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## Acknowledgments

The *Technology Education Journal, Volume IX,* is a refereed journal published by the North Carolina Council on Technology Teacher Education. This historic tenth volume of the publication is the result of the contributions of numerous technology education professionals. Articles included in the journal represent the most current research and insights of the technology teacher education faculty in North Carolina. Uniquely, this is the first volume of the NCCTTE Journal to include multiple articles with co-authors from disciplines other than Technology Education and there are more articles by TE graduate students than ever before. This volume includes scholarly works completed in 2007-8.

The following authors are recognized for their contributions to this volume:

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## Refereed Articles

# Python as a Tool to Teach Introductory Programming

## Preparing Technology Students for Future Challenges

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### Abstract

Students' successes in the workplace will depend on their abilities to adapt to new applications and technologies. Technology as it stands today demands that workers learn new skills and be prepared for change. Technological knowledge can be generalized and built upon, such that new learning can scaffold on prior knowledge. Although many general technology competencies can be infused into courses which are focused on learning specific applications (e.g. learning Microsoft Word 2007), this must be a point of focus for the instructor. Without this focus learning is more non-generalized which doesn't prepare students as well for change.

The use of the Python programming language as a teaching tool for introductory computer programming and logic can benefit students in the areas of: problem solving, design, and generalizations about programming. Added to this is the fact that the syntax of the Python language is similar to C++ and JAVA, and offers a solid foundation for future programming courses.

Students find heightened levels of real-world use and value with the Python language when compared with a language used only "for teaching." With Python, students are not hampered by learning extensive syntax rules that other languages require (ex. C++ and JAVA).

In practice, public school through college-level students can use Python to focus on design and creativity issues associated with programming. They can learn syntax-related issues of programming later in other courses, once they have a firm grasp of the basics of programming. Alternatively, if the curriculum calls for only one course, Python offers a commercially viable language without the syntax constraints of other languages.

## Python as a Tool to Teach Introductory Programming

**J. Burton Browning**

### Introduction

There is no question that the enhancement of a learner's skills in the areas of creativity, problem solving, and technology fluency are paramount to success in many curricular areas, most importantly computer programming. Presenting students with a problem such that they have to use problem solving skills to find the solution has a viable research base. PBL (Problem Based Learning) makes sense with regards to teaching computer programming as new programming challenges are always on the horizon. In fact, Gallagher & Stepien note that students "achieve essentially the same knowledge level as those receiving traditional instruction" when PBL methods, such as with the instructor as a facilitator instead of traditional teacher, are used (Gallagher & Stepien, 1996).

In fact, one could argue that these three areas - creativity, problem solving, and technological fluency - are also important in many job settings, and are certainly important in today's technologically saturated society. The ability of a student to "bridge the gap" between applications and become fluent with technology in general, is a talent that can be used throughout a working career. However, many universities and colleges teach specific applications and do not teach generalized technology fluency.

It is a regular occurrence that new computer technologies come about almost monthly that require us to "re-learn" and "adapt." In fact, as of early 2008, on the heels of the latest release of Windows Vista, Microsoft has announced the successor to Vista - Windows 7 - is being prepared to be released. This simply illustrates how imperative it is to enhance users' ability to adapt rapidly to computer technology changes.

Curricular programs which require a programming language or computer technology course can benefit from the use of the Python programming language as a teaching tool. The benefits it offers in the areas of creativity, problem solving, and technological fluency can serve students well in other fields of study. Python can also help create scaffolding for growth in other areas of technology education. It is an especially good first language for students who wish to pursue a career in technology or computer programming when compared to C, Delphi, and JAVA (Nikula, Sajaniemi, Tedre, and Wray, 2007).

Python is a free, open-source, internationally supported platform that offers features that include: cross-platform compatibility, Rapid Application Development (RAD), Visual Studio

.NET integration, and large collection of add-in or extension Software Development Kits (SDK). Some examples of available SDKs include Guido Van Robot for robotics simulation, Vpython for 3D visualization, BioPython for use in molecular biology, and Pygame for game programming. Additionally, Jython is being used at Georgia Tech for use in media computation courses involving the manipulation of sound, images, and video (Potts, 2007).

**Students who take an introductory programming and logic course are better prepared from the knowledge they gained learning how to implement creativity and problem-solving techniques, as a key aspect of computer program design, to succeed in future technology challenges they may face. In fact, Sellwood (1991), De Luca (1993) and Williams and Williams (1997) (in Lavonen, J. Meisalo, V. and Lattu, M. 2001) argued that creative problem-solving activities are an integral part of design and technology education, in contrast to instruction that is a step-by-step process, engaging students in reproducing artifacts in an environment dominated by the teacher. Based on the speed in which technology is changing, students will need to increase their abilities to use problem-solving techniques and minimize their reliance on traditional methods of learning in order to be adaptive technology consumers.**

## Technology Education: Preparing a foundation for learning

Two general schools of thought exist with regards to teaching students about computer technology, one based on the proficiency of the student to perform specific tasks, such as send and receive email and a second based on technology fluency or "literacy" (Childers, 2006). As such, the former school of thought does not emphasize that students need to "think on their feet" to be better prepared to adapt to changes. Seymour Papert in 1980 described the necessity of creating computer cultures rather than isolated experiences to learn with and about technology (Papert, 1980). Papert defined a computer culture as a place that is conducive to technology fluency in contrast to computer literacy (Papert, 1980). This "technology fluency" is a more accurate description of what would better prepare students for change. As such, we are not sufficiently preparing learners to be self-reliant and adaptable for technological change that will occur.

There appears to be a tendency by many educational institutions to overtly teach specific applications use and how to follow "how to" directions from step 1 to step 10. This would be diametrically opposed to teaching generalized techniques for using applications and problem-solving methods to understand how to use new technologies. In particular, these generalized techniques build on the work of several researchers who note that, "using technology well requires knowing more than merely how particular software tools operate" (Lambrecht, 2007).

Technological fluency branches off from where the rote memorization of steps first sprout. As an example, often we see courses that teach Microsoft Word instead of a generalized course in word processing that encompasses Microsoft Word, Abi word, OpenOffice Writer, etc. Indeed the very textbooks that educators have available are generally application specific and list guided and numbered "follow along" steps. Teaching students to use a specific technology tool, such as Microsoft Word 2007 does not prepare them for other versions of word processing software as well as presenting to them generalized concepts about word processing and problem-solving techniques to prepare them for inevitable changes forthcoming in the field of technology. As an example, the 2007 version of Microsoft Word is quite different than previous versions. Blake and Rosenblum (2007) state that, "You may be in for quite a surprise. Microsoft has made massive changes to the user interfaces" when discussing Microsoft Word 2007. Childers notes that "Literacy suggests understanding and the ability to adapt and increase that understanding" as a working definition (Childers, 2006). This ability to adapt to changes, to be prepared for the future, and to be able to complete whatever tasks are necessary on the computer would be the desired goal of technology fluency.

Although perhaps lamentable on some levels, it is quite understandable that many institutions, especially technical schools and community colleges, often are required by their constituents to offer "program specific" training such as with specific packages (e.g. Microsoft Word 2007, QuickBooks version x, etc.). In fact community colleges are designed to support the "needs of the community" and as such, training on specific packages is part of the appeal. Indeed, in the face of competition with commercial entities that offer certifications and training on these packages, one can easily see that the aforementioned institutions must offer similar courses to "stay competitive" with students. The lamentable aspect, again, is that the training is not transferable in some respects when the program undergoes a radical change, which is inevitable, thus requiring formal retraining in some cases. The positive aspect of using Python as an introductory language is that the skills learned are generic enough to transfer to many other languages and technology endeavors.

## Python Use in Brunswick Community College, Supply NC

Brunswick Community College (BCC), located in Supply, NC has a student body of a little over 1000 students. These predominately local students are split into a variety of degree areas, from college transfer to two-year degree and diploma programs. Students interested in a college transfer degree, or in one of two two-year computer programming, business administration, or information systems degrees are either required or elect to take Introduction to Programming and Logic. Students must meet minimum math and English proficiency requirements prior to taking the course. This four-year, college-transfer course gave students their first experience (generally) with programming and design issues associated with computer programming. As such, it started them off on a language that offered no real future value (only perhaps in a very small way as a migration path to Visual Basic - not Visual Basic.NET.

Until 2001, BCC used Microsoft BASIC from a command prompt to teach Introduction to Programming and Logic courses. It was a non-compiled language (although third party tools allow this), and certainly hardware specific (not cross-platform). There were positive aspects of the language, but generally it was thought that a more modern and industry-useful language was needed.

As a replacement for BASIC to learn programming, it was determined that Python was a proper replacement as an introductory language. The numerous benefits were a welcomed change, and were considered carefully regarding their fit into the existing technology curriculum. Summarized benefits included: 1) Cross-platform (runs on PC, Mac, UNIX, etc.); 2) Ability to be compiled (such as to a DOS or Windows executable); 3) Used widely as a commercial language; 4) Endorsed and supported by Microsoft and Google; 5) Extremely extensible (many add-on modules available); 6) Open source and free; 7) Actively maintained; 8) Java and C/C++ like syntax (offers good migration path); 9) Easily uses a command prompt; and 10) GUI programmable (with Visual Basic-like syntax).

In fact Whitelaw noted advantages of Python including, "The amount of code that had to be written, both in terms of lines of code and in terms of functionality, was not huge," (Whitelaw, 2001). Dr. Whitelaw in 2001 referenced Python's large number of built-in data types, standard library, its readable nature, and teachable qualities. She further stated that, "Students got to grips with basics quite quickly and could advance on their own as well," and that, "Python's interactive mode and its interpreter made it easy to test or demonstrate programming principles and for the students to debug their own code quickly" (Whitelaw, 2001).

Considering these benefits, the language was adopted at the community college during the 2001 year and has been in use as the sole introductory language since that time. College transfer students and students in two-year associate degree programs (Information Systems and Computer Programming) all take the course during fall and spring semesters.

Regarding industry use, Python is well supported in many areas including server scripting, applications development, gaming, graphics, and teaching. Microsoft and Google, to name a few firms, are both active supporters and users of Python. In fact, Google even hired the inventor of Python to further the use and development of the language (Jones, 2005).

As a student advisor, professor, and Lead Instructor for the programming and logic course in question, the author had an opportunity to collect over seven years worth of anecdotal data from students on the previous course using BASIC and the new course using Python. As such, informal discussions with students, student evaluations of the course, and follow-up with students in subsequent courses in programming yielded valuable anecdotal data which could lead to furthers studies in this area. The author has noted in informal discussions with students each semester (before and after their first course in programming – Introduction to Programming and Logic) since 2001 that in general, students report: 1) They think Python is a language they will not only use in college; 2) They better understand more advanced languages (they report that C++ and JAVA - and to a lesser degree Visual Basic "use almost the same syntax); 3) They think Python is a "fun" language (based on less overhead compared to other languages; 4) They more fully understand logic and design as it applies to programming and program design (many have said they prefer to prototype a program in Python, even after learning another language).

Anecdotal data seems to suggest that students find more real world use and value with the Python language when compared with a language used only "for teaching." Data gathered from discussions with students who had BASIC reported, among other things, that they felt they had learned a language they would never use again, that it was "worthless," and they felt under-prepared for languages they learned later in college, such as C++ and JAVA. Students seemed to see and make better connections between Python and other higher-level languages than they had with BASIC.

## Discussion

Anecdotal evidence appears to support the premise that using a Rapid Application Development (RAD) language, such as Python, removes some of the syntax constraints from students and allows them to focus on design fundamentals. In fact, noted high school computer science teacher and Python proponent, Jeff Elkner stated, "We had switched to teaching C++, from Pascal, when the College Board switched to C++ for the AP exam. I was having a great deal of difficulty with C++. I was turning off 50 percent of my students. I found myself fighting with the syntax and I was really frustrated trying to explain clearly what computer science was about while using a language that seemed to get in the way." (Willison, 2000).

As such, their creativity in the computer problem-solving process is not hampered by the syntax of the language. After they have learned the fundamentals, the syntax used in the language is similar enough to C++ and JAVA such that they can build on language-specific syntax details. Examples would be to terminate a command with a semi colon as opposed to no termination (as far as a formal ASCII character) in Python. "The synergetic blend of procedural, functional, and object-oriented programming styles available through Python provides a good nucleus of concepts which will serve a student well when branching out to other languages later, whether in the direction of C/C++/Java, LISP/Scheme, or any of several other well-traveled pathways." (Urner, 2001).

Informal discussions with former Python students from Brunswick Community College revealed several patterns to support how Python serves the purpose of teaching general skills that students can scaffold onto in other programming classes. Summary data from students revealed that:

- JAVA and C++ were much easier to learn since they were structurally and syntactically similar to Python;
- Learning how to function with a prompt-driven system in Python prepared them for JAVA and C++;
- They already understood class design (in JAVA and C++) since Python classes were so similar;
- JAVA and C++ are really about the same as Python except that you have to terminate lines with a semi colon.

Again, this was anecdotal evidence, summarized over seven-plus years of teaching Python as an introductory language. The vast majority of students had not previously completed a programming course (either at BCC or in high school). As such, this was their first introduction to programming of any sort, so they had no pre-conceived notions as to language format or structure. Students seemed to find value in the "real-world" usability of the language and utilize problem-based learning. Students were empowered to implement creative solutions to programming problems that had value to them. With the variety of additional SDK's for Python, students were able to make connections and adaptations to problems presented to them. Lastly, students who went on to other programming course reported that their Introduction to Programming course was an important foundation class and they made connections to other languages better based on parallels they found with Python.

## Conclusion

If the goal of a technology curriculum is to impart technology fluency, then there should be at least one course in computer programming included. At the very least it should be an optional or elective course for those students who are interested. Students who have had Python as a first programming language have reported that they had "no idea" of the intricacies of applications design and, in fact, consider and think about structures (such as loops, etc) they have learned about in class when using other applications. There seems to be a more generalized cognition of how programs function after having an introduction to programming course.

Considering the particulars of the course, it could be structured to teach a specific language or to teach a more generalized language that students can both use in real-world settings and build on when they learn other languages. As many students are turned off by "educational languages" or "dead languages", it appears appropriate to use a language that is well known and useful. Python offers maintainability, cross-platform compatibility, and extensible features, all at the right price – free!.

The RAD nature of Python allows students to focus on design fundamentals and aspects of problem solving as it relates to program design. Students are not hampered by learning extensive syntax rules that other languages such as C++ and JAVA require. Elkner's 2001 statement that, "Python greatly simplifies programming examples and makes important programming ideas easier to teach," only further supports the idea that Python is well suited as a first language. If the adoption of Python by Google, Microsoft, and many schools (2008, wiki.python.org) is any indication of success, then Python has a long career ahead of it and we will do well to start our students off learning this powerful and easy-to-implement language.

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# An Examination of Perceptions and Workplace Conditions of Technology Teachers in North Carolina

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**Abstract**

In the fall of 2007, over 100 middle school and high school technology educators from the state of North Carolina were surveyed regarding perceptions and environmental issues. Information gathered included the educators' perceived value of their program; student performance; teaching facilities; and available hardware and software. Data on core and extra-curricular learning activities was also collected.

Areas examined include the educators' willingness to participate in professional development opportunities in relation to the perception of the program they teach under; innovation and school reform projects; and the redesigning of the technology education core curricula courses. Other facets of the research include teacher interest in a project versus the willingness to teach the corresponding subject matter as well as teachers that were interested in teaching but not attending workshops or other professional development prospects. Frequencies and correlations were compared and contrasted in relation to the perception of the program and the facilities, and in comparison to local and national test scores. While there is no standardized measure for middle schools in regards to the Vocational Competency Achievement Tracking System (VOCATS) and End-Of-Course (EOC) scores, the high school scores in each area were intensively explored. In addition to the continuous and categorical data, write-in fields were also incorporated for a more well-rounded set of records.

## Introduction

Is it fair to say that "as a man thinketh…so is he?" Does this only apply when you have all of the necessary resources? What if you don't think you have the proper tools to be optimally effective? At the Southeast Center for Teaching Quality (SECTQ), teachers are clear about the working conditions that they need in order for them to be successful with students – time, empowerment, facilities and resources, leadership and professional development (SECTQ, 2004). These findings are interesting when compared to the data collected in the Technology Education Teacher Survey (TETS) from 2007. Several studies have shown a perceived value of a curriculum is a meaningful predictor of the [teacher's] adoption of curriculum (Wilson, Kirby and Flowers, 2001). While there may be some truth to the method of adopting curriculum, other factors also have an important role as well. According to SECTQ (2004), teachers reported that working conditions more associated with overall school context like leadership and facilities were less important than the aspects more directly associated with their classroom. Aspects that are more directly associated with a teacher's classroom include teaching facilities and available hardware and software. While all of the factors certainly work together to ensure successful learning for each child, Bandura (1997) writes that a powerful construct that varies greatly among schools that are systematically associated with student achievement is the collective efficacy of teachers within a school. This implies that unless the teachers believe that they can effectively facilitate the learning process, they may not reach the students as efficiently as possible.

***Vocational Education***

Marshall (1995) wrote that school-to-work programs come in many varieties, including youth apprenticeships, co-op programs and career academies. Before they became popular in the 1990's, they had a more generic name: vocational education (Marshall, 1995). Vocational education was developed in response to the Smith-Hughes act of 1917, which focused on the growing need to prepare young people for jobs that were created as a result of the industrial revolution (Rojewski, 2003). While the Smith-Hughes act was certainly an important cornerstone of the technical education movement, the concepts that brought it about have been reiterated in a program of today – Project Lead The Way.

Project Lead The Way (PLTW) was created in order to meet the needs of vocational education in the 21st century. As PLTW's mission statement says, 'We will create dynamic partnerships with our nation's schools to prepare an increasing and more diverse group of students to be successful in science, engineering and engineering technology (Project Lead The Way, 2006). The number of students being serviced via PLTW is astounding, and is growing astronomically each year. For the 2007-08 school years, the total reported number of participating schools is 2,242 with 201,200 enrolled students. The projected numbers for the 2008-09 school years are 2,880 participating schools with 233,000 students enrolled in the courses (Project Lead The Way, 2006).

PLTW is a contemporary attempt to prepare students for the workforce, much like the vocational education courses of the past had done. Vocational education was a collective term used in high schools to identify curriculum programs designed to prepare students to acquire an education and job skills, while enabling them to enter employment immediately upon high school graduation (Lynch, 2000).

The premise of any effective Career and technical education program can be summed up by Brown:

> Career and technical education programs motivate students to get involved in their learning by engaging them in problem-solving activities that lead to the construction of knowledge, and by providing them with hands-on activities that enable them to apply knowledge. In addition, CTE programs bring students and adults (parents, teachers, community leaders) together in a setting of collaborative learning (p.1).

At the secondary level, the similarity between the Career and Technical Education (CTE) charter schools and school-to-work concepts is often pointed out (Goodman, 1998). Highlighting similarities can make the difference with student learners, where connections and personal relevance are important factors in learning. According to Cohen and Besharov (2002), CTE programs offer students an alternative to college prep programs, programs that they may not have the interest, ability or skills to pursue.

Lewis (1999) writes that one key area of opportunity for integration is the relationship between technology education and vocational education. An important observation that Lewis makes points out that many aspects the two fields coincide, including the situated nature of instruction – the laboratory focus – and learning by doing (1999). The laboratory is an integral part of the technology classroom; much of the content is approached as "hands-on / learning by doing". The laboratory and classroom combined concept is the optimal solution for now, however, many hybridized ideas of classrooms and laboratories are being tested to explore a more effective system.

The integration of other ideas, concepts and disciplines into technology education is one way of ensuring that it stays relevant in the secondary school system of today. According to Colelli (1993), there are six elements which could be provided by introductory technology courses if technology educators were to get involved:

1. A balanced technical core
2. A powerful catalyst for curricular change
3. A viable solution to the curricular cram in teacher education programs across the nation
4. An excellent recruitment tool for technology teacher education
5. A window of opportunity to reverse the trend toward extinction of technology education
6. An opportunity to make a meaningful contribution in the battle for economic competitiveness.

The integration of other disciplines in technology education classrooms, particularly those in the STEM fields – Science, Technology, Engineering and Mathematics – has positive and negative effects. The students become more well-rounded and competitive from the exposure of other ideas, however, diluting the essence of technology education may not be the best avenue at the present time. Thomas (2003) reports that since engineering is not recognized as a school discipline, pre-engineering is being infused into current technology education programs with the support of the engineering and engineering technology professions. Even though the engineering discipline is being infused into technology education programs, technology education itself still suffers an image and identity crisis, both with the public and with other professions (Rogers, 2005; Pearson, 2003; Wicklien, 2003). If technology education is unclear as to where it fits in the scope of learning, are the teachers that instruct the students unclear as well?

## Findings

The North Carolina Department of Public Instruction (NC-DPI) collaborated with the International Technology Education Association and the Career and Technical Education Division of the DPI to develop the Technology Education Teacher Survey (TETS). The surveys, which compiled information from middle and high schools, were distributed at a conference in the early fall of 2007, and 107 respondents participated. The Technology Education Teacher Survey of 2007 consisted of self-reported data gathered from technology teachers from the state of North Carolina. These particular teachers generally attend conferences two to three times per year – in the summer, winter, and occasionally any other local workshops that may be offered. Of the 107 surveys gathered, 40% (n=43) opted to not leave contact information for further opportunities.

The majority of technology teachers – 79.4% – that responded (n=84) were males from suburban, middle-class areas with 501-1000 students at the school. The average teacher that filled out the survey had taught between six and fifteen years – long enough to notice changes in the field of technology education, yet short enough to still have fresh ideas.

Of the responses collected in the 2007 Teacher Education Teacher Survey, the average rating a teacher assigned to themselves was an 8.07 out of 10, while giving their students a score of 7.36 out of 10 (n=107). The teachers' perceived values are displayed in Figure 1. The perceptions of value (from left to right) are for the teacher (#1), their students (#2), the superintendent (#3) , the career and technical education director (#4 - *if the school had one*), the principal (#5), the guidance counselors (#6) and the parents (#8), respectively.

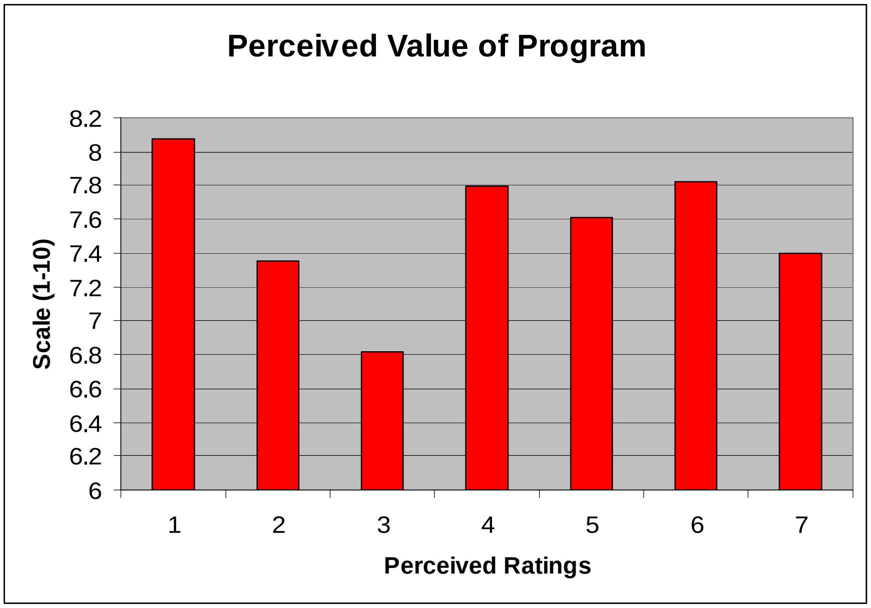


*Figure 1*

The discouragingly low score is for how the teachers think their superintendents would rate the technology education program. The student performance is reported to be near the average of all students academically, and they score at the state averages on the VoCATS EOC assessments.

On a scale of 1 to 3 with three being the highest, it is interesting to note that more teachers are attracted to forming school reform projects and after school programs (mean of averages=1.72) than they are with learning new software to teach during the regular school day (mean of averages=1.54). The facilities are below average overall, and the furniture in the classrooms is only acceptable. If the technology is not up to par, where is the money going in the schools? The average classroom has one computer for every two students (*see Figure 2*), and the software they are using is acceptable.

Even though Project Lead The Way is gaining momentum each year, the technology teachers of North Carolina would prefer to begin a Technology Student Chapter versus teaching PLTW courses.

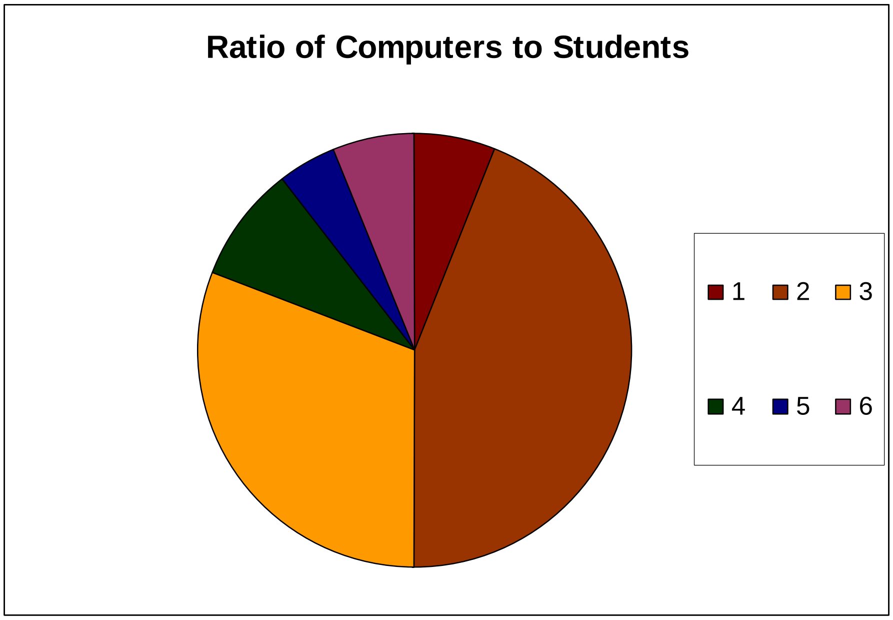


*Figure 2*

**Scale:** **1** – 1 computer to 1 student, **2** – 1 computer to 2 students, **3** – 1 computer to 3 students, **4** – 1 computer to 4 students, **5 –** 1 computer to > 4 students

The Open Answer section was broken into three areas – Career Technical Organizations, Facilities and Professional Development. The question for the career technical organizations asked if the school had a Technology Student Association (TSA) chapter and if not, under what circumstance you (the teacher) would be willing to have one. The common responses were that more time was needed, more information was needed, and finding students that were interested in the organization. One teacher summed up the majority of concerns in one quote – "I need more info – need more time set aside for club activities [and] how to get students interested." Unfortunately, there were teachers who reported having double-duty when it came to their obligations – more than one teacher was also the coach for the school. One teacher was the head football coach of his or her school, and another reported coaching two sports. A lack of funding was the fourth reason, and a lack of mentors was the fifth reason for not having a TSA chapter in their schools.

Many of the responses in the Facilities section delineated the need for new equipment and how the current laboratory room was converted from another room (ex: a weight training room, metal manufacturing shop, single-wide trailer). Over half of the Facilities responses indicated a modular set-up, though many of the computers were old and out-dated. In the Professional Development open response section, the teachers listed specific software titles that they would be interested in learning.

## Discussion

It seems as if the attention given to technology education is not the same as what is given to other disciplines in the secondary school system. This could simply be because, even 91 years after the Smith-Hughes Act of 1917 was passed, people as a whole do not understand the need for technology education, so it continues to be suppressed instead of being made readily available. One way to bolster this idea is with the teachers who are assigned to teach the technology education courses. What area of expertise does the head football coach have? Coaching! It seems as if technology education is lumped in with courses that are not as prestigious, like social studies or home economics. The ideas and skills learned in a technology education classroom are ones that are readily-used once a student graduates, whereas balancing chemical equations and finding the cosine of an angle may not be used for many years, if at all.

It would be interesting to ask the different groups of people in the survey what their perceptions of the local technology education program would be. All of the data is based on the teacher's view, which is not fully reliable in that there were a few new teachers who did not have a good idea of how the principal, CTE director, superintendent or parents may view the program.

## Conclusions

There is a definite lack of information in reference to teachers and their perceptions of what they can do with what they have. The bulk of "teacher perception" research explores race, learning styles and test scores as defining factors. It would be interesting to re-visit the teachers' perceptions at the conclusion of each school year. Conducting this study once a year would not only lend valuable literature to the field of technology education, but it would allow the curriculum developers to have a gauge for subsequent curricula editions.

As a whole, the results of the Technology Education Teacher Survey from 2007 were not entirely surprising. It is disheartening that technology education is still not as valued as it should be, but improvements are being made yearly. I recommend that more studies and surveys similar to this one be conducted – the best way to demonstrate the worth of something is to continually advocate for it. The fields of mathematics and science did not begin in 1917 as some others may have – there are centuries of information and research to back the value of those fields. Perhaps in a few centuries, this topic of technology education's importance will be displayed enough to be well established.

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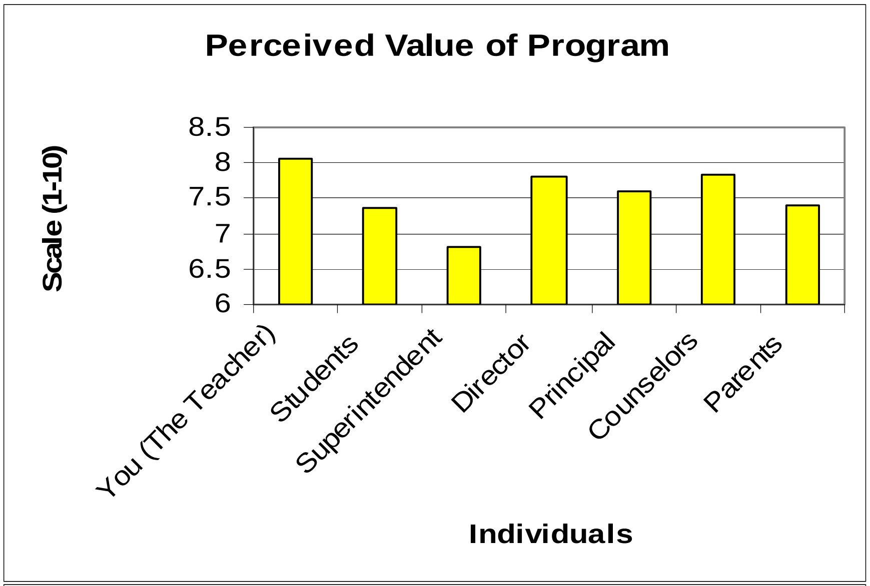
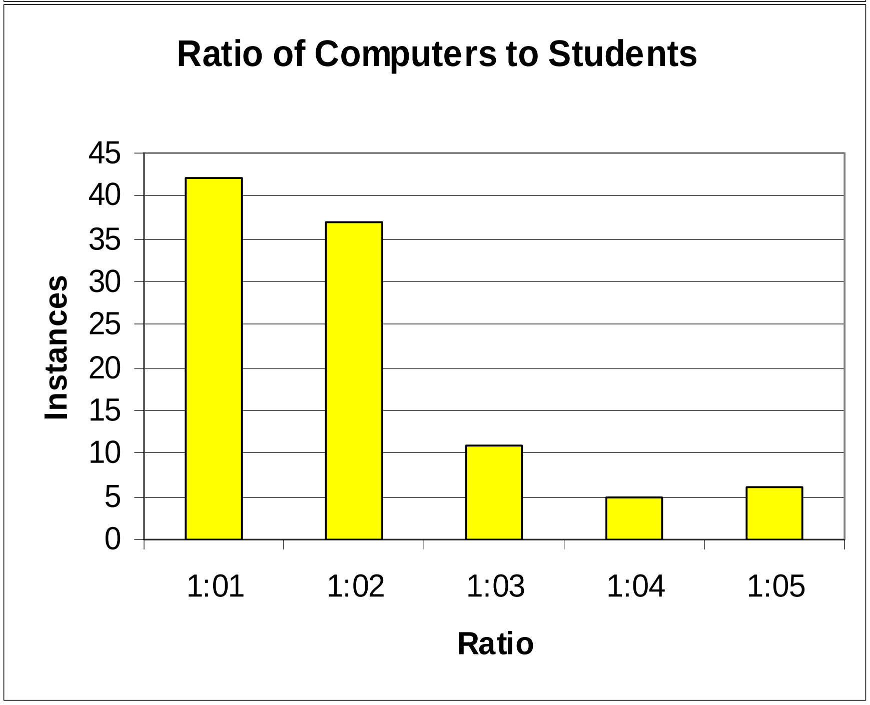
**Appendix**


Perceived Value of Program
Scale (1-10)
8.5
8
7.5
7
6.5
6
You (The Teacher)
Students
Superintendent
Director
Principal
Counselors
Parents
Individuals


Ratio of Computers to Students
Instances
45
40
35
30
25
20
15
10
5
0
1:01
1:02
1:03
1:04
1:05
Ratio

# VARK: An Introspective Look at Introductory Graphic Communications Courses at North Carolina State University

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**Abstract**

Over the years researchers have repeatedly modified their instructional design and teaching methodology, and have steadily noticed what they thought to be inequalities or inconsistencies in student results. Researches have often wondered if the revision of instruction shifts results on the basis of student ability. They have also considered whether or not instructional revision challenges or affects interest in an improved teaching style. Upon reflection of these experiences the realization is that these inconsistencies are not inconsistent at all. They are the result of a necessary modification of an instructional design system that must adapt to meet the need of current students. In order to better understand the type of instruction students prefer, the VARK questionnaire can be used.

Educational researchers suggested that individuals have preferred methods of learning. After observing more than 9000 classes and noticing vast differences in course instruction and student outcome, Neil Fleming, an inspector in the New Zealand educational system, created the VARK questionnaire. This questionnaire was aimed at better understanding how individuals learn based on visual (V), aural (A), read/write (R), and kinesthetic (K) practices.

The VARK questionnaire was administered to students in technology education undergraduate introductory courses. The data was examined based on gender, age, academic level and course of study. This data may motivate instructors to modify instruction, develop appropriate teaching strategies that can enhance instruction, and increase student participation and retention.

## Introduction

Researchers technology and graphics education have examined and debated the most effective methods for delivering instruction to a diverse population of students. Within these students exist learning preferences that have been shaped by individual experiences (Clark & Ernst, 2007) inside and outside of the traditional classroom setting. Given this, instructors should become aware of the learners' characteristics in order to adequately revise and adapt instructional materials to meet the current needs of the learner. These differences in learning should ultimately influence teaching methods as well as inform the instructor on the types of materials to organize and use for instruction.

The goal of this study was to investigate preferred learning styles of students in undergraduate introductory graphics courses utilizing the VARK questionnaire. The results from this study could be used to assist in the continued development or revision of the instructional practices and activities most suitable for student learning.

## VARK Questionnaire

The VARK Questionnaire is used in this study to ascertain the preferred learning styles of undergraduate technology education students. VARK is a widely used questionnaire, composed of sixteen questions, that assists in determining learning preferences, including multimodal learning styles. The questionnaire was developed in 1987 by Neil Fleming, an inspector in the New Zealand educational system and later a staff developer at Lincoln University. Due to vast differences in instructional methods and student results (Fleming & Baume, 2006), Fleming was interested in exploring how learning preferences affect learning outcomes.

Fleming began investigating modality preferences and how these preferences influence individual learning. Modality preferences include visual (V), aural (A), read-write (R) and kinesthetic (K). Fleming (1995) identified visual learners (V) as those whose preference for receiving information is in the form of graphs, charts, and flow diagrams. Although many believe their most dominant learning style to be visual, the most common modality preference in society is aural (A). Aural learners favor the exchange of information in the form of speech or "learning by ear." There are also learners that prefer to construct knowledge based on reading and writing, which have been identified by the VARK questionnaire as read-write (R) learners. The final group of learners includes those who gain knowledge through hands-on experiences. This group of individuals is coded as kinesthetic learners (K). In addition to the four types of preferred learning styles aforementioned, the VARK questionnaire also identifies multimodal learners. This type of learner does not exhibit a clear preference for learning and can easily adjust to diverse methods of instruction or multiple ways of acquiring knowledge.

### *Comparison of Learning Styles Inventories*

When comparing the VARK questionnaire to other learning styles inventories, such as the Myers-Briggs Personality Type Inventory and Kolb's Learning Style Inventory, the differences are in the outcomes and purposes for usage. Looking more closely at each inventory, the Myers-Briggs Personality Type Inventory indicates individual preferences based on four dimensions: extraversion/introversion, judging/perceiving, sensing/intuition, and thinking/feeling (Morgan, Richard, & Rushton, 2007). Lastly, Kolb's Learning Style Inventory is a learning model of cognitive processes also based on a four-stage learning cycle. The learning cycle includes concrete experiences-*feeling*, reflective observations-*watching*, active experimentation-*doing*, and abstract conceptualization-*thinking* (Hay Group, 2005). Although each inventory has common characteristics that could be used for organizing and developing instructional materials, the VARK questionnaire lends itself more than the others for improving teaching and learning strategies (Fleming, 2007).

## Methodology

In the fall semester of 2007, 53 students enrolled in introductory graphics courses were randomly selected to participate in a research study of preferred learning styles. This foundational graphics course is the first in a series of technical graphics courses for graphics communications majors as well as a general education requirement for other majors such as engineering, and visual and performing arts (See Table 1 for demographical information).

**Table 1: Gender, Age, Academic Level and Course of Study**

| **Gender** | | **Age** | | **Academic Level** | | **Course of Study** | |
|---|---|---|---|---|---|---|---|
| Male | 94% | 18 or less | 43% | Freshmen | 55% | TED/GC | 17% |
| Female | 6% | 19-20 | 38% | Sophomore | 25% | Engineering | 68% |
| | | 21-22 | 15% | Junior | 9% | Others | 15% |
| | | 23-24 | 4% | Senior | 11% | | |
| | | 25 or more | 0% | Graduate | 0% | | |
| | | | | PBS | 0% | | |

The main course objective is to assist students in developing and improving decision-making and design skills utilizing concurrent engineering design practices by solving 2D and 3D spatial problems. Course information is presented to students primarily through visual-based instruction including sketching, computer graphics, and computer-aided design applications.

At the beginning of the semester, before administering the questionnaire and survey, an overview of the research study was provided for the students. Following, course instructors distributed the VARK Questionnaire and demographics survey to students. To ensure students were adequately exposed to the instructional presentation style of the instructors, the second distribution of the questionnaire and demographics survey did not occur until after the completion of midterm exams. Before each round, instructors were given an instruction sheet that outlined directions for administering the questionnaire. Students were also informed that participation in this study was voluntary, therefore not a requirement for the course. Responses were collected by the instructor and returned to the researcher for evaluation.

**Data Analysis**

Statistical procedures were used to evaluate the preferred learning styles of the students based on pre and post instruction data. Mean scores were used to analyze pre instruction and post instruction data. Summary statistics were generated to summarize the self-reported data. A paired t-test was used to analyze preference gains or losses due to receiving visual-based instruction. Analysis of variances (ANOVA) methods were also generated to examine changes in preferred learning styles by age and course of study (major).

Fifty-three students completed the questionnaire and survey. Table 1 displays the demographical information for participants. The summary statistics of mean scores, variance, standard deviation, and standard error are shown in Table 2.

**Table 2: Summary Statistics**

| Learning Style | n | Mean | Variance | Std. Dev. | Std. Error Mean |
|---|---|---|---|---|---|
| Visual | 53 | 0.1698 | 9.8360 | 3.1362 | 0.4380 |
| Aural | 53 | -0.7358 | 7.1597 | 2.6758 | 0.3675 |
| Read-write | 53 | -0.1321 | 6.3476 | 2.5194 | 0.3461 |
| Kinesthetic | 53 | 0.0566 | 9.0544 | 3.0091 | 0.4133 |

The mean scores indicate pre and post instruction data as well as the average of change in student learning style preference. The variance of change indicates the spread of learning style preferences around the learning preference average. The data analysis indicates moderately high preference variability across the four preferred learning styles.

Given the null hypothesis, which proposes that visual based instruction does not have a measurable effect on preferred learning style, student responses were also analyzed using a paired t-test (Table 3).

**Table 3: Paired t-test of Preferred Learning Style Pre/Post Treatment Rating**

| Learning Style | n | Mean Difference | Std. Err. | $\lvert t \rvert$ |
|---|---|---|---|---|
| Visual | 53 | 0.1698 | 0.4308 | 0.6951 |
| Aural | 53 | -0.7358 | 0.3675 | 0.0505 |
| Read-write | 53 | -0.1321 | 0.3461 | 0.7403 |
| Kinesthetic | 53 | 0.0566 | 0.4133 | 0.8916 |

The results from the paired t-test suggest that the treatment, visual-based instruction, does not significantly effect visual, read-write, and kinesthetic modes of learning. There is evidence, however, to suggest that the treatment, does influence aural learning preferences.

Results from the paired t-test, a one-way ANOVA by age (Table 4) and by course of study (Table 5), along with the Tukey-Kramer HSD test were generated to identify and compare possible changes of the participant's mean preference scores. Results from the one-way ANOVA by course of study suggests that overall participants within the three groups did not have significantly different learning preferences after the treatment except visually. The data showed evidence that a relationship may exist between choice of major and visual learning preference. The results for the one-way ANOVA for age suggested that visual and aural learning preferences were affected by the treatment based on the means. Although the data suggest a change it was not statistically significant.

**Table 4: Means for One Way ANOVA for Age**

*Visual*

| Age | n | Mean | Std. Err. | P-value |
|---|---|---|---|---|
| | | | | 0.2530 |
| 18 or less | 23 | 0.1739 | 0.6465 | |
| 19-20 | 20 | -0.2000 | 0.6933 | |
| 21-22 | 8 | 0.0000 | 1.0961 | |
| 23-24 | 2 | 4.5000 | 2.1923 | |

*Aural*

| Age | n | Mean | Std. Err. | P-value |
|---|---|---|---|---|

| | | | | 0.3284 |
|---|---|---|---|---|
| 18 or less | 23 | -0.3478 | 0.5551 | |
| 19-20 | 20 | -0.8000 | 0.5953 | |
| 21-22 | 8 | -2.1250 | 0.9412 | |
| 23-24 | 2 | 1.000 | 1.8825 | |

*Read-write*

| **Age** | **n** | **Mean** | **Std. Err.** | **P-value** |
|---|---|---|---|---|
| | | | | 0.8697 |
| 18 or less | 23 | -0.3478 | 2.6043 | |
| 19-20 | 20 | 0.2500 | 1.8883 | |
| 21-22 | 8 | -0.3750 | 3.8521 | |
| 23-24 | 2 | -0.5000 | 2.1213 | |

*Kinesthetic*

| **Age** | **n** | **Mean** | **Std. Err.** | **P-value** |
|---|---|---|---|---|
| | | | | 0.4724 |

| | | | |
|---|---|---|---|
| 18 or less | 23 | 6.8696 | 0.5341 |
| 19-20 | 20 | 7.8500 | 0.0573 |
| 21-22 | 8 | 7.3750 | 0.9057 |
| 23-24 | 2 | 5.5000 | 1.8113 |

**Table 5: Means for One Way ANOVA for Course of Study**

*Visual*

| Study | n | Mean | Std. Err. | P-value |
|---|---|---|---|---|
| | | | | 0.0440 |
| Engineering | 36 | 0.5000 | 0.5008 | |
| Education | 9 | -2.1111 | 1.0015 | |
| Other | 8 | 1.2500 | 1.0623 | |

*Aural*

| Study | n | Mean | Std. Err. | P-value |
|---|---|---|---|---|
| | | | | 0.2416 |
| Engineering | 36 | -0.4722 | 0.4421 | |

| | | | | |
|---|---|---|---|---|
| Education | 9 | -2.1111 | 0.8841 | |
| Other | 8 | -0.3750 | 0.9377 | |

*Read-write*

| **Study** | **n** | **Mean** | **Std. Err.** | **P-value** |
|---|---|---|---|---|
| | | | | 0.0843 |
| Engineering | 36 | 0.1111 | 0.4076 | |
| Education | 9 | -1.7778 | 0.8151 | |
| Other | 8 | 0.6250 | 0.8645 | |

*Kinesthetic*

| Study | n | Mean | Std. Err. | P-value |
|---|---|---|---|---|
| | | | | 0.5358 |
| Engineering | 36 | 0.1667 | 0.5051 | |
| Education | 9 | 0.0556 | 1.0102 | |
| Other | 8 | -1.000 | 1.0715 | |

**Conclusions and Recommendations**

As indicated in the study, modes of learning include visual, aural, read-write, kinesthetic, and multimodal preferences. Considering this, it becomes necessary for instructors to modify their instructional design system to meet the needs of current students. They must adapt instructional practices using a learner-centered, multimodal approach for teaching and learning. To develop these materials, learners' characteristics must be examined and instructors must have a better understanding of their student population.

Based on the data collected for this study it is recommended that stratification be done to allow for more female participants. This would provide opportunity for independent t-test on male and female pre and post instruction preferences to be analyzed.

This study could also be replicated with a control group that would receive treatment primarily in the form of project-based learning. A comparative analysis of visual-based learning and project-based learning and its influence on preferred learning styles could then be examined. Since both approaches to learning utilize visual-based instruction, this type of comparison may provide insight on more effective methods for instruction, assignments/projects, and retention.

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**Representing Students' and Instructors' Understanding of Sustainable Development Using Cognitive Mapping**

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12 May 2008

Abstract

Sustainable development is a term much-debated yet not often clearly understood. Its use has spread rapidly since the publishing of *Our Common Future* by the Brundtland Commission in 1987, and its importance has been recognized by many international organizations and conferences, including the United Nations, who named the years 2005 – 2014 the U.N. Decade for Education for Sustainable Development. A review of literature shows, however, that a relative lack of understanding of sustainable development exists among university students. Technology education presents a unique opportunity for sustainable development education because it provides a framework for students to integrate aspects of multiple disciplines within a single learning environment.

This study assessed, using cognitive mapping, the understanding of sustainable development of students and instructors at Appalachian State University in multiple sections of an Intro to Sustainable Development course and a Society and Technology course. Instructors exhibited a more distributed knowledge across multiple aspects of sustainable development. Students exhibited knowledge in certain aspects of sustainable development. Students in the Intro to Sustainable Development course responded with more words pertaining to social and cultural aspects, while students in the Society and Technology course responded with more words pertaining to science and technology. It was concluded that cognitive mapping is effective for evaluating understanding, but the process can be more effective as a teaching aid. Suggestions for further research are included.

Representing Students' and Instructors' Understanding of Sustainable Development Using Cognitive Mapping

The terms "sustainability" and "sustainable development" have gained increasing attention and acceptance in recent years. With increasing popularity have also come increased scrutiny and confusion as the terms are debated in academic circles and used by the general public, but often with an unclear understanding of the exact meaning of the words. Many authors even use the words interchangeably, even though sustainability refers more to an end and sustainable development can refer to both a means and an end. This complexity makes teaching the concepts to others difficult. Sustainable development education often does not conform to traditional educational structures, instead requiring an interdisciplinary approach. Understanding how students and educators understand sustainable development can assist in improving the sustainability curriculum. One method for achieving this is using cognitive maps.

*History*

The idea of sustainable development began to take shape during the latter half of the twentieth century as part of an "international cooperative negotiation process" (Lourdel, Gondran, Laforest, & Brodhag, 2005, p. 255). This international cooperation began during the 1970s and 1980s as groups of experts met to discuss the needs of humanity (Kates, Parris, & Leiserowitz, 2005). These experts attempted to identify and categorize the concerns and desires of people throughout the world, resulting in the following four major themes: peace, freedom, development, and environment (National Research Council, 1999). The events of the Cold War were the major impetus for efforts to achieve global peace. The freedom theme refers to the independence gained by multiple colonies as well as the struggle for human rights. Following independence, development, with a specific focus on the economic sector, became a desire for the former colonies as they strove to achieve the status of their former rulers and other Western countries (Kates, Parris, & Leiserowitz, 2005). The environment theme was the last to emerge, partly as a reaction to the effects of the events characterized by the other three themes, especially development.

The conflict between environment and development was first acknowledged at the 1972 Stockholm Conference on the Human Environment. Later, the 1980 World Conservation Strategy of the International Union for the Conservation of Nature proposed that conservation could assist development (Kates, Parris, & Leiserowitz, 2005). The greatest breakthrough in thinking occurred in 1982 when the United Nations created the World Commission of Environment and Development (WCED), chaired by Gro Harlem Brundtland, the Prime Minister of Norway. The Brundtland Commission, as it came to be called, issued a report in 1987, entitled *Our Common Future*. This report combined the themes of environment and development into the concept of sustainable development. The report defined sustainable development by stating: "Humanity has the ability to make development sustainable – to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 8). Since that time, the use of the term sustainable development has grown rapidly (Kagawa, 2007).

Other proceedings followed, including the 1992 United Nations Conference on Environment and Development held in Rio de Janeiro and the 2002 World Summit on Sustainable Development in Johannesburg (Kates, Parris, & Leiserowitz, 2005). These conferences, respectively, produced *Agenda 21*, which outlined desired principles and actions, and the *Report of the World Summit on Sustainable Development*, which reaffirmed the United Nations' commitment to sustainable development (Kates, Parris, & Leiserowitz, 2005). There has also been a growing sustainability interest in industry, characterized by individual companies' efforts, such as the triple bottom line – a measurement of a company's success in economic, environmental, and social terms; and by collective efforts, such as the Dow Jones sustainability index (Carew & Mitchell, 2002). In addition, the years 2005 to 2014 have been established as the United Nations Decade for Education for Sustainable Development (Kagawa, 2007).

*Defining Sustainable Development*

Despite large international efforts to establish the need for sustainable development, no single clear definition of the term exists. There is no single model of a sustainable society because sustainability is a "normative ethical principle, not a scientific concept" (Elshof, 2005, p. 173; see also Robinson, 2001). It is similar to, for example, the concept of democracy, in that there is no single definition of the term in practice. In the same way that multiple effective democratic models exist, so too can multiple sustainability models, making a single definition elusive. Most texts continue to refer to the rather vague and open-ended Brundtland Commission idea of "meeting the needs of the present without compromising the ability of the future." Several researchers have addressed the complexity and appropriateness of the terms sustainability and sustainable development. Despite some contention, the general agreement is that the "constructive ambiguity" of the terms lends them strength (Elshof, 2005, p. 173). Within this "malleability," some absolutes have been established (Kates, Parris, & Leiserowitz, 2005, p. 10). Sustainable development is considered to have three pillars: social, economic, and environmental (Kates, Parris, & Leiserowitz, 2005).

Part of the complexity of defining and understanding sustainable development stems from the fact that it is "both a means and an end" (Carew & Mitchell, 2002, p. 350). This complexity allows different groups, both working under the umbrella of sustainable development, to act in different and sometimes opposing ways (Padoch & Sears, 2005). Another part of the complexity of sustainable development is the fact that the term encompasses social and natural science components that, themselves, exist as part of larger wholes (Paehlke, 2005). Terms like efficiency and sufficiency, both of which are used in a social science context, are defined by natural science measures (Paehlke, 2005). For example, sufficiency, a moral idea that humans have reached, or are reaching, a limit to material wealth, is measured in terms of the physical capacity of Earth's production. Added to these ideas are political agendas, intergenerational equality, and intragenerational equality, along with already-complex environmental considerations.

The most serious efforts to define sustainable development have been quantitative indicators, such as the Commission on Sustainable Development, the Wellbeing Index, the Environmental Sustainability Index, the Genuine Progress Indicator, the Ecological Footprint, and over 500 other measures (Parris & Kates, 2003). The Brundtland Commission also outlined other principles including precaution, prevention, and solidarity (Lourdel, Gondran, Laforest, Debray, & Brodhag, 2007). A collection of commonly agreed-upon principles can be found in Table 1.

Table 1
*Principles of Sustainable Development*

| Principle |
|---|
| Recognition and respect for the limits of nature's capacity for regeneration, and limits to society and the economy. |
| Recognition of the interdependence and intradependence of ecosystem, socio-system, and economy. The more extreme view explicitly rejects the notion of nature existing to provide human needs or wants, and promotes a view of interconnected and interdependent relations between human and non-human entities. |
| Intergenerational equity, in other words the right of future generations to inherit a healthy and ecologically balanced environment from present generations. |
| Intragenerational equity, for example redistribution of wealth, power, and opportunity with a view to reducing current interpersonal and international disparity. |
| Respect for social and cultural freedom, with concomitant acceptance of the responsibilities inherent in social and cultural freedom. |
| Meaningful involvement of stakeholders in decision-making processes, including the public and private sectors, international and local representatives, and non-human agents. |
| Equal representation for economic, environmental, and social priorities in decision-making. |
| Recognition of the unique contextual factors in each decision-making situation. |
| Taking responsibility for the impacts resulting from one's decisions. |

Note: From Carew & Mitchell, 2002, p. 351.

*Sustainable Development and Education*

The United Nations is not the only organization to emphasize the importance of sustainable development education. Governments and regulating bodies in the United Kingdom and Australia have adopted certain requirements for graduating students, including a requirement by the Institution of Engineers, Australia, the accrediting body for undergraduate engineering courses, that students have an "understanding of the principles" and an "understanding of the need for sustainable development" (Carew & Mitchell, 2002, p. 350; see also Kagawa, 2007; Stir, 2006). In the United States, there are a few institutions that have a form of an environmental literacy requirement (Moody & Hartel, 2007). Environmental literacy means that students "have basic awareness and understanding of how the earth works as a physical system, recognize the relationship between the natural environment and human impacts on it, and have an appreciation for the complexity of these interactions" (Moody & Hartel, 2007, p. 356). Moody & Hartel found 7 institutions, in addition to the University of Georgia, that have an environmental literacy requirement, which can be fulfilled by taking between one and four courses, depending on the school (2007).

One of the problems facing institutions of higher learning, along with every other interested party, is achieving a standard definition of sustainable development. A subject cannot be taught if it is not understood by its teachers. Even though many institutions profess a commitment to sustainability, their measures for addressing it on their campuses often are incomplete or address only one or two pillars of sustainable development. Shriberg found that most colleges and universities that do assess sustainability on their campuses focus mainly on environmental issues, rather than economic or social ones (2002). The colleges and universities that do assess sustainability in any way are a minority, however. A "scarcity of publications" exists that have assessed university students' actual knowledge of sustainable development (Kagawa, 2007, p. 320). This fact may be due in part to an overall lack of curriculum commitment to sustainability education (Martin, 2003). The research that does exist generally focuses on engineering and technology students.

Technology Education, in particular, "has the potential to help students envision, transform, design, and construct a more sustainably built world, one, which is, understood more in a 'relational totality' (O'Sullivan, 1999) rather than as a collection of isolated components" (Elshof, 2005, p. 174). This "relational totality" could encompass the complexities of sustainable development, but often technology education is laced with a "technological gestell" (Irwin, 2003, p. 286). Gestell, or enframing, is a term that philosopher Martin Heidegger refers to as the essence of modern technology (Godzinski, 2005).

According to Heidegger, in the world of modern technology, enframing is the process by which Truth reveals itself as a standing-reserve, or something that humans treat as if it is waiting to be used by humans (Heidegger, 1977). In this same way, modern technology treats nature as a standing-reserve, a resource waiting for humans to extract from it (Godzinski, 2005). According to this perspective, technology is a facilitator that perpetuates an anthropocentric view of the world. As long as humans have such a view, they will continue to act in ways that exploit nature, since actions are determined by beliefs (White, 1967). As long as this philosophy is prevalent in technology education, sustainable development will have difficulty progressing within this field, since sustainable development requires a much more ecocentric approach.

***Differences between Students and Instructors***

The perception also exists that interest in sustainable development is low within the technology education field. Elshof found that teachers estimated not only their colleagues' interest to be lower than their own, but also student interest in sustainability to be very low (2005). Furthermore, at the University of Georgia, where an environmental literacy requirement exists, only 16% of the faculty considered the undergraduate student body to be environmentally literate (Moody & Hartel, 2007). These perceptions may have some factual basis.

In the same study by Moody & Hartel, students ranked themselves on their environmental literacy before taking a sustainable development course, with 74% stating a high to moderate level of environmental literacy, yet these same students had almost identical self-evaluated increases in level of knowledge and concern after taking the course as students who ranked themselves as having low environmental literacy before taking the course (2007). This statistic suggests that perhaps many students are overly optimistic about their actual knowledge of sustainability. Another study found that students thought sustainable development was important despite their low knowledge of it (Azapagic, Perdan, & Shallcross, 2005). For students who do have some knowledge of sustainable development, the environmental dimension is strongly identified, but the social and economic dimensions are only marginally identified (Kagawa, 2007). These findings suggest an uneven and incomplete distribution of knowledge of sustainable development in education.

Luckily, most studies have found that courses in sustainable development are effective in increasing either awareness of, or action for, sustainable development (Moody & Hartel, 2007; Stir, 2006; Lourdel et al., 2005; Lourdel et al., 2007). Lourdel et al. found that students possessed a strong understanding of the environmental aspect of sustainable development before taking a course in sustainability. After the course, students displayed a more complete knowledge of sustainable development. Similar results were found in a later study (Lourdel et al., 2007). This study compared students' knowledge with that of their teachers. The types of words used by both students and teachers to describe sustainable development were often similar, suggesting students inherit teachers' understanding. Teachers' knowledge of sustainable development was found to be more complex than the students' (Lourdel et al., 2007).

### *Cognitive Mapping*

The understanding in both depth and complexity was assessed by Lourdel et al. using cognitive maps. This instrument identifies knowledge and the interconnections of that knowledge, providing a visual representation of the knowledge an individual has (Lourdel et al., 2007). It arises from a theory of learning that states knowledge is constructive. In other words, new information is not simply copied or memorized, but is interpreted based on a person's already existing knowledge (Lourdel et al., 2007). This theory is known as constructivism.

Constructivism is a term that describes philosophies of education and theories of learning (O'Donnell, 1997). Historically, it stems from the work of Jean Piaget and other cognitive psychologists. According to Piaget, knowledge has an adaptive function (von Glasersfeld, 2005). An individual's knowledge or understanding of the world is not necessarily a representation of an external reality, but a "mapping of actions and conceptual operations" that have been "proven viable in the knowing subject's experience" (von Glasersfeld, 2005, p. 4). As an active participant in the learning process, the individual constructs – hence, constructivism – a personalized meaning within the context of prior experience (O'Donnell, 1997). Because each individual creates his or her own personal knowledge, shared meanings can only be assumed to be shared (O'Donnell, 1997). Abstracting and generalizing these meanings allows others to understand, creating a shared meaning (Fosnot & Perry, 2005). A cognitive map is one example of the way in which understanding can be symbolized.

### *Cognitive Maps and Sustainable Development*

Cognitive maps are well-suited for use in sustainable development education. Following constructivist theory that learning, and thus, understanding, is nonlinear, cognitive maps are nonlinear representations of understanding (Fosnot & Perry, 2005). This structure allows a cognitive map to represent complex concepts, including sustainable development. Furthermore, cognitive mapping techniques have been used for evaluating structural and methodological changes to curriculum (Toral et al., 2007). These changes are essential, especially in technology education with its potential to create relational totalities, for integrating the interdisciplinary aspects of sustainable development.

## Statement of the Problem

Research shows that students have, at best, a limited knowledge of sustainable development, but if sustainable development is to progress, more students and instructors not only must be aware of it, but also must be able to understand it in all aspects of its complexity. Understanding how students and teachers understand sustainable development can facilitate further learning by identifying knowledge discrepancies between instructors and students, in order to fill in gaps in curricula and address weak points, while continuing to focus on well-understood concepts. This study is designed to assess the knowledge of sustainable development, represented by using cognitive mapping, of students and teachers in selected courses at Appalachian State University.

## Research Questions (RQ)

RQ1: How do students understand, as represented by cognitive maps, the concept of sustainable development?

RQ2: How do instructors understand, as represented by cognitive maps, the concept of sustainable development?
RQ3: How does instructors' knowledge of sustainable development compare to students' knowledge?

## Limitations

The findings are limited to the knowledge of students and instructors in selected courses at Appalachian State University.

## Method

Subjects were asked to complete cognitive maps of sustainable development. These maps were analyzed to determine the depth and complexity of subjects' knowledge relative to other groups of subjects.

*Sample*

Subjects were students and instructors in courses in the technology and sustainable development programs at Appalachian State University. This sample was both a convenience and purposeful sample, since students in these courses were expected to have some knowledge of sustainable development. Also, although not included in any research questions, students in these two programs were expected to have different emphases in their knowledge of sustainable development. It was thought that sustainable development students would display a greater knowledge of social aspects of sustainable development and technology students would display a greater knowledge of the technical aspects.

There were 46 students in two sections of an undergraduate Introduction to Sustainable Development course (SD 2 and 3) and 7 students in a graduate Foundations of Sustainable Development course (SD 1). There were also 92 students in four sections of an undergraduate Society and Technology course (TEC 1, 2, 3, and 4). Some of these responses were removed from data analysis because of incomplete or incoherent maps, resulting in a total of 81 students from technology. There were also 2 instructors each from sustainable development and technology, for a total of 4. See Table 2.

Table 2
*Sample (n)*

| | Students | Instructors |
|---|---|---|
| SD 1 | 7 | 1 |
| SD 2 | 20 | 0 |
| SD 3 | 26 | 1 |
| Subtotal | 53 | 2 |
| TEC 1 | 19 | 1 |
| TEC 2 | 14 | 1 |
| TEC 3 | 27 | 0 |
| TEC 4 | 21 | 0 |

| | | |
|---|---|---|
| Subtotal | 81 | 2 |
| Total | 134 | 4 |

*Instrument*

Cognitive maps are used to identify knowledge as well as to represent how this knowledge is interconnected. A stimulus word is given and then subjects fill out the rest of their individual map by writing down concepts and drawing arrows between different concepts to represent relationships. An example with 'education' as the stimulus word is seen in Figure 1. The instrument can be seen in Appendix A.

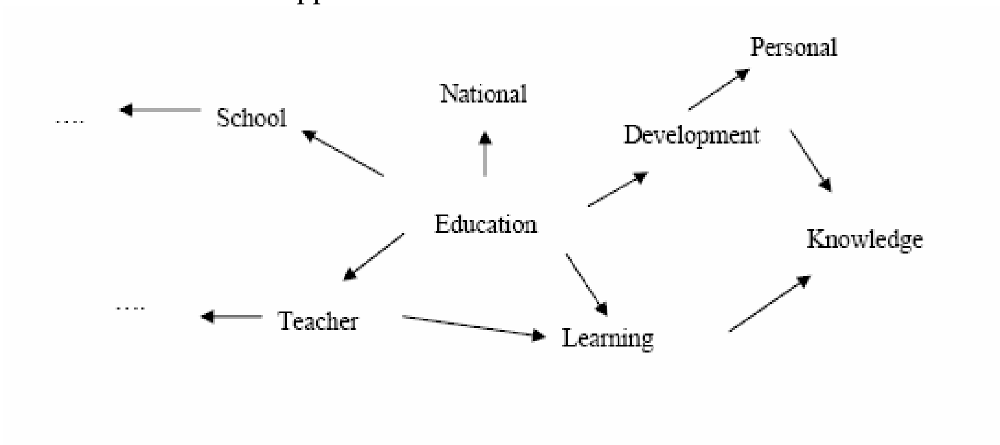


*Figure 1*. Cognitive map of education.

From Lourdel et al., 2007

*Procedure*

The instrument was administered to classrooms of students. A short verbal introduction explained cognitive mapping and the examples covered in the instrument. Subjects were then asked to complete an individual cognitive map with "sustainable development" as the stimulus word. Subjects were given 5 minutes to complete this task.

*Analysis*

Each map was analyzed by first sorting all the words used into semantic categories. These categories were adapted from Lourdel et al., 2007. For this study, six categories were chosen – Social/Cultural, Environmental, Economic, Scientific/Technical, Political/Procedural, and a miscellaneous category. Categorization of words was made based on operational definitions for these categories, found in Appendix B. Some assumptions were made to classify ambiguous words and ideas such as resource management; reduce, reuse, recycle; preserve; conserve; poverty; walking/biking; and efficiency. These words were categorized based on the categorization of other words within close proximity to the ambiguous word, assuming the subject intended the same sense for both words when creating the cognitive map. The semantic categories are supposed to represent all aspects of sustainable development.

The mean number of words used for each category was calculated for students in sustainable development courses, professors in sustainable development courses, students in technology courses, and professors in technology courses. In addition, the percentage of maps with at least one word in a category was calculated. Lastly, a complexity ratio was calculated. This ratio was derived by summing the number of inter-category links on each map and dividing by the number of possible links. This latter number was determined by a combination based on the total number of categories with at least one word for each map. For example, if a subject had written words that could be classified in three different categories, yet only made one inter-category link, the complexity ratio would be 0.3 (1÷3).

## Results

The results can be seen in Tables 3, 4, and 5. There was no statistical significance between the mean number of words in each category for any two groups. As seen in Figure 2, though, instructors did use a greater number of words in each category and demonstrated a more balanced and distributed understanding of sustainable development. The mean number of words in each category for professors is spread more evenly across all the semantic categories, rather than concentrated in one or two categories, as it is for students. As seen in Figures 3 and 4, students in the sustainable development courses demonstrated a greater understanding of the social and cultural aspects, whereas technology students listed a greater number of words in the scientific/technical category. These results were to be expected due to the particular curriculum emphasis of the courses. Technology instructors' maps also more closely resembled the maps of students in the sustainable development courses than those of the sustainable development professors, suggesting perhaps that technology instructors have learned about sustainable development in a similar manner as sustainable development students. In addition, the mean number of possible links for students and instructors is consistent with the overall findings. Professors created maps containing words in a greater number of categories than students did (Table 4).

Table 3
*Mean number of words in each category*

| | | Soc/Cult | Env. | Econ. | Sci/Tech | Poli/Proc | Misc |
|---|---|---|---|---|---|---|---|
| Overall | Students | 1.85 | 2.00 | 0.92 | 3.97 | 0.72 | 0.84 |
| | Instructors | 4.00 | 3.50 | 2.00 | 1.75 | 0.50 | 1.50 |
| SD | Students | 2.96 | 2.09 | 1.57 | 3.70 | 0.85 | 0.89 |
| | Instructors | 4.00 | 4.00 | 3.50 | 1.00 | 0.00 | 2.00 |
| TEC | Students | 1.12 | 1.94 | 0.49 | 4.15 | 0.63 | 0.81 |
| | Instructors | 4.00 | 3.00 | 0.50 | 2.50 | 1.00 | 1.00 |

Table 4
*Overall Results for Students and Instructors*

| | | Soc/Cult | Env. | Econ. | Sci/Tech | Poli/Proc | Misc |
|---|---|---|---|---|---|---|---|
| Mean # of words | Students | 1.85 | 2.00 | 0.92 | 3.97 | 0.72 | 0.84 |
| | Instructors | 4.00 | 3.50 | 2.00 | 1.75 | 0.50 | 1.50 |
| Std. Dev. | Students | 2.12 | 1.87 | 1.34 | 3.65 | 1.07 | 1.54 |
| | Instructors | 2.58 | 1.91 | 1.83 | 1.26 | 0.58 | 1.73 |
| Pct. of maps with at least one word | Students | 69 | 80 | 51 | 90 | 41 | 37 |
| | Instructors | 100 | 100 | 75 | 75 | 50 | 75 |

Table 5
*Complexity Ratio for Students and Instructors*

| | Mean # of links | Mean # of possible links | Complexity Ratio |
|---|---|---|---|
| Students | 2.31 | 4.51 | 0.51 |
| Instructors | 2.75 | 6.25 | 0.44 |

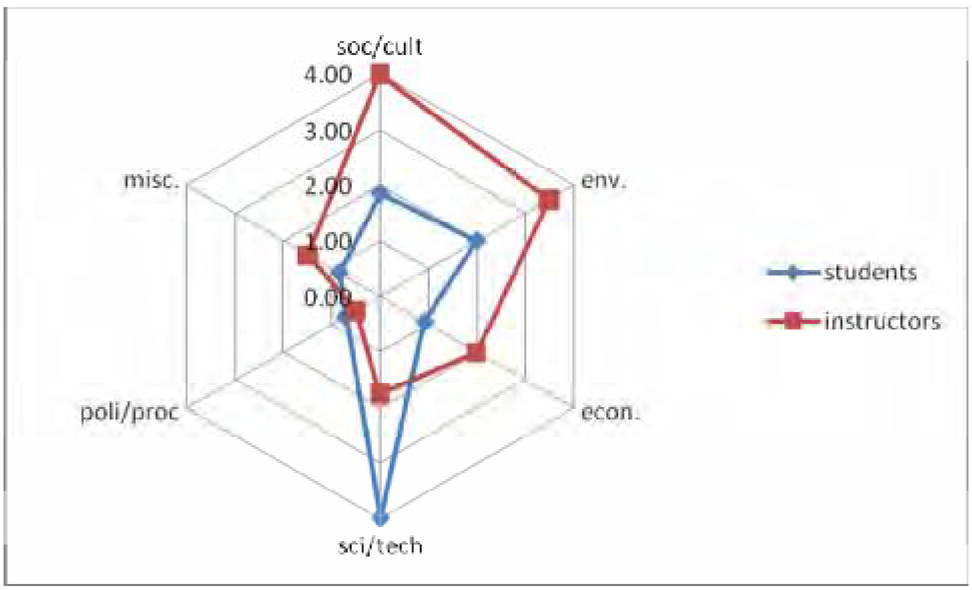


*Figure 2.* Mean number of words in each category for students and instructors

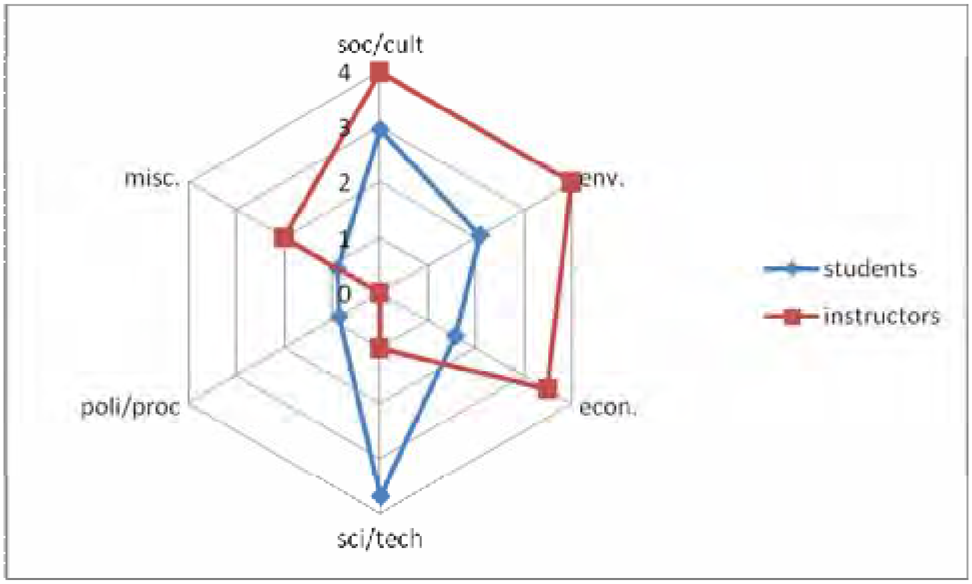


*Figure 3.* Mean number of words in each category for sustainable development students and instructors.

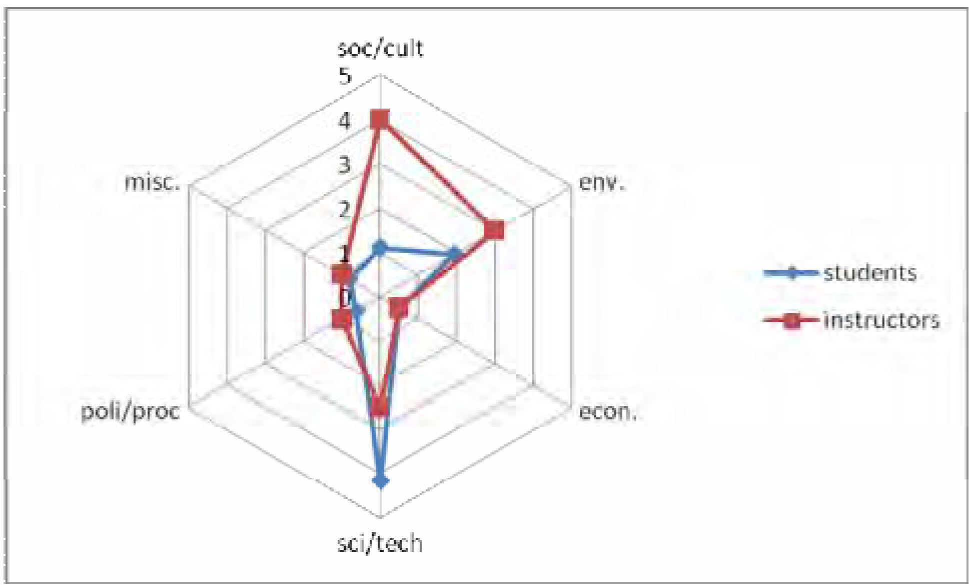


*Figure 4.* Mean number of words in each category for technology students and instructors.

Discussion

The results of this study support previous findings that cognitive mapping is able to represent the multidimensional aspects of sustainable development that are understood by students and instructors. These aspects are represented by both the semantic categories and the inter-category links. Unlike previous research, subjects in this study did not demonstrate a stronger identification with the environmental dimension in comparison with the economic or social/cultural dimensions. In fact, all three dimensions were almost equally identified with, although the economic dimension was somewhat neglected.

The results of this study also suggest that curriculum change can improve students' knowledge of sustainable development. It shows that curriculum does have an impact on student knowledge. Students in sustainable development courses identified more words in the social/cultural and environmental categories, but students in technology courses identified more words in the scientific/technical category. All professors, regardless of course, identified almost the same number of words in the social/cultural and environmental categories, suggesting that the difference in student knowledge is related to the topic of the course and not entirely the personal knowledge of the professor. Also, there is potential for sustainable development education to work in technology education at Appalachian State because technology instructors already possess knowledge of sustainable development.

The low complexity ratios and overall lack of inter-category links may suggest a failure to integrate knowledge and that knowledge of students exists as a "collection of isolated components" (Elshof, 2005, p. 174). Alternatively, the low number of links may have been due simply to a failure to clearly convey or understand directions.

## Suggestions for Further Research

Although cognitive maps were shown to be effective assessment tools in this study, they can be much more effective as a pedagogical tool. A cognitive map can represent a person's thoughts, but only to a certain degree. Using a longitudinal design with multiple iterations of the cognitive mapping procedure, paired with interviews to help fully interpret the maps, could create more accurate representations of knowledge. Such a procedure could help to refine how the cognitive mapping procedure is explained and analyzed.

In addition, semantic categories need to be refined so that ambiguities can be resolved about certain words such as resource management, poverty, efficiency, and others. These words could be classified in multiple of the existing categories since they invoke certain ideas in multiple categories. Alternative data analysis, using, for example, a three-set Venn diagram representing the three pillars of sustainability, may also help in classifying and categorizing the data.

## Summary

A relative lack of understanding of sustainable development exists among university students, yet multiple national and international organizations acknowledge the importance of sustainable development education. Understanding how students and teachers understand and learn about sustainable development can facilitate further learning. Technology education, in particular, presents a unique opportunity for sustainable development education because it provides a framework for students to integrate aspects of multiple disciplines within a single learning environment. This study assessed the knowledge of sustainable development, represented by using cognitive mapping, of students and teachers in selected courses at Appalachian State University. Instructors exhibited a more distributed knowledge across multiple aspects of sustainable development. Students exhibited knowledge in certain aspects of sustainable development, including the social/cultural, environmental, and scientific/technical categories. The results could best be used as a pedagogical tool in an interactive manner with participants.

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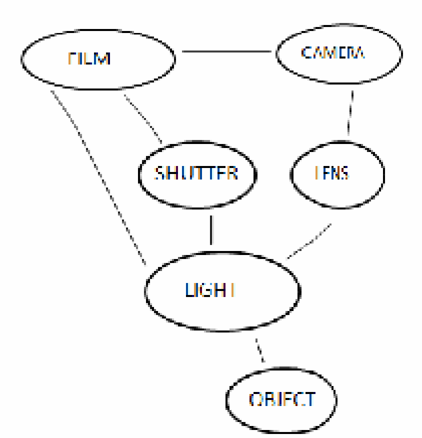
## Appendix A (Instrument)

### Cognitive Mapping Survey

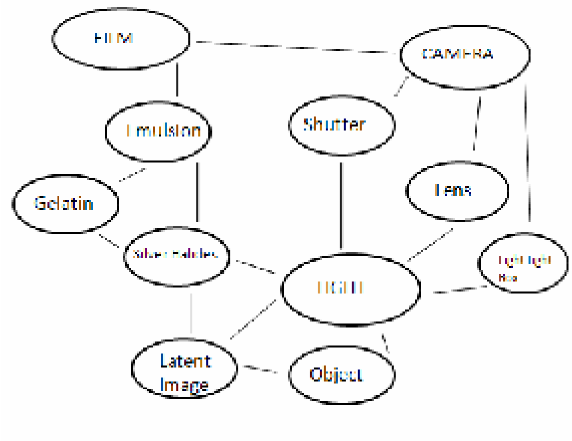
Cognitive maps - also called concept maps - provide a method for visually representing an individual's knowledge of a given subject. Thoughts, concepts, and ideas are recorded in bubbles with arrows or lines linking related terms. Generally a stimulus word – some type of broad category or overarching term – is placed in the middle of a page. Related thoughts, concepts, or ideas are then linked to the stimulus word. Linkages can also be drawn between terms, and must not always stem from the stimulus word.

Cognitive maps can be thought of as a brainstorming activity. One word produces thoughts of other, related words and so on. Essentially, you will create a map of your cognitions, or thoughts. The following are examples ranging from topics of photography to illegal drug use to dinosaurs.

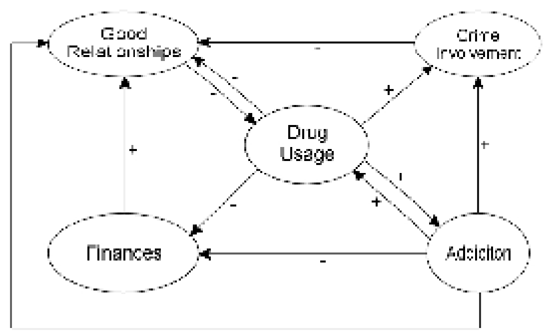



To the left is a simple cognitive map of the concept of photography.

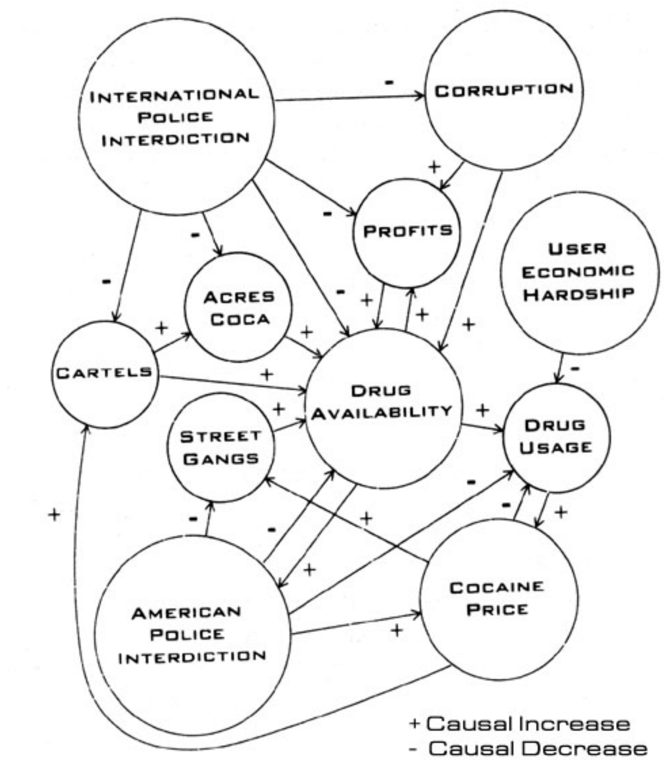
To the right is a more complex cognitive map.



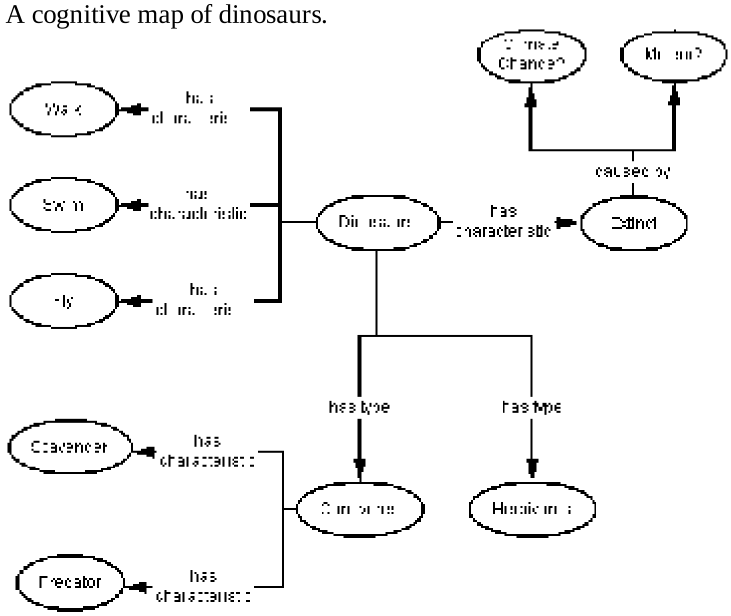

A simple cognitive map of drug use.




A more complex cognitive map of drug use.




A cognitive map of dinosaurs.




As you can see, all of these cognitive maps are slightly different. There are no correct or incorrect cognitive maps. Some of the relationships between terms have been characterized by causal relationships or with specific terms. These specifics are not necessary for the upcoming task. Simple lines and arrows are sufficient.

Please complete a cognitive map for your personal conceptualization of ***sustainable development***. Include any and all thoughts, terms, characteristics, relationships, etc. that you think of when you think of sustainable development. Draw lines between terms that you feel have any type of relationship to one another.

Year: Fr. So. Jr. Sr. Grad. Prof.
Major:___________________________
SD Concentration? Yes No
SD Minor? Yes No

Please complete a cognitive map for your personal conceptualization of ***sustainable development***. Include any and all thoughts, terms, characteristics, relationships, etc. that you think of when you think of sustainable development. Draw lines between terms that you feel have any type of relationship to one another.


Editor's Note: Blank space was left for drawing

Appendix B (Category Operational Definitions)

**Environmental** – anything related to the overall health of the natural environment, including availability of, and degradation of, natural resources. Examples include: natural resources, biological processes, resource depletion, pollution, climate change, global warming, air/water/soil quality.

**Economic** – anything related to the financial effects of development, as well as various groups' capability to access resources for monetary reasons. Examples include: global versus local financial impacts, affordability, greed, corporate culture, bottom-line thinking, efficiency (related to saving money).

**Scientific/Technical** – anything related to specific human-developed systems or artifacts investigated or developed to address problems related to sustainable development. Examples include: efficiency (related to saving resources), renewable energy, farming, ecology, any application of SD principles toward creation of an artifact or system, materials.

**Policies/Procedures** – anything related to actions or policies or procedures established by a formal governing board or representative body to impose solutions or plans of actions to achieve goals related to sustainable development. Examples include: government, other organizations, EPA, laws, planning, zoning, regulations, codes.

**Social/Cultural** – anything related to human interactions, habits, psychology, values, beliefs, social norms, or informal codes of behavior (as opposed to formal/governmental). Examples include: access to resources (ex/food, water, fuel, etc.), equity, generational equity, fairness, concepts of global vs. local effects, population, human health, habits/trends/human tendencies.

**Miscellaneous -** abstractions, adjectives, or metaphors that convey a meaning that captures the sense or spirit of sustainability without fitting into another single category. Examples include: victim, friendly,doom and gloom, green, Al Gore.

**Complexity –** links represent the number of purposive, non-random connections between different categories. For example multiple connections could be made between Sci/Tech and Economics, but the level of complexity would only be 1.

# What Technology Means to Rural Secondary Students

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**Introduction:**

The scientific, technological, and academic communities are vital in reforming education and encouraging young people to study and pursue careers in science, technology, engineering, and mathematics (Kesidou and Koppal, 2004). In 2006, the East Carolina University (ECU) Department of Engineering received a National Science Foundation (NSF) grant designed to increase opportunities for secondary students to increase their knowledge of technology, science, engineering and mathematics in rural eastern North Carolina via educational experiences with college faculty during a 3 week summer academy. The grant, "Innovative Technology Experiences for Teachers and Students," incorporates solid modeling, biomechanics, robotics, data collection and analysis and social issues in technology into educational experiences. This program is a response to the concern about shortages of technology-literate workers in rural eastern North Carolina and is intended to assist secondary students in developing the knowledge and skills needed to contribute in a technological society.

North Carolina has one of the largest populations of rural students in the United States, ranking second nationally in the number of children living in rural places (610,000), fifth nationally in the percentage of children in rural places (45%), and third nationally in the number of rural children of color (208,540) (The Rural School Community Trust, 2007).

This study specifically focuses on rural secondary students in the eastern region of North Carolina and their understanding of the nature of technology.

**Figure 1: Rural Eastern North Carolina -**
**Service Region of East Carolina University**


Highly rural areas such as eastern North Carolina are critically dependent on students learning math, science and technology to vitalize the economy and improve the overall quality of life for their regions. The need for a technologically literate workforce emphasizes the importance of technology education programs in rural schools. According to Volk and Dugger (2005), one of the fundamental issues in technology education is teaching students to have an understanding of what actually constitutes "technology" and fostering an accurate conceptualization of technology as a discipline. Volk and Dugger suggest that technology educators in the United States often have difficulty educating the public about technology given the lack of a common definition and understanding.

This paper discusses findings from a descriptive study performed during year one of the aforementioned NSF grant program conducted at ECU in which 55 out of 60 total participants (rural NC secondary students) define technology prior to receiving instructional experiences of the program. The study analyzes student demographic and descriptive variables and compares the findings of this sample to those in larger studies.

Focus questions include;

1. How do rural secondary students define technology?

2. Do demographic and descriptive variables influence definitions of technology among students? For example, do males generally differ from females, or do students who have taken more technology courses generally differ from students who have taken a fewer number of courses?

3. How do rural secondary students' definitions of technology compare/contrast to others found in the literature such as in the Volk and Dugger (2005) and Rose and Dugger (2002) studies?

According to Rose and Dugger (2002), the International Technology Education Association has encouraged additional research on common understanding and definitions of technology be conducted in the U.S. and abroad.

**Related Literature:**

*What is "Technology"?*

"Technology is how people modify the natural world to suit their own purposes. From the Greek word *techne*, meaning art or artifice, technology literally means the act of making or crafting, and more generally refers to the diverse collection of processes and knowledge that people use to extend human abilities and satisfy needs and wants." (The Standards for Technological Literacy, 2007. p2)

The Standards for Technological Literacy stress the importance of having a foundational understanding of technology. This is discussed at length in Standards One, Two and Three; Standard 1. Students will develop an understanding of the characteristics and scope of technology.

Standard 2. Students will develop an understanding of the core concepts of technology.

Standard 3. Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
In their well-known text Technology, Change and Society, Pytlik, Lauda and Johnson (1985) provide several cornerstone definitions from the study of technology over time;

1. "Technology embraces the means by which man controls or modifies his natural environment" (Spier, 1968, p 131).

2. "The technology of a people is their major means of adjusting to the environment" (Arensberg and Niehoff, 1971, p 64).

3. "The information, techniques, and tools with which people utilize the material resources of their environment to satisfy their needs and desires" (Lenski, 1974, p 498).

These definitions of technology have similar philosophical underpinnings to the definition adopted by the International Technology Education Association. The standards and definitions purposefully differentiate "technology" as an extension of human capability or potential - as opposed to an individual product or other narrowly defined concept. This includes distinguishing the natural world from the human-made world and strongly encourages the invention or use of tools and techniques. Such themes echo throughout the K-2, 3-5, 6-8, and 9-12 grade benchmarks as a foundation for understanding the scope of technology.
Technology has been defined in academic circles for many years. Technological literacy begins with a foundation in which the learner has solid understanding of the nature of technology. However, recent studies have suggested that the common societal perceptions of technology often do not accurately reflect that which the discipline has embraced. Using an open-ended question, Volk and Dugger (2005) studied to what degree expert rhetoric matched public reality and perceptions concerning the definition of technology. This study compared responses of Americans and Chinese (residents of Hong Kong).

The following table from their 2005 study describes the findings.

When you hear the word "technology, what first comes to mind? (2004 Data)

| | HK % | US % |
|---|---|---|
| Computers | 47 | 68 |
| Advancement | 7 | 2 |
| New Inventions | 7 | 1 |
| Electronics | 5 | 5 |
| Information | 4 | 0 |
| Science | 3 | 1 |
| Space | 3 | 1 |
| Things That Make Life Easier | 3 | 0 |
| Machinery | 2 | 1 |
| Internet | 1 | 2 |
| Education | 1 | 1 |
| Others | 19 | 18 |

Volk and Dugger also analyzed responses from a 2001 poll asking the following question "Which more closely fits what you think of when you hear the word technology?" The table below from their study describes their findings.

Which more closely fits what you think of when you hear the word "technology"? (2001 Data)

| | HK % | US % |
|---|---|---|
| Computers and the Internet | 34 | 63 |
| The application of knowledge..... Changing the natural world | 66 | 36 |
| Don't know/refused | - | 1 |

Between 2001 and 2004, the percentage of respondents who viewed technology as computers/information technologies increased for the U.S. and Hong Kong participants. In both 2001 and 2004, approximately two-thirds of the U.S. sample thought "computers." Hong Kong citizens appeared to have a broader view of technology. Respondents in the Hong Kong study were more likely to use descriptors that transcend computers and hardware, with terms such as "advancement," "new inventions," and "information." These findings resemble information from the Rose, Gallup, Dugger, & Starkweather (2004) study which noted that for Americans, "computers have no rival in the public's mind as emblematic of 'technology'" (p.2). The Volk and Dugger study also points out that the U.S. ITEA/Gallup data did not distinguish between urban and rural participants. They suggest the possibility that a fast-paced and technologically stimulating urban area such as Hong Kong could produce a more inclusive perception of technology (Volk and Dugger, 2005).

*Technology Education in Rural Areas*

We live in an increasingly complex technological society. It is critically important to prepare students with the knowledge and skills needed to succeed in a technology driven work place. In a speech concerning education and technology, Larry Irving, former Assistant Secretary for Communication and Information for the U.S. Department of Commerce, stated that in today's world, technical literacy is as important as the common three subjects, reading, writing, and arithmetic (Irving, 1999). Dede, Korte, Nelson, Valdez, and Ward (2005) have emphasized that 21st century workers must have skills in science, math, and information and technology. They suggest that a primary challenge for United States education is to promote and increase student interest in gaining scientific and technological skills.

Unfortunately, rural schools often do not have the equipment, staff and other resources needed to teach and learn technology for a variety of reasons. Many rural areas suffer from economic problems and societal issues which permeate local schools. Irving (1999) states more work needs to be done to provide access to technology and training in public schools because many children in low-income, minority or rural areas still do not have adequate technology access or ownership. This issue is compounded in the southern United States which still remains distinctly rural in culture and character (Irving, 1999). The Southern Governors' Association (2004) states that approximately 6.5 million students attend schools in rural areas in the southern United States. Rural districts tend to have fewer technological resources in their schools. With North Carolina's population over 40% rural, technology education is important for the success of these students as they move into higher education and the workforce.

**Methods:**

*Participant Selection*

As a part of the grant program, 6 rural counties in eastern North Carolina were identified for participation. Ten high schools were selected from these counties to participate based on numerous grant specifications including achievement data and diversity. After high schools were identified, 6 students from each school (total of 60 students) were chosen to participate in a three-week summer academy. Student selection criteria included a special attempt to focus on female students, minority students, and students from lower socio-economic status backgrounds who represent the populations in the rural areas. Each school could nominate up to 15 students. Once the initial nomination list was prepared, students were interviewed by a group of teachers and guidance counselors then asked to present a written statement of interest. The statement of interest was evaluated and included in the selection process. Final student participation was also based on parental permission and student availability for summer involvement. All costs (including transportation) were provided by the grant so students of low-income families could attend without cost as a factor. Of the 60 total grant participants, 55 students were present and willing to participate in this study.

*Design of Instrument and Data Analysis*

The intent of the study was to gain an understanding of participants' conceptualization of technology through the analysis of their writing. Secondly, the researchers wanted to understand if demographics could be used to explain patterns of responses. Finally, student responses were to be compared to responses found in similar studies of larger populations. To accomplish these goals, questions asked by Volk and Dugger (2005) and Rose and Dugger (2002) in previous studies were used as a basis for developing the questionnaire. The first page provided instructions asking participants to silently and independently define the term “Technology” to the best of their abilities without help from any source. Ample space and time was provided for writing. This open ended response decreased suggestive thinking and/or random guessing associated with multiple choice questions.

On the second page, students were asked demographic/descriptive questions. Below are the questions and the coding used for analysis;

1. Age (Actual number)
2. Grade (Actual number)
3. Gender (Coded 1 = male, 2 = female)
4. Race (Coded African Heritage = 1, Caucasian = 2, Hispanic/Latino = 3, Biracial = 4, Native American 5, Asian = 6)
5. The number of math, science and technology classes completed during high school (Actual number)
6. Hobbies including technology (Coded yes = 1, no = 2)
7. Desire to have a career using technology (Coded yes = 1, no = 2, not sure =3 )

The questionnaire was administered on the second day of the three-week summer academy to reduce influence from participating during the academy. Participation was optional and input was anonymous A proctor was in the room for observations and to clarify instructions as necessary.

Analysis procedures included coding and entering of data into statistical analysis software. Participant writing data were individually read and categorized based on themes which emerged. Each theme category was assigned a representative number which was added to the data set for analysis.

**Findings:**

Demographic data is reported in Table 1. The sample was intended to be diverse and represent characteristics of people residing in the rural communities and schools within the region. Notable statistics include 38% of African descent, 34% Caucasian and 15% Hispanic/Latino. Additionally, 53% were males and 47% were females. This data suggests diversity suitable to the mission of the grant in terms of gender and race. Additionally, 71% of respondents were sophomores or juniors. Fifty-five respondents of 60 total grant attendees were present and participated.

**Table 1: Student Demographics by Grade**

| Grade | N | % |
|---|---|---|
| Freshman | 9 | 16 |
| Sophomore | 28 | 51 |
| Junior | 11 | 20 |
| Senior | 7 | 13 |
| **Totals** | **55** | **100%** |

**Table 2: Student Demographics by Ethnicity & Gender**

| Status | M | F | Total | Total % |
|---|---|---|---|---|
| Native American | 2 | 1 | 3 | 5 |
| African Descent | 9 | 12 | 21 | 38 |
| Asian | 2 | 0 | 2 | 4 |
| Hispanic/Latino | 4 | 4 | 8 | 15 |
| Caucasian | 10 | 9 | 19 | 34 |
| Biracial | 2 | 0 | 2 | 4 |
| **N Totals** | **29** | **26** | **55** | |
| **% Totals** | **53%** | **47%** | | **100%** |

Approximately half of the respondents had hobbies which involved the use of technology. Removing the rising freshmen because of their inability to have taken secondary courses, 24% of the remaining 46 respondents had not taken technology classes. Fifty-eight percent of respondents desired to have a future career using technology, 16% did not want to work with technology and 25% were not sure.

Tables 3, 4 and 5 display the data.

**Table 3: Hobbies that Involve Technology**

| Response | N | % |
|---|---|---|
| Yes | 28 | 51 |
| No | 27 | 49 |
| **Total** | **55** | **100%** |

**Table 4: Frequency of High School Classes Taken in Math, Science and Technology**
N=46 (9 Rising freshmen removed)

| Number of Classes | Math | Science | Technology |
|---|---|---|---|
| 0 | 0 | 0 | 11 |
| 1 | 16 | 19 | 23 |
| 2 | 16 | 17 | 9 |
| 3 | 8 | 9 | 2 |
| 4+ | 6 | 1 | 1 |
| **Totals** | **46** | **46** | **46** |

**Table 5: Desire to Have Career in Technology**

| Response | N | % |
|---|---|---|
| Yes | 32 | 58 |
| No | 9 | 16 |
| Not Sure | 14 | 26 |
| **Total** | **55** | **100%** |

To analyze the respondents' definitions of technology, the researchers read through all questionnaires first then categorized the findings based on themes which emerged. The literal words were used and the researchers did not attempt to infer or imply any meaning from respondents' writing. Thirty-one percent defined "technology" as a way of improving ease or speed, 25.5% defined technology as computers or electronics, 16.5% defined technology as combining or applying science and math, 4% used the word "things" for their definition, and 5 % said technology was information. Fifteen percent of students had responses which did not correspond or relate with those of the other participants. The categories which emerged along with the number of responses (frequency and percent) are displayed in Table 6.

**Table 6: Themes Which Emerged From Participant Definitions of Technology**

| **Theme** | **N** | **%** |
|---|---|---|
| Ways to make life easier and/or faster | 17 | 31% |
| Electronics/computers/hardware/software | 14 | 25.5% |
| Combining/applying science and math | 9 | 16.5% |
| "Things/Stuff" | 4 | 7 % |
| "Information" | 3 | 5% |
| Responses without theme | 8 | 15% |
| **Totals** | **55** | **100%** |

Using the themes which emerged as a guide for further analysis, data was stratified into categories. Demographic data for each participant with similar definitions was compiled and analyzed as a group. For example, demographic data from all respondents who defined technology as "computers" was pooled and averaged, then compared to other theme categories. Respondents whose definitions did not fall into a theme category were not included in this analysis and were analyzed independently.

Table 7 displays means of demographic data by theme of response.

**Table 7: Means of Demographics by Theme**

| | **Demographic Categories and Means** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Themes (Below)** | ***Age*** | ***Gender*** | ***Grade*** | ***Career in Technology*** | ***Classes in Math*** | ***Classes in Science*** | ***Classes in Technology*** | ***Hobbies in Technology*** |
| *Ways to make life easier and/or faster n=17* | 15.7 | 1.4 | 2.2 | 1.7 | 2.1 | 1.8 | 1.4 | 1.3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Computers/ electronics n=14* | 15.2 | 1.6 | 2.3 | 1.5 | 1.8 | 1.6 | 1.0 | 1.8 |
| *Combining/applying science and math n=9* | 15.4 | 1.3 | 2.4 | 1.4 | 2.3 | 1.9 | 0.6 | 1.2 |
| *"Things" n=4* | 14.8 | 1.8 | 1.8 | 2.3 | 1.0 | 0.5 | 0.8 | 1.8 |
| *Information n=3* | 15.0 | 1.0 | 2.0 | 1.7 | 1.3 | 1.0 | 0.7 | 1.7 |
| **Variance** | **0.13** | **0.09** | **0.07** | **0.10** | **0.30** | **0.35** | **0.11** | **0.01** |
| **Standard Deviation** | **0.36** | **0.29** | **0.27** | **0.32** | **0.55** | **0.59** | **0.33** | **0.09** |

Eight of the 55 responses could not be categorized. Of those 8, no similar demographic trends of note were detected. Seven of the 8 responses lacked sensible interpretation. One response which stood out from the other responses read:

*"Technology is a field of research that creates and invents complicated things to help with everyday problems."*

This response was unlike any of the others in the sense that it used key terms such as "field of research," "invent" and "problems."

This participant's demographics were:

| Age | Gender | Grade | Career in Technology | Classes in Math | Classes in Science | Classes in Technology | Hobbies in Technology |
|---|---|---|---|---|---|---|---|
| 14 | female | sophomore | yes | 1 | 2 | 1 | yes |

## Discussion:

The first question of the study was "How do rural secondary students define technology?" In this sample, 3 distinct themes emerged encompassing 73% of all respondents. Generally, technology is considered as either a way of making things easier or faster, computers/electronics, or the combination of math and science. The researchers were surprised to see that "easier/faster" outranked "computers/hardware" in this sample.

The second question of the study asked if demographics would describe patterns of responses. Trends of note detected include;

- Respondents who simply defined technology as "things" averaged the youngest in age, lowest in grade, highest percent in female, had the lowest number of math and science classes, and had either no desire to work with technology as a career or were not sure.

- Respondents who stated that technology is a way to make life "easier or faster" had the highest average age. These students also had the highest average of technology classes taken (mean of 1.4 classes as opposed to the next highest mean of 1.0 classes).

The researchers believe that the analysis of demographics should be studied further before making any claims because of minimal variability between groups. Based on this data, further research with larger, additional samples should be sought to better inform this question.

Finally, when comparing the findings of this study with that of the Volk and Dugger (2005) study, there are several key observations. All substantive themes which emerged from this sample were also evident in the multi-national study of China and the United States with the exception of "combination of math and science." The researchers found it interesting that 16.5% of the respondents in this sample had a tendency to connect science and math to technology. It is possible that the presence of these students at a "Math, Science, Technology and Engineering" summer academy may account for these responses via power of suggestion or understanding of the purpose of the presence at the academy. Surprisingly, the responses of these rural North Carolina secondary students were less centered on the idea of "computers/electronics" than that found in previous studies. a smaller percentage of respondents defined technology as "computers or electronics." Respondents in this sample thought of technology as computers at 25.5% as opposed to 47% in Hong Kong and 68% in the U.S. in the Volk and Dugger study. The common response of "easier or faster" was much higher than in other studies and was the most common response, accounting for 31% in this study as opposed to 3% and 0% respectively.

The grant program is a three year process which is duplicated each summer for the following 2 years with different students from the same region of eastern North Carolina. Additional data will be collected and analyzed during the summers of 2008 and 2009.

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# Professional Development Online: A Market Analysis

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## Introduction

Professional development is important for teachers because knowledge, skills, and dispositions that are transferred by teachers to students help to determine the efficiency and effectiveness of the school. As such, a natural place to address improvement in schools is through the continuous education of the educator (Glickman, Gordon and Ross-Gordon, 2004).

Professional development is defined by the ITEA (2003) as being a continuous, lifelong process that begins early, continues through college and extends through the in-service years.

Glickman (1998) indicated the terms professional development and in-service are often used interchangeably but there is a distinct difference. Cohen (2001) explains this distinction when she identified professional development of teachers as consisting of pre-service (i.e. college training programs) and in-service (i.e. school district based training and graduate course work). ITEA (2005) identified three venues for participating in professional development: formal education; informal education; and professional organizations. Members of professional organizations have opportunities to participate in professional development in several formats including conferences, workshops, member networking, journals, publications, and correspondence certificate programs. A recent and growing venue for delivery of professional development by organizations, public and private, is via online through the World Wide Web.

**Online Professional Development**

Several fields have begun utilizing online professional development to address continuing education, certification, recertification, and licensure requirements of professionals within these fields. The use of online professional development in medicine provides opportunities for physicians and nurses to remain current and maintain licensure. Similarly, lawyers can participate in online professional development. Research into the application of online professional development to the profession of education has increased in the past decade. Halsdorfer (2006) found that online professional development is a necessary consideration since face-to-face in-service time is often dedicated to school reform efforts. Ginsburg, Gray, and Levin (2004) found that advantages of online professional development for teachers include convenience, capacity to be individualized, compilation of best practices, and capability to deliver content-based instruction and information. With recognition of the evolution of online professional development and its application in many professions, a question was raised as to the potential value of online professional development for ITEA members.

**Perceived value of online professional development by Technology Teachers**

A market analysis as outlined by Virtual Advisor Inc. (2004) was undertaken by surveying a stratified random sample of current ITEA members as of October 31, 2006, from the United States. Three distinct groups of high school, middle school, and elementary school teachers were identified and stratified by their ITEA region. A sample of 10% was randomly selected from each category to represent the membership. Comparison groups of non-members (past ITEA members whose membership lapsed between October 31, 2003, and October 31, 2006) were selected in a like manner. These groupings are shown in Table 1.

Table 1. Stratified Random sample of teachers by group membership

| School | Member | Non member |
|---|---|---|
| High School | 117 | 50 |
| Middle School | 78 | 34 |
| Elementary School | 13 | 4 |

n = 296

The interest survey was mailed to 296 people, and 97 instruments were returned with usable data as shown in Table 2. Of these respondents, 88 indicated they were K-12 teachers and 4 indicated they were supervisors. Also, 15 of the respondents indicated having a position other than teacher, administrator, college/university, or supervisor. The respondents' average of experience in Technology Education was 16.34 years.

Table 2. Returned surveys by group membership

| School | Member | Non member |
|---|---|---|
| High School | 43 | 16 |
| Middle School | 27 | 7 |
| Elementary School | 4 | 0 |

n = 97

The participants were asked if they would be interested in a program that allows them to earn Continuing Education Unit (CEU) credits by reading an article in a technology education professional journal and answering questions about it in an online test. Of the 95 respondents, a majority (64) indicated they were interested, 23 said they were potentially interested, and 8 said they were not interested in such a program. When asked if they would likely participate in this type of program, 95 responded. Fifty respondents indicated they would participate, 31 said they possibly would participate, and 14 indicated they would not participate in a program that allows them to earn CEU credits by reading an ITEA article.

The participants were asked if they would be willing to pay a small fee (approximately $10) for each CEU earned through such a program. Of the 94 responses, 42 indicated a willingness to pay while 31 said they might be willing to pay a small fee. Another 21 said they would not be willing to pay a small fee for CEU credit.

The participants were asked which journal(s) would be appropriate for such a program. Ninety respondents rated *The Technology Teacher* appropriate while 60 respondents indicated the *Journal of Technology Education*. Thirty-four saw *Technology and Children* as appropriate and the *Journal of Technology Studies* by 33. When asked which journals the participants read on a regular basis, 86 indicated they read *The Technology Teacher*, 25 read the *Journal of Technology Education*, 8 read *Technology and Children*, and 9 read the *Journal of Technology Studies*.

Participants were asked how they currently gain most of their CEU credits. Of the 60 responses, 31 participants indicated College/University courses , 22 participants indicated professional conferences, and 7 participants indicated state or district sponsored workshops as the primary manner of obtaining CEU credits.

The participants were asked about topics that would be helpful to them. Of the 73 responses, 30 participants indicated technical updating as most important. Twenty-eight respondents indicated pedagogical and teaching issues as most important. Fifteen respondents indicated research findings and reports as the most important topic to them.

A question inquired if participants belonged to another association with such an online CEU program in place. All 97 respondents responded to the question. Only 7 of the respondents indicated belonging to such an organization and 5 of the 7 reported they had already used it for CEU credit. The remaining 90 indicated they do not belong to another association with such a CEU program. When asked if participants encountered any difficulties obtaining the earned

CEU credits from their state or district, 5 of the 87 respondents indicated encountered problems. None of the respondents provided information explaining the problems encountered.

Participants were asked if such a system should be restricted to ITEA members or should the system be open entry. Of the 95 respondents, 55 said the system should be open entry and 40 indicated the system should be restricted to ITEA members. When asked if a restricted to members only program would be an effective enticement to draw more ITEA members, 27 of the respondents thought it would draw more members, 35 thought it might draw more, and 35 thought a restrictive program would not draw more members.

The participants were asked to identify the most important benefits of their ITEA membership. Journal access was most frequently indicated (22) followed by networking (18), resources and information (17), and updates on current trends (15). See Table 3 for the entire listing of responses and frequencies.

Table 3. Important benefits of ITEA membership

| Benefit | Frequency |
|---|---|
| Journal access | 22 |
| Networking | 18 |
| Resources and information | 17 |
| Updates on current trends | 15 |
| Conferences | 8 |
| Idea garden | 5 |
| Insurance | 5 |
| Standards for technological literacy | 2 |
| I do not know | 2 |
| Members only section | 1 |
| Professional development | 1 |

**Summary**

The results of the survey reveal several interesting things that are worth considering and possibly responding to in the future. Sixty-seven percent of the respondents indicate an interest in the ITEA offering an online CEU program. Over one-half of the respondents (53 percent) indicated they would participate in such a program and 45 percent were willing to pay a small fee for the service. Twenty-four percent of the respondents express a potential interest in the ITEA offering an online CEU program with 32 percent indicating they might participate in a program if offered. A like number, 33 percent, indicated they might be willing to pay a small fee for the service. Only 9 percent indicated no interest in such a CEU program with 15 percent saying they would not participate.

If the ITEA is to offer an online CEU program, there needs to be an appropriate venue. The majority of the survey respondents (95 percent) feel *The Technology Teacher* is appropriate for such a program. Another 63 percent feel the *Journal of Technology Education* is appropriate. Appropriate content offerings will also be a concern for an online CEU program. Forty-one percent of the respondents indicate technical updating as the most helpful topic for CEU credit, followed closely by pedagogical and teaching issues representing 38 percent of item respondents.

**Recommendations**

Based on the results of the ITEA Interest Survey, it is recommended that ITEA pursue offering CEU credit by reading professional journal articles and taking an online assessment. This CEU credit is to be used in state re-certification and certificate updating. ITEA should utilize *The Technology Teacher* as the venue for offering online professional development and granting CEU credit. ITEA should also investigate the use of the *Journal of Technology Education* for use in this CEU program. ITEA should investigate similar CEU credit programs and set the price accordingly. CEU credit topics should be based around technical updating and pedagogical and teaching issues. It remains unclear if the CEU program should be offered in an open-access format. This open-access format issue should be addressed through further study.

**Conclusion**

Online professional development is being utilized by professional organizations in a variety of fields. If developed and implemented by the ITEA, online professional development would be a method to help fulfill Advancing Excellence in Technological Literacy (AETL): Professional Standard PD-6, "Professional development will prepare teachers to be responsible for their own continued professional growth" (ITEA, 2005, p.82).

The availability of an online professional development program that grants CEU credit would provide a service to the membership that is convenient and timely. State and local school agencies could recognize the service and include the program in their professional development plans. If the service is offered in an open-access format, the potential for participation is vast. Certainly, open access would provide a greater opportunity for promoting technological literacy although it would not guarantee participation in the program.

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