The Rural Educator

Volume 30 | Number 1 Article 6

11-15-2008

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Recommended Citation

Anderson, S. (2008). Rural Research Brief: Math Infusion in Agricultural Education and Career and Technical Education in Rural Schools. *The Rural Educator, 30*(1), 1-4. DOI: https://doi.org/10.35608/ruraled.v30i1.455

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Math Infusion in Agricultural Education and Career and Technical Education in Rural Schools

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Historically, rural schools and the educational opportunities that they offer have been viewed as inferior to that of the urban and suburban counterparts (Howley & Gunn, 2003). It is no surprise that rural education faces its own set of challenges meeting the demands of educational legislation. Small populations and geographical isolation are major factors school administrators must face in order to offer a high quality education to its students (Reeves, 2003). Rural education also offers many advantages that most urban and suburban schools are not able to utilize, their agricultural education program.

Formal agricultural education started in America when the Smith-Hughes Act legislation passed in 1917. This legislation put agriculture in the secondary education classroom to prepare students for the workforce. From that point agricultural education has had its role in the formal education system. In 1998, the federal government passed the Carl D. Perkins Federal Vocational and Technical Education Act. This legislation increased the amount of money for Career and Technical Education (CTE). Because more vocational jobs are requiring postsecondary degrees academic-vocational integration is now more significant. Agricultural educators are preparing their students for future careers as biologists, business and industry leaders, political officials, and many other advanced careers.

Agriculture allows for the opportunity to make science and mathematics both real and relevant to the student. Science and mathematics in agriculture is not a new development. John Hillison (1996) stated that the scientific revolution in American agriculture occurred in the late 1800s because farmers demanded more scientific research, which led to the passage of the Hatch Act in 1887. This legislation paved the way for agricultural experimentation, scientific research, and the cooperative extension service. Agriculture is an applied science and applied mathematics, why are we just now concerned with incorporating science and math into career and technical education?

There have been many steps that have led up to the infusion of academics and CTE. The 1990 amendment to the Carl D. Perkins Vocational Education Act of 1984 provided funds to integrate academic and vocational education (Powell, Agnew, & McJunklin, 2005/2006). This amendment gave more money to schools who were integrating the curriculum. Infusing academic learning standards into CTE will help strengthen the entire academic curriculum. "All students need an understanding of basic science concepts. Teaching science through agriculture would incorporate more agriculture into the curricula, while more effectively teaching science" (National Research Council, 1988). Also, 39% of high school seniors are not performing at a basic level in mathematics (National Council of Teachers of Mathematics, 2000). Thus, there is a need for science and mathematics enhanced CTE curriculum.

We as educators want all students to have an understanding of basic academic skills. The reason we teach the basic skills is students can transfer that knowledge to new situations (Powell, Agnew, & McJunklin, 2005/2006). A successful student will be able to transfer that knowledge to a new situation, thus this successful student becomes a productive member of society.

With the No Child Left Behind legislation, current CTE programs are at risk. Students must achieve in proficiency in nine subgroups (Daggert, 2003). If CTE cannot adapt to the standards of NCLB, there may not be viable option. If CTE starts to decrease in numbers, school administrators may not see the importance of vocational education and cut programs. CTE must adapt to the changes in our education system in order to survive.

Because of legislation like No Child Left Behind, the reauthorization of Perkins funding; career and technical education has a questionable role in our educational system (Stone, Alfeld, Pearson, Lewis, & Jensen, 2005). With that in mind, the purpose of this study is to examine the literature surrounding academic achievement in regards to contextual learning and address CTE as a context for learning mathematics. Agricultural Education and CTE as a context for learning mathematics will lead to gains in student achievement. This hypothetical statement has led to a new strand of empirical research that greatly affects rural school districts.

According to the Nation's Report Card issued by the National Assessment of Educational Progress (Grigg, Donahue, & Dion, 2007), 39% of 12th grade students are not performing at a basic level in mathematics and less than one quarter of the students are placing at a proficient level. These statistics raise the question why high school seniors are not performing well in mathematics. Many high school students complete their required mathematics courses early in their high school careers, thus not receiving instruction in mathematics the last two years of school before entering college or the workforce (Stone, Alfeld, Pearson, Lewis, & Jensen, 2005). This gap in instruction can be a cause in the low performance on standardized tests. This gap can be closed by infusing mathematics into career and technical education. 11th and 12th grade students who have already completed the required math courses can continue to receive math instruction.

The National Council of Teachers of mathematics developed six principles for school mathematics; equity, curriculum, teaching, learning, and assessment (2000). Looking further into two of the principles, equity and learning we can see a role for contextual learning. The principle of equity states that all students are capable of learning mathematics when they have the access to high-quality mathematics instruction. Also, the council's research has shown the importance of contextual knowledge in understanding mathematics (National Council of Teachers of Mathematics, 2000). This leads us to teaching mathematics in a contextual environment, using real-life applications.

Gutiérrez examined the importance of teaching mathematics in context, she states that all good teachers focus on context. Students need to be able to see themselves as part of the curriculum as well as the curriculum being part of a larger picture (Gutiérrez, 2007). Contextual learning methods can give students a perspective of how math works in the "real world." These real world applications have many student benefits; students know how to execute a mathematical theory, students know why the theory works, and they know where the theory works (Shinn, et al., 2003).

"Contextual relationships have the potential to strengthen links among learning environments of school, home, and informal settings and add meaning to mathematical knowledge for students" (Shinn, et al., 2003, p. 22). In the pilot study of math-enhanced CTE project, students outperformed their counterparts that did not receive the contextual style model on mathematics standardized tests (Stone, Alfeld, Pearson, Lewis, & Jensen, 2005). Additional studies have shown that generalizable mathematics skills instruction in CTE has shown an increase in mathematics academic achievement (Wu, 2003). Thus, this study can begin to assume that contextual teaching methods will lead to gains in student success.

Nearly every high school student enrolls in at least one CTE course, 43% of all students enroll in at least three specific labor market preparation classes (Silverberg, Warner, Fong, & Goodwin, 2004). SLMP courses are the specialized courses within each career cluster. With access to such a large percentage of students, CTE is a viable option for learning mathematics within a specific context. Stone, et al. (2005) purpose that CTE can use the mathematics that is already inherent in the curriculum to provide a context for mathematics theory.

Research conducted by Stone (2005) at the National Research Center for Career and Technical Education (NRCCTE) proposed a model for mathematics infusion in CTE. This model allows for a guideline for CTE teachers to use the implicit mathematics already present in the curriculum in an explicit manner. This proposed model allows a learner to see where the math is located in the "real world" then follows the example using mathematics terminology and methods. The research conducted by Stone and his colleagues (2005), used teams of mathematics teachers and CTE instructors to develop math infused CTE curriculum.

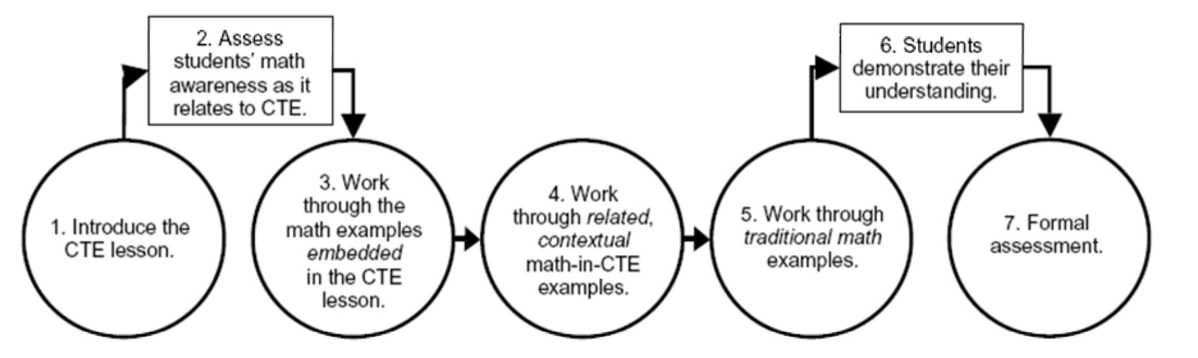

Figure 1. NRCCTE Proposed Model for Mathematics Infusion in CTE

Before the infusion of mathematics and CTE can take place, the CTE teacher must want to and be able to do the mathematics. In a research study conducted in Virginia, agricultural educators indicated that mathematics was a component of the agriculture curriculum and they believed that math instruction in agricultural education would lead to higher academic achievement (Anderson, 2006). However, as teachers are aware of the benefits of mathematics instruction in CTE, they are not adequately trained in mathematics education and therefore the explicit mathematics rarely makes it to the forefront (Stone, Alfeld, Pearson, Lewis, & Jensen, 2005). This leads to the need for professional development in mathematics instruction for the CTE teacher. However, research has shown that in order to change classroom culture and behavior, deep and sustained professional development is needed (Supovitz & Turner, 2000). To adequately develop a math infused CTE curriculum will take a lot of time and money to implement.

Conclusions

The increased pressure for gains in academic performance in mathematics and science are not going to dissipate and rural schools must find a way to meet these challenges. NCLB and Perkins legislations have also put pressure on career and technical education to increase academic standards in CTE curriculum. Infusing mathematics into the curriculum will give students a chance to see the mathematics in a real-world context. The model of infusion proposed by the NRCCTE has given a viable option to aid in teaching mathematics in context. Further research is needed in order to guide us to the best model of mathematics infusion. The NRCCTE model should be tested across more CTE curriculums to determine if can be implemented nationally. Also, more research is needed on the professional development that CTE and mathematics teachers receive in order to determine its effectiveness. Most of the research in mathematics infusion has taken place with in-service teachers. Mathematics infusion needs to start with the pre-service teachers. An analysis of teacher preparation programs can determine if future CTE instructors are receiving adequate mathematics and science courses to be able to proficiently infuse those academics into the curriculum.

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