Using Technology Enabled Career-Technical Education to Enhance American Education

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Abstract – **Recent data has determined that American teenagers have been performing at stagnant levels for decades. Comparative analyses of education systems around the world determine that the absence of educational improvements are due to a lack of demand to learn. This study determines that career-focused education and personalized learning are two major factors that contribute to the academic successes of top education systems. Career-technical education (CTE) has shown to improve student engagement in secondary and post-secondary education. Furthermore, research supports that career-technical education is most effective in middle school, an optimal time for career exploration with less of an emphasis on core academic courses than high school. Barriers to CTE implementation in middle school include a lack of career counseling and funding. This paper explores an approach that allows CTE to reach more students in the American education system by using technology-enhanced learning to alleviate such barriers. Personalized e-learning allows for student choice, maximizing learning effectiveness and improving motivation to learn. This study concludes the merits of such an approach to enhance the American education system.**

Key Words – Career-technical education, technology-enhanced learning, secondary education, personalized learning, academic engagement

INTRODUCTION

I. Background

Around 100 years ago, American education took an almost unprecedented leap forward by making high school secondary education compulsory, driving much of America's economic boom for the last 100 years [1]. However, as the U.S. News reports in 2018, "At no level – early childhood, K-12, higher ed – are we [American education] even in the top 10 internationally... It is scary and it does not bode well for the future" [1]. Innovative leaps forward in American education have not been taken in recent decades, as the Program for International Student Assessment announced in 2019 that American teenagers have been performing at stagnant levels since 2000 [2, 3]. With education being essential to acquiring knowledge, maintaining society, stimulating the economy, and developing human virtue [4], such evidence of lack of improvements in the American education system in decades prompts a need for change.

II. Comparative Analysis

One of the best ways to improve a system is to learn from mistakes and successes of education systems from all over the world. However, as the United States is a heterogeneous society of many students with diverse backgrounds, comparisons to other countries with homogenous societies will have limitations. Limitations that could impact the comparability between countries include language barriers and cultural differences among the United States' large immigrant population [5]. This study acknowledges these limitations while focusing on data-backed objective comparisons to propose approaches for improvements to the American education system.

Comparative analyses between American and other international education systems demonstrate a lack of efficiency in areas of American education. Stephen P. Heyneman summarizes data of over 60 countries from the OECD's study called the "Programme for International Student Assessment" (PISA), which shows that American schools devote around 3 and 5 more hours/week to core academic subjects than Northern European countries, yet students from those countries have higher PISA achievement scores than American students [5]. Heyneman concludes that such inefficiency in American education compared to other countries results from a lack of a 'demand to learn.' Heyneman defines 'demand to learn' as a "culturally-shaped attitude or disposition that places the value of education higher or lower on a scale of socially desirable activities" [5]. Adopting the best practices across the globe to increase student motivation and demand to learn is essential. Conducting a deeper comparative analysis between education systems further unveils the causes for this lack of demand to learn and outputs several markers for improvement of the American education system. This paper chooses to analyze education systems in Singapore and Northern Europe for their similar standards of living to the United States and their high international rankings.

Ranking as best in the world according to OECD in 2015 and as first for primary and secondary levels in PISA scores from OECD's 2019 data, Singapore's students are achieving undeniably high academic results [6]. Analyzing

the top reasons for Singapore's success reveals that a curriculum focused on practical knowledge, real-world skills, and personalized learning pathways are large contributors to Singapore's high rankings on PISA studies [7].

Singapore dedicates a top reason for their education system's success to a curriculum focused on problem-solving and real-world applications [7]. Singapore's curriculum equips students for practical knowledge in specific real-world subjects and careers, which surveys and studies have shown American education lacking in. In a survey conducted by The New York Times, students reported that the American secondary education system should better prepare students for real life. Bella Perrotta from Kent Roosevelt High School states, "I am frustrated about what I'm supposed to learn in school. Most of the time, I feel like what I'm learning will not help me in life" [8]. Skye Williams from Florida summarizes the issues to address in American education in her statement: "I think that the American education system can be improved by allowing students to choose the classes that they wish to take or classes that are beneficial for their future" [8]. Results from a poll of ninth and tenth graders in California found more than 90% of respondents stated that they would be more motivated to learn and more engaged in their education if skills and knowledge relevant to future careers were a focus in their classes [9].

Singapore's education system provides students with options for different learning pathways, depending on their preferences and learning profiles. After course exploration in primary and secondary school, students choose between two vocational pathways from Polytechnics and Junior Colleges that can both lead to University [10]. These personalized pathways originated from the belief that every student learns differently with different career interests and at different paces. Implementing elements of Singapore's personalized learning pathways in American education can enhance students' learning experiences, as such a model of learning has produced high academic performance and demand to learn.

Beyond Singapore, Northern European education systems also demonstrate success from personalized pathways. Compared to American teenagers, Northern European teenagers are 10+ percent more likely to graduate from secondary school. John H. Bishop from Cornell University lists the number one key for Northern European success as "Parents/students decide which program of study to enter." [11]. Mike Anderson analyzes the benefits of personalization and student choice in education, finding that student choice through personalization can provide a solution to Heyneman's top reason for inefficiency in American education: a lack of demand to learn. Personalization allows students to be active participants in their education and learn in the zone of proximal development in subjects they're motivated to pursue, leading to high student engagement [12]. Additional research demonstrates that student choice and personalized learning will lead to improved academic performance on tests such as the PISA achievement test, concluding that, "students who were given a choice in their learning and whose instruction met their learning needs showed significant improvement on standardized tests" [13].

Nations such as Singapore and those in Northern Europe address student motivation to learn through curriculums focused on career-relevant, practical knowledge and personalized vocational learning pathways.

III.   Purpose Statement

Based on the comparative analysis on Singapore and Northern Europe's successes, this paper will explore approaches to increase student engagement and demand to learn in American education through career-relevant, practical learning, technology-enhanced learning, and personalization of learning pathways.

VALUE OF CAREER-TECHNICAL EDUCATION

Engagement with school declined approximately 20% between elementary school and middle school from nearly 80% to 60%, with a further decline to only 44% engagement in high school [14]. In comparison, students in secondary education with greater exposure to career planning and career exploration were found more likely to be engaged in their education [15]. Career-technical education (CTE) is the pathway to career-relevant planning and exploration to increase demand to learn in American education and fulfill students' requests for classes that prepare them for real-world careers. CTE is the practice of teaching specific career skills to students, including business, finance, information technology, law, arts, training, and more [16].

As evidence of the benefits of practical-centric learning and career-technical education, data from 2019 shows that 95% of CTE students graduate high school. This is compared to the national average graduation rate of only 85% [17]. Increasing high school graduation rates enables more students to follow a path to success while strengthening the American economy [18]. With better graduation rates also comes higher student satisfaction with education, as "80% of all CTE students say they're satisfied with their education and the career prospects that come with it," which is almost twice as many students in proportion as the 45% of students satisfied with traditional education [19]. The impact of CTE courses also extends beyond secondary education to the workforce and the long-term benefits of successful education. As labor force data of public high school graduates from 2013 in Figure 1 depicts, a 12% lower unemployment rate is demonstrated from those with 3.00 or more CTE credits compared to those with 0.00-0.99 CTE credits.

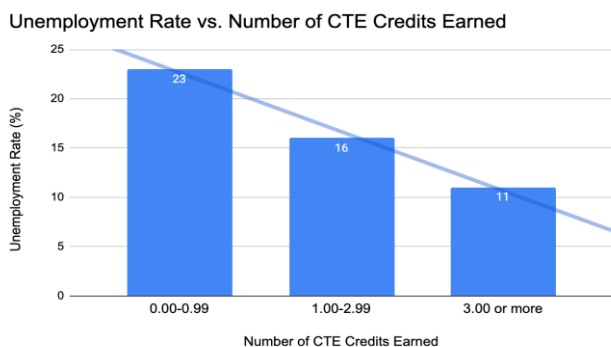Unemployment Rate vs. Number of CTE Credits Earned

FIGURE 1: Labor force data from public high school graduates from 2013 by percentage unemployment rate vs. the number of CTE credits earned. Raw Data Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:2009), Base-year, 2013 Update, Second Follow-up, and High School Transcript File.

Maximizing CTE's impact addresses the concerns raised by research studies and surveys depicting low student motivation and a lack of real-world preparation in American education [8, 9].

DATA: CASE STUDY WITH CTE

This study uses data from Michigan's Department of Education and the 100,000+ students that participate in Michigan's CTE programs each year to further analyze the benefits of CTE with a real-world case study [20]. The data in Table 1 showcases that students enrolled in CTE programs demonstrate performance that exceeds state targets in technical skills, school completion, graduation rate, and placement rate. This data further validates the potential of CTE programs to improve secondary education.

TABLE 1: Performance indicators from students in Michigan's CTE program. Raw Data Source: Michigan Department of Education, "MI CTE Reports." Cteis.Com, 2020, reports.cteis.com/.

Performance Indicator	Performance	Relation to State Target
Technical Skills	63.53%	Exceeds Target
School Completion	98.44%	Exceeds Target
Graduation Rate	96.61%	Exceeds Target
Placement Rate	96.36%	Exceeds Target

However, enrollment in CTE in America is still minimal and currently declining, with less than 3 CTE credits earned by students in their 4 years of high school education,

as Figure 2 illustrates. This paper therefore explores an approach to maximizing CTE's demonstrated benefits.
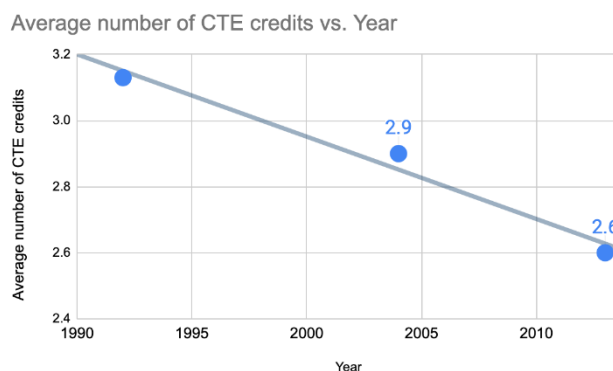

Average number of CTE credits vs. Year

FIGURE 2: Average number of career and technical education (CTE) credits by year earned. Raw Data Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Education Longitudinal Study of 1988, 2002, 2009, 2013 (NELS:88)

APPROACH: CTE IN MIDDLE SCHOOL

While CTE in high school has demonstrated benefits in graduation rates, student motivation, and employment rates, research has shown that students benefit most from career exploration in middle school — learning about potential careers, building self-awareness, and developing a plan for reaching future goals [21]. Career-technical education is the most effective to middle-school students, whose brains are receptive to training employability skills: critical thinking, adaptability, problem-solving, oral and written communications, collaboration, creativity, responsibility, professionalism, ethics, and technology use [21, 22]. As these employability skills are reported to be critical to the workforce as well as postsecondary success, middle school is a pivotal time for college and career readiness [23]. Expanding CTE courses in middle schools allows students to explore career options and determine their subjects of interest before high school. CTE in middle school can effectively prevent dropouts and increase student motivation, serving "as a key dropout prevention strategy, mitigating many of the challenges students face as they transition into high school, such as disengagement or lack of preparation" [24]. Implementing career-technical education to middle schools across the United States increases students' demand to learn from an early age to carry on to later stages of education in high school and postsecondary engagements.

Emphasis on core academic courses, especially in high school when these core academic courses are considered essential for college preparation, has limited accessibility to CTE [23]. Misconceptions about CTE courses and college-preparatory options have made the implementation or expansion of CTE difficult for many schools. Research conducted in Mississippi school districts concerning the

perception of CTE by students and educators indicates 55% of the 403 Mississippi residents interviewed believed that students enrolled in CTE courses could not receive college-preparatory diplomas [25]. Although CTE courses have demonstrated excellent results in terms of college preparation and high school graduation, and aid students in applying their core academic knowledge to real-world skills [18], the disconnect between CTE courses in high school and college-preparatory education prevents CTE from reaching its potential.

Analysis of the average number of credits earned by curricular areas (core academics vs. CTE) demonstrates that while credits earned in core academic courses have been increasing, credits earned in CTE courses are declining (see Figure 3.) The disconnect between college preparation and CTE and the emphasis on core academic courses has limited career-technical education's impact on the education system and its students.

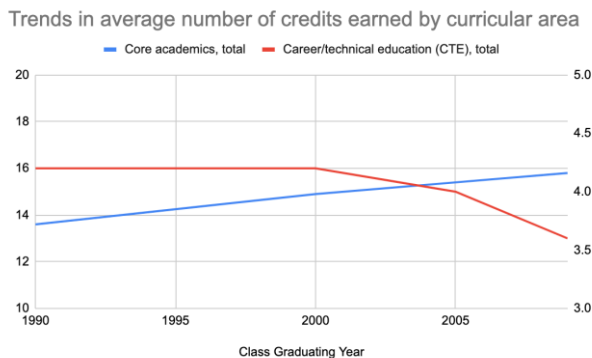Trends in average number of credits earned by curricular area

FIGURE 3: Average number of credits earned by 1990, 2000, 2005, and 2009 public high school graduates during high school, by curricular area (total core academics compared to CTE). Raw Data Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 1990, 2000, 2005, and 2009.

Implementing CTE in middle school diminishes the barrier from the emphasis of core academic courses since the courses students take in high school impact their college admissions, whereas middle school has a lower workload and academic pressure in comparison. Having CTE courses in middle school is the best time to build a foundation for students' communication, time-management, problem-solving, critical thinking, and work-related skills critical for success in later secondary education and post-secondary careers [23].

APPROACH: CTE WITH TECHNOLOGY-ENHANCED LEARNING

There are 2 major barriers to implementing CTE in secondary schools: a lack of school counselors, and a lack of funding [23]. Research studies validate an approach using technology-enhanced learning to lower these barriers.

I. Career Counseling

Counselors and other career development professionals are instrumental in assisting students with self-exploration, future planning, career exploration, and work-based learning in classrooms [23]. Career guidance is critical as students who participate in such guidance demonstrate better grades, greater knowledge of jobs, higher self-esteem, and more engagement in career and academic planning [23]. However, a lack of awareness or access to market data and other relevant information on career pathways by many career counselors limits student exposure to career pathways to their own direct experience [24].

Although the current use of online tools and other technologies cannot replace school counselors, scalable technologies such as Career Cruising, the DISCOVER program, and the CHOICES program can decrease counselors' burdens while guiding students' decisions about their future course-taking and potential careers [21, 23]. Career Cruising, an online future planning and exploration program, is already being put to use in Wisconsin's school districts for self-exploration, creating online portfolios, discovering potential interests, skills, interests, abilities, and jobs [23]. A study conducted with a similar interactive program, DISCOVER, which has vocational self-assessments and an abundance of occupational information, found that middle-school students who worked with DISCOVER for one hour a day over a two-week period revealed significant gains in career maturity [21]. Additional programs such as MAPP, the Life Values Self-Assessment Test (LVAT), and CareerOneStop can all aid in career counseling through online self-assessments and information on planning for future-readiness. Many such programs are certified with validity studies on their accuracy and also provide free guidance to counter issues with funding for career counseling [26]. The occupational information and scalable career-interest assessments provided in these programs alleviate the barriers of lack of access, awareness, and training to market data or career pathways from school counselors.

II. Funding for CTE

Educational funding is a major factor of student success as it enables acquisition of required materials, services, and administrative support. Financial challenges to implementing CTE in middle school prevent it from maximizing its impact. Although the Carl D. Perkins Career and Technical Education Act supports career exploration in middle school, Perkins funding for states is decreasing with current funds at about $150 million less than the Fiscal Year 2010 levels, indicating a lack of adequate funding for new and developed CTE programs.

Alleviating budgetary limitations to CTE is possible through education technology by reducing reliance on manual resources, being flexible and scalable, and by improving course management efficiency. Curriculum

redesigns with technology-enhanced learning in the U.S. evidenced average savings of 31% with reduced course delivery costs [27]. Cost savings from the technology redesign did not sacrifice quality — student outcomes improved, with 72% of projects delivered by students showcasing higher quality [27]. Advance CTE presents the use of technology as one of five core strategies for expanding CTE, with online and virtual courses to be leveraged to reach economies of scale across vast geographic regions [28]. Quality-controlled virtual courses can reduce material, classroom, and staff costs to bring CTE to students across the United States.

APPROACH: PERSONALIZED E-LEARNING

By enabling career exploration in middle school, students will be more informed on their subject and career interests to make decisions on personalized learning pathways in high school. As research into student choice, as well as successes in Singapore and Northern Europe reveal, personalized learning is a key strategy for improving students' demand to learn and their academic results. Case studies on using technology to create personalized learning plans have found average increases of 30% in student achievement and test scores [29].

Virtual learning environments provided by technologies such as Brightspace create personalized learning plans and content (videos, e-portfolios, documents) to suit the individual learner's needs. By presenting students with their own engagement data, Brightspace increased 81% of its learners' study times [27].

Furthermore, with the possibilities of technology ever-growing, personalized adaptive learning through machine learning can boost academic engagement and results by synthesizing large amounts of data to produce fully student-centered learning [30]. Using technology to bring personalized learning combined with career exploration throughout secondary education addresses the lack of demand to learn in American education and improves students' satisfaction with their learning.

LIMITATIONS

New research points to possible limitations of the long-term benefits of CTE, finding that employment advantages provided by vocational training are limited to the start of the career and diminish with age [31]. Rapidly changing economics and required skill sets demonstrate the necessity for more research into improving CTE programs to be more adaptable and thus provide life-long employment advantages.

A limitation of this study is its narrowed focus on exposure to CTE in secondary education without accounting for variations in quality of CTE across programs. Additional research into the characteristics of high-quality CTE programs is necessary to understand the other possible benefits of CTE and recommend the best practices across different programs. Furthermore, this study did not differentiate between the effectiveness of different methods of student access to CTE: public schools, private schools, shared-time CTE schools, and full-time CTE schools. More longitudinal data studies and analyses of student performance and workforce data will broaden the scope of studies on the American education system in relation to CTE.

CONCLUSION

The findings from this research paper reveal the merits of an approach to elevating the American education system through technology-enabled career-technical education in secondary education. The comparative analyses between international and American education systems demonstrated the validity of improving demand to learn through education on career-relevant, practical knowledge, and personalized learning. CTE has proven benefits for graduation rates, student satisfaction of learning, the workforce, and the American economy. An optimal approach is to implement CTE throughout secondary education, including and emphasizing its implementation in middle school. In addition to evidence that middle school is the best and most impactful time for career-relevant exploration, implementing CTE in middle school alleviates the barriers that come with the emphasis on core academic courses in high school.

Technology-enabled learning can further reduce the barriers that prevent CTE in middle school from maximizing its impact: a lack of resources for career counseling and funding for schools. Computer-assisted career guidance resources such as Career Cruising, DISCOVER, and CHOICES improve counseling scalability and have proven benefits for career exploration as well as students' career maturity. Additionally, technology-enhanced learning provides counselors with self-assessment tools such as MAPP and the Life Values Self-Assessment Test to make accurate interest and career assessments accessible to students. Flexible and scalable in nature, technology-enhanced learning can address concerns with funding by reducing reliance on manual resources and improving course management efficiency. Results from curriculum redesigns with technology-enhanced learning have demonstrated that technology can reduce costs while improving the quality of education.

Personalized learning through technology has vast opportunities and many potential benefits. By increasing student choice and thereby improving student engagement, personalized learning makes education more efficient and effective. Acknowledging the possibilities of machine learning to further individualize education leaves additional research into this area a worthy topic for improving education.

Further research can study the possible effects of career-technical education and personalization on students' mental health. By enabling students to discover career goals and study subjects they are interested in, personalized CTE

education broadens the scope of learning and allows students to adjust their learning to their strengths.

While making changes to an established system comes with risks, the stand-still state of current American education poses greater risks to the future generation and the American economy.

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