Open Courseware and STEM Initiatives in Career and Technical Education

Paul A. Asunda, Ph.D
Southern Illinois University

Abstract

The past several decades have been times of widespread change in world economies. The 21st century has witnessed scientific technological innovations that have had an impact on almost every sector of our social institutions and the way we do things. To succeed in these changing economies and secure meaningful employment, STEM literacy and education is viewed as a priority. This essay reviews STEM initiatives and curriculums that support integration of Science, Technology, Mathematics and Engineering in Career and Technical Education (CTE) curriculum. A variety of open course software that can be directed to address different aspects of enriching STEM activities in CTE curricular subjects is presented.

Paul Asunda is an Assistant Professor in the Department of Workforce Education and Development at Southern Illinois University at Carbondale. He can be reached at pasun07@siu.edu.

Introduction

STEM education is becoming increasingly important given the economic and social issues facing the 21st century workplace. The fields of science, technology, engineering and mathematics (STEM) are viewed by many as critical for the future of any nation and the world as a whole (Lawrenz, Huffman & Thomas, 2006). To compete in the present and future global economy, it is essential for any nation to develop a workforce that is literate and savvy in these areas. It is important for all students to be STEM literate, including those who have not traditionally been able to participate in STEM field and initiatives, to have opportunities to learn the knowledge and skills they will need in a technologically oriented future. The National Governors Association [NGA] (2007) reported that Leon Lederman, a renowned physicist posited that STEM literacy implied that an individual operating in a knowledge–based economy has the ability to adapt to and accept changes driven by the new technology, work with others across borders, anticipate the multilevel impacts of their actions, communicate complex ideas effectively to a variety of audiences, and find measured yet creative solutions to problems which are today unimaginable.

STEM education and initiatives have often been called a meta discipline, the creation of a discipline based on the integration of other disciplinary knowledge into a new whole (Lantz, Jr. 2009). The scope and versatile nature of the Career and Technical Education discipline areas provide a platform for the integration of STEM subject areas, accomplishing the goal of providing all students a STEM geared curriculum. Of late, educators in the field of Career and Technical Education are aligning the curriculum with STEM initiatives. Such a curriculum allows for both a general education perspective and a career and technical education application that prepares

students for jobs in the new economy (Addair, 2010; Association for Career and Technical Education [ACTE] 2009; Hyslop, 2010).

The purpose of this essay is therefore two fold, first to examine initiatives that seek to support integration of science, technology, engineering and mathematics in career and technical education constituent subjects; and second to present a list of Open software that can help educators interested in integrating aspects of STEM fields meet the demands of teaching the 21st century students.

STEM initiatives started as a way to promote collaborative practices in STEM education and related curricular areas so that students would be prepared to study STEM fields in college and pursue STEM related careers. President John F. Kennedy's *'Decision to Go to the Moon'* speech almost fifty years ago on May 25, 1961, was a turning point for science, technology, math, and engineering initiatives in the school curriculum. During this period, President Kennedy launched the Apollo program for the space race, challenging NASA's scientists to accomplish the seemingly impossible goal of a manned-moon landing within 10 years. This led to an era of unprecedented scientific research and development that incorporated STEM education initiatives in schools and colleges across the United States, producing a highly trained generation of scientists and engineers, and ultimately making history when Neil Armstrong walked on the moon on July 20, 1969 (Science & Math Informal Learning Experiences [SMILE], n.d.).

The need for public understanding and preparation of future innovators is critical again today. Armario (2011) reported that scores from the 2009 National Assessment of Education Progress released on January 25, 2011 indicated that US students were still struggling in science with less than half considered proficient and just a tiny fraction showing the

advanced skills that could lead to careers in science and technology. Further, Armario stated that the secretary of education Arne Duncan said that students are not learning at a rate that will maintain the United States' role as an international innovation leader. In the new global workplace, the long-term economic prosperity and international competitiveness of the United States depends on the country's capacity to innovate in addition to providing a world-class education to all students. In 2009 President Obama identified three overarching priorities to reinvigorate innovation through STEM education initiatives (a) increasing STEM literacy so all students can think critically in these subject areas, (b) improving the quality of math and science teaching in order for American students to no longer be outperformed by those in other nations, and (c) expanding STEM education and career opportunities for underrepresented groups, including women and minorities (Prabhu, 2009).

To this end, the Obama administration launched the *Educate to Innovate* campaign that seeks to harness public-private partnerships to improve STEM education; make STEM education more accessible, move American students up the international rankings in STEM literacy, and expand STEM career opportunities. In his State of the Union Address 2011 the president pledged to prepare an additional 100,000 STEM teachers by the end of the decade (National Economic Council, Council of Economic Advisers, & Office of Science and Technology Policy, 2011).

STEM education offers students one of the best opportunities to make sense of the world holistically, rather than in bits and pieces as they prepare for jobs in the new economy. STEM education removes the traditional barriers erected between the four disciplines by integrating them into one cohesive teaching and learning paradigm helping students make connections between school, community, work, and the

global world (Lantz, Jr., 2009). Thus, STEM education is a priority not only because we need today's students to become tomorrow's leaders in innovation and help the US economy, but also to increase STEM interest and skill.

Career and Technical Education (CTE) curricular options play a critical role in preparing individuals for the world of work. CTE offers a holistic education that is dynamic, flexible, and responsive to the ever-changing needs and advances of technology, education, the workforce, and the economy. CTE incorporates innovative methods, ideas, and resources that provide students with a range of skills necessary to be considered workforce ready and secure meaningful work (Bray, Luzzo, Green, Gore, Katt, & Harrington, 2008).

One curricular option that has gained momentum within the field of CTE is the linking of technology education programs with engineering preparation programs. The field of technology education has edged closer to infusing aspects of engineering design into the curriculum. To further complement these efforts, professional bodies and organizations that are affiliated to CTE and workforce preparation have renamed themselves and retooled their missions and goals. Consider the following trends:

1. The formation of the National Center for Engineering and Technology Education (NCETE) in 2005. The ultimate goal of NCETE is to rethink the pedagogy of technology education programs to include more engineering content and design, problem solving, and analytical skills and to implement those changes in technology teacher education programs around the United States.
2. The renaming of International Technology and Engineering Educators Association (ITEEA) formerly known as International Technology Educators Association (ITEA). ITEEA is devoted to improving

technology education and engineering through the use of technology, innovation, design, and engineering experiences at the K-12 school levels,

3. Renaming of the technology education division of the Association of Career and Technology Education to Engineering and Technology Education Division, with a lower case "e" i.e. eTED as its acronym.
4. The National Association of Industrial Technology changed its name two years ago to the Association of Technology, Management and Applied Engineering (ATMAE) and, most recently the National Association of Industrial and Technical Teacher Educators (NAITTE) is now the Association for STEM Teacher Education (ASTEM).

Such endeavors continue to provide a framework for the integration of science, technology, engineering and mathematics into the CTE curriculum. Further, Herschbach (2009) noted that in contemporary school curriculums at all instructional levels and particularly at the middle and high school levels, the term engineering has found its way into course descriptions in one form or another. According to Gattie and Wicklein (2007), an engineering perspective emphasis provides a vehicle to, (a) increase interest and improve competence in mathematics and science among CTE students by providing an arena for synthesizing mathematics and science principles and (b) improve technological literacy by exposing students to a more comprehensive methodology that generates the technology.

Technology Education, STEM Related Curriculums, Initiatives, and Organizations

The notion that technology education boosts technological STEM literacy may encourage students to pursue

more studies in science, mathematics, and engineering. In recent years, academies, online curricular activities, and organizations that engage in STEM education have been established to encourage the infusion of STEM not only in technology education but in all subjects purported to be related to engineering education. For example, Schaffhauser (2011) reported that Purdue University had introduced an online course developed for elementary teachers specifically to strengthen their teaching strategies in STEM. In this essay, efforts to integrate STEM into the school curriculum will be viewed to comprise (a) STEM related curriculums, and (b) STEM related initiatives and organizations.

STEM Related Curriculums

Examples of pre-engineering curriculums that embrace STEM outreach activities that seek to integrate technology education aspects include: Project Lead the Way, STEM Academy, CISCO investment in STEM, and Microsoft Math Partnership. Project Lead the Way (PLTW) is a national pre-engineering program that partners with middle schools and high schools to provide a rigorous, relevant STEM education. Through an engaging, hands-on curriculum, PLTW encourages the development of problem-solving skills, critical thinking, creative and innovative reasoning. The STEM academy program is designed to improve STEM literacy for ALL K-12 students. It is presented in a Moodle format (an open source course management system) and is accessed via the Web. This program is built around hands-on projects that focus on standards-based foundations, gender awareness, socio-economic concerns, and general learner needs that seek to improve STEM literacy for all students.

Cisco Networking Academy provides comprehensive coursework to teach the “T” in STEM education, i.e. applied

computer technology related skills that lead to industry based certifications like Cisco Certified Network Associate (CCNA), and Cisco Certified Network Professional (CCNP) that reinforce skills in technology, math, science, and engineering. Cisco curriculum is offered through online coursework, detailed lesson plans, assessments, and teacher professional development (Cisco Networking Academy, 2010).

The Microsoft Math Partnership (MMP) program is highly concentrated in Washington State. It is a public-private initiative to enable educators, and encourage businesses and the state government to focus new attention and resources on improving middle-school students' participation and achievement in math, science and technology. Over time the plan is to expand MMP programs to other states. In contemporary CTE classes, educators are implementing STEM related curriculum in an effort to integrate STEM initiatives into their instructional activities (Microsoft, 2009).

STEM Related Initiatives and Organizations

Several national organizations that support STEM initiatives include the following:

The National Aeronautics and Space Administration (NASA) has a primary responsibility for advancing America's scientific security and economic interests through robust space exploration and aeronautics research programs. NASA missions to understand and explore depends upon educated, motivated people and as such has a strong interest in inspiring and motivating students to pursue careers in science, technology, engineering and math. NASA, thus implements programs to advance STEM education, for example the NASA Means Business competition. In this competition college students compete to develop promotional plans to encourage educators to involve their students in outreach activities that

support STEM education (National Science Foundation and National Aeronautics and Space Administration, 2007).

The National Consortium for specialized Secondary Schools of Mathematics, Science and Technology (NCSSSMST) is the nation's alliance of secondary schools and programs preparing students for success and leadership in science, technology, engineering, and mathematics. It seeks to serve its members' students and professionals, by fostering collaborations, to inform STEM policy, and to advocate transformation in education.

National Math and Science Initiative (NMSI) was formed following a report issued in 2005 by the National Academies entitled "Rising Above the Gathering Storm." This document reported that among America's greatest economic and intellectual threats was the decline in the number of students who are prepared to take rigorous college courses in math and science and equipped for careers in those fields. NMSI supports training and incentive programs for both teachers and students in Advanced Placement and Pre-AP math and science courses. It also supports the expansion of UTeach, a program that encourages math and science majors to enter the teaching profession by offering compact degree plans, early teaching experiences, and financial assistance for undergraduates.

National Action Council for Minorities in Engineering (NACME) provides leadership and support toward increasing the representation of people of color i.e. African American, American Indian, Latino women and men etc. in STEM-focused careers.

National Science Foundation: Advanced Technological Education Program, with an emphasis on two-year colleges, the Advanced Technological Education (ATE) program involves partnerships between academic institutions and employers to promote improvement in the education of science and engineering technicians at the undergraduate and

secondary school levels. The ATE program supports curriculum development; professional development of college faculty and secondary school teachers; career pathways to two-year colleges from secondary schools and from two-year colleges to four-year institutions; and other activities. A secondary goal is articulation between two-year and four-year programs for K-12 prospective teachers that focus on technological education.

American Association for the Advancement of Science (AAAS): Project 2061 is a long-term initiative of AAAS to help all Americans become literate in science, mathematics, and technology. To achieve this goal, Project 2061 conducts research and develops tools and services that educators, researchers, parents and families, and community leaders can use to make improvements in K-12 education and beyond (National High School Alliance [HS Alliance], n.d.).

In addition to the aforementioned national initiatives, different states have implemented programs and organizations to meet STEM needs at the local levels. A common theme that transverse the STEM related curriculums and STEM related initiatives and organizations is that they implement the power of the World Wide Web and computer related technologies to share information and supplement instruction geared toward infusing aspects of STEM into the curriculum.

Teaching STEM in the 21st Century

Twenty-first century educators are constantly bombarded with changes including new methods of communication, new forms of technology, and ever changing teaching practices that seek best ways to instruct and disseminate information. In most recent times, global competition for STEM talent is growing as many countries increase their capacity to improve their own STEM education

systems. Addair (2010) indicated that demand for STEM professionals with education past high school but below a bachelor's degree is increasing. Nonetheless, it is worrying that amid the worst economic recession in decades, hundreds of thousands of technology-related jobs went unfilled in 2009 due to a lack of qualified workers. The US Department of Labor has projected that by 2018 the US will have more than a million of job openings in STEM fields, i.e. healthcare workers, veterinary doctor assistants, pharmacy technicians, forensic-science technicians and dental hygienists are some of the fastest growing occupations (Lacey & Wright, 2009). To succeed in economies that are rapidly embracing STEM related careers, individuals would be required to develop the skills necessary to secure meaningful employment. As a consequence this has posed a great challenge to teachers at all levels of the academy to seek ways to be responsive and accommodate in their teaching the changing needs of the workforce and students.

Dugger (2010) argued that there are a number of ways that STEM can be taught in schools today. One way is to teach each of the four stem disciplines individually. Another way is to teach each of the four STEM disciplines with more emphasis going to one or two of the four; this is what is happening in most US schools today. A third way is to integrate one of the STEM disciplines into the other three, e.g. integrating engineering aspects into science, technology and mathematics. And lastly, a more comprehensive way is to infuse all four disciplines into each other and teach them as an integrated subject matter. It is imperative that teachers become STEM technically literate as well as be aware of various STEM teaching models, in addition to available open source and freeware software that may supplement their teaching.

Open Source Software and STEM Instruction

A 2010 report to the president of the United States; "*Prepare and Aspire: K12 education in Science, technology, engineering and Math (STEM) for America's Future*" documented that educational technology can power innovative learning tools and traditional teaching methods that could dramatically improve STEM preparation and inspiration of all students, including those at risk of losing interest in STEM subjects (President's Council of Advisors on Science and Technology, 2010). Similarly, a national research report on teachers' media usage found that educators are incorporating more internet dependent technologies into their instruction. The report also revealed that shrinking school budgets were promoting many educators to look for free resources (Devaney, 2011).

The advancement of educational technology and availability of open course software has enhanced teaching, impacting the way educators instruct at all levels of education. Open source software is computer software that has a source code available to the general public for use as is or with modifications. "Open source software" is also called "Free software", "libre software", "Free/open source software (FOSS or F/OSS)", and "Free/Libre/Open Source Software (FLOSS)" (Couros, 2006). Open-source software gives educators more options than ever before. Today, instructors have dozens, if not hundreds, of options for free and open source applications that help them present lessons on everything from learning the alphabet to complex algebra computations. Open source software can be developed to support customization, such as instructional materials that include different approaches suited to different levels, learning styles, and problem sets that may adapt to student responses.

Open source software can provide simulations and engaging visual lessons as well as projects that can help students comprehend why they need to learn certain key concepts that may enhance STEM literacy. Software that supports STEM concepts helps students understand how the "S", "T", "E" and "M" work in tandem. Science deals with and seeks the understanding of the natural world (National Research Council [NRC], 1996). Thus the science component in STEM promotes scientific literacy which is the ability to use scientific knowledge i.e. physics, chemistry, biological sciences, and earth/space sciences to understand the natural world and participate in decisions that affect it (NGA, 2007). The technology piece allows for a deeper understanding of the three other components of STEM education. ITEA (2007) stated technology is the modification of the natural world to meet human needs and wants. On the same note, Dugger (2010) stated that technology is concerned with what can and should be designed, made and developed from natural world materials and substances to satisfy human needs and wants. Some processes used in technology to alter and change the natural world are "invention", "innovation", "practical problem solving" and "design". Thus the "T" perpetuates technological literacy, which implies the ability to use, manage, understand and access technology. Technological knowhow and skills allows students to apply what they have learned, utilizing computers with specialized and professional applications like CAD, CAM, and computer simulations and animations to design artifacts that satisfy human needs. The engineering aspect of STEM education puts emphasis on the process and design of solutions, instead of the solutions themselves. Engineering literacy is the understanding of how technologies are developed via the engineering design process. Engineering design is the systematic and creative application of scientific and mathematical principles to practical ends such as design,

manufacture, and operation of efficient and economical structure, machines, processes and systems. This approach allows students to explore mathematics and science in a more personalized context while helping them to develop the critical thinking skills that can be applied to all facets of their work and academic lives as they understand the build world around (NGA, 2007). Dugger (2010) stated that the mathematics component provides an exact language for technology, science, and engineering. Hence, mathematical literacy means the ability of students to analyze reason and communicate ideas effectively as they pose, formulate, solve and interpret solutions to mathematical problems in a variety of situations (NGA, 2007).

STEM literacy does not imply achieving literacy in these four areas distinctively, but calls for designing STEM instruction to help students articulate how the four disciplines weave together to realize solutions to practical problems and challenges. Open source software and simulations can help meet this goal. Open source can be used to supplement learning that embraces STEM aspects, allowing students to explore CTE curricular options in greater detail and in practical application (Lantz, Jr., 2009). If appropriately used, open source software can provide varied teaching strategies experiences like online instruction, project based assignments, videos, webgames, lab and job simulation, and social networking communities. These strategies help educators provide students with learning opportunities that exemplify real world content and hands on lab opportunities that may increase students engagement in STEM related content, as well as help them comprehend how the disciplines work together. Additionally open source software might provide teachers with ongoing opportunities for professional development training. This allows for collaboration, creating a community of peers among those interested in STEM instruction.

Constructivism Theory, STEM and Open Source software in CTE Instruction

Recent theories focusing on the nature of learning promote the constructivism theory. Schunk (2004) explained that constructivism is not a theory but an epistemology that explains the nature of learning and how individuals construct what they learn and understand. Thus, a number of educators have come to regard constructivism as a learning theory. Knowles, Holton, and Swanson (1998) argued that constructivism stressed that all knowledge is context based and that individuals make personal meaning of their learning experiences. It then follows constructivism as a learning approach augurs well with contextual learning as described by Brown (1998). Brown stated that Contextual teaching and learning theory is rooted in constructivist practice. Teaching in a context is not a new idea; in his writings Jean Piaget (1968) viewed the origin of knowledge as genetic epistemology which he also called constructivism, due to his belief that knowledge acquisition is a process of continuous self-construction. Further, John Dewey (1963) stated that there was an intimate and necessary relation between the process of experience and education. According to Dewey this was a fundamental aspect toward application of contextual learning into U.S. classrooms. Dewey advocated a curriculum and teaching method tied to children's experiences and interests. Such experiences promote authentic learning experiences helping the teacher to connect topical content to real world situations and stimulate students to make their own connections between knowledge and its applications to their lives. One good example of teaching in a contextual environment as viewed by Piaget (1968) and described by Dewey (1963) is the *West Bridge Design Contest*, a simulator software designed to offer students realistic, engaging introduction to engineering concepts. In this

simulator contest students learn about the engineering design process by applying math, science, and technology to create devices and systems that meet human needs. Such a group-wide inquiry project poses a problem to students, requiring them to conduct original research where they must use technology to gather and analyze data, design, test, and improve upon a proposed bridge design that is perceived as a viable solution. In light of this, it can be argued that the activity in which knowledge is developed and deployed is not separable from learning and cognition (Brown, Collins & Duguid 1989). In other words, learning and cognition may be fundamentally situated in an activity. This affords students with a problem solving learning opportunity that is realistic and hands on.

Various open source software programs on the World Wide Web can be integrated into the curriculum to teach STEM concepts providing students with opportunities to be innovative in a contextual learning environment. Open source software that supports such an initiative provides students opportunities of cognitive apprenticeship as described by Brown, et al. (1989). Cognitive apprenticeship methods try to enculturate students into authentic practices through activity and social interaction that may support innovation. Such learning experiences help students engage in virtually the same types of problem solving activities that real innovators do but perhaps not on the same scale. Brown, et al. further postulated that activity shapes students' skills and provides experiences that are important in understanding concepts. They stated that representations arising out of activity cannot easily be replaced by descriptions. Greeno, Moore and Smith (1993) stated that, for students to make connections between concepts, instruction should be designed to influence the activity so that it includes attention to affordances that are invariant across changes in the

situation and that will support successful interactions in a new environment.

In view of these observations, open source software when appropriately incorporated into STEM education can fit into any of the STEM instructional models as described by Dugger (2010). Such an undertaking can provide students with hands-on activities and virtual innovative field trips that are meaningful and relevant to students' lives and the world around them. Such opportunities might be said to enhance STEM literacy as well as co-produce innovative knowledge through activity and collaborative learning. Thus, contemporary learning theories provide instructors with strategies to incorporate open source software that afford learners with a variety of learning opportunities that enhance STEM instruction. However, to be able to utilize open source software to their fullest potential as teaching tools, educators need to understand the fundamental difference between open source and freeware software and their limitation.

Open Source Software for STEM Instruction in CTE

Open source software typically does not require a license fee. Alternatives to open source software are *freeware, free software, and shareware*. Freeware is software that is made available for everyone to use at no cost e.g. web browsers like Mozilla Firefox however, the author retains the copyright and users cannot modify the source code unless they get permission to do so. On the other hand, free software is software that can be used, modified, copied and redistributed without restriction and for no cost, e.g. Moodle course management system. A major difference between free software and freeware is that freeware is not proprietary and can be distributed freely. Therefore, educators should note that some proprietary software may not be compatible with free

software, for example, those that depend on a user paying for a license in order to lawfully use a software product. Lastly, Shareware is a type of software and a way to distribute the software. Authors of shareware give users a license to try out the software for a specific period of time. If a user wishes to continue using the software after this trial period, he or she is required to register with the author by paying a small fee (Ontario ministry of small business and consumer services, 2008).

Use of open source and freeware software may be considered supplemental if educators incorporate them appropriately in their teaching practices enabling students to realize instructional learning objectives in a way that previously could have not been met. Educators need to know that this group of software can help them and the institutions they work for save on licensing costs, maintenance costs because of increased reliability over a period of time, flexibility with regard to modification of software to meet instructional needs, and on training costs for both technical staff that support and use the system. However, free comes with limitations and costs, some of the downsides associated with open source software according to the Ontario ministry of small business and consumer services (2008) include but are not limited to: (a) lack of personalized support, unlike proprietary software, open source and freeware software do not come with phone support or personalized e-mail support, (b) restricted choice, there are fewer program choices available for open source or freeware software, (c) speed of change, every day software is being modified in the open source world, which can make it difficult to ensure that the software is compatible with other applications, and (d) no warranty, open source and freeware software does not come with a warranty, as there is no single company backing the product.

Thus, educators at all levels should consider whether the overall costs of using an open source or free ware software will be higher than that of proprietary software in addition to its relevancy to support desired learning outcomes of the program and courses in which it is used.

Figure 1 and 2 illustrate some freeware and open source software that could be utilized in a technology oriented classroom to facilitate integration of STEM activities and support educators teaching philosophies (PcWorld, 2009). In addition, the following sites provide additional links to resources that teachers and students may find useful:

1. http://www.educational-freeware.com, this site specializes in finding and reviewing high-quality free learning software and Websites from the Internet;
2. http://www.user.shentel.net/rbowman/files/myfree.htm, contains an extensive list of free educational technologies software that technology teachers do not want to miss;
3. http://www.dirfile.com/freeware/teachers.htm, offers a list of freeware for teachers use
4. http://www.bestfreewaredownload.com, this site categorizes free software into those for Audio, Graphics, Web development etc.
5. http://www.filehippo.com, contains several categories of freeware, demo and shareware programs that can be downloaded
6. http://www.oercommons.org, and http://www.curriki.com/ offer free-to-use teaching and learning content like K-12 lessons, college courses etc. from around the world;
7. http://opensource.ebswift.com/, software is classified into categories e.g. system, educational, graphics, webmaster resources, games etc
8. http://en.wikipedia.org/wiki/List_of_open_source_software_packages, the Wikipedia page for open source software packages.

9. http://free.ed.gov/ Federal Resources for Educational Excellence, is a U.S. Department of Education website that compiles free teacher resources with topics from Math to World Studies.
10. http://www.teach-nology.com/ TeAchnology provides free and easy to use resources for teachers dedicated to improving the education of today's generation of students.

Figure 1: Freeware software in Science, Technology, Mathematics, and Engineering subjects

SCIENCE		
Freeware Tool	Description	Site
Genius Maker 3.00 freeware	1-Genius Maker contains 34 educational softwares covering the subjects Mathematics, Physics and Chemistry for High school students. Out of 34 softwares, 9 software's are Free and the remaining are for trial.	http://www.bestfreewaredownload.com/freeware/t-free-genius-maker-freeware-tktjpbgi.html
LDS Home schooling	2-Site is designed for home schooling. Contains links to more than 100 free courses for sciences.	http://ldshomeschoolinginca.org/science.html

TECHNOLOGY		
Freeware Tool	Description	Site
4teachers.org	site helps teachers locate and create ready-to-use Web lessons, quizzes, rubrics and classroom calendars.	http://www.4teachers.org/
easy freeware	Archive of freeware downloads that contains hotlinks to various technology Freeware.	http://www.easyfreeware.com/freeware/technology.html

MATHEMATICS		
Freeware Tool	Description	Site
Math for kids10	Free math lessons and math homework help from basic math to algebra, geometry.	http://www.rocketdownload.com/program/math-for-kids-79194.html
Mixed up math 1.0	A math puzzle where equations are mixed-up.	http://www.rocketdownload.com/program/mixed-up-math-10268.html
Math basics	Math Basics is a simple math quiz application – only available for those with Macintosh computer systems.	http://www.rocketdownload.com/program/math-basics-79193.html

ENGINEERING		
Freeware Tool	Description	Site
Filebuzz	Page presents engineering software with snap shots and descriptions of each software.	http://www.filebuzz.com/files/engineering/freeware-1.html
Uconeer	Uconeer has 397 units in 46 categories. Covers all the basic categories but adds engineering specific categories like enthalpy, entropy, heat capacity, heat transfer coefficient, moment of inertia, stress, surface tension, thermal conductivity, torque and viscosity.	http://www.easyfreeware.com/uconeer-109-freeware.html
Electrical Mechanics	Electrical, Mechanics and Maths engineering educational software package.	http://www.bestfreewaredownload.com/download/t-free-electrical-mechanics-and-maths-freeware-tsletozf.html

2D ENGINEERING		
Freeware Tool	Description	Site
A9CAD	A9CAD is an excellent ACAD-compatible program for the occasional CAD use.	http://www.a9tech.com/
CadStd	CadStd is a general purpose, easy to learn CAD/drafting program.	http://www.apperson.org/cadstd/
JustCad	JustCad is designed, to make cad drawing as simple as possible.	http://www.justcad.com
Blender	Blender is a free open source 3D content creation suite.	http://www.blender.org

3D ENGINEERING		
Freeware Tool	Description	Site
Google SketchUp Pro8	Google SketchUp Pro 8 is a suite of powerful features and applications for design and engineering professionals.	http://www.google.com/sketchup/download/
Vector Engineer Cad Software	A complete technical drawing and multi-purpose cad software system that offers all the features required to create accurate professional drawings.	http://www.vectorengineer.com/

Figure 2: Software for general uses as preferred

SCIENCE		
Freeware Tool	Description	Site
Genius Maker 3.00 freeware	Genius Maker contains 34 educational softwares covering the subjects Mathematics, Physics and Chemistry for High school students. Out of 34 softwares, 9 software's are Free and the remaining are for trial.	http://www.bestfreewaredownload.com/freeware/t-free-genius-maker-freeware-tktjpbgi.html
LDS Home schooling	Site is designed for home schooling. Contains links to more than 100 free courses for sciences.	http://ldshomeschoolinginca.org/science.html

TECHNOLOGY		
Freeware Tool	Description	Site
4teachers.org	site helps teachers locate and create ready-to-use Web lessons, quizzes, rubrics and classroom calendars.	http://www.4teachers.org/
easy freeware	Archive of freeware downloads that contains hotlinks to various technology Freeware.	http://www.easyfreeware.com/freeware/technology.html

MATHEMATICS		
Freeware Tool	Description	Site
Math for kids10	Free math lessons and math homework help from basic math to algebra, geometry.	http://www.rocketdownload.com/program/math-for-kids-79194.html
Mixed up math 1.0	A math puzzle where equations are mixed-up.	http://www.rocketdownload.com/program/mixed-up-math-10268.html
Math basics	Math Basics is a simple math quiz application – only available for those with Macintosh computer systems.	http://www.rocketdownload.com/program/math-basics-79193.html

ENGINEERING		
Freeware Tool	Description	Site
Filebuzz	Page presents engineering software with snap shots and a description of each software.	http://www.filebuzz.com/files/engineering/freeware-1.html
Uconeer	Uconeer has 397 units in 46 categories. Covers all the basic categories but adds engineering specific categories like enthalpy, entropy, heat capacity, heat transfer coefficient, moment of inertia, stress, surface tension, thermal conductivity, torque and viscosity.	http://www.easyfreeware.com/uconeer-109-freeware.html
Electrical Mechanics	Electrical, Mechanics and Maths engineering educational software package.	http://www.bestfreewaredownload.com/download/t-free-electrical-mechanics-and-maths-freeware-tsletozf.html

2D ENGINEERING		
Freeware Tool	Description	Site
A9CAD	A9CAD is an excellent ACAD-compatible program for the occasional CAD use.	http://www.a9tech.com/
CadStd	CadStd is a general purpose, easy to learn CAD/drafting program.	http://www.apperson.org/cadstd/
JustCad	JustCad is designed, to make cad drawing as simple as possible.	http://www.justcad.com
Blender	Blender is a free open source 3D content creation suite.	http://www.blender.org

3D ENGINEERING		
Freeware Tool	Description	Site
Google SketchUp Pro8	Google SketchUp Pro 8 is a suite of powerful features and applications for design and engineering professionals.	http://www.google.com/sketchup/download/
Vector Engineer Cad Software	A complete technical drawing and multi-purpose cad software system that offers all the features required to create accurate professional drawings.	http://www.vectorengineer.com/

Conclusion

In this essay a variety of organizations that support STEM initiatives, STEM curriculums and possible open source software that may support the instruction of science, technology, engineering and mathematics (STEM) have been presented. Employment prospects in contemporary society as well as those of the future will heavily depend on those that are STEM literate. In other words, those with skill sets and knowledge of how the four disciplines and general education weave together to realize solutions to practical problems, and are better prepared to innovate and compete in the global economy will be at an advantage. Technological innovations will constantly change the way that students learn and how teachers plan and disseminate knowledge. Thus the 21st century CTE educator is challenged to seek innovative ways to integrate and supplement their teaching practices with new technologies to prepare students for the world of work in a learning environment with dwindling resources. Availability of open source and freeware software can provide instructors with supplemental teaching resources that can help them connect with 21st students as well meet curriculum objectives. Not only CTE instructors but also all educators will be required to seek and attend professional development activities that will impart and update their knowledge and skills of the potential of these innovative software technologies in supporting learning outcomes, and how students may use them. To this end STEM literacy, availability and appropriate use of open source and freeware software to support desired learning outcomes will be a big component in the professional development of all educators who seek to integrate aspects of STEM education into their instructional practices.

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