Assessing Student Learning of Systems Engineering Concepts in an Online Education Module

(Technical Paper)

An Analysis of the Relationship Between Common Core State Standards and Student Success

(STS Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Introduction

Just ten years ago, American students were taught using many of the same methods and tools as were used decades prior; only recently has social and technological innovation progressed far enough to permanently transform the landscape of education in the United States. Traditionally, education has been conducted in physical classrooms, where students use pencil, paper, books, chalkboards, and perhaps counting blocks to assist in their learning. The instructor works alongside the students, curating and delivering personalized lessons and monitoring the progress of his or her students in real time. Modern technological advances, however, have drawn students and educators out of their individual classrooms and into less personalized forms of education. More and more courses are being developed on the Internet to allow students to complete their coursework online, and teachers who continue to teach in physical buildings do so under the national benchmarks of knowledge instructors must make their students meet called the Common Core Standards. While online education is proven to promote reflection, higher order thinking, and quantitative reasoning, researchers have found that it also weakens collaborative learning and student-faculty interactions (Dumford, 2018). Similarly, while Common Core Standards have the potential to save schools money and time, critics write that the Standards also fail to provide necessary accommodations for students with disabilities and can leave teachers feeling overlooked ("Pros and Cons of Common Core Standards," n.d.). These tradeoffs affect both the education and the wellbeing of all people involved, and must therefore be considered carefully. It is critical to explore and understand how technological innovations in education currently function within society and what improvements or changes can be made to optimize positive outcomes in our education system.

The proposed project aims to develop online educational modules that will disseminate information about how U.S. citizens can use the five Constitutional pillars outlined in the Preamble (Defense, Justice, Liberty, Tranquility, and Welfare) to measure and improve upon their personal, community, and national wellbeing. In doing so, my project team hopes to not only teach users about wellbeing, but also to assess and improve upon current tools used in online education. The final deliverables for this project will be a course developed on a preexisting online educational platform that teaches participants about wellbeing as it relates to the five pillars of the Constitution as well as a functional prototype of an optimized online educational platform. The science, technology, and society project will explore the societal impact of another recent development in education, the Common Core Standards. I will examine how the Common Core Standards function within the larger context of the education system to determine if this innovation successfully solves the problem it sets out to achieve, and to provide recommendations about how it can be further improved.

Technical Topic: Online Education to Unite U.S. Citizens

Objectives

Gross Domestic Product (GDP), a statistic that quantifies the size and growth of a nation's economy, has increasingly become an international thermometer used to assess and compare societies' wellbeing (Stiglitz, Fitoussi, & Durand, 2018). While this number successfully, measures economic growth, it fails to consider many critical aspects of wellness and prosperity. Jeroen van den Bergh (2009) details eight major shortcomings of GDP, including a failure to consider how citizens characterize happiness and an inability to account for basic needs such as food, water, freedom, and respect. Previous work to define optimal alternatives to GDP has led experts to establish other metrics such as the ISEW, aimed at measuring the

consumption-related services that directly influence human welfare, and the GPI, which encompasses additional categories like voluntary work, criminality, divorce, leisure time, unemployment and damage to the ozone layer (van den Bergh & Antal, 2014). Yet, sociological norms such as "bounded rationality" and "historical lock-in" have prevented these alternatives from becoming prevalent, impactful metrics of wellbeing (van den Bergh, 2009). A previous Capstone team worked to develop a new metric that is more reflective of national values and can be successfully disseminated to the public. This team used historical data to create a metric known as PAWS that employs the five pillars of the US Constitution as outlined in the Preamble as broad indicators for measuring progress. This metric has the potential to make a large impact in the way individuals, communities, and nations work to improve their wellbeing, but it must be disseminated to the public before it can do so. Therefore, my technical project sets out to increase awareness of the PAWS metric and to provide U.S. citizens with the knowledge required to use this metric to make a positive impact on wellbeing in ways that the GDP metric currently cannot. The primary focus is to create an informative and functional online learning site that teaches users about PAWS and provides a platform for discussion and resources. Ultimately, the platform will help users incorporate the aspects of the five Constitutional pillars into their own lives to improve their wellbeing and the wellbeing of their community.

Team

This technical project is conducted by myself and four other undergraduate Systems and Information Engineering (SIE) students at the University of Virginia, Alara Bedir, Rahi Desai, Neha Kulkarni, and Ryan Wells. Our team is advised by faculty advisor, Stephanie Guerlain, and COO of the Promise America Alliance, Arthur Rashap. Our project is a continuation of the work of a former capstone team of seven undergraduate students with the same advisors. We intend to

continue their progress toward developing an optimal, well-known alternative to GDP by creating an online platform through which users can learn about wellbeing as defined by the PAWS metric.

Methods and Approaches

Research and analysis of existing online learning platforms will be conducted by the team to develop a thorough understanding of the role current technology plays in online learning and how this technology can be improved to strengthen subject retention, community development, and user engagement. Current technologies that are frequently used to deploy online learning content include Nearpod, a web-based student engagement platform that allows teachers and facilitators to incorporate interactive learning components such as discussion boards and quizzes into slideshow lessons, and Nimble Author, a module creation tool that helps teachers engage their students through clickable buttons and animation. However, a web-based technology that possesses the ideal engaging, collaborative, multimedia features that our project requires does not yet exist. Due to time constraints, the team is unable to create a new functional platform on which to develop a course about wellbeing as defined by the PAWS metric, but will instead create an online course given available online platforms as well as wireframe a prototype for a new web-based platform that meets the needs of students and instructors that current technologies do not fulfill.

A one-week course will be developed using existing online technologies. The course will contain an onboarding survey, a module for each of the five pillars, and an exit survey. Module content development will focus on gathering important background information about each pillar of the Constitution, posing critical discussion questions, and finding professionals who are experts in applicable fields of study. The surveys will feature both open-ended and Likert scale

questions to provide user data to be analyzed during testing. Rapid prototyping and testing will be employed to explore and improve upon previous designs quickly. The product will be tested on easily accessible and relevant user groups such as students and faculty in the Curry School of Education, participants at the University of Virginia's Contemplative Sciences Center, and students in the Batten School of Leadership and Public Policy. We will use the qualitative and categorical user data from these user groups to assess the effectiveness of the course and to determine areas for continued development.

The development of a new web-based learning platform prototype will begin with usability evaluations of existing technologies. A gap analysis will then be conducted to determine the functional requirements of the platform and develop an initial wireframe. Again, rapid prototyping and testing with the aforementioned user groups will occur to allow the design to be improved with each iteration.

Analyses and results of both components of the project will be reported in a conference paper that will be presented at the Systems and Information Engineering Design Symposium (SIEDS) in May 2020. Our goal upon completion of the project is to deploy an online platform that allows users to learn about the pillars of the Constitution and how they apply to personal, community, and national wellbeing, as well as to develop a prototype for an online education platform that engages students and fosters community to fill needs unmet by current technology.

STS Topic: An Analysis of the Impact of Common Core Standards on Student Success

One aspect that is critical to increased national wellbeing is the quality of education in our nation's school system. However, our nation's educational progress has recently remained stagnant, while other countries continue to improve, threatening the future of our nation's health

and happiness ("About the Standards: Common Core State Standards Initiative," n.d.). The United States has historically held a high position in elementary education rankings, but today it ranks 24th in Science and Reading and 39th in Math according to scores on the Program for International Student Assessment (PISA), indicating the need for reform in the American education system (DeSilver, 2015). To address this problem, the National Governors Association Center for Best Practices and the Council of Chief State School Officers (CCSSO) developed the Common Core State Standards Initiative as "a state-led effort to establish consensus on expectations for student knowledge and skills that should be developed in grades K-12" (Porter, McMaken, Hwang, & Yang, 2011). The Common Core Standards outline what students should know and be able to do at the end of each grade, with the intent to influence curricula. Proposed benefits of the Common Core Standards include consistency through shared expectations, increased focus on curricula, efficiency in curricula and assessment building, and increased quality of assessments (2011). Despite these potential positive outcomes, the Common Core Standards have also received a great deal of criticism by the public and experts alike. A study by Yinying Wang and David Fikis (2017) reveals that the public sentiment on Twitter towards the Common Core Standards are overwhelmingly negative, with all 50 states posting tweets with negative sentiment more often than they post tweets with positive sentiment.

Social problems, such as those the Common Core Standards are designed to address within the education system, are inherently complex, riddled with networks of ill-defined interacting components that are not restricted by the rules and order science provides, and as such should be solved with equally complex social solutions such as political or organizational policy. On the other hand, technical problems are well-defined, specific, and stationary, and can therefore often be solved in isolation and implemented relatively easily. Therefore, societies are

often inclined to adopt a technical solution that appears to quickly and easily resolve intricate social quandaries, as was done when nuclear warfare was developed in an attempt to remedy deep-seated Cold War debates and when wind turbines were introduced as a way to combat looming climate change problems. Atomic physicist Alvin M. Weinberg first defined the term 'technological fix' to describe this "use of technology to respond to certain types of human social problems that are more traditionally addressed via political, legal, organizational, or other social processes" (Newberry, 2005). While this framework is a useful technique for analyzing the role of certain technological innovations in society, critics of the theory have persisted since the theory's inception. E.M. Burns and K.E. Studer argue that Weinberg's theory is "naively confident" about the methods and principles of science that that it too "narrowly defines" the complexity of problems (Burns & Studer, 1976). Sean F. Johnston, Professor of Science, Technology, and Society at the University of Glasgow (2018), critiques the ethical framework behind the technological fix theory, claiming that its basis in utilitarian ethics (doing the action that will maximize positive outcomes) is not as favorable as deontology or virtue ethics, which consider behavior and personal rights when judging innovation. Analysis of the Common Core Standards as a technological fix will combat these criticisms by demonstrating how this framework can reveal overlooked relationships between the development of standardized curriculums and student progress within American elementary education systems. This innovation may be a simple technical solution to an extremely intricate social problem, and there may be other critical factors contributing to the United States' failure to improve academically that cannot be solved by standardizing learning goals. We may continue to make little progress unless these other issues within the education system are addressed directly.

Evaluating the education system's actor-network reveals underlying factors that contribute to nationwide stagnant progress in education. The concept of an actor-network stems from Bruno Latour's Actor-Network Theory (ANT), the idea that "tracing the complex relationships that exist between governments, technologies, knowledge, texts, money and people... result in science and technology, and by examining them it becomes easier to describe why and how we have the science and technology that we do" (Cressman, 2009). As with all theories, there are critiques of this method that demonstrate pitfalls of the framework. Among these are M. I. Reed's argument that ANT theory focuses on how things "get done" and in turn excludes a thorough analysis of the social structures through which those things are accomplished, and Habers' similar claim that ANT is "overly oriented towards the contribution of things to the production of the social order, almost neglecting... the 'sociality' of the stability of things" (Walsham, 1997). Despite these criticisms, ANT remains a useful framework for understanding the complexities of our sociotechnical world and lends itself well to the analysis of the role Common Core Standards play in the American education system (Cressman, 2009).

The education system is comprised of many actors, or entities that influence other entities through a relationship in a network. For example, national, local, and state governments work together to provide policy and programs to school administration, who works with teachers and staff to implement and successfully maintain those policies. Parents work to provide food, shelter, support, and learning opportunities at home. Each of these actors, along with the physical school building, instructional materials, and curricula, interact with students on a daily basis in a manner that affects the knowledge they obtain and thus impacts the way those students shape the world even after they graduate. When viewing the implementation of Common Core Standards within this actor-network of education, new insights are revealed. The Common Core is

developed by the government, yet is adopted and used by instructors. This transition from policymaker to teacher can shift attitudes about the program and distort the initial concept of the Standards when used in practice. The Common Core must also be supported by other entities; the Standards will have varying degrees of success if the instructors working to achieve them do not have the resources or accommodations necessary to successfully carry out their plans. Finally, the actor-network reveals that regardless of the Common Core Standards, student success is not simply a measure of what occurs in the classroom but is also influenced in a variety of ways by life at home. This analysis points to the notion that the Common Core alone will not be enough to bring American students to a high and equal level of academic success, but that additional social solutions will have to be developed to truly reach the goal the Common Core Standards set out to achieve.

Framing the Common Core Standards as a technological fix within the actor-network of the education system provides an opportunity to better understand the reasoning behind developing Common Core Standards to improve the standard of learning, the barriers that may affect the Common Core from achieving that goal, and the outside factors that influence student achievement. This analysis thus provides a valuable opportunity to inform decision makers with findings that can influence policy to fully address the underlying problems that currently exist within our education system.

Research Question and Methods

The proposed research question is: Are the Common Core Standards a comprehensive means of achieving the intended goal of raising all U.S. students to a high and equal standard of education?

To answer this question, I will use a combination of exploratory methods. Given that the Common Core Standards is federal policy, I will first use policy analysis to examine the motivation behind and efforts for establishing the Common Core Standards by education policymakers. Documentary research methods will then allow me to organize and interpret past work to analyze the role of Common Core Standards in the classroom, existing views of the Common Core Standards, and data that explores the success of the Standards over time. Interviews of elementary education experts in the Curry School of Education will provide me with meaningful qualitative and observational results of the Common Core Standards and with empirical opinions about setting national standardized guidelines to supplement my literary findings. Finally, wicked problem framing will allow me to discover indirect and hidden connections between the symptoms and root causes of the American education system's failure to improve. This method aligns with my research question because it supports the organization and reinterpretation of a problem that may appear amenable to a technical fix, but remains unsolved, just as the Common Core may appear to fix the problem at hand but does not resolve the fundamental issues within the system. Assessing my research problem through these methods will provide me with a holistic understanding of the American education system and the Common Core Standards so that I can successfully interpret and analyze the true impact these Standards have on improving education in the United States.

Conclusion

Upon completion of this technical project, I will have an online learning platform that allows participants to learn about their personal, community, and national wellbeing through a series of modules derived from the five pillars of the Constitution. The platform will also help increase knowledge about alternative metrics for measuring wellbeing other than GDP. Given

enough exposure, the learning modules have the potential to transform the way in which Americans interpret the meaning of wellbeing and act as a driver for social and political change. Additionally, technological innovations in online education have the potential to improve the methods and techniques online educators use to teach their students.

My STS project will assess whether the Common Core Standards are a comprehensive means of achieving the intended goal of raising all U.S. students to a high and equal standard of education. The final report will explore the actor network that comprises the education system and determine how the Common Core Standards ameliorate, or fail to ameliorate, the problems within the system that contribute to declining test scores among U.S. elementary school students. I anticipate discovering obstacles that the Standards fail to address when trying to improve the education system and will aim to propose solutions that solve the roots of those problems in the hopes of improving the education system in not only the context of test scores, but also in that of wellbeing.

References

- "About the Standards: Common Core State Standards Initiative". (n.d.). Retrieved October 24, 2019, from http://www.corestandards.org/about-the-standards/
- Bergh, J. C. J. M. V. D. (2009). The GDP paradox. *Journal of Economic Psychology*, *30*(2), 117–135. doi: 10.1016/j.joep.2008.12.001
- Bergh, J. van den, & Antal, M. (2014). Evaluating Alternatives to GDP as Measures of Social Welfare/Progress (WWWforEurope Working Paper No. 56). Retrieved from WWWforEurope website: http://hdl.handle.net/10419/125713
- Cressman, D. (2009). A brief overview of actor-network theory: Punctualization, heterogeneous engineering & translation.
- DeSilver, D. (2017, February 15). U.S. academic achievement lags that of many other countries. Retrieved October 24, 2019, from https://www.pewresearch.org/fact-tank/2017/02/15/us-students-internationally-math-science/.
- Dumford, A. D., & Miller, A. L. (2018). Online learning in higher education: Exploring advantages and disadvantages for engagement. *Journal of Computing in Higher Education*, 30(3), 452–465. https://doi.org/10.1007/s12528-018-9179-z
- E.M. Burns and K.E. Studer, "Reply to Alvin M. Weinberg," Res. Policy, vol. 5, pp. 201-202, 1976
- Johnston, S. F. (2018). The Technological Fix as Social Cure-All: Origins and Implications. *IEEE Technology and Society Magazine*, *37*(1), 47–54. doi: 10.1109/mts.2018.2795118
- Mathis, W. J. (2010). The "Common Core" Standards Initiative: An Effective Reform Tool? Boulder and Tempe: Education and the Public Interest Center & Education Policy

Research Unit. Retrieved October 24, 2019 from

http://epicpolicy.org/publication/common-core-standards

- Porter, A., McMaken, J., Hwang, J., & Yang, R. (2011). Common Core Standards: The New U.S. Intended Curriculum. Educational Researcher, 40(3), 103–116. https://doi.org/10.3102/0013189X11405038
- Pros and Cons of Common Core Standards. (n.d.). Retrieved October 24, 2019, from Mississippi College Online website: https://online.mc.edu/articles/education/pros-cons-commoncore-standards.aspx
- Stiglitz, J., J. Fitoussi and M. Durand (2018), Beyond GDP: Measuring What Counts for Economic and Social Performance, OECD Publishing, Paris, https://doi.org/10.1787/9789264307292-en.
- Newberry, B. P. (2005). Encyclopedia of Science, Technology, and Ethics. In *Encyclopedia of Science, Technology, and Ethics* (Vol. 1, pp. 1901–1903). Detroit, MI: Macmillan Reference USA.
- Walsham, G. (1997). Actor-Network Theory and IS Research: Current Status and Future Prospects. In A. S. Lee, J. Liebenau, & J. I. DeGross (Eds.), *Information Systems and Qualitative Research: Proceedings of the IFIP TC8 WG 8.2 International Conference on Information Systems and Qualitative Research, 31st May–3rd June 1997, Philadelphia, Pennsylvania, USA* (pp. 466–480). https://doi.org/10.1007/978-0-387-35309-8_23
- Wang, Y., & Fikis, D. J. (2019). Common Core State Standards on Twitter: Public Sentiment and Opinion Leaders. Educational Policy, 33(4), 650–683. https://doi.org/10.1177/0895904817723739