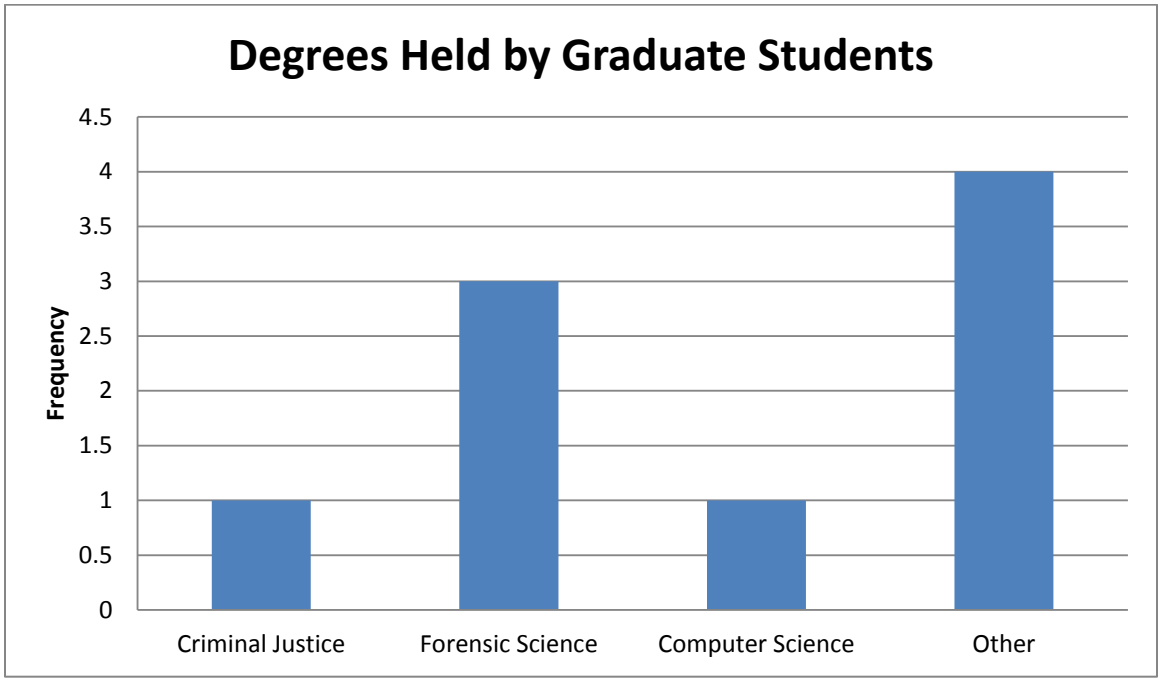
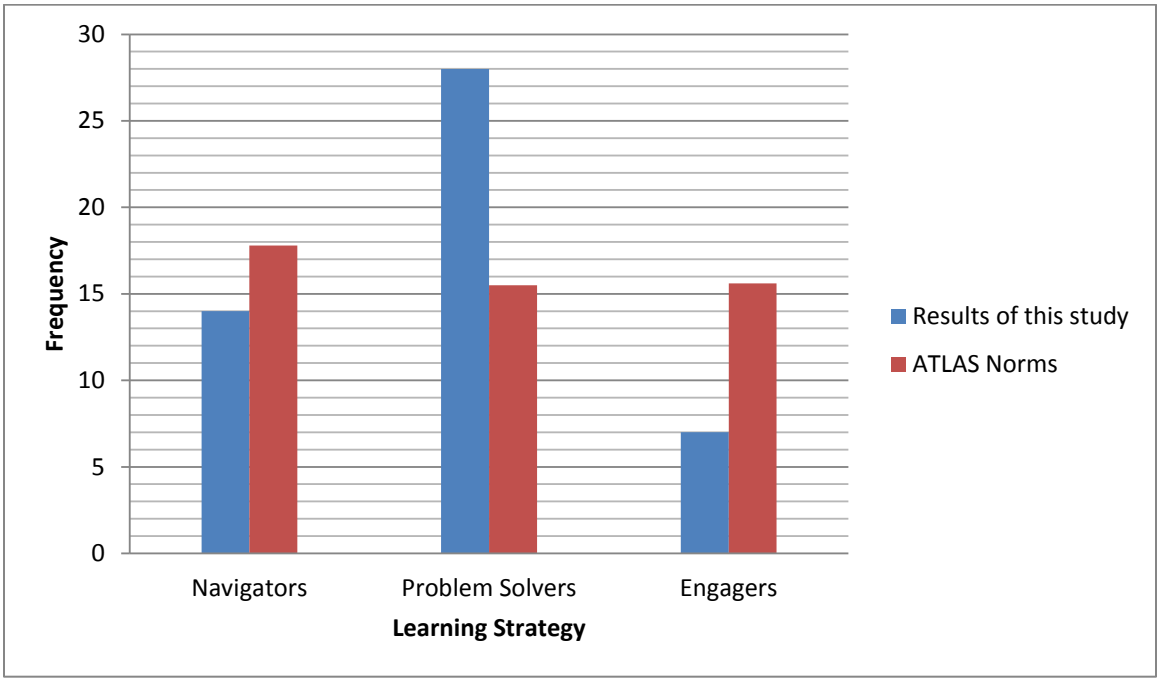


Figure 8 - Degrees Held by Graduate Students



Results from the Assessing The Learning Strategies of AdultS (ATLAS) were significantly different when compared to the normal distribution of learning strategies which are normally fairly evenly distributed among the three groups. (See Figure 9) The data from this survey showed 32.7% of respondents were classified as Navigators where the norm is 36.5%, 55.1% were classified as Problem Solvers where the norm is 31.7%, and 12.2% were classified as Engagers where the norm is 31.8%. See figure 7. The 14 respondents that were classified as Navigators, 9 of them were further classified into subgroup 1 and 5 into subgroup 2. 11 of the 28 participants in this study that were identified as Problem Solvers were placed into Problem Solver subgroup 1 and 17 placed in subgroup 2. Of the 7 respondents identified as Engagers, 5 were placed in subgroup 1 and 2 in subgroup 2.

Figure 9 - Comparison of ATLAS Norms to the Results of This Study



Additional chi-square tests were performed to investigate any relationship between preferred learning strategies of the 49 digital forensics examiners and students studying digital forensics that participated and the other demographic variables of sex, status, private or law enforcement, graduate or undergraduate, age, education level, and major. A series of two-way chi-square tests treated each demographic variable as the independent variable and the learning strategy preference as indicated by ATLAS type as the dependent variable. The chi-square analysis was appropriate because these variables contain categorical data. A criterion level was set at .05.

A chi-square analysis was performed to determine if there was a significant relationship between the preferred learning strategy and the sex of the participants. The participants were

grouped by three categories of Navigator, Problem Solver, or Engager and by the binary sex categories of male or female. No significant relationship was found between the preferred learning strategy and the gender of the participants (X^2 = 1.992, df = 2, p = .369).

A chi-square analysis was performed to determine if there was a significant relationship between the preferred learning strategy and the status as a digital forensic examiner and student studying digital forensics of the participants. The participants were grouped by three categories of Navigator, Problem Solver, or Engager and by the binary status category of digital forensic examiner or student studying digital forensics. No significant relationship was found between the preferred learning strategy and the status of the participants (X^2 = .522, df = 2, p = .770).

A chi-square analysis was performed to determine if there was a significant relationship between the preferred learning strategy and the digital forensics examiners that are in the private industry and those in law enforcement. The participants were grouped by three categories of Navigator, Problem Solver, or Engager and by the binary status category of private industry or law enforcement. No significant relationship was found between the preferred learning strategy and the status of the participants (X^2 = .633, df = 2, p = .729).

A chi-square analysis was performed to determine if there was a significant relationship between the preferred learning strategy and the student status as an undergraduate or graduate student of the participants. The participants were grouped by three categories of Navigator, Problem Solver, or Engager and by the binary status category of undergraduate or graduate. No significant relationship was found between the preferred learning strategy and the status of the participants (X^2 = .3.212, df = 2, p = .201).

A chi-square analysis was performed to determine if there was a significant relationship between the preferred learning strategy and the age of the participants. The participants were grouped by three categories of Navigator, Problem Solver, or Engager and by the binary status category of dages 18 to 39 years or 40 and older. No significant relationship was found between the preferred learning strategy and the status of the participants (X^2 = .426, df = 2, p = .808).

A chi-square analysis was performed to determine if there was a significant relationship between the preferred learning strategy and the status of digital forensics examiners' major. The participants were grouped by three categories of Navigator, Problem Solver, or Engager and by the binary status category of major of criminal justice, forensic science, or computer science or another major. No significant relationship was found between the preferred learning strategy and the status of the participants (X^2 = .348, df = 2, p = .840).

A chi-square analysis was performed to determine if there was a significant relationship between the preferred learning strategy and the status of majors of the students studying digital forensics. The participants were grouped by three categories of Navigator, Problem Solver, or Engager and by the binary status category of major in criminal justice, forensic science, or computer science or another major. No significant relationship was found between the preferred learning strategy and the status of the participants (X^2 = 3.457, df = 2, p = .178).

A one-way chi-square goodness of fit test was done to determine if this distribution of digital forensics examiners and students that were studying digital forensics would be expected by chance. The frequencies of learning strategy preference found in this study were significantly different for the expected frequencies based on the ATLAS norms ($x^2 = 13.185$, df = 2, p = .001) (See Figure 10)

Figure 10 - ATLAS

ATLAS

	Observed N	Expected N from ATLAS Norm	Residual
Navigator	14	18.0	-4.0
Problem Solver	28	16.0	12.0
Engager	7	15.0	-8.0
Total	49		

Discussion

Digital forensics is a discipline of forensic science that has developed in the past 30 years. Digital forensic examiners have various backgrounds, as do the students studying digital forensics, which has made educating this diverse group of constituencies complicated. Studies have been done in other, more established areas of forensic science, but none of those studies have addressed learning strategies, what standards should be taught in a standardized curriculum for digital forensics, or what instructional methods are effective for digital forensics examiners or students studying digital forensics.

The purpose of this study was to utilize an online survey to provide a description of the learning strategies of digital forensics examiners and digital forensic students in order to improve digital forensics education and training. It also examined the relationship between the learning strategies of the students studying digital forensics and digital forensics examiners already working in the field. The demographic data of this group was also examined in order to identify a relationship, if any, between the demographics and the learning strategies.

Discussion

In June 2008, a Digital Forensics Working Group, consisting of a group of digital forensics researchers, educators, and practitioners met to increase ideas for research topics in digital forensics. One of the main topics discussed was the challenge of educating the varied group of constituencies (Nance, Hay, & Bishop, 2009). The demographic data in this study reported that the majority of digital forensics examiners hold Bachelor's degrees, and the majority of those degrees are not in Computer Science, Forensic Science, or Criminal Justice. This verified the background diversity of this group of digital forensics examiners. The bulk of

digital forensics examiners also worked for law enforcement agencies. This group was fairly evenly dispersed among the local, state, county, and federal agency levels.

The demographic data for the students studying digital forensics showed that the majority of students were at the undergraduate level, and they were predominantly forensic science majors with 60.9% of them being undergraduate students. However, the remaining students were at the graduate level, and these graduate students reported that the majority of them, 44.4%, held undergraduate degrees in an area other than forensic science, computer science, and criminal justice. This verified the varied backgrounds of students studying digital forensics. This also showed that students studying digital forensics at the graduate level and digital forensics examiners share a similar diverse background.

The first research question addressed in this study was, "What were the learning strategies of digital forensics examiners as determined by Assessing The Learning Strategies of AdultS (ATLAS)?" When the ATLAS test item responses were examined it was determined that digital forensics examiners did not follow the normal distribution of the adult population's learning strategies which shows 36.5% of the population being Navigators, 31.7% as Problem Solvers, and 31.8% as Engagers. This data showed this group of digital forensics examiners was predominantly Problem Solvers. Problem Solvers initiate a learning activity by looking for external resources, such as books, journal articles, etc. They also focus on the different options available for completing the task instead of following a narrow focus. They will use stories as a way of providing a concrete example for learning. They often have trouble making decisions since they focus on so many alternatives to learning. They also have a tendency to procrastinate because it allows more time for thinking. They also view trial-and-error as a learning opportunity instead of failure. They see learning as an adventure and prefer to work on their own

rather than being given deadlines and rigid orders. This can prove helpful in the field since digital forensics examiners are often faced with new issues as a result of evolving technology. However, their procrastination tendencies may lead to back logs in the laboratories. They are very confident in their abilities and will often as questions simply to benefit others. They are descriptive and detailed when answering questions, and will often use examples to help them explain answers (Conti, 2009). As digital forensics examiners this type of learning strategy can be helpful in that they work independently to find evidence utilizing different methods for obtaining the same information. Their descriptive and detailed way of explaining their findings is important when presenting the evidence in court and for complete and thorough examinations. Using examples to help jurors understand the information being presented is also useful.

The next research question addressed was, "What were the learning strategy preferences of students studying digital forensics as determined by Assessing The Learning Strategies of AdultS (ATLAS)?" After analyzing the data from student responses to ATLAS, the students also did not follow the ATALS normal distributions of the adult population, and were largely Problem Solvers. As students this means they do not perform well on multiple choice tests because this limits their divergent thinking. These types of students perform better when given a task without rigid requirements about how the task should be completed. They would be more receptive to classes that give them projects with a basic abstract outline, but allow them the freedom to investigate and come up with the process of how it will be completed on their own. The instructor of students that are Problem Solvers should provide an environment of practical experimentation, give examples of personal experience, assess the learning by asking open-ended question and planning problem solving activities (Yildirim & Soyunov, 2010). For example, in a digital forensics course, students would be more benefitted from an activity where

a problem is presented and students are asked to discuss the different methods for getting a solution instead of the instructor giving them the solutions. A laboratory assignment where students are given simulated cases and asked to analyze a file for evidence would also give students an open-ended type of assessment. Another example would be an assessment that asked students to write a report over their findings and explain how they found their evidence and what significance it has to the case. Since Problem Solvers tend to be story tellers, as well, giving them a project where they must present a problem would give them the opportunity to use this skill in explaining the problem. It would also allow them to give any real-life examples to help them describe how they came to their conclusions. Such activities would simulate the laboratory experience they would be working with in the field, and give them experience in explaining their work as they would in a court environment. These types of courses would attract students whose preferred learning strategy is Problem Solver, and they would eventually work in the field as digital forensics examiners. This type of curriculum would also follow the guidelines of transformative learning theory, which is used in higher education institutions. Transformative learning is a theory of education in which adult students are encouraged to think for themselves instead of simply memorizing facts and processes. This type of curriculum would ask students to actively engage in the learning process, and not just do what is required with no inquiries or exploration.

The third research question addressed was, "To what extent was there a relationship between learning strategies and demographic variables of age, sex, race, education, major, and experience in the field?" The majority of the participants' preferred learning strategy was Problem Solver. When comparing each learning strategy to the demographic data, there

appeared to be to no significant relationships between the demographic variables and the preferred learning strategies as seen in the chi-square tests performed.

The last research question posed was, "Was there a difference in the learning strategies between digital forensic examiners and students studying digital forensics as determined by Assessing The Learning Strategies of AdultS (ATLAS)?" Upon comparison of the preferred learning strategies of digital forensic examiners and students studying digital forensics there was no considerable difference. The data showed that 53.8% of the examiners and 56.5% of the students studying digital forensics were classified as Problem Solvers. Therefore, both groups will utilize the external resources available to them while exploring alternate options. They are both confident in their own abilities, but will ask questions in order to benefit others. Digital forensics examiners and students studying digital forensics prefer to work independently and will tell stories that are examples of the situation to further help explain a problem. Instructors for this group of digital forensic examiners and students studying digital forensics should provide experimental learning activities and assess their learning with unrestricted questions as multiple question examinations do not work well for Problem Solvers.

Limitations

The number of participants in this study was limited to a convenience sample, broadening the study to include a broader sample should be done in a future study. Therefore, the descriptions of the learning strategies of digital forensics examiners and students studying digital forensics were limited to those participants in this study and may not be generalized to the entire population of digital forensics examiners and students studying digital forensics. This small sample size also limited the statistical data analysis that was able to be performed.

Recommendations for Future Research

Future studies should be done to include a broader sample of students studying digital forensics and digital forensics examiners. Additional studies should investigate the specific traits of Problem Solvers and test what instructional methods work best for them. Experimental studies of teaching methods should also be performed to see which methods produce higher learning for this group. These studies should lead to the development of a standardized curriculum for the education and training of digital forensics examiners and students studying digital forensics.

Conclusion

Digital forensics examiners' and students studying digital forensics' learning strategies were both predominantly Problem Solvers. Both groups in this study will begin a task by looking at the external resources available to them and then look for alternative methods for completing the assignment. Digital forensic examiners and students studying digital forensics in this sample also prefer to work on their own. They will ask questions simply for the benefit of others, and use personal experience examples to help in understanding. The demographic data regarding age, sex, race, level of education, experience in the field appeared to have no effect on the preferred learning strategy of each examiner and student in this sample. Instructors should provide unrestricted learning activities so their divergent thinking is not too limited, and evaluate their learning utilizing open-ended questioning rather than assessments that use multiple choice questioning. This description is only limited to the digital forensics examiners and students studying digital forensics that were in this convenience sample. A similar study should be conducted in the future that tests a larger sample. Future studies should also be conducted to test

which instructional methods are more effective for Problem Solvers, and then a standardized curriculum based on these instructional methods should be developed specifically for the education and training of digital forensics examiners and students studying digital forensics.

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