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Enrollment in Technology Education Based upon Scores in Mathematics and Science

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ENROLLMENT IN TECHNOLOGY EDUCATION BASED UPON SCORES IN MATHEMATICS AND SCIENCE

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APPROVAL PAGE

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CHAPTER I

INTRODUCTION

Middle school is a period in a student's early career where choices of electives are initiated (Clark & Flood, 2010). This, in a subconscious manner, prods students to think of careers that interest them. Currently, there is a government driven push for linking science, technology, engineering, and mathematics (STEM) in education. In 2006, Virginia Polytechnic Institute (Virginia Tech) became the first institute to introduce a master's program in STEM (Sanders, 2006). A membership group, The STEM Education Coalition (2008), had listed over 300 partners by June 2008 comprised of universities, schools, industries, and government agencies. There is no doubt that the drive toward STEM is continuing.

Parental influence has a great part to play in a student's choice of electives, and ultimately of careers. Parent engagement starts as early as elementary school and continues through the child's career (Clark & Flood, 2010). Given the contemporary scene, parents are aware that the job market is more stable if the applicants are multi-skilled, and this is what an engineering or scientific background provides. Such parents are more likely to lay greater emphasis on mathematics and science achievement for their children.

The purpose of this research is to gather information on what drives enrollment in technology education electives in middle school, and whether it has something to do with student's mathematics and science proficiency. Since technology education deals with several branches of engineering, and this being mathematics and science intensive, the

inference is that students who have an aptitude for these two core subjects would prefer to elect technology education courses.

Statement of the Problem

The problem of this study was to determine if a relationship exists between 7th and 8th grade students choosing to enroll in technology education as an elective based on their success in mathematics and science subjects.

Hypotheses

The hypotheses that guided this study were:

H_1: Seventh and eighth grade students who have elected to take technology education as an elective course earn higher grades in mathematics.

H_2: Seventh and eighth grade students who have elected to take technology education as an elective course earn higher grades science.

Background and Significance

This study was envisioned when it was discovered that Texas had completed a study of college going seniors. In May 2007 the Texas Legislature created a review panel for career and technical education (CTE) and the panels' recommendations were put forward the following year (Bettersworth et al., 2008). Their findings led to the conclusion that "students who followed a CTE curriculum enhanced with mathematics outperformed their peers on mathematics assessments, including college placement tests" (Bettersworth et al., 2008, p. 4).

It was reasoned that this study was needed to indicate whether students who intrinsically have aptitudes and a home/environment culture that enable them to succeed in mathematics and science subjects at the middle school level, they would be more likely

to take up technology education in middle school and high school, which in turn helps their mathematics and science scores in high school. The significance of the research was also in part due to the fact that the researcher would gain "important knowledge about the human condition" (Fraenkel & Wallen, 2000, p. 30), which, in this case, refers to enrollment in technology education.

Limitations

This study was limited specifically to 7th and 8th grade technology education students at Lanier Middle School, Fairfax, Virginia. It was based on their grades in mathematics and science.

Assumptions

This study makes the following assumptions:

1. Student records of grades in mathematics and science will be taken from the school year 2009-2010 and compared with enrollment in technology education during the same school year 2009-2010. Technology education classes run for a semester, as compared to mathematics and science classes that run for the entire year. It is assumed that this factor would have little effect on the study.

2. Grade variation due to different teaching methods by the group of teachers teaching mathematics and science would average out over the size of the sample taken for the study.

3. Honors students would be spread out within the students sampled to the extent that their grades would have very little effect on skewing data for the study.

Procedures

This study will be carried out by using students enrolled in the school and school

databases to determine which students chose technology education as an elective and relate that to their scores in mathematics and science during the previous semester. This would be undertaken to find out whether there is a positive correlation between preference for technology education to their aptitude in mathematics and science.

Definition of Terms

The following terms have been defined in order to give the reader a better understanding of the content in the research paper.

College Placement Tests: Tests such as the Scholastic Aptitude Test (SAT), the scores of which colleges consider as admission criteria.

CTE: Career and Technical Education. Fields of curriculum that cover industrial technology and engineering, with a job focus in mind.

Elective: A subject which a student can choose from a group of subjects, normally for a semester and sometimes for an academic year.

7th Grade Science: A mandatory subject for all students in the school covering laws in nature titled “Investigations in Environmental Science 7”.

7th Grade Mathematics – A mandatory subject for all students in the school covering recognition of patterns in a numerical analysis, titled “Mathematics 7”.

7th Grade Technology Education: A program of lab based studies chosen as an elective that covers various engineering and technological fields, titled “Technology Exploration 7” and which also helps students to map out future career paths. The curriculum integrates mathematics, science, English, and engineering fields to prepare students for college and the workplace. The course is titled “Technology Exploration 7”.

Overview of Chapters

Chapter I is an introduction to the study and the rationale for carrying out the particular research. There are existing studies conducted on high school students which indicate higher mathematics scores if they elected to take CTE subjects (Bettersworth et al., 2008). It was thought to be interesting to find out if this was true in middle school, i.e., if students who elected to take technology education subjects had good scores in mathematics and science to start.

Chapter II will cover a Review of Literature to enable the researcher to obtain a deeper knowledge of the subject being researched and to compare and contrast other research on the subject. Chapter III will cover Methods and Procedures in which the researcher will describe methods that will be used to collect and analyze data. This will include defining the population for the study, listing the research variables, describing whether an instrument is being used and if so the instrument design, the method of data collection, and the statistical analysis.

Chapter IV will cover findings of the study after analyzing and coalescing the results of analysis of data. Chapter V will detail conclusions based on the findings and how they relate to the hypotheses guiding this study.

CHAPTER II

REVIEW OF LITERATURE

The content of this chapter covers literature related to technology education and linkages to mathematics and science. The researcher also describes how mathematics and science are used in a workplace manufacturing environment.

CTE and Mathematics/Science in Industry

Technology in general and career and technical education (CTE) in particular is inseparable from both mathematics and science. This is evident as engineers, scientists, and technologists push the natural laws of nature to the limit to design and manufacture useful products for mankind. Some of the products of technology even require pure mathematics such as the Taguchi loss function (Ross, 1989) and Taguchi's variance analysis (Ross, 1989) to improve quality of manufactured products in a competitive environment. Research by Suzaki (1987) indicates that a steady flow in a manufacturing set-up is achieved by aiming for production linearity. This is attained by leveling the production schedule as exemplified by the Toyota Production System (Suzaki, 1987). This is a typical example of application of mathematical tables and figures in a technological field.

CTE and Curriculum

Real world applications use applied mathematics and applied science to get the job done. It is no wonder then that companies such as Pitsco who are in the business of technology education (Synergistic Division) base their curriculum on subjects such as algebra (Frankenbery, Holland, Delaney, & Baker, 2009-2010). Carolina High School and Academy in Greenville, SC, discovered that after the introduction of the Pitsco

Education Algebra program, seventy percent of students passed the state End-of Course (EOC) exam as compared to fifty percent for the same EOC exam for the previous year (Frankenberry et al., 2009-2010). This indicates that a hands-on application of mathematics assists in learning subject theory.

CTE and Academia

McCuen and Greenberg (2009) conducted a survey to determine whether school counselors had any influence on students' decisions to choose engineering as a career and discovered that counselors had very little influence on students' engineering careers. This was attributed to the fact that counselors had very little knowledge of science and engineering. One the other hand, the survey showed that students started considering engineering as a career path from the sixth to the eighth grade. What was interesting was the fact that the recommended seminar for counselors to attain more knowledge on this subject included science and mathematics mentoring programs.

Hudson (2004) indicated that in the year 1999-2000, 71 percent of sub-baccalaureate students in the country (who are expected to take more rigorous courses in science and mathematics) chose a vocational career as compared to just 38 percent of all degree seeking undergraduate students. A study of multiple intelligences in the classroom (Armstrong, 1994) showed that a teaching strategy for logical-mathematical intelligence is to have an interdisciplinary approach which is exemplified in technology education. Fraenkel and Wallen (2000) used sensory experiences, expert opinions, and logic to determine what should be the nature of research in education, which led them to the 'scientific method' of defining a problem or query, clarification of the definition, hypothesized on what could have been a solution, organized an experiment to test the

hypothesis, and interpreted results. They went on to state that experimental research was the most conclusive of scientific methods, indicating that, although a theoretical academic educational background is necessary for forming a basis to understand the problem and possible solutions, the conclusive proof that what was envisioned actually exists, is established by an application based approach, which falls into the realm of career and technical education (CTE).

Evans and Burck (1992) did a statistical analysis on the effects of CTE interventions on academic achievement and obtained results supporting CTE as a positive contributor to academic achievement, with elementary students of average ability profiting the most.

In May 2007 the 80th Texas Legislature created a CTE Review Panel by passing a House Bill (H. B. 3485). The Review Panel's (Bettersworth et al., 2008) findings were interesting. They found out that CTE was rigorous when it developed students' capacity to improve and expand their thinking and reasoning skills, and to recognize real-world applications of these skills. They also found out that students who followed a CTE curriculum enhanced with mathematics outperformed their peers on math assessments, including college placement tests.

One of the most defining entities linking technology education to mathematics and science is the movement towards STEM as a curriculum. In 2005 the US Congress passes The Deficit Reduction Act of 2005 (P.L. 109-171. The statute charged the US Department of Education through the Academic Competitiveness Council (ACC) to:

- Identify all federal programs with a mathematics or science education focus;
- Identify the effectiveness of those programs;

o Determine areas of overlap or duplication among those programs;

o Identify target populations served by such programs; and,

o Recommend processes to efficiently integrate and coordinate those programs.

In May 2007 The US Department of Education published a report through the ACC which recommends more funding for STEM education at all levels and increased focus on experimental/quasi-experimental learning at the K-12 level. This ties in with the curriculum use by Technology Education courses wherein the experimental method of learning provides tangible conclusions and authentic assessment.

Virginia Tech offers an M. S. program that is called "Integrative STEM Education" and offers eight courses in their graduate program from which four courses may be chosen for 12 graduate credits (Sanders, 2006). Johns Hopkins University offers a master's degree in education with STEM as a concentration for 15 credits (Johns Hopkins University, 2010). Massachusetts Institute of Technology (MIT) has collaborated with a non-profit organization, "For Inspiration and Recognition of Science and Technology" (FIRST), Ally, to build interest in STEM-related education by innovation (Aronowitz, 2010). MIT is also tapping into its Alumni Association to promote an interest in science and technology as an integrated STEM initiative.

Summary

If one peruses the literature outlined in this chapter it is apparent that there is a strong correlation between CTE, Mathematics, and Science. Data indicate that there is a correlation between enrollment in CTE classes and higher mathematics scores at the high school level. The purpose of this research is to investigate whether students who have an aptitude for mathematics and science enroll for CTE courses at the middle school level. This information would be useful to educational planners at both Federal and State levels

and would be a basis for improving the Science, Technology, Engineering, and Mathematics (STEM) focus to compete with the ever-changing global environment (Rapp, 2010).

Chapter III will cover Methods and Procedures in which the researcher will describe methods that will be used to collect and analyze data on student scores in mathematics and science courses with respect to them being enrolled or not enrolled in technology education courses.

CHAPTER III

METHODS AND PROCEDURES

The purpose of this study was to determine if middle school students who are proficient in mathematics and science elect to enroll for technology education. This chapter identifies methods and procedures used to collect and analyze data for this study. The researcher will also identify the population used for the study, the research variables, design of instruments, and statistical analysis.

Population

The population for this study was all 254 students who were in the technology education class in the school year 2009-2010 at Lanier Middle School in Virginia.

Research Variables

The independent variable in this study was enrollment of students in the Technology Education 7/8 course in the school year 2009-2010. This is the experimental group.

The dependent variables are the scores in mathematics of the entire school in the 7^{th} and 8^{th} grade mathematics curriculum during the school year 2009-2010, and the scores in science of the entire school in the 7^{th} and 8^{th} grade science curriculum during the school year 2009-2010.

Method of Data Collection

The researcher used existing data from the Lanier Middle School database to filter out students enrolled in technology education in the second semester 2009-2010. The same database was used to determine their 2009-2010 grades in their mathematics and science classes. These data were compared with the mathematics and science scores of all

other students in the database who were not enrolled in technology education to determine if there was a level of significance between the two sets of data in science and mathematics performance. .

Statistical Analysis

The data gathered was analyzed using a t-test to determine whether there was significance between the two sets of data. After determining the value of t, the level of significance was found which helped to accept or reject the hypotheses and draw conclusions.

Summary

This chapter outlined the methods and procedures used to collect data for this study. The experimental group included the entire roster of 254 students who were enrolled in the technology education course Technology Explorations 7/8 during the school year 2009-2010 at Lanier Middle School. Research variables, instrument design, methods of data collection, and statistical analysis were covered in this chapter. Since the format of the data was different from what was required to perform numerical analysis, and also since just mathematics and science scores were required, the researcher used the spreadsheet Microsoft Excel to filter, sort, and tabulate the 2009-2010 scores of students in mathematics and science for the seventh and eighth grade classes at Lanier Middle School, separately for students who had enrolled in technology education classes and those who had not. Chapter IV will cover Findings, which will be the results of analysis of data.

CHAPTER IV

FINDINGS

The purpose of this study was to compare seventh and eighth grade students at Lanier Middle School who enrolled for Technology Education, and those who did not, to ascertain whether this enrollment had a significant difference in their mathematics and science proficiency. The purpose of this chapter was to report the findings from the school database (school year 2009-10) provided by the Director of Student Services at Lanier Middle School. A summary of the findings is presented at the end of this chapter.

Report of Findings – Mathematics

Data from the school database were used for this research. The total population of students who enrolled in technology education classes in the seventh and eighth grades at Lanier Middle School in the school year 2009-10 was 254 (N1m). Of these students 194 (76.4%) students received a grade higher than a "C+" in mathematics (Table 1) and the balance 60 (23.6%) students received grades of "C+" or below in mathematics. In case of the students who did not enroll in technology education classes, the total number of students was 913 (N2m). Out of these students 640 students (70.1%) received a grade higher than a C+ in mathematics and the balance 273 (29.9%) students received grades of "C+" or below in mathematics.

A t-test was carried out for comparing technology education students and non-technology education students' mathematics scores, t_m. The mathematics grades of students in each category were averaged and the mean grades were 85.2 (M1m) and 84.5 (M2m) respectively. The t value, t_m, for a one-tailed test was found to be 1.088 at 1165 degrees of freedom. The level of significance at $p > 0.05$ was 1.645.

Table 1

Student Totals for Level of Proficiency Achieved in Mathematics

PROFICIENCY LEVEL ACHIEVED IN MATHEMATICS	STUDENTS ENROLLED IN TECH. ED.	STUDENTS NOT ENROLLED IN TECH. ED.
SCORED GRADES HIGHER THAN "C+"	194	640
SCORED GRADES OF "C+" OR BELOW	60	273
TOTAL STUDENTS	254 (N1m)	913 (N2m)

Report of Findings - Science

Data from the school database were used for this research. The total population of students who enrolled in technology education classes in the seventh and eighth grades at Lanier Middle School in the school year 2009-10 was 254 (N1s). Of these students 206 (81.1%) students received a grade higher than a "C+" in science (Table 2) and the balance 48 (18.9%) students received grades of "C+" or below in science. In case of the students who did not enroll in technology education classes, the total number of students was 886 (N2s). Out of these students 696 students (78.6%) received a grade higher than a C+ in science and the balance 190 (21.4%) students received grades of "C+" or below in science.

A t-test was carried out for comparing technology education students and non-technology education students' science scores, t_s. The science grades of students in each

category were averaged and the mean grades were 86.02 (M1s) and 85.56 (M2s) respectively. The t value, t_s, for a one-tailed test was found to be 0.791 at 1138 degrees of freedom. The level of significance at $p > 0.05$ was 1.645.

Table 2

Student Totals for Level of Proficiency Achieved in Science

PROFICIENCY LEVEL ACHIEVED IN SCIENCE	STUDENTS ENROLLED IN TECH. ED.	STUDENTS NOT ENROLLED IN TECH. ED.
SCORED GRADES HIGHER THAN "C+"	206	696
SCORED GRADES OF "C+" OR BELOW	48	190
TOTAL STUDENTS	254 (N1s)	886 (N2s)

Summary

In this chapter, the researcher collected data from the school database which contained grades of all students for all subjects in the school year 2009-2010. Data were processed using a one-tailed t-test to compare findings. Chapter V will provide a summary of the research, draw conclusions to answer research goals based on data collected and the statistical analysis, and make recommendations for future studies.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this chapter was to provide a summary of the research carried out. The conclusions and the recommendations provided in this chapter were based on the information collected and analyzed by the researcher of this study.

Summary

The technology education curriculum in Virginia has evolved from being a workshop class to one where students are able to reinforce their mathematics and science concepts with hands-on projects to support the theoretical background in the core classes with application and experimental based learning. These ideas have been researched in the past, and students who have taken technology education classes improve their mathematics performance (Bettersworth et al., 2008). The purpose of this research was to determine whether this is true, that whether students who enroll for technology education classes are already more proficient in mathematics and science.

This purpose was translated to defining the problem of this study, which was to determine if a relationship exists between 7^{th} and 8^{th} grade students choosing to enroll in technology education as an elective is based on their proficiency in mathematics and science subjects and accordingly hypotheses were formulated. The hypotheses in this study stated that seventh and eighth grade students who had elected to take technology education as an elective course earn higher grades in the core subjects of mathematics and science. If these hypotheses were shown to be true, then it would change the entire premise of earlier studies which assumed that students started off with the same abilities. It was also reasoned that this study was needed to determine whether students who had

sufficient aptitude and a home/environment culture that enabled them to succeed in mathematics and science subjects at the middle school level and would be more likely to enroll in technology education in middle school. An extension of this reasoning would be that student enrollment in high school would follow the same pattern.

The limitations of this research were that the study was limited to 7^{th} and 8^{th} grade students at Lanier Middle School, Fairfax, Virginia. Other schools may have different population demographics and different teaching styles of mathematics, science, and technology teachers. Schools in states outside the state of Virginia may have different technology education curricula from that in Virginia which has a very high number of modular multi-discipline technology classrooms where the curriculum supports the mathematics and science Virginia Standards of Learning (SOLs). In such a case this research may not be applicable to middle schools in other states. Some schools in Virginia, and in other states as well, have technology education as a mandatory elective in middle school and in such cases this research would not be applicable.

Conclusions

Following are this study's conclusions based upon the hypotheses and findings:

Hypothesis H_1 stated that seventh and eighth grade students who had elected to take technology education as an elective course earned higher grades in mathematics. This hypothesis was tested with a t-test and found the resulting value to be 1.088. The level of significance at $p > 0.05$ was 1.645. Since t_m was smaller than the level of significance (critical t-value) at the $p > 0.05$ level, the researcher observed that there was no significant difference between students' proficiency in mathematics whether they enrolled in technology education or not. In conclusion the researcher rejected hypothesis

H_1 that seventh and eighth grade students who had elected to take technology education as an elective course earned higher grades in mathematics, since the results of the study did not support this hypothesis.

Hypothesis H_2 stated that seventh and eighth grade students who had elected to take technology education as an elective course earned higher grades in science. This hypothesis was tested with a t-test and found the resulting value to be 0.791. The level of significance at $p > 0.05$ was 1.645. Since t_s was smaller than the level of significance (critical t-value) at the $p > 0.05$ level, the researcher observed that there was no significant difference between students' proficiency in science whether they enrolled in technology education or not. In conclusion the researcher rejected hypothesis H_2 that seventh and eighth grade students who had elected to take technology education as an elective course earned higher grades in science, since the results of the study did not support this hypothesis.

This study was not influenced by aptitude of individual students nor the differences in the students' environment because all students in the school were included by the research. The results of the study thus rejected both hypotheses and it would now be assumed that proficiency in the core subjects of mathematics and science is not a significant factor that motivates students to enroll for technology education classes. However research conducted by the Texas board of Education study (Bettersworth et al., 2008) concluded that enrollment in technology education classes improves mathematics performance. This is very positive for technology education at least for its influence on mathematics performance. Rejection of hypotheses in this study taken along with the results of the Texas study would indicate that although students of varied proficiency in

mathematics enroll for technology education and their proficiency in mathematics increases after they complete technology education classes.

Recommendations

Based on the findings and conclusions of this study, the researcher recommended the following for future studies:

1. This study might have been modified to compare enrollment in technology education classes in the eighth grade with proficiency in mathematics and science in the seventh grade.

2. A study may be conducted to determine whether the percentage of students who score grades above a "C+" in all core subjects in the seventh grade improves in the eighth grade if they enroll in technology education classes in the seventh grade.

REFERENCES

Armstrong. T. (1994). *Multiple Intelligences in the classroom.* Alexandria, VA: Association for Supervision and Curriculum Development (ASCD)

Aronowitz, S. (2010) *International Journal of learning and media.* Retrieved from http://thejournal.com/Articles/2010/01/05/MIT-and-FIRST-Ally-To-Encourage-STEM-Education-Careers.aspx?p=1

Bettersworth et al. (2008). Recommendations of Career and Technical Education Review Panel. State Board of Education. Retrieved March 22, 2010 from http://ritter.tea.state.tx.us/teks/cte/CTEReviewPanelRecs.pdf

Clark, H. D. & Flood, L. (2010). Connecting with parents of young children. *Virginia Journal of Education*, *103*, 22-23.

Evans, J. H. & Burck, H. D. (1992). The Effects of Career Education Interventions on Academic Achievement: A Meta-Analysis. Journal of Counseling and Development, September/October 92, 71, 63-68. Retrieved from http://www.psca-web.org/Resources/Jay%20Carey/EvansandBurck.

Fraenkel, J. R., & Wallen, N. E. (2000). The Nature of Educational Research, *How to Design & Evaluate Research in Education* (4th Ed.). (pp 4-13). San Francisco: McGraw-Hill Companies, Inc.

Frankenbery, M., Holland, A., Delaney, M., & Baker, A. (2009-2010). Pitsco Education Algebra. *The Pitsco Network*, *11*, 16-21.

Johns Hopkins University. (2010). Retrieved from http://education.jhu.edu/teacher/msed/stem/

McCuen, R. H. & Greenberg, J. (2009, July). Educating Guidance Counselors on Engineering as a Career and Academic Choice. *Journal of professional Issues in*

Engineering issues and practice. *135*, 91-94.

Rapp, D. (2010, March/April). Redesigning STEM, *Scholastic Administrator*, *9*, 33-36.

Ross, P. J. (1989). *Taguchi Techniques for Quality Engineering.* Singapore: McGraw Hill.

Sanders, M (2006). Integrative STEM Education at Virginia Tech, retrieved from http://teched.vt.edu/TE/STEM.html

Shafer, L. (2004, February). Issue Brief. *National Center for Educational Statistics, 018*, 1-3.

STEM education coalition. (2008). Retrieved from http://www.stemedcoalition.org/

Suzaki, K. (1987). *The New Manufacturing Challenge.* New York: Macmillan, Inc.