Journal of STEM Teacher Education

Volume 48
Issue 3 *Winter*

Article 1

December 2011

Complete Issue

The JSTE TEACHER EDUCATION
Winter 2011 Issue Contents
Volume 48, Number 3

Bits and Pieces

When do you say good-bye?

I thought about this question as I decided to say good-bye to JSTE as its editor at the end of this year. I have just completed my third year as editor. Two years ago I was the editor of JITE, and then I served one year as editor of JSTE, so technically this is the second time I have said good-bye to this wonderful research journal.

I served as editor of the *Journal of Industrial Technology Education (*JITE) for two years, but due to the fact that I did not have an associate editor to take my place I agreed to stay on for one more year. I was prepared to say good-bye to JITE as editor then, as it worked out I was only saying good-bye to JITE. The national leadership of JITE decided to make a change and expand to include Science, Technology, Engineering and Math. So the new journal became the Journal of Science, Technology, Engineering, and Math Teacher Education (JSTE). This move was an effort to increase membership in our national organization, the *Association for sTEm Teacher Education* (ASTEMTE) During this past year a lot of work was put into the new journal but not much has changed, we are still short of help and I have yet to locate an associate editor to take my place next year, so I am again saying good-bye, but this time it is to JSTE.

<u>In this issue</u>

Volume 48-3 has a wide range of manuscripts along with two very good At Issue articles and one Under Review article. This volume has three research manuscripts that should provide the reader with some interesting perspectives on technology teacher education.

At Issue

The Three "Faces" of Technology Education is an interesting piece written by Duane Renfrow. In this article the author talks about technology education and the students who take the industrial technology education classes. He describes these technology education students as being in three categories or "faces". The three "faces" are explained, as well as why students are in each group and why is so important that all three receive the same support.

The second "At Issue" article was written by Terrie Rust who gives readers an overview of the Albert Einstein Distinguished Educator Fellowship program. The program was established 20 years ago with the intention of Fellows bringing their education practice to help inform education policy. The author goes on to describe her time as a Fellow and the learning experiences she had while working in the program. Each Einstein Fellow's experiences vary according to their agency placement, assigned duties, and their personal goals. Being in the program as a Fellow is a tremendous opportunity for teachers to learn and gain personally from this experience. The author finishes the article by telling interested teachers how to apply to become an Einstein Fellow.

Manuscripts

Starting off this section is an interesting manuscript by Linda Otto and Michael Kroth titled *An Examination of the Benefits and Costs of Sabbatical Leave for General Higher Education, Industry, and Professional-Technical/Community College Environments*. The research conducted by the authors, compare and explain the different types of benefits and costs incurred at different levels of education and industry. The results of the study can be used to determine how sabbatical leave might be used in professional-technical and community colleges to benefit the faculty, students, and organization.

The next manuscript and research comes from an international setting. *Learning Styles In Technical Drawing Courses As Perceived By Students In Egypt and Nigeria,* was written by Hamdy Elbitar and Umunadi Kennedy. The study conducted by the authors, deals learning styles and how they affect student outcomes. The authors researched methods that would improve learning style inventory, and help technical industrial teachers determine student's attributes in individualized education activities in technical drawing courses at the technical/industrial levels. Research for this study was conducted in the countries of Egypt and Nigeria and the results show that students in all countries around the world can benefit from the findings.

The final manuscript in this volume is titled, *Leaning Effects of Design Strategies on High School Students,* written by John Mativo and Robert Wicklein. In this study the authors conducted an experimental design research method to study the learning effects of design strategies, comparing engineering design processes with trial and error design approaches. Using a common design project for the central focus, the experimental and control groups showed a negative practical medium effect between the two groups.

Under Review

If you are interested in Geographic Information Systems (GIS), Richard Lisichenko wrote a good review about a not so new book. First published in 2000, it has undergone extensive revisions to include all the latest updates. *Getting To Know ArcGIS Desktop* by Ormsby, Napoleon, Burke, Groessl, and Bowden explains the foundation layout structure and operations for the GIS field and has advanced tools and analytical extensions available. In his article, the author goes on to tell the finer points of the book and how to successfully use it.

The Final Good-Bye

Saying good-bye to JSTE wouldn't be final until I say good-bye to all those who have assisted me over the past three years. I really need to start off with a big thank you to ASTEMTE President, George Rogers. Without his help and guidance we would not have made it this far. I have not worked with anyone who has tried so hard and put in as many hours as he has. Without an associate editor, I had to ask a lot from my assistant editors, Tad Foster, Dominick Fazarro, and Kara Harris. Manuscript reviewers work in the background without a lot of notice but they are so important to the Journal. Their names have never been published, and they need a big thank you for all the work they have done. If it weren't for them the journal would not have been a quality research journal. The person who does the most work and puts the journal together is Style Editor, Dar Cole; she makes us all look good. The last person to thank is the circulation manager, Emily McKinley who insures that we get our issues of JSTE on time.

With that being said I would like to say a final good-bye to everyone who has been involved with the journal and to all our readers. It has really been a pleasure working with everyone over the past three years.

JSTE Editor
Dr. Robert T. Howell

The Three "Faces" of Technology Education

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Abstract

There are three "faces" of Technology Education. What is meant by this? It means that more emphasis should be given to the students who take industrial technology education (ITE) classes at the high school level with less emphasis given to standards, objectives, or outcomes developed by national organizations. Viewed in this light, three different faces, or types of students, can be envisioned as being served by ITE programs. The first face seen is that of a young person wearing safety glasses, a hard hat, and with a pencil behind one ear. The second face is that of a young person wearing safety glasses who is holding an iPod listening to music. The third face is that of a young person wearing safety glasses who is operating a graphing calculator. The purpose of this paper is to identify the three "faces" of ITE, to show how current curriculums address the first and third "faces", and to suggest how the second "face" should be supported.

Identifying the Three "Faces" of Technology Education

The first student type is made up of students who see high school as the end of their professional education. These students want to work when they complete high school. Making money is a key motivation. These students will become our carpenters, machinists, CAD designers, printers, and auto mechanics, just to name a few. Most people recognize these professions as career and technical occupations. The type of high school instruction that provides this type of education typically consists of learning entry level skills and is known as Career & Technical Education. At some point these students may pursue further training at technical centers or colleges.

The second student type is made up of students who see high school as a passage to the next level. These students make up a large proportion of students in high school. These could be called the "typical" student. These college bound students will become teachers, health care professionals, lawyers, industry professionals, and business people. These students take technology classes just because they want to. They want hands-on activities that produce something of value. These students are most satisfied with what would be considered a shop or drafting class. The knowledge that they gain will stay with them all of their lives. They are not necessarily interested in an industrial career or becoming technologically literate related to the huge content base represented by "technology". These students are already typically more technologically literate than most teachers by the time they get to high school.

The last student type is made up of those gifted in academic skills. They see high school as a stepping stone to more intense education. This student type represents the smallest proportion of students in high school. University education is a given for these students and they will not have much difficulty at either the high school or higher education levels due to their abilities. These students excel in challenging concepts and they will become engineers, physicists, researchers, and mathematicians. These students are most satisfied with courses that base their content in Science, Technology, Engineering, and Mathematics, known as STEM content areas. STEM will be further examined within this paper.

The student types listed above represent students that are served by ITE. Unfortunately the second student type, or "typical" student, is not being well served with the curriculums being emphasized within our current organizations. It is evident that ITE programs are set up either to be Career and Technical Education or STEM based Technological Literacy Education. What about the needs of those students who have no intentions of becoming engineers or carpenters, but want to be able to use their hands with their minds to accomplish something "real" for the purpose of expanding their educational experience? What curriculums are being supported by our national organizations that provide good practical applied technology? Can this type of education be found in what is being supported now? No, because it does not fit well with the purposes of either Career and Technical Education or ITEEA's (International Technology & Engineering Educators Association) version of Technology Education. Following is an overview of the purposes of Career & Technical Education and Technological Literacy as proposed by ITEEA and explanations of how the outcomes of these two content areas do not fit the needs of the "typical" student.

Career & Technical Education

The main goal of Career & Technical Education is to provide leadership in developing an educated, prepared, adaptable and competitive workforce (Association for Career and Technical Education, 2011). This type of education at the high school level is about learning entry level skills. Many technology education programs follow this concept and acquire funding for career and technical education.

The State of Kansas Department of Education, with which the author is most familiar, has developed a model with six clusters. These clusters include: Arts, Communication, and Information; Business, Marketing, and Management; Environmental and Agricultural Systems; Health Science; Human Resources and Services; and Industrial, Manufacturing, and Engineering Systems. Within these clusters can be found numerous knowledge and skills areas. This model contains eleven academic and technical skills including; employability; ethics; systems; teamwork; career development; problem solving; critical thinking; information technology application; legal responsibilities; communication; and health, safety, and environment. The Kansas model even breaks career and technical education into five school levels. These levels include; Career Awareness (Elementary School), Career Exploration (Middle School), Career Preparation & Applications (Secondary), Career Preparation & Applications (Postsecondary), and Career (Lifelong Learning) (Kansas State Department of Education, 2008).

Many of the components found in this model would work well for the "typical" student who just wants to work with his or her hands. The main drawback with these types of classes is that at the high school level they should be designed to prepare a student for entry level skills and employment after high school. The typical student, or second type of student, is really not interested in starting a career after high school. This student will attend a college or university right after high school. Of course that does not mean that this student will not eventually end up in a technical occupation.

ITEEA's Technology Education

The current approach to Technology Education is based on Technological Literacy which is "the ability to use, manage, assess, and understand technology" (Technology – Education, 2010). So, what is technology? Technology is "the cumulative sum of human means developed in response to society's needs or desires to systematically solve problems" (Markert & Backer, 2010, p13). The problem with the study of all technology is the sheer mass of information that could be studied with this concept. ITEEA has developed twenty standards organized into five categories for the study of technology. Here are the five categories:

* The Nature of Technology--characteristics and scope of technology; core concepts of technology; the relationships among technologies and connections between technology and other fields
* Technology and Society--cultural, social, economic, and political effects of technology; effects of technology on the environment; role of society in the development and use of technology; influence of technology on history
* Design--attributes of design; engineering design; role of troubleshooting, research and development, invention and innovation, experimentation in problem solving
* Abilities for a Technological World--apply the design process; use and maintain technological products and systems; assess the impact of products and systems
* The Designed World--medical technologies; agricultural and related biotechnologies; energy and power technologies; information and communication technologies; transportation technologies;

manufacturing technologies; construction technologies (Eric Digests, 2001)

These are very good concepts for a general education curriculum especially at the elementary and junior high school levels to give students a good overview of what technology is in its many forms; however, technology as a whole is so large that a person could study his or her whole life and still only get a superficial understanding of some of the concepts.

Recently ITEEA has moved toward an academic discipline by becoming more and more involved with STEM, which is an approach to education that is designed to revolutionize the teaching of subject areas such as mathematics and science by incorporating technology and engineering into regular curriculums by creating a meta-discipline (Fioriello, 2010). Offshoots from STEM include curriculums that are designed more for the academic student such as the two similar programs *Project Lead the Way* and *Engineering by Design*. *Project Lead the Way* is a program designed to serve middle school and high school students of diverse backgrounds from those already interested in STEM-related fields to those who are more inspired by the application of STEM than they are by traditional math and science courses. Students will have the opportunity to create, design and build things like robots and cars, applying what they are learning in math and science to the world's grand challenges (Project Lead the Way, 2011). *Engineering by Design* is a program committed to providing technological study that challenges students and facilitates creativity, enabling all students to meet local, state, and national technological literacy standards. Students are prepared to engage in STEM related activities in the high school years and beyond (Idaho Engineering Technology Education, 2011).

ITEEA's version of technology education is valid but it still ignores the needs of the "typical" student who desires hands-on activities for the sheer pleasure of it.

Three Equal Fields

This paper is not a proposal for getting rid of anything currently being taught that is considered technology education. What is being proposed is that our national organizations should show support for general hands-on, applied technology classes at the junior high school and high school levels, and if there is no support from these organizations then there should be a separate organization developed that is dedicated to applied technology classes that are student centered rather than content or career centered.

Three distinct curriculums or fields can be envisioned with names such as Career Technology, Applied Technology, and Academic Technology. Career Technology and Academic Technology have been explained above, and would remain as they are, but Applied Technology would be developed to serve the second student type which was described previously.

Applied Technology could be developed using the best aspects of Industrial Arts curriculums. This concept may be disconcerting to some since a great deal of time and money has been spent trying to throw away industrial arts concepts. But before putting this article down in disgust, please read on. As stated at the beginning of the paper the "students" who are served by technology education curriculums should be considered rather than highly held standards or models. There are many very good objectives that were developed for Industrial Arts programs that provide a valid content area for students who want hands-on, real, activities. Here are nine objectives that would suit the needs of the typical student seeking practical applied technology experiences:

1. Student Centered - provides a ready avenue of self-expression for large numbers of persons who find many other avenues for such experiences closed.
2. Appreciation & Use – to develop in each pupil an appreciation of good design, materials, and workmanship.
3. Self-Realization & Use – to develop in each pupil the habits of self-reliance and resourcefulness in meeting practical situations.
4. Cooperative Attitudes - to develop in each pupil a readiness to assist others and to join in socially accepted group undertakings.
5. Health & Safety - to develop in each pupil desirable attitudes and practices with respect to health and safety in the use of materials, tools, and machines.
6. Interest in Achievement - to develop in each pupil a feeling of pride to do useful things and to develop certain worthy free-time interests.
7. Habit of Orderly Performance - to develop in each pupil the habit of an orderly and efficient performance of any task
8. Drawing & Design - to develop in each pupil an understanding of all kinds of common graphic representations and the ability to express ideas by means of drawings and sketches.
9. Practical Skills & Knowledge - to develop in each pupil skill in the use of common tools and machines, and an understanding of the problems involved in building products. (Giachino & Gallington, 1977)

These are very simple, student centered, objectives. This applied technology concept should be considered as “foundational education”. Achieving the goals listed above “is” the justification for providing it. There is no underlying intent to be tied to academic subjects, nor does it imply that it is for career skills. Could students take the skills that they learn in these classes and actually go to work using those skills? Most certainly, they have in the past. Would students use engineering design techniques to build things? Of course, well developed Industrial Arts courses did, and still do in many school districts. They also use the components of engineering such as, mathematics, drafting, design, and the scientific method.

Applied Technology courses should not compete with the other two fields, they should complement them. Students should be free to move among the three fields using skill and knowledge to enhance advanced courses. Here are a few examples of how this could work. A student taking an Applied course in Welding would be better prepared to take an Academic Technology course in Robotics Design or Electric Car Design because that student would have the skill to correctly weld components together. A student who takes an Applied Furniture course may be interested in getting into a Career Cabinetmaking program. A student in a Career Drafting program may wish to take an Applied Advanced CAD course because it would fit into his schedule and give him more experience.

Conclusion

If, in fact, there are "three faces of industrial technology education" then there should be three avenues for students to choose from. Each one of these fields have distinct purposes and should complement instead of compete against each other. Students should be free to move easily among the three fields. All three fields should be equally respected.

It is past time for teachers to be allowed to say "shop class" without having to put a quarter in a jar. With our country's economy, the citizens of the country may need to have more practical skills because they may not have the money for a repairman to come in and replace a switch plate. There may not be as great a demand for engineers as there will be for people with basic Industrial Arts skills.

Author

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Einstein Fellowship

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Abstract

In 2010, the Albert Einstein Distinguished Educator Fellowship program celebrated 20 years of bringing K-12 classroom teachers of science, technology, engineering, and math (STEM) to Washington, DC to serve in federal agencies and on Capitol Hill. The intent is for Fellows to bring their education practice to help inform education policy. From September 2010 through July 2011 I served as an Einstein Fellow at the National Science Foundation. My specific position was in the Directorate of Education and Human Resources, Division of Research and Learning in Formal and Informal Settings, Lifelong Learning Cluster. The Lifelong Learning Cluster focuses on areas of informal education; this is an area we now identify as serving as strong a learning purpose as does formal education.

The National Science Foundation (NSF) is a grant-awarding agency, but research from these grants has resulted in major changes in our society. Currently, grants for education are focusing on STEM education in a myriad of aspects, from instructional technologies, robotics, reaching underserved groups, identifying exemplary STEM schools and programs, creating after-school programs, creation of films, new websites, and more.

In the course of my time with NSF, I surveyed teacher groups and reported to the Cluster on the impacts of informal education resources on their students and classroom practice. Results and implications of one survey were published in the *Technology and Engineering Teacher*, the professional journal of the International Technology and Engineering Educators Association (ITEEA) in April 2011. These surveys helped the Cluster Program Officers understand the usefulness of specific informal education resources and teacher accessibility to these resources.

Another aspect of my position at NSF was aiding the Presidential Award for Excellence in Science and Mathematics Teaching (PAEMST) program, a program to recognize outstanding K-12 science and math teachers. This program is under the auspices of The White House, but is administered by NSF. Applications for the PAEMST awards are accepted by each state; the top applications are sent to NSF and reviewed by experts who then recommend the top winners for science and math in each state to The White House. These awardees are brought to DC for an award ceremony, professional development, an opportunity to speak with education leaders in DC, and to meet the President. Members of the PAEMST team included four Einstein Fellows (myself included), and two NSF Program Officers. My duties involved leading sessions, preparation of printed materials, introducing dignitaries, and participation in the Awards Ceremony. Two such recognitions were held during my tenure, each lasting four days. I accompanied one of the groups to their Presidential photo and was able to see President Obama in person!

Each Einstein Fellow's experiences vary according to their agency placement, assigned duties, and their personal goals for their fellowship experience. One hopes to make a lasting impression, contributing to something that will be valuable after they have left the position. My contribution to the Directorate for Education and Human Resources was the research and compilation of the education and outreach resources, director contact information, and additional information for each of NSF's 101 Research Centers. These Research Centers, supported through NSF grants, are situated throughout the United States and represent most of the Directorates at NSF. There had never been one document which placed all 101 of those easily at hand. I also worked with the Large Facilities group at NSF and did a similar document for their 18 facilities, located internationally. These documents will allow NSF Directorates to share the information with those divisions and clusters which may be able to help meet the needs of those institutions.

One exceptional aspect of the Einstein Fellowship is the number of opportunities Fellows have for professional development. We toured NBC, USA Today, the American Institute of Physics, the National Institute of Health, the CIA, the Library of Congress, the Patent and Trademark Office, the National Academies, and the PBS NewsHour studio. We attended numerous forums, House and Senate sessions, and workshops on education. We attended conferences and conventions. Several of us were able to address the President's Council of Advisors on Science and Technology (PCAST). I spoke to PCAST about their need to use the "correct" definition of the T in STEM…technology (their September 2010 report had identified the T as computer science; as I pointed out to them, it was not even a T descriptor!). We participated on panels at the Wilson Center for International Studies. I participated on a panel addressing the scalability of education programs. It would take me another page just to describe the other opportunities I, alone, experienced this year. These unique experiences are some which make the Einstein Fellowship an outstanding opportunity for STEM teachers.

The Einstein Fellowship is open to K-12 STEM teachers with a minimum of five years of continuous teaching experience in their STEM field. ASTE members can help by identifying outstanding candidates who meet the criteria and encouraging them to apply. The fellowship is an exceptional opportunity to be recognized for teaching expertise and to make an impact in the education policy arena.

Details on the Albert Einstein Distinguished Educator Fellowship are available at: http://www.triangle-coalition.org.

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An Examination of the Benefits and Costs of Sabbatical Leave for General Higher Education, Industry, and Professional-Technical/Community College Environments

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Abstract

The purpose of this literature review is to examine the differences in the use of sabbatical leave among the arenas of general higher education, industry, and professional-technical/community college. The purposes and policies applied to sabbatical leave, along with the cost of using sabbatical leave in these three environments are compared and contrasted to determine what similarities and differences exist. The potential benefits of the use of sabbatical leave to enhance organizational commitment are then examined. The result of this review can be used to determine the need for further study of how sabbatical leave might be used in professional-technical and community colleges to the benefit of the faculty, students and organizations.

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Introduction

Community colleges have been in existence in the United States for 100 years (Pederson, 2001). Their original focus was a liberal arts education, much like a university. During the Great Depression that focus changed to job training, and today's community colleges have progressed to a point of offering both (Goan & Cunningham, 2007). The professional-technical components of the community college system are instrumental in providing job skills for many professions not generally requiring the 4-year degrees offered by universities.

Having an educated populace is beneficial to everyone. Professional-technical education has an important role to play in educating those who wish to go beyond high school but are perhaps ill-prepared, unwilling, or simply unable to afford to attend a university. According to a study done of California's system by UC Berkeley, for every dollar spent on a community college, there is a gain of three dollars, while for every dollar not spent there is loss of two dollars (Sturrock, 2005). This gain is realized through better educated populaces that have better jobs, pay more taxes and are less likely to rely on social services. This suggests that education not only pays for itself, but it also infuses money into our systems beyond what is originally spent in community college monies.

To provide quality education, it is critical that the professional-technical faculty in community colleges are not only well-trained, but also kept fresh and active in their fields of emphasis. One method of providing well-trained, fresh and motivated professional-technical faculty is the use of sabbatical leave. Sabbatical leave has existed in some form for many years. In English translations of the Hebrew scripture this period of rest is generally referred to as the Sabbatical Year, it has also been called the Sabbath Year, Fallow Year, Year of Rest and Year of Remission (Endres, 2001). This year of rest was originally created for the land (Endres, 2001) rather than for the people, but in allowing the land to rest it naturally occurred that the people received rest as well. Hebrew sabbatical practices were created to revitalize all people and land; in academics it was designed to revitalize faculty (Bast, 1992).

Sabbatical leave is viewed very differently by people at various levels of higher education. Some see it as a right; others see it as a privilege. The arguments range from the idea that everyone deserves a sabbatical at a regular interval whether they have a specific project in mind or not, to the idea that only tenured faculty with a legitimate, demonstrated need should be granted sabbaticals (Endres, 2001).

Sabbaticals give professors in general higher education the opportunity to pursue and refine their research interests, something which heavy teaching loads often prohibit (Mindell, 2009). The focus of sabbaticals for professional-technical faculty is focused on new and improved skills rather than research; but like those in general higher education, full teaching loads often prevent them from gaining these skills. The sabbatical leave allows for professional growth that should bring the faculty member back to the college or university with new and improved skills, published works or new methods of teaching. The ultimate beneficiary is the student (Endres, 2001).

Community colleges play a critical role in providing professional-technical and work force training (Gilroy, 2009). The need for qualified instructors who are able to stay current in their fields is important in providing this training. Instructors who spend years teaching may have difficulty maintaining current skill sets and industry credentials without taking time away from teaching to maintain and update them. Sabbatical leave is one option that can be used to help these faculty members.

Many community colleges provide professional-technical programs for their communities. To provide these programs they hire faculty members who are experts in these technical fields. In order to maintain this high level of expertise it seems critical that these faculty are given time to actively engage in their fields. Sabbatical leave is one method of providing them this time. While some of these institutions do have policies in place for sabbatical leave for their faculty others do not. The use of sabbaticals can be an expensive endeavor for a community college so it is critical that need is determined when deciding whether to implement it or not. This problem of establishing need is one that must be addressed so sound decisions can be made by institutions considering the use of sabbatical leave.

The purpose of this article is to distinguish between the needs, benefits and costs to general higher education faculty, industry professionals, and professional-technical faculty in the use of sabbatical leave. Benefits and costs to be considered will include those to the faculty/professionals as well as the institutions, organizations and communities they serve.

Following are the questions this article addresses:

1. What possible costs exist for the faculty/employees, the institution and the community when implementing a program for sabbaticals for professional-technical faculty, other higher education faculty and industry professionals?
2. What possible benefits exist for the faculty/employees, the institution and the community when implementing a program for sabbaticals for professional-technical faculty, other higher education faculty and industry professionals?
3. Is there a difference in purpose, and therefore a difference in sabbatical policy implementation, for

professional-technical faculty, other higher education faculty and industry professionals?

Sabbatical Leave in General Higher Education

Institutions of general higher education include all colleges and universities that offer educational services beyond the high school level. Sabbaticals in academia can be traced back to a need for an incentive to attract potential faculty members to Harvard University in the late 1800s (Carr & Li-Ping Tang, 2005). According to Birkhead (2009), when policies for sabbaticals were originally established in academics, they were meant to allow instructors "to have a change of scenery; to experience a different university or research institute; to learn new techniques, to develop collaborations or to write papers or a book" (p. 25).

Sabbatical leave policies in general higher education vary in their implementation but often loosely follow the Biblical tradition of sabbaticals for the land by allowing up to one year of sabbatical time for every 6 years spent teaching. The sabbatical time is paid at a percentage of the faculty member's full salary which varies depending on whether a full year is taken or if the faculty member takes the option of only one semester. Following is an example of a policy from Southern Illinois University Edwardsville that follows this norm:

> Preamble: Board of Trustees policies 2 Policies C-3-(b-S) provide that sabbatical leaves for faculty shall be granted only on the basis of an approved plan designed to improve the professional performance of the applicant and benefit the institution. What follows are the SIUE policies pertaining to the implementation of that Board policy.

> 1. Continuing members of the academic faculty may become eligible for sabbatical leave upon completion of a period of meritorious service as defined by this policy. Such leave shall be granted for purposes of (1) research or creative activity that will enhance the faculty member's academic and professional stature and contribute to the academic reputation of the University, and (2) scholarly study to advance knowledge in the discipline or other areas of professional expertise.
> 2. A continuing member of the academic faculty shall become eligible for a full sabbatical leave at the end of not less than six years of full-time service from the initial date of full-time appointment or six years of full-time appointment from the terminal date of a previous sabbatical leave. With the exception of faculty time paid through an external grant, all time spent on unpaid leave of absence shall be excluded in determining years of service. Full sabbatical leave may be granted for a maximum period of six months at one hundred percent of salary or for twelve months at fifty percent of salary. ("Sabbatical Leave Policy", 2008, para. 1-3)

Multiple reasons can be found for wanting and using sabbatical leave. These include learning new techniques, developing research, conducting research, studying, writing, conducting reviews, creating art work and developing courses or curriculum (Sima, 2000). This list is not all inclusive, but is given here as an example.

The benefits of sabbaticals in general higher education are three-fold. There is benefit to the faculty member, the institution and the student. For the faculty member, it serves to allow for rejuvenation, reflection, fresh perspectives, opportunity for development of new professional relationships, staying current in his or her discipline and ultimately enhancing teaching (Sima, 2000). For the institution, it offers increased faculty efficiency, versatility, productivity, strengthened programs, enhanced learning environments, higher morale, increased institutional loyalty, enhanced faculty recruitment and retention and enhanced overall academic climate and reputation (Sima, 2000). These benefits combine to offer the ultimate benefit to students by having knowledgeable, well-prepared, motivated faculty in their classrooms.

The cost of a sabbatical is borne both by the faculty and the institution. The faculty member must provide his or her own funding for the activities he or she engages in during the sabbatical. This can be accomplished through use of personal funds, grants, fellowships, loans and so on. The cost to the institution includes covering or canceling classes and paying for benefits, and continuing to pay the faculty member's salary during the absence. Since many sabbatical leave policies only allow the faculty member to collect a percentage of his or her salary, the resulting salary savings can be used to recover some of these costs. When a sabbatical is being supported with the full-salary for the faculty member the institution administration must make a decision to set aside funds to cover these expenses.

Sabbatical Leave in Industry

While sabbatical leave has been around since the late 19^{th} century, it had typically been used strictly in academia. After World War II, industry started to look at its uses but did not really embrace sabbaticals in a real way until the 1960s. At that time union negotiations allowed steel and aluminum workers to be given 13-week sabbaticals to allow for retraining (Greengard, 2000). Next, other large organizations such as Control Data and IBM began allowing sabbaticals for non-production employees. As organizations began to become more competitive and the work more intense, they also realized the need to give employees a break (Greengard, 2000).

The Society for Human Resource Management reports that in 2007 about 16% of U.S. employers offered unpaid sabbaticals and 4% gave paid ones (Lublin, 2008). While the need for sabbaticals in industry appears to be valid, Carol Sladek, head of Hewitt Associate Incorporated's Work/Life Consulting Practice in Lincolnshire, Illinois, states, "Many employers still have a hard time offering a big chunk of time off, whether it's paid or unpaid, to employees just because it's difficult in terms of operations." (Clark, 2010)

Sabbatical leave in industry takes on many forms. The Abacus Planning Group, Inc. requires all employees to take a four-week, paid sabbatical every five years. During this sabbatical they are not allowed to have any contact with their office and are asked to spend the time reflecting on their career and life ("Abacus Wins Praise", n.d., para. 2). The Journal of Accountancy includes an example sabbatical policy on its website for use by accounting firms. This example suggests sabbaticals be offered every five years with a duration of three months for partners and two months for managing associates with full pay and benefits ("Sample Sabbatical Program Policy", n.d., para. 1-2). PricewaterhouseCoopers offers two types of sabbaticals, one for personal growth and the other for social services. Employees are paid between 20 and 40 percent of their regular salary and are permitted to take up to six months for their sabbatical (Sahadi, 2006). Companies like Microsoft only allow sabbaticals for upper-level employees and require that some job/career related performance standards are met (Semas, 1997).

The purpose of sabbaticals varies but several common themes exist throughout industry. Organizations use sabbatical leave to retain employees by preventing burnout which leads to low productivity, depressed morale and high turnover. They use it as a recruitment tool to draw in top performers. They even use it to help in ethics issues which can arise when one employee may perform a job for years without anyone else ever seeing what he or she really does (Carr, Li-Ping Tang, 2005).

Employees also have multiple purposes for using sabbatical leave. Based on company policy they may use it as they would a vacation, or they may use it to learn a new skill that will improve their performance in their position. Individuals also may take the opportunity to take a look at their personal mission to determine if they are truly where they belong, opening up the potential for career changes based on what is learned on sabbatical (Hubbard, 2002).

The benefits to industry of offering sabbatical leave to employees are several. Depending on the type of sabbatical offered, the benefit could be as simple as gaining the goodwill of employees. But for some sabbatical types an organization will get employees back with new skill sets that can add to their productivity (Larson, 2005). If offering sabbatical leave helps them to retain their current employees, organizations can also benefit when they do not have to spend money to hire and train new employees (Bolch, 2006). A critical benefit to employees is the potential to avoid burnout and remain in a position for the long term, gaining increased levels of responsibility and respect. It can also give them renewed focus on their jobs and enthusiasm for the work they do (Paul, 2002). The use of sabbaticals will allow for more creative and effective employees and can improve the financial bottom line (O'Sullivan, 2008).

Concerning benefits to an organization, Lublin (2010), founder of Dress for Success, states, "If we want to keep good, sane, driven people in the field, we have to change" (p. 1). To accomplish this goal she gives several changes that need to be made in her industry that may apply to others as well. One of these changes she gives states of employees, "Give them a break. After two-and-a-half years at Do Something, employees can take a month long paid sabbatical to do volunteer work if they commit to another year" (p. 1). According to Andrew Clark of the John Lewis Partnership, staff who are given and take advantage of sabbaticals return with renewed commitment and new perspectives (Clark, 2010).

One notable exception to the general benefits of sabbatical leave may exist when we look at organizations which have mandatory sabbatical leave. The word mandatory tends to have negative connotations and may leave people with the impression that their organization is in some way causing them harm by forcing them to take time away from their jobs. The Cripps Harries Hall firm made major revisions to their mandatory sabbatical policy, changing it from requiring partners to take three months away from work every ten years to taking six weeks off every five years (Ganz, 2008). Their reasoning for creating sabbaticals seems valid. It allows partners to recharge while away from work while allowing those who stay behind to recognize that no single individual is irreplaceable. The employee attitudes were at times, however, found to be detrimental rather than positive (Ganz, 2008).

The cost to business in implementing sabbaticals can be high depending on the type of sabbatical they grant. When offering paid sabbaticals there can be high cost in filling positions while the employee is gone. There is also the cost of maintaining benefits for the employee, which is often part of a sabbatical policy for both paid and unpaid leave (Carr & Li-Ping Tang, 2005). It is even possible that industry may choose to implement sabbaticals as a cost saving measure. Rather than lose employees permanently, they may give mandatory sabbaticals at no pay saving them salary money along with future recruitment budgets (Berris, 2009). The BT Group, a provider of communications services, has offered its people a sabbatical of up to one year at 25% salary with the general purpose of allowing for individual, personal renewal while at the same time saving the company money during a downturn in their industry (Churchard, 2009).

Other costs are not always directly related to money. They include lost productivity of the worker on sabbatical along with increased workload for those remaining. There is the risk that the employees will find other jobs while on sabbatical and not return (Larson, 2005). This cost can be mitigated by having strong, legal agreements with employees before allowing sabbaticals which require them to return to work for a set period of time upon the completion of their time away.

Sabbatical Leave for Professional-Technical Faculty

Professional-technical institutions may be independent schools or they may be incorporated into the community college system. They provide job skills for students who wish to enter the job market but do not wish to complete a full range of studies needed for general higher education degrees.

The traditional academic sabbatical was primarily designed to allow the faculty member to conduct research in his or her area of study. The need for professional-technical faculty to take sabbatical leave often differs from that of those teaching the more traditional academic subjects. One issue that differentiates higher, general education faculty sabbatical needs from professional-technical faculty needs is that technical faculty teach technical skills. The technology that they use and present to their students can change rapidly (Petty, 1985). For example, consider the field of Information Technology, in which the skills a technician needed 20 years ago are significantly different from those that are needed now (Marriott, 2001). Keeping these skills current requires continuing involvement and study in the field.

Another issue that differentiates the needs of professional-technical faculty is the standards that are being adopted nationwide for student achievement. The adoption of student achievement standards in professional-technical education is requiring complete re-engineering of the teaching methods currently in use (Moore, 2007). In the state of Georgia, a plan has been developed and implemented that ties the student standards to the professional development of the faculty (Foster, 2009). Sabbatical leave can allow faculty to spend quality time in other colleges learning from other faculty and can allow them to take classes to learn new methods for reaching these standards. This would go beyond professional development that may be provided during the school year.

There is another issue of emerging fields. Professional-technical faculty need to stay ahead of newly developing technology (Drage, 2009). In order to remain competitive in a global market, students require training in high-growth, high-demand job skills (Emeagwali, 2010). To teach these skills requires that faculty stay current in them. On the opposite end of the spectrum, some of the older fields have the potential to die out if high standards of training are not maintained. Examples would include professions such as watch repair or fine instrument repair. Training in these fields can be very labor intensive and expensive to offer and require faculty to be experts in their fields (Predmore, 2005). Sabbatical leave could be used to allow faculty to re-enter their fields and practice and refresh their skills.

These types of issues have created the need for sabbatical leave that allows for re-immersion in the field for technical faculty in addition to time for taking classes, visiting other institutions and having time for general renewal.

Current sabbatical leave policies often address sabbatical leave from a research perspective but do not address the needs of professional-technical faculty. An example from the Frostburg State University Faculty Development and Sabbatical Subcommittee Handbook is as follows:

> 1. Potential Enhancement of the University.
> Examples: Work done under a government or foundation grant.
> Scholarship potentially leading to publication.
> Creative work potentially leading to a publication, performance, or exhibition.
> 2. Maintenance or Improvement of Skills and Knowledge.
> Examples: Additional course work beyond the terminal degree (or, in exceptional cases, toward the terminal degree) or in an alternate field.
> Scholarship.
> Creative and artistic work.
> Development or alternative teaching strategies.
> 3. Course, Program, or Curriculum Development not to include work routinely performed by Faculty Members without a Sabbatical Leave or work for which release time is provided.
> Examples: Development of a new course, program or curriculum.
> Reorganization of a course, program, or curriculum.

> A major consideration is the need for the sabbatical to accomplish the work proposed. (*Frostburg State University Faculty Development and Sabbatical Committee Handbook*, p. 9)

An example from Marshall Community and Technical College differs in its stated purposes and seems more likely to meet the needs of the professional-technical educator.

> SECTION 5.9. SABBATICAL LEAVE
>
> 5.9.a. Purpose: A sabbatical is to provide activity that will improve teaching effectiveness, develop professional competency, and increase contribution of service to the college and its community.
>
> 5.9.b. Descriptions: A sabbatical is a compensated leave of absence of one or two semesters for a nine-month faculty member and twelve months for administrators. Sabbaticals shall be granted for approved projects involving full-time independent study, research, or any creative work that will generate new teaching skill and abilities and enhance professional growth and development. ("Policy# 5.00", 2005, p. 1)

The key difference between the two examples is that Marshall's stated purposes include the items to develop professional competency and to enhance professional growth and development. These items are critical for professional-technical faculty in their attempt to remain competent in the fields they teach.

The benefits of sabbatical leave for professional-technical faculty to the institution include several key items. The institution has the potential to be nationally recognized if it has high-level experts in the fields. An example from the

Madison Area Technical College is Marline Pearson, who was recognized in a PBS documentary based on the results of her work while on sabbatical (Madison Area Technical College, 2010). In order to receive national recognition for a program it is critical that faculty maintain the highest levels of proficiency in their fields, which a sabbatical can allow them to do. Another key benefit would be the same one indicated for general higher education and industry: faculty members return to work revived and refreshed and ready to continue with their institution (Benshoff & Spruill, 2002).

Conclusion

This review of existing literature indicates that sabbatical leave has a place in academia as well as in industry. Differences do exist in the benefits, costs, and implementation for the three areas examined. A benefit that was common to the three areas was that of renewal and refreshing of the employee upon return from sabbatical leave. A benefit that differed is that many general higher education sabbaticals result in research products that are not seen as often in industry or professional-technical education. A unique benefit appears in industry: those left behind were able to learn new skills by filling in for the employee on sabbatical.

A common cost was the replacement of personnel during their absence. A difference in cost was seen in cost mitigation. In either education setting the use of partially paid sabbaticals allowed for payment of part-time/adjunct instructors to fill class loads. In industry the cost was more often absorbed by not replacing the employee and allowing their duties to fall on others in the organization.

The examples of institutional sabbatical policies show similarities in sabbatical leave implementation between the two areas of education, but considerable differences in industry. In the educational settings sabbaticals were generally set to run based on semesters. Sabbaticals in industry were more often implemented in weeks and months and were shorter. There also appeared to be more stringent requirements placed on educational sabbaticals while industry sabbaticals had looser requirements.

The literature supports the idea that the use of sabbatical leave in general higher education, industry and professional-technical education can be of benefit to both the institution granting it and the person receiving it. For general higher education the purpose tends toward research needs; in industry the purpose tends toward refreshing, renewing and retaining personnel; and in professional-technical education the purpose is usually to allow the faculty member to update/maintain the technical skills they are teaching in the classroom.

The cost of sabbaticals for professional-technical faculty to institutions is very similar to what is borne by the other two environments. The length of the sabbatical will influence payment of all or a portion of salary and benefits along with the cost of covering the faculty member's course load with part-time/adjunct faculty. The potential cost of losing faculty exists in this realm as in the others and can be mitigated by clear statements of policy concerning return to work after sabbatical completion.

The benefits of sabbatical leave for professional-technical faculty differ from those seen in general higher education and industry because of a difference seen in the purpose of the leave. While general higher education is seeking research benefits and industry is seeking revitalization, professional-technical institutions are seeking improved knowledge of current industry standards and skills. The benefits to the organization are tied directly to the purpose of the sabbatical.

Improving organizational commitment is a goal for any organization desiring to excel in all aspects of its mission. Employees with commitment beyond simple fear of their inability to find another job or sense of obligation will do more than simply fulfill their contractual obligations. They will go above and beyond them for their organization (Golding, 2007). Sabbaticals are one benefit that may be used to influence this organizational commitment.

This literature review would indicate room for further research of sabbatical leave both in practice and policy. Further study would benefit those charged with determining the goals, costs and benefits in each of the three environments. Comparing the overall goals of the organizations and the impact of sabbatical leave in reaching those goals should enhance appropriate organizational use of sabbatical leave.

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Learning Styles in Technical Drawing Courses as Perceived by Students in Egypt and Nigeria

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Abstract

Students have unique ways of learning, which may greatly affect the learning process and its outcome. In the process of education, instead of classifying students according to their insufficiency, teachers should try to get to know them and determine their cognitive, sensorial and kinetic characteristics. This study on improving learning style inventory, aims to help technical industrial teachers determine students' attributes in individualized educational activities in technical drawing course at technical/industrial colleges.

The study involved four stages: determining the questions for the learning style inventory, preparing the trial inventory, applying the inventory, and determining validity and reliability. Nine experts validated the instruments: four lecturers from the University of Nigeria; Nsukka, Nigeria, and Delta State University; Abraka, Nigeria, while five lecturers and experts validated the instrument in the College of Education, Assiut University; Assiut, Egypt and College of

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Education, Suez Channel University; Suez, Egypt. The reliability coefficient of 0.92 was determined using students that are not part of the population under study, but registered technical drawing as a common course in College of Technical Education; Beni- Suef University, and University of Nigeria. All the data obtained were analyzed using SPSS (t-test). As a result of the analysis eight factors were determined.

Introduction

The choices of learning styles by the students multiplied greatly in recent time, yet some students have not embraced some of the styles. Students have unique ways of learning, which may greatly affect the learning process and consequently their academic achievement and its outcomes. In the academic situations, it has been observed that performance of students vary from one person to another. Some perform excellently well in their academic pursuit while others perform below expectation and exhibit a dismal academic performance in spite of careful instruction and different learning styles adopted by the student (Ordu, 2004). However, the findings of some researchers show that poor performances of students is a result of the inappropriate learning styles adopted by the students (Heilat & et. al, 2010). Most researchers opined that most students apply the learning style that seems most appropriate to them at any particular time. Some learn listening to the lectures, telling anecdotes, and listening to technical education reports, while some examine and handle new tools and equipment in the school workshop during practical lessons. Researchers also observed that students learn by looking at pictures, singing, making practical jokes, drama, and movement of the legs and body. Furthermore, students learn by listening and watching radio and television, making and receiving calls and texts, using cell phones, picture taking, and even sending e-mails to friends and relations.

In the tertiary institution where there are serious academic activities, students prefer a quiet and peaceful environment when learning to enable them to reason properly, discuss the lesson and take lecture notes. Tertiary in this study refers to formal education institutions called universities. Technical and industrial education students learn by understanding abstract concepts and putting the sketches, graphic drawings or maps of the abstract objects on paper. Lending credence to the foregoing ways and styles of learning by the students, the issue of the individual learning style that can yield a better result to enhance students' poor performance is still begging for an answer.

Learning and Learning Style

Learning is the transformation of internal representations. Learning may be said to have occurred if the mental processes by which one represents reality and internal understandings have been changed in enduring ways that are adaptive or advantageous to the individual. Anyamele (2004:136) citing Holloway provided the background for the discussion of the process of learning. They argue that any learning situation involves an interaction of three factor(s): a task to be accomplished, a style of learning it, and learning. In addition, they suggested that the model of learning the teacher operates on would be reflected in the interaction of these factors. One main distinction they marked is between "active" and "passive" learning. The passive model reflects behaviourist assumptions about the processes of learning and is based on a static conception of knowledge as a copy of reality, which has to be committed in its present form to the memory of the learner. In this view of knowledge, the task of the learner is a straight forward one, knowledge in this circumstance is objective, external and quantitative in the sense that the more one learns the better his chances of being regarded as a competent student (Ololube, 2009). Here, in this study learning can be assessed in terms of what the student has achieved, the time taken on the task, and the relative efficiency of different "treatment". It is clear that a learning style body of knowledge has been accepted into the education literature and professional development agenda since the 1980s (Hickcox, 2006).

Learning style can be seen as the particular ways in which learning is done by the individual student in tertiary institutions. Hornby (2006) explained it as a style of learning. Learning style is defined as "a set of factors, behaviors, and attitudes that facilitate learning for an individual in a given situation" (Reiff, 1992: 7).

James and Blank (1993) categorized learning styles into three realms: perceptual, cognitive, and affective. The perceptual realm includes up to seven ways learners take in and absorb information from their environment. According to Cherry (as cited by Harvey, 2002), these seven perceptual learning-style factors are aural (listening), haptic (touching or holding), interactive (verbalizing and discussing with others), kinesthetic (body movement), olfactory (employing the sense of smell), print (reading and writing), and visual (viewing pictures, images, objects, and activities).

Bruce and Gerber (1995:444-458) characterized the different ways in which students experience learning as memorizing, acquisition of facts, procedures which can be retained or utilized in practice, abstraction of meaning, and an interpretative process aimed at understanding reality. Bruce and Gerber further assert that the first two of these ideas are related to the surface approach to learning, the next two concepts relate to deep approaches to learning, with the fifth being somewhere in between. An analysis of the results of the same study shows six different ways in which student learning is experienced or understood by teachers. These conceptions are presented by description:

1) Learning is seen as acquiring knowledge through the use of study skills in the preparation of assessment tasks.
2) Learning is seen as the absorption of new knowledge and being able to explain and apply it.
3) Learning is regarded as the development of thinking skills and the ability to reason.
4) Learning is seen as developing the competencies of beginning professionals.
5) Learning is seen as changing personal attitudes, beliefs, or behaviours in responding to different phenomena.
6) Learning is seen as a participative pedagogical experience.

Ololube (2006) reiterated the above discussion and explained it as what learning is, how it is achieved, the learning style adopted and how the accomplishment of learning is demonstrated. These categories according to Ololube are internally related, and they indicate how learning is understood.

Muir (2001) explains that based on what we have learned, we conclude that students need:

• A variety of teaching strategies
• A variety of learning paths
• Activities which they can read, visualize, hear, say and do
• Instructional guidance leading to independence
• Ability to work on their own with appropriate assessment methods
• Appropriate tools and technology for independent and guided study

Statement of the Problem

There is a growing concern over the astronomical decline in students' academic achievements in technical drawing courses in tertiary institutions in Nigeria and Egypt. It appears to the researchers that the products of the tertiary institutions in Nigeria and Egypt are performing below expectation. The dwindling state of students' academic achievements calls for an immediate and urgent solution in tertiary institutions in Nigeria and Egypt. The choice of a good learning style is a difficult task for the students because a lot of physical and mental energy is required, and the success of the technical and industrial education program depends on the preferred learning styles of the students. A poor choice of individual learning style and acquisition of knowledge by the students in the classroom can lead to inappropriate behaviour and frustration on the part of students. Learning styles selected by individual students might affect their achievements positively or negatively depending on their disposition and environment at different levels. One style is not necessarily preferred over the other as a result of individual differences, but achieving balance with the chosen learning styles can lead to individual benefits.

In developing learning styles, students are faced with challenges of selecting appropriate styles suitable for achieving educational objectives. At the moment, it appears that some factors contributing to poor achievement include students' poor study habits, learning styles, (Kazulu, 1990) and teacher ineffectiveness (Ezike, and Obodo, 1990). The conventional methods of learning style adopted by the students in different tertiary institutions appear inefficient for the learning of technical drawing subjects. Hence it is desirable to investigate learning styles in technical drawing for the tertiary institutions students in Egypt and Nigeria.

Purpose of the Study

It is based on this, therefore, that the study is aimed at identifying the learning styles that can bring the objectives of Technical/Industrial education to reality and to ascertain the perception of students on these styles.

Specifically, the study is meant to:

1) Identify the Learning Style appropriate for a Technical/Industrial Drawing course
2) Determine the Learning Style that can enhance technical/industrial students' performance
3) Ascertain students' perception of these Learning Styles, which can enhance technical/industrial students' performance.

Research Questions

1) What are students' perceptions on the learning style that can enhance the students' performance in Nigeria?
2) What are students' perceptions on the learning style that can enhance the students' performance in Egypt?

Hypothesis

Ho1: There is no significant difference between the mean responses of students' perception on the use of learning styles in Nigeria and Egypt.

Methodology

The study adopted the cross sectional survey method. The population was made up of the 46, 20, 12 and 18 students in their first, second, third and fourth years in the Technical Education Department, Delta State University, Abraka in Nigeria (2009/2010 session); while the population of students in the Architecture and Civil Construction Departments, was given as 32, 36, 34 and 30 in the first, second, third and fourth years at the Beni- Suef University, Egypt. The entire population of students in Nigeria and Egypt were involved in the study. There was no sampling because of small number of students involved in the study. The instrument used was inventory of learning style (Güvan & Özbek, 2007) (Platsidou & Metallidou, 2009) (Hogan, 2009). The inventory was designed using a four – point rating scale. Two 27-item inventories were designed to elicit information using the inventory in Delta State University, Abraka, Nigeria and Beni-Suef University, Egypt, college of industrial education respectively.

Nine experts validated the instruments; four lecturers from the University of Nigeria and Delta State University, and five lecturers and experts in the College of Education, Assiut University and Suez Channel University. The reliability coefficient of 0.92 was determined using students that are not part of the population under study, but registered technical drawing as a common course in Suez Channel University and University of Nigeria. A grand mean value of 2.50 and above qualifies the learning style while a grand mean value below 2.50 disqualifies the learning style. All the data collected at the end of the analysis were analyzed using t-test with SPSS package.

Results

Research Question 1
What are students' perceptions on the learning style that can enhance the students' performance in Nigeria?

Table 1
Response on Students' Perception on the Learning Style in the Tertiary Institution in Nigeria

S/N	HOW CAN I LEARN?	Completely Appropriate	Appropriate	Inappropriate	Completely Inappropriate	$\overline{X}$	SD
		4	3	2	1		
1.	I like telling anecdotes	25	34	26	8	2.82	0.93
2.	When I listen to the course, I draw about the subject that I try to learn.	28	55	4	6	3.13	0.77
3.	I like listening to technical education reports.	28	36	24	5	2.94	0.88
4.	I always examine and handle new tools and equipment.	40	42	8	3	3.28	0.76
5.	I always feel pleased if there are pictures related with the subject in the book I read.	53	30	5	5	3.41	0.82
6.	I like sketching and drawing when reading.	8	9	27	49	1.74	0.95

7.	I don't like making practical jokes on my friends.	10	23	41	19	2.26	0.91
8.	I have difficulty in imagining events on my mind.	10	17	37	29	2.09	0.96
9.	When I listen to the lesson or study, I move my legs involuntarily.	12	16	38	27	2.14	0.99
10.	I like telling rather than writing when I learn.	21	17	50	15	2.58	0.90
11.	I learn the subject easier with pictures and maps.	37	38	8	10	3.42	3.24
12.	I like reading aloud when I learn.	6	14	42	31	1.95	0.86
13.	I listen to radio and television loudly.	6	22	36	29	2.05	0.90
14.	I like cleaning the blackboard, and opening and closing the window.	21	31	26	15	2.62	1.01
15.	I prefer a silent environment	74	14	3	2	3.72	0.63
16.	It difficult for me to draw graphs, pictures and maps.	9	17	35	32	2.03	0.96
17.	When I listen to the lesson noise my friends make causes me to have difficulty in learning.	40	24	16	13	2.98	1.08
18.	I think that the best way to remember what I learn is to imagine them on my mind.	54	33	4	2	3.50	0.69
19.	I don't like eating something or chewing when I study.	27	18	26	22	2.54	1.15
20.	I learn better by taking	52	36	3	2	3.48	0.67

	notes repeatedly after each lesson.						
21.	I don't like technical education group assignment.	12	26	29	26	2.26	1.01
22.	When I learn, like playing with coins or keys in my pocket.	6	5	28	54	1.60	0.86
23.	I like learning by discussing the lessons with my friends in the class.	53	34	4	2	3.48	0.69
24.	When I study, I frequently take a break and do other things	26	23	30	14	2.66	1.05
25.	I want my teacher to correct me by explaining when I give wrong answers in the lesson.	68	19	4	2	3.65	0.67
26.	I remember easier when I learn the subject by applying it.	58	33	1	1	3.59	0.58
27.	I learn better by taking notes and writing when I repeat the lesson.	64	26	3	0	3.66	0.54
	Grand Mean					**2.91**	**0.615**

Data in Table 1 shows the result obtained from the respondents on students' perception on the learning styles in Nigeria. The mean ranged from 1.60 to 3.72 which qualified the students adopting their peculiar learning styles in Nigeria. In most of the items the students attested that the best learning usually depends on the content of a particular study or context of the lesson note given to them by the technical drawing teacher. In the Table, items with a mean below 2.50 is inappropriate as a learning style while mean above 2.50 is considered appropriate. Table 1 had a grand mean of 2.91 and SD = 0.615.

Research Question 2

What are students' perceptions on the Learning Style that can enhance the students' performance in Egypt?

Table 2

Response on Students' Perception on the Learning Style in the Tertiary Institution in Egypt

S/N	HOW CAN I LEARN?	Completely Appropriate	Appropriate	Inappropriate	Completely Inappropriate	$\overline{X}$	SD
		4	3	2	1		
1.	I like telling anecdotes	42	71	12	7	.3.11	0.78
2.	When I listen to the course, I draw about the subject that I try to learn.	48	65	11	8	3.16	0.82
3.	I like listening to technical education reports.	33	57	27	15	2.82	0.94
4.	I always examine and handle new tools and equipment.	48	68	8	8	3.18	0.80
5.	I always feel pleased if there are pictures related with the subject in the book I read.	45	68	8	11	3.11	0.85
6.	I like sketching and drawing when reading.	23	27	57	25	2.36	0.98
7.	I don't like making practical jokes on my friends.	38	63	22	9	2.99	0.86
8.	I have difficulty in imagining events on my mind.	33	44	34	21	2.67	1.02

9.	When I listen to the lesson or study, I move my legs involuntarily.	28	38	45	21	3.15	1.09
10.	I like telling rather than writing when I learn.	25	28	47	32	2.35	1.05
11.	I learn the subject easier with pictures and maps.	50	68	8	6	3.15	0.82
12.	I like reading aloud when I learn.	46	72	8	6	3.19	0.75
13.	I listen to radio and television loudly.	25	39	46	22	2.41	1.04
14.	I like cleaning the blackboard, and opening and closing the window.	46	72	10	4	3.21	0.71
15.	I prefer a silent environment	46	70	8	8	3.17	0.79
16.	It difficult for me to draw graphs, pictures and maps.	24	31	48	29	2.38	1.02
17.	When I listen to the lesson noise my friends make causes me to have difficulty in learning.	23	29	50	30	2.34	1.02
18.	I think that the best way to remember what I learn is to imagine them on my mind.	20	34	48	30	2.33	0.99
19.	I don't like eating something or chewing when I study.	23	33	49	27	2.39	1.00
20.	I learn better by taking notes repeatedly after each lesson.	28	34	42	28	2.47	1.05
21.	I don't like technical education group assignment.	28	24	49	31	2.37	1.07
22.	When I learn, like playing with coins or keys in my pocket.	22	28	46	36	2.27	1.04

23.	I like learning by discussing the lessons with my friends in the class.	42	71	15	4	3.14	0.73
24.	When I study, I frequently take a break and do other things	24	31	49	28	2.39	1.02
25.	I want my teacher to correct me by explaining when I give wrong answers in the lesson.	20	30	51	31	2.39	0.99
26.	I remember easier when I learn the subject by applying it.	22	37	48	25	2.51	1.47
27.	I learn better by taking notes and writing when I repeat the lesson.	28	22	51	31	2.36	1.06
					Grand Mean	**2.71**	**0.409**

Table 2 shows the perception of students from item 1-27 indicating their mean responses and standard deviation. The mean ranges from the minimum of 2.27 to maximum mean of 3.51 with their respective standard deviation of 1.04 and 1.09. It can be explained further in Table 2 that the appropriate learning styles are usually indicated as values above 2.50 as appropriate and inappropriate learning styles are usually below 2.50. The benchmark of the study is 2.50 as clearly stated in the research work. Table 2 had a grand mean of 2.71 and standard deviation of 0.41.

Hypothesis Testing

Ho1: There is no significant difference between the mean responses of students' perception on the use of learning styles in Nigeria and Egypt.

Table 3
SPSS Summary of T-test analysis of student perception on the use of learning styles in Nigeria and Egypt

	N	Mean	Std. Deviation	Std. Error Mean
EGYPT	132	2.7095	.40921	.03562
NIGERIA	93	2.9047	.61460	.06373

Table 4
SPSS Summary of T-test Analysis of student Perception on the Use of Learning Styles in Nigeria and Egypt

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Differ-ence	Lower	Upper
EGYPT	76.072	131	.000	2.70947	2.6390	2.7799
NIGERIA	45.578	92	.000	2.90473	2.7782	3.0313

The results from Table 3 and 4 indicated that there is a significant difference between the learning styles in Egypt and Nigeria as perceived by students in the institutions in the different countries. This indicated that there is significant difference between the mean perception on the learning styles in Nigeria and Egypt.

Discussion

The findings of the research questions revealed that the learning style in Nigeria was not appropriate in items 6, 12 and 22 while it is appropriate in the other items not mentioned. The responses of the students indicated that they adopt the best learning styles in learning the technical drawing subject in Nigeria. The responses in Table 1 indicated that in item 6, 12 and 22 are inappropriate learning styles for acquiring technical drawing skills as perceived by the students in Nigeria.

Olaitan (1999) indicated that for the learning process to be effective, knowledge of subject matter as well as skills in technical drawing should be demonstrated by students and teachers. The students' responses showed that learning styles in technical drawing are rigid and peculiar to particular students. The students attested that different learning styles can be used to achieve learning in schools. Educators have called for improved quality of learning styles so that the needs of typical students, such as underachievers or slow learners, can be met by helping them improve upon their achievements in technical drawing and engineering.

Okafor (1993) carried out a study on the teaching and learning styles for increasing the interest of senior secondary school students in technical drawing. The study was designed to determine the learning styles and strategies for increasing the interest of senior secondary school students in technical drawing. The findings of the study revealed that students interest in technical drawing include among others: a better learning styles for technical drawing students, retention of good learning style to improve performance of the students and the use of appropriate learning styles.

Judging from the results on Table 1, it indicates that the majority of the items had a mean above 2.50 which suggests that the learning styles adopted by the students in Nigeria are multifaceted and peculiar to the need of a student. The Table further revealed that students adopt a particular learning style when the need arises and they are determined. The most suitable learning styles enable them to achieve their academic needs in the classroom. The study revealed that the students regarded the learning styles as a component skill approach to acquisition of knowledge in technical drawing. Learning styles is considered by the students as a panacea for building competence in the classroom and a strategy for effective performance. The National Policy on Education (2004) stipulates among other things that technical education should ensure students acquisition of appropriate skills, abilities and both theoretical and practical competences as equipment for them to contribute to the development of the nation.

The findings in this study show a number of diverse opinions of students with regards to their learning styles in various levels and institutions. They opined that learning styles as a prerequisite for writing examinations is in order as this can lead to effectiveness of students and to adapt the best style suitable to individual students to enhance familiarity with course content and lecturers as well as a providing adequate documentation for record purposes.

The findings also revealed that there is a significant difference between the mean perception of students in Nigeria and Egypt. The implication of the study is that students should be properly guided on the best learning styles in Nigeria and

Egyptian Universities to enable students to achieve the best in technical drawing in the different countries.

Recommendations

Based on the findings of the study, the following recommendations were proffered as instrument for re-engineering technical drawing courses in Nigeria and Egypt:

i) The students in Nigeria and Egypt should be properly guided and given incentives to select individual learning styles that are appropriate and applicable in their environment for them to achieve their personal academic objective.

ii) The students in Nigeria and Egypt should adopt a suitable learning style that would be beneficial to them.

iii) The two countries should agree on exchange programmes between Nigeria and Egypt to create an environment where students can interact, and exchange ideas on their individual learning styles to enable them improve on their personal learning style for academic growth.

iv) The institutions in Nigeria and Egypt should establish E- libraries in the various universities where students could explore their learning style through E- mail, face-book and other means of exchanging knowledge through information and communication technology.

v) Students in Nigeria and Egypt should establish a stronger diplomatic tie where scholarship and study grants information are given to students to travel and study either in Nigeria or Egypt to establish a better international relationship between their countries in order to learn and adapt their own individual learning style.

v) The students in both countries should be given the enabling environment for self-study skills in technical drawing programme using learning styles applicable or peculiar to individual students in Nigeria and Egypt.

Conclusion

From the foregoing discussion, it is obvious that students have different opinions regarding preferred learning styles and there is a difference in these opinions among students in Nigeria and Egypt. It is a settled fact to know that good environments for the students will cultivate individual choices of learning styles, which is a key to national development and modernization in the different countries. It is hoped that even those who are seen practicing the selection of learning styles in the institutions are equipped with lifelong skills through exposure to functional education. In the absence of the students' learning styles peculiar to individual choice, their educational goals cannot be actualized in their various institutions. In Nigeria, the learning styles most accessible and acceptable to all, is the best learning style that can assist the individual student to achieve their academic attainment. This is also applicable to different students in Egypt and other parts of the world.

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Learning Effects of Design Strategies on High School Students

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Abstract

An experimental design research method was used to study learning effects of design strategies comparing engineering design processes with trial and error design approaches. Students that met participation requirements were randomly selected and assigned into one of the two high school groups. The engineering design process was identified as the experimental treatment group while the trial and error process was identified as the control group. A common design project was created as the central focus for the instructional topic in both the experimental and control group for the study. Researchers collected end of treatment data from the student participants at the completion of a five-day program period. A one-way ANOVA was used to evaluate data from the *Engineering Design Test*. Analysis revealed an *F*-value of 4.398 with a significance of 0.043 between groups. A Cohen's *d* effective size of -0.680 was realized, indicating a practical medium effect.

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Learning Effects of Design Strategies on High School Students

Educators within technology education have had much debate over the benefits of engineering instruction within the field. Some educators advocate that engineering-based instruction can elevate the field of technology education to higher academic and technological levels and provide an ideal platform for integrating mathematics, science, and technology (Wicklein, 2006). Individual technology teachers and some state departments of education have made attempts to develop engineering-based curricula. Additionally, nationalized curricula like *Project Lead the Way* and *Engineering by Design* support engineering-related instruction for the secondary level. However, it is evident from an examination of the literature that there are certain aspects inherent to the engineering design process that are not included in most of the engineering-based instruction developed by teachers and nationalized curricula (Wright, 2002). Too often, engineering instruction taught within the technology education classroom is based on a trial and error approach to solving technological problems (Hailey, Erekson, Becker, & Thomas, 2005). Although engineering-related terms may be used within this methodological structure, the central features of working within constraints and predictive analysis is either omitted completely or addressed in a cursory fashion.

There is little to no quantitative data that can be generalized to the field that pertains directly to the learning effects of predictive analysis as a basis for teaching engineering design. Predictive analysis requires the use of mathematical and scientific strategies to evaluate a potential design solution prior to ever creating a physical artifact or model. Engineers employ this process as a common practice to determine which potential design possibility would best solve a given technological problem. This research sought to add to the knowledge base related to utilizing an engineering design process which included predictive analysis within a high school technology education instructional format.

With respect to infusing engineering design into K-12 technology education, scholarly research has focused on student competencies in mathematics and science, instructional needs for teaching engineering design, student interest in STEM subjects, and pedagogical methods in integrating STEM subjects into an engineering framework (McKenna and Agogino, 1998; DeGrazia, Sullivan, Carlson, & Carlson 2001; Dearing and Daugherty, 2004; Richards and Schnittka, 2006; Ross, Bayles, & Titus 2006; Spence, Bayles, & Corkum 2006). In a recent study of 283 in-service technology teachers, Gattie & Wicklein (2007) found that most technology teachers (90 percent) considered themselves to be teaching courses and topics related to engineering or engineering design and that almost half of their instructional time (45 percent) was committed to this activity. The majority of technology teachers surveyed in Gattie and Wicklein's research viewed engineering design as the appropriate focus for technology education. Cunningham, Knight, Carlsen, & Kelly, (2007) suggested that teachers' lack of knowledge about engineering was one of the principle obstacles that must be overcome in order to successfully integrate engineering concepts into middle and high school classrooms. This view was further expressed by a study within the National Academy of Engineering (NAE, 2009), which placed the deficiency at the feet of teacher preparation programs, stating "One significant deficiency we observed in engineering professional development at the secondary level is a lack of critical analysis and reflection on pedagogy per se" (p. 23). In a study to identify appropriate learning outcomes for high school technology education students with an engineering design focus, Rhodes and

Childress (2006) identified the number one necessary outcome as *the ability to identify problems that could be solved through engineering design*. Clearly, understanding what constitutes an appropriate and effective engineering design problem for secondary level students is essential in order to teach engineering design authentically and accurately. In addition to identifying appropriate design problems for the classroom, the ability to teach appropriate engineering design strategies is another crucial element. Currently most engineering-based instruction at the high school level is based on a trial and error approach to solving technological problems. This approach employs the process of students randomly selecting solution strategies that are based on hunches rather than mathematical and/or scientific applications. Using trial and error overlooks an essential feature of the engineering design process, which is the use of analytical predictive analysis to determine best options for solving a problem. Without a clear and distinct application of predictive analysis, any technological problem-solving effort would be severally limited in its results and would not be an effective method of solving most real-world problems. Unfortunately, predictive analysis is often omitted or only moderately addressed in many technology education programs. The effect of the many technology education programs that utilized a trial and error approach in solving technological problems was that students did not have an opportunity to engage in mathematical and scientific applications. Students are often left with the understanding that engineering is no more than a series of basic trial and error approaches to technological problem solving, which is incorrect and misleading.

Further, real-world technological or engineering design problems are usually ill-defined, complex, and vague (Dym, Agogino, Eris, Frey, & Lieifer, 2005). Based on the Accrediting Board for Engineering and Technology (ABET) standards, engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative and replicating), in which the basic sciences, mathematics, and engineering sciences are applied to convert resources optimally to meet stated needs (ABET, 2007). To successfully solve engineering design problems, designers undergo the process of identifying the needs and constraints connected with the problem, generating solution ideas, and evaluating the solutions that will satisfy the users' and customers' needs (Dym, 1994). Khandani (2005) suggested the engineering design process should include defining the problem, gathering pertinent information, generating multiple solutions, analyzing and selecting a solution, and testing and implementing the solution.

During the last two decades, the complex, uncertain, and dynamic nature of real-world problem solving has interested cognitive psychologists (e.g., Sinnott, 1989; Voss, Wolfe, Lawrence, & Engle, 1991), applied psychologists (e.g., Zsambok & Klein, 1997), educational psychologists (e.g., Spiro, Feltovich, & Coulson, 1996), and instructional technologists (e.g., Jonassen, 1997; Shin, Jonassen, & McGee, 2003). This stream of research focuses on the differences in the characteristics of well-defined problems, often used in classrooms (Spiro, Feltovich, Jacobson, & Coulson, 1992), and ill-defined problems, most common in the real world. One of the essential findings from previous studies was that well-structured and ill-structured problem-solving activities required different kinds of skills and abilities (e.g., Schraw, Dunkle, & Bendixen, 1995). In fact, many problems encountered every day pose uncertainties in various ways, including the complexity of the problem context; multiple and often conflicting perspectives among stakeholders; diverse solutions or no solution; and multiple criteria for solution evaluation. These are the general features of ill-defined problems

(Jonassen, 1997, 2000; Kitchener, 1983; Shin et al., 2003; Wood, 1983). The complexity of the problems, the existence of conflicting perspectives, and the potential for multiple solutions do not merely make the problems more sophisticated; rather, these features change the nature of the problems. Thus, ill-defined problem solving demands a different set of intellectual skills and attitudes that may not be necessary conditions for solving well-defined problems that have clear goals and known rules to apply (Jonassen, 1997; Schraw et al., 1995; Shin et al., 2003). All too often secondary level students within technology educations programs in the United States are limited or are completely void of exposure to ill-defined problem solving.

Theoretical Foundation

The theoretical or conceptual framework for this study was based on the general models of design that were formulated and established by the International Technology Education Association (ITEA) and various educators within the field of engineering education (Burghardt, 1999; Eide, Jenison, Mashaw, & Northup, 2002, 2008; Koen, 2003). Table 1 expresses the similar yet unique differences between what these two design models are describing as (a) *Technology Education Design* and (b) *Engineering Design* processes. The two design scenarios provided the basis for the theoretical framework for this research study. The highlighted text in italics represent the unique differences that guided the focus of this study (***bold italic*** =Engineering Design Process and *italic*=Technology Education Design Process).

Table 1: Comparison of Engineering Design and Technology Education Design Process

Engineering Design Process (Eide, Jenison, Mashaw, & Northup, 2002)	**Technology Education Design Process** (Standards for Technological Literacy, 2000)
Identify the Need	Defining a Problem
Define the Problem	Brainstorming
Search for Solutions	Researching & Generating Ideas
Identify Constraints	Identifying Criteria
Specify Evaluation Criteria	Specifying Constraints
Generate Alternative Solutions	Exploring Possibilities
Analysis	*Select an Approach and Develop a Design Proposal*
Mathematical Predictions	*Building a Model or Prototype*
Optimization	*Testing & evaluating the Design*
Decision	Refining the Design
Design Specifications Communication	Communicating Results

Method

The research question and protocol for this project are explained in this section as well as explanations of the primary research activities that were accomplished during the project. A null hypothesis was established to guide this study and is stated as:

> There is no significant statistical difference in engineering design learning ability for students who participated in an engineering activity based on predictive analysis when compared with an engineering activity based on trial and error.

Identification of School Partner. The target population for this research came from a high school located in Northeast Georgia. High school students at the 11th and 12th grade level were the potential participants for this experimental research.

Selection of Participants. A total of 40 high school students (11th and 12th graders) were randomly selected for this project. During April of 2009, a letter was sent to all qualified 11th and 12th grade students inviting them to participate in a special program during the summer of 2009. Qualification of students to be selected for this experiment was based on academic standing (GPA 2.5 or higher), in good standing with the selected high school, and parent/guardian permission to participate in the study. Based on the responses from the potential participants, 40 students were randomly selected to participate in the study.

Random Assignment of Participants. From the total pool of participants, the students were randomly assigned to either the experimental treatment group (predictive analysis group) or the control group (trial and error group). Each group had a total of 20 participants. Within each group, students were further randomly assigned to one of five (5) development groups with four (4) students per group. This was done to allow each member of the group to take part in the solution process.

Selection of Instructional Topic and Preparation for Instructor Training. As presented at the end of this paper, a soft drink (aluminum) can crusher design challenge was selected for the instructional content of this experiment. This instructional activity was selected based on its perceived appropriateness as an engineering-related technological problem and was deemed age and gender suitable by the researchers. The activity involved the design and development of a soft drink (aluminum) can crusher device that would require students to use their knowledge about lever systems and calculations that result in mechanical advantage. Researchers viewed this as a classic problem that could be solved in an analytical manner, based on the level of student knowledge related to physics lever mechanisms and mathematical concepts. The challenge was deemed to be gender free, because anyone could own and operate a soft drink can crusher without discrimination. The instructional activity content was designed to be completed in five days with three-hour per day class sessions. Assumptions made to determine activity completion rates were based on predictive analysis and trial and error processes taking place within the first day. The second, third, and fourth days were to be spent in the laboratory implementing day one decisions and tweaking those decisions as needed. Presentation and evaluation day was the fifth day, where students would explain and demonstrate their process to problem solving.

Selection and Training of Instructors. A purposeful selection of two technology education teachers to participate in this study was done from a local pool. Each teacher was a veteran of the classroom (five or more years of teaching experience at the high school level) and had knowledge of the design process. The teacher whose school hosted the experiment was assigned the treatment group while the second teacher was in charge of the control group. They underwent training in the objectives of the research study. After this assignment, each underwent further training regarding the instructional topic and the instructional methodology that each would use during the program of instruction (experimental group=predictive analysis and control group=trial and error). The experimental group teacher received training in classical lever class problems and mechanical advantages that accompany such arrangements. The control teacher received the traditional technology education approach to solving a problem through a trial and error method. Teachers were supplied with the appropriate laboratory and written materials needed for the instructional programs. Instructors were required to follow a strict instructional regiment that aligned with their assigned instructional methodology.

Preparation of Classroom and Laboratory Facilities. The research was conducted at a high school in northern Georgia within the technology education classroom facility of that school. The facility was divided in two, with one section populated with more than twenty computers for students to use as needed, and the second section a laboratory with hand tools and machines that would support the instructional activity solution. The arrangements of the classroom/laboratory facility were identical for both the experimental and control groups. Students could move in and out of the two rooms as needed. Instructional materials were prepared by the research staff and supplied to the teachers.

Conducting the Instructional Programs. The program was implemented during a five-day period in mid-June 2009. Instruction for the experimental group took place from 9:00 a.m. to 12:00 p.m., and instruction for the control group took place from 1:00 p.m. to 4:00 p.m. The selection of the two different times was done to prevent cross-talk among the student participants. At the completion of the instructional period, all students were administered a standardized *Engineering Design Test* that measured capability to understand and apply a comprehensive engineering design process. The *Engineering Design Test* had been tested and revised for validity and reliability.

Data Collection and Analysis. Data was collected from the student participants at the completion of the five-day program period. All data was quantitative and based on student responses to the *Engineering Design Test*. Once data had been collected, it was entered into the SPSS statistical software. An analysis of variance (ANOVA) was conducted to determine differences between groups and within groups. Further, to investigate whether a practical effect existed, a Cohen's *d* analysis was performed. These analysis methods provided the statistical results to enable the comparison of the design methods.

Results and Discussion

Analysis addressing the research question, *Is there a significant difference in engineering design learning ability for students who participated in an engineering activity based on predictive analysis when compared with an engineering activity based on trial and error?*, yielded an F value of 4.398 having significance at 0.043 for between the groups, indicating that there is a statistical significant difference in engineering design learning ability between the two student groups. Table 2 indicates the results of the ANOVA.

Table 2: Analysis of Variance for Engineering Design Learning Ability

	Sum of squares	df	Mean Squares	F	Sig.
Between Groups	70.225	1	70.225	4.398	0.043
Within Groups	606.750	38	15.967		
Total	676.975	39			

To further investigate whether a practical effect existed, a Cohen's *d* analysis was used to determine the effect size for the difference between groups that range from 0.2 (small effect), 0.5 (medium effect), and 0.8 (large effect) (Cohen, 1988). For this group, a Cohen's d of -0.68 resulted. This result indicated that a practical effect existed between the two student groups. From a possible score of 36 on the *Engineering Design Test*, the treatment group (predictive analysis group) had a mean of 20.65 (SD=4.49) on the test, while the control group (trial and error group) had a mean of 23.30 (SD=3.44). The mean scores indicated that the trial and error group performed better than the treatment group.

The researchers sought to understand the reasons behind the differences in the group test scores, especially since the null hypothesis was rejected in the opposite direction of the expected results. The following explanations provide the researchers thoughts and conclusions to explain why the results of the experiment yielded this effect.

1. Although the instructional activity was well thought through and considered with regard to age, gender, and topical relevance the issues related to identifying appropriate instructional topics that lend themselves to incorporating predictive analysis strategies that are in-

line with student prior knowledge of mathematics and science is difficult to determine. The researchers were not aware of any past educational research which identified instructional topic selection with regard to the incorporation of predictive analysis strategies for secondary level students. Further research needs to be conducted to help identify the critical and essential features that should be included in instructional activities that seek to help high school students engage in engineering design processes that include the components of predictive analysis.

2. Time that was devoted to student's learning the engineering design process was limited and was determined to be too short. The 12 hours of instructional time within this experiment was insufficient for students in the treatment group to gain a full understanding and appreciation of the predictive analysis procedures that were needed to solve the instructional activity. Inversely, the control group did not need significant additional learning time to employ the trial and error strategies that students used to solve the instructional activity since this was the common default approach to solving technological problems. Tying together mathematics and science concepts and relating them to physical solutions to technological problems must be orchestrated in a fully articulated way that is both systematic and repetitive in order to build confidence and effectiveness by the student user. In this research, the treatment group was exposed to both physics and mathematics that pertain to lever systems. The reason for the exposure was to help students relate to the lever classes and apply their basics to the project design. Few student teams within the group attempted to use this knowledge in their design and abandoned

most forms of this knowledge due to pressure of time and limited confidence in the use of the computational manipulation that would be translated into physical reality as a solution. Could it be that the treatment group did not reach their goal due to circumstantial factors rather than the learning strategy that was intended? This question is worth investigating in future experiments. A prolonged amount of instructional time on relevant learning activities culminating with an appropriate learning challenge should be considered when teaching engineering design to high school students.

3. The *Engineering Design Test* was not sensitive enough to measure the subtleties between the two student groups. The *Engineering Design Test* was created to measure student knowledge of the engineering design process and may not be able to discriminate the unique variations of student prior experiences in technological problems solving. A further examinations and refinement of the *Engineering Design Test* is currently underway.
4. Small population size. Limitations of the small numbers in each group may have been a factor in the differences between treatment groups. Further research needs to be done with larger numbers of students where random selection and assignment can be accomplished with samples from more complete populations.
5. Time of day effects could have caused a difference. Although random selection and random placement of the participants was conducted, there could be unknown elements that worked in favor of the control group that met in the afternoon over the treatment group that met in the morning. Considering that the study took place in the summer and 11^{th} and 12^{th} graders stay up late

during summer – although there is no data to support the assertion nor do the researchers believe this to be a factor – they suggest that an element of not being fully awake for the morning group (predictive analysis group) be investigated for any potential contribution to the outcome. Future research is recommended for the time of day to minimize the day effect.

The reasons observed above raise practical and critical questions in determining how much time, curriculum design, and instructional methodology is required to adequately integrate a new approach to build engineering design content knowledge in high school students. The time required to build and integrate the essential instructional and learning tools that will yield students connecting and applying STEM (science, technology, engineering, mathematics) content is still unknown. Incorporating the engineering design process that includes significant uses of the predictive analysis process seems to be a logical approach to connecting STEM content together; however, much more research will need to take place before educators can be successful with this approach.

Initial learning of content, whether science, technology, engineering, or mathematics, is necessary for transfer to other areas and topics. The National Research Council (NRC, 1999) discussed how learning involves transfer on previous learning. This explanation of learning transfer identified three variables crucial to learning: (1) degree of mastery of the original work, (2) degree to which people learn with understanding rather than merely memorized sets of facts or following a fixed set of procedures, and (3) the amount of time it takes to learn material is proportional to the material being learned. Further, the discussion suggested that attempts to cover too many topics too quickly could hinder learning and subsequent transfer because students would learn isolated sets of facts that may not be organized and connected, or they are introduced to organizing principles that they cannot grasp because they lack enough specific knowledge to make them meaningful. These are factors that likely contributed to the outcome of the study in classic engineering programs; students pull from different resources of courses taken to create a solution for a given problem. This approach provides ample time to build up the intellectual capacity and affective characteristics that enable one to make an analytical approach realistic.

Conclusion

To strengthen and better understand the impact of future experiments, the researchers suggest the inclusion of measurements of mathematics and science gains from the experiment activity. Measured gain is the value added component to student understanding and use of new concepts, skills, and/or attitudes that have been acquired through participation in a learning event. Future experiment designs are encouraged to establish student current knowledge level and expected knowledge level after participation. This measurement could be achieved by administering a pre-assessment survey to the students at the beginning of the experiment and a post-assessment survey at the end of the activity and comparing outcomes of both assessments. The difference in post and pre assessment is the value added. The value added will inform whether participation in the experiment design contributes towards the learning of new material and help develop intended higher level of knowledge transfer. The higher level of knowledge transfer would equip the participant with a generalized approach to problem solving activities that shapes individual methods of design to solve various problems with effective solutions.

This study was set to investigate learning effects of design strategies using an engineering design process versus a trial and error approach. The outcome revealed that the control group (trial and error) performed significantly better than the treatment group (predictive analysis group). The researchers sought reasons that could have led to this outcome and observed that, time constraints in integration of predictive analysis tools was the likely factor that led to lower performance by the treatment group. The selection and design of the instructional activity used in the experiment may have also contributed to the results of this study. Hatamura (2009) advised that the best approach in human activity is to act wisely, acquire knowledge of potential failures and let knowledge guide actions.

The researchers propose that adequate preparation be given to all those that use the engineering design process as a means to teach engineering content and engage in STEM education. This preparation should include immersion in both mathematics and scientific concepts and more importantly, rigorous applications in several problems with known results before students attempt to solve ill-defined problems that require significant levels of learning transfer.

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Appendix

Soda Can Crusher Challenge

You may be an environmentally conscious person. You have noticed that your family buys and drinks significant amounts of soda. Your family may prefer to buy soda in regular 12 oz. or 355 ml aluminum cans. Here are some interesting facts about aluminum: Huge earthmover vehicles extract bauxite from the earth. The bauxite is then mechanically crushed to separate it from impurities before being transported to a smelting plant where high energy is used to melt and extract aluminum. The aluminum is then sent to factories for stamping and extruding to create the can that soda is placed in. Assuming the energy spent in this manner to develop a soda can is 100 percent, recycling would use only 5 percent energy to develop the same can. Recycling aluminum cans makes a lot of sense because it saves valuable energy.

YOUR CHALLENGE:

To help improve the process for recycling aluminum soda cans you and your team are to design, construct, and test a wall-mounted soda can crusher that will reduce a standard size and shape a 12 fl. oz. soda can to one inch in height. This reduction in height will aid in storing more cans in recycling bins and collection sites.

Design Specifications:

Design and product must address the following:

1. Must be safe to operate
2. Must be able to be operated with 2 lbs. of force
3. Should be aesthetically pleasing
4. Should be functional (reduce 12 fl. oz. aluminum can to 1 inch in height)
5. Should be reliable (be able to crush 20 cans in 2 minutes)
6. Must fit within the following dimensions: 24” (height) X 6” (width) X 6” (depth)

Constraints/Limitations:

1. Produced from teacher supplied materials
2. Produced using available laboratory tools
3. Produced within the allotted time limit

Evaluation of Assignment:

1. Detailed documentation of can crusher design
2. Working can crusher product
3. Functional test of can crusher

Evaluation of Assignment:

Evaluation Criteria	Points Value
Size Limitation of Product (24” X 6” X 6”)	5
Safe Operation of Product	10

Reliability/Durability of Product (10 can in 2 minutes)	15
Detailed Documentation of Design Process	20
Operation - Force Applied (5 lbs. force)	25
Functional Product (can reduced to 1 ½" height)	25
TOTAL	**100**

Materials List:
All products must be constructed from the following list of materials:

Material	Size	Quantity
Wood Screws	1 ½"	20
Wood Screws	1"	20
Board	2" X 4" X 45"	1
Board	1" X 6" X 3'	1
Plywood	¼" X 2' X 4'	1
Dowel Rod	3/8" X 4'	1
Wood Glue	Capacity	Capacity
Thumb Tacks	Normal	5
Rubber Bands	¼" X 2"	4

Tool Used:
Tools used to construct the product must be done under the direct supervision of the instructor or research staff.

Evaluation Rubric

Evaluation Topic	Below Standard	At Standard	Above Standard	Specific Comments
Size Limitation of Product (24" X 6" X 6") 5 pts. Maximum	Product not completed	Product constructed within size limitations	Efficient utilization of materials to construct product	
Safe Operation of Product 10 pts. Maximum	Product functioned in an unsafe mode	Product functioned safely	Product functioned safely and efficiently	
Reliability/Durability of Product (10 cans in 2 minutes) 15 pts. Maximum	Product not able to perform required amount of processing within time period	Product able to process required amount of processing within time period	Product able to process required amount of processing prior to time period ending	
Detailed Documentation of Design Process 20 pts. Maximum	Use of engineering design notebook was inadequate and not complete	Use of engineering design notebook was adequate and complete	Use of engineering design notebook indicated superior understanding of documentation process	
Operation – Force Applied = 5 lbs. 25 pts. Maximum	Force needed to operate product exceeded 5 lbs. of force	Force needed to operate product was within operating	Force needed to operate product was less than 5 lbs. force	

		force parameters (5 lbs. + 0.25 lbs. force)		
Functional Product (Can crushed to 1 ½ inch height) 25 pts. Maximum	Crushed can exceeded the 1 ½ inch height criteria	Crushed can was within the 1 ½ inch height criteria (1 ½ inch + 0.25 inches)	Crushed can was less than the 1 ½ inch height criteria	

This study was conducted to compare and evaluate the differences in student learning effects of engineering design taught from a trial error based approach versus a predictive analysis approach using an experimental design research method.

UNDER REVIEW

Getting To Know ArcGIS Desktop
By: Ormsby, Napoleon, Burke, Groessl, and Bowden, (2010).
Format: (Softcover, 592 pp. ISBN: 9781589482609)
Publisher: Redlands, California: ESRI Press

Abstract

The Geographic Information Systems workbook, *Getting To Know ArcGIS Desktop* (Ormsby, Napoleon, Burke, Groessl, and Bowden, 2010), is published by the Environmental Systems Research Institute (ESRI). This book has served as a key resource for learning the basic operations of the ArcGIS Desktop software system. It is an extremely successful product that is used for many purposes worldwide. Aside from its foundation layout structure and operations, more advanced tools and analytical extensions are available for purchase. Made available in the year 2000, ArcGIS Desktop has undergone a series of modifications with each version. In parallel, the book has adapted its content to stay current. Primarily a reference for ArcGIS technical operations, "Getting To Know ArcGIS Desktop" also includes some description of GIS theory. There are a variety of exercises, along with a disk that contains trial software and exercise data.

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Review

There are eight sections of *Getting To Know ArcGIS Desktop*: Getting to know GIS, Getting started with maps and data, Displaying data, Getting information about features, Analyzing feature relationships, Creating and editing data, Presenting data, and Modeling. Each section contains a series of chapters that cover aspects of each section in greater detail, a total of 20 chapters. Nested in each chapter are a series of exercises that provide the hands-on learning component. In general, the book is organized in a logical manner. The assumption is made that the reader is new to both GIS and ArcGIS software. As the content is engaged in a sequential manner, the reader will first be exposed to fundamental operations and progress towards the more advanced.

To introduce newcomers to GIS, section one: Getting to know GIS, contains two chapters that describe some of the basic principles of GIS, along with an introduction to ArcGIS Desktop. Although the primary focus of *Getting To Know ArcGIS Desktop* is familiarizing the reader with ArcGIS Desktop operations, the first chapter needs to describe the principles of GIS in a more thorough manner. Aspects of GIS are clearly communicated, but a more thorough review would be beneficial. Chapter two, Introduction to ArcGIS Desktop, is similar in that additional descriptions of the structure of ArcGIS Desktop software is merited.

Section two: Getting started with maps and data, begins the process of familiarizing the reader with ArcGIS Desktop through exercises. Through engaging tasks such as displaying data, accessing basic navigation tools, and exploring some simple ways of representing data, the reader becomes familiar with the ArcGIS Desktop environment. Since GIS is based on spatial data models, representing information in map format is the primary method of sharing information. Using maps, section two introduces the reader to GIS in an effective manner.

Section three: Displaying Data, carries the mapping theme to operations that represent map information in a variety of ways. The exercises are well structured, and explain operations that are valuable towards depicting map information used daily in the workplace. However, the potential exists to combine these exercises with those found in section seven: Presenting Data. This section deals primarily with the development of a final cartographic product that can be shared with others. Both sections deal with the visual aspects of mapping. There is no definitive right or wrong in this case, only a matter of opinion. However, it does bring up the dilemma in GIS education of discussing one aspect of the technology, and subsequently, touching on others in the process.

Section four: Getting information about features, provides the reader with the skills to query attribute information connected to geographically referenced GIS data. Although attribute queries are not actual spatial analysis operations, they are both very useful and often a precursor towards performing spatial operations. These consist of analyzing the topologic, proximal, and directional qualities of geographically referenced data. That sort of analysis is described in section five: Analyzing feature relationships. For both sections, *Getting To Know ArcGIS Desktop* provides a very good foundation towards learning the basics of querying GIS data.

Section six: Creating and editing data, is by far the most ambitious. Its chapters cover the topics of: building geodatabases, creating features (GIS data), editing features and attributes, and geocoding addresses. Books have been written that solely cover these topics, but considering the intent of this book, an adequate amount of operations are presented to the reader. This situation also applies to section eight: Modeling. As for operations not included, the exercises provide enough background to locate where in the ArcGIS Desktop environment to look for them.

One of the resources of the software that is seldom given credit is the help option. The ESRI Corporation did an outstanding job of including in ArcGIS Desktop a massive amount of information concerning both GIS concepts and operations in a user-friendly manner. The format is such that after engaging the book's content, individuals could independently continue to learn more advanced GIS content. Graphically, both the book and help option provide illustrations that are very descriptive and helpful. The ESRI Corporation has developed a variety of publications that are visually pleasing, and *Getting To Know ArcGIS Desktop* is clearly in line with that tradition.

Although this text is well organized and does a fine job of preparing the reader to use ArcGIS Desktop, subsequent editions may benefit from utilizing a theme approach. This implies the use of scenarios in exercises that connect GIS technical operations with real-world situations. This approach would help answer the questions of "why" certain operations were conducted.

Regarding data and software, loading each shouldn't pose a problem. Once the software is loaded, the reader will be asked to register with the ESRI Corporation. Doing so will provide access to additional resources provided by the company. Minus any confounding hardware/software issues, each exercise runs as described in the book. Although the software included in the disk will operate for only 180 days, that provides an adequate amount of time to complete all exercises.

Overall, *Getting To Know ArcGIS Desktop* is a wonderful resource for those just learning GIS, as well as an excellent reference for those familiar with the software.

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