NSU Florida
NOVA SOUTHEASTERN UNIVERSITY

Transformations

Volume 3
Issue 1 *Winter 2017*

Article 4

6-30-2017

Finland: An Exemplary STEM Educational System

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Abstract

There is a need for an increase in the number of students entering fields of science, technology, engineering, and mathematics (STEM) and the only way for that to happen is for educational reforms to be put into place (PCAST, 2012). Improvement and focus on STEM education are a concern of all nations whether they have an emerging economy or one that is long established. The world of the 21st century is such that in order to compete globally countries must invest in STEM education (Kennedy & Odell, 2014). The United States scores on the Program for International Student Assessment (PISA) were not in the top ten for reading, mathematics, nor science. To rectify this, it is imperative that changes be made to the educational system (Schleicher, ed., 2012). Looking at countries that are consistently at the top is one way to find potential solutions and models of reform. One country that has successfully reformed their educational system is Finland. Within their educational system, the strategies of collaboration and communication are widely utilized by the instructors as well as the students (Sislian, Gabardo, Macedo, & Ribeiro, 2015). While analyzing a single country's instructional program can give insights into what makes it successful, it is beneficial to compare that country to others that are also achieving success in order to determine any trends and commonalities. The countries used for this comparison were chosen because they were different culturally, geographically, and politically, but in spite of their differences, they were among the top-scoring nations on the PISA.

Canadian Comparison

The Canadian education system and how it compared on the PISA scores was detailed in the report *Comparative indicators of education in the United States and other G-8 countries: 2011. NCES 2012-007* compiled by Miller and Walden (2011). Students begin school in the pre-primary levels at ages 4 or 5, and then advance through primary, lower secondary, and upper secondary level (Miller & Walden, 2011). This is significantly different than in Finland where students do not begin formal education until the age of 7. Compulsory education begins with primary school in Canada and continues into upper secondary levels through the age of 16 (Miller & Walden, 2011). The education system of Canada is considered decentralized because each educational jurisdiction within the provinces has leeway to adjust the system as necessary for their population and circumstance. There were approximately 10.4 million students enrolled in schools in Canada at the time of the report (Miller & Walden, 2011). On the 2009 PISA, Canada scored higher in reading than the United States, France, Germany, Italy, Russian Federation, and the United Kingdom. The Canadians also scored higher in science than the United States, Germany, the United Kingdom, France, Italy, and the Russian Federation. In mathematics, Canada outscored France, Germany, Italy, Russian Federation, United Kingdom, and the United States (Miller & Walden, 2011). Interestingly, Canada was not only scoring well at the top end of the PISA scale, it also had a lower percent of students below proficient than France, Germany, Italy, Japan, Russian Federation, United Kingdom, and the United States. Which means that Canada is not only finding success at the top of the achievement scale but also at the opposite end (Miller & Walden, 2011).

Canada, much like Finland is consistently scoring in the top ranks on the PISA (Schleicher, ed., 2012). In the article *Formative assessment and the contemporary classroom:*

Synergies and tensions between research and practice by Jens Rassmussen and Martin Bayer takes a closer look at the top scoring countries of Canada, Singapore, and Finland as compared to Denmark (2011). For Canada, Ontario was selected as the model since each province is slightly different and Ontario's PISA results were a close match to the results for the country as a whole. Denmark was selected because it is a country that could be considered average based on scores on the PISA. All of the countries in the article have a strong focus on teacher education programs. Canada, like Finland, has a strong teacher education program. While there are differences between the structures of the programs, there are also commonalities (Rassmussen & Bayer, 2011). One of the similarities is that Canadian and Finnish education programs focus more on research than philosophy. In Canada, before prospective teachers are accepted into the education program they must have attained a four-year degree in subjects taught in schools. The education program itself is focused on successful teaching strategies with diverse student populations, and teacher performance (Rassmussen & Bayer, 2011). The education program for Canada has a strong focus on not just conducting research, but in utilizing research based strategies with students. The Canadian system also gives its teaching candidates hands on experience with instructional materials, planning instruments, and assessment tools, thus creating a solid foundation for teacher training (Rassmussen & Bayer, 2011). It seems clear that Canada, as well as Finland, value providing professional training to educators and in both countries this recognition of teachers as professionals and as researchers has led students to academic success as measured by the PISA tests (Miller & Walden, 2011).

In *Comparative Analysis of Science Education Systems of Turkey and Canada*, an article written in 2011, by İlknur Guveni and Ayla Gurdal, Ontario's educational system is again used to represent Canada as a whole because the scores reflect those of the country as a whole.

Canada was selected by the authors because of the country's rank of second in science as opposed to the thirty-third place on the PISA tests for Turkey. The authors noted significant differences between the countries and their respective science education programs as a way to provide a roadmap for improvement for the Turkish science education program (Guven & Gurdal, 2011). One point of significance was that the Canadian science objectives are very streamlined and succinct. The major emphasis for the Canadian strands was students become scientifically literate (Guven & Gurdal, 2011). Science in Canada is taught using the constructivist approach. It is inquiry based and student-centered. It is also focused on scientific skills with real world connections to technology, society, and the environment (Guven & Gurdal, 2011). By keeping the strands simple, the objectives clear, and the courses targeted, Canada has hit upon an effective system for science education. Canada and Finland are not the only countries to achieve this sort of success with science, as well as with reading and mathematics. Estonia and Singapore have also placed in the top at all three categories on the PISA. Since these countries are in different geopolitical spheres than Finland and Canada, it is worth examining the educational systems there.

Estonian Comparison

The Finnish education system differs slightly from the Estonian education system in a few ways. In *Estonian schoolscapes and the marginalization of regional identity in education* discusses how much of Estonian education is deeply rooted in their European cultural identity. Finnish education focuses primarily on the education of its teachers to be better adept at educating the masses. The dynamics of the Estonian education system have political undertones. Estonian education focuses on indoctrinating over three hundred thousand Russian immigrants

into Estonian culture. This poses a challenge in that it serves as a distraction from preparing students to compete academically on a global scale (Brown, K. D., 2005).

Comparison to Singapore

The knowledge gained from Singapore educators on a visit to Finland is explained explicitly in the article *Finland versus Singapore- what should be done to guarantee best education results?* (Kouvo, 2016). One of the major observations of the Singapore educators was the emphasis Finnish educational system placed on collaborative learning. There were two main questions that prompted the visit. How do you get students to feel as a group when they are studying online? Why do you choose to work so tightly in networks (Kouvo, 2016)? The Singapore education system acknowledged that lifelong learning is a relatively new concept to them in comparison to the Finnish educational system that has always placed high value on community colleges and institutes of higher learning. According to the author, in Finland, the tradition of community colleges and public education has existed longer than the country itself. Civilizing the whole population has been a national project ongoing since the late 1800s (Kouvo, 2016). The author also stressed that the Singapore educational system is actually open to understanding and adapting some of the practices of the Finnish system in order to better serve its own citizens. The visit of the Singaporeans confirms that the essential issues of lifelong learning are global (Kouvo, 2016).

Wendy Wong in the article *Finnish Education System vs. Singapore Education System* (2013) does an excellent job of distinguishing between the methods of the Finnish and Singapore Education Systems. The article expressed the basis for each education system as a whole; Finland's educational system is based on collaborative learning while Singapore's system is based on competitive learning (Wong, 2013). There does seem to be some bias by the author as

much of the focus is on the benefits of the Finnish policies as opposed to the drawbacks of the Singapore education policies. Even while acknowledging this bias, it is apparent throughout the article that both principles have been successful. For example, Singapore children start formal education at age three, while Finnish children do not begin school until seven years old (Wong, 2013). The author does an admirable job of explaining why each system has been effective, while still pointing out the obvious differences, such as class sizes in STEM classes. In the Singapore education system, the primary level students are given the PSLE (Primary School Leaving Examination). The Finnish children are not measured at all for the first six years that they are in school (Wong, 2013). The children in Singapore are under relentless stress to view PSLE score as "all or nothing" (Wong, 2013). This score will determine which route they will take and what secondary school they will attend. Even in the case of the teachers, all Finnish teachers must have a master's degree and in Singapore there is a shortage of teachers (Wong, 2013). Overall, the article is to be commending for explicitly explaining the different policies and strategies performed in each educational system.

The article, *Preparing Future Engineers around the World* (Wu, 2011), focuses on the different approaches of Singapore and Finland when it comes to STEM, in particular. At the School of Science and Technology (SST) in Singapore, all 400 students carry laptops (Wu, 2011). At the age of 12, they are entered into a four-year program that will prepare them for junior college. They also have a lot of standardized testing to determine what applied subject track they will follow (Wu, 2011). Students also undergo a lot of standardized testing to determine what applied subject track they will follow. A lot of financial resources are inserted into the Singapore educational system, as well. On the other hand, the Finnish educational system is very laid back. Finnish teachers spend far less time in the STEM classrooms. The focus

in Finland is on having extremely qualified teachers. Only one in ten applicants are selected for teacher preparation programs for every ten applicants (Wu, 2011). Fifth and Sixth graders begin learning about chemistry and physics. They have absolutely zero standardized tests, and the country spends very little money on education per student. As a result of their teachers being so highly prepared and qualified, they are trusted to actually teach the information in an effective learn-by-doing approach where the students are tasked with figuring out answers on their own through inquiry instead of being directed towards an answer or simply being given one (Wu, 2011).

Finnish Education Reform

Finland rejected curriculum tailored to state standardized testing. Educators design the curriculum of each school. Finland used career track based curriculum that was determined by student test scores. A common curriculum was established immediately following the 1970 reform (Chung, J., 2016). An outstanding feature of Finnish education is equity. Equal education, equal resources, effective evaluation of education and highly trained teachers are the hallmark of Finnish education reform. Finnish education decentralized its approach to education and allowed autonomy with the schools to improve education (Chung, J., 2016). The government also made a conscientious effort to make resources available to all of their citizens young and old alike (Darling-Hammond, 2010). These reforms have led to Finland becoming a major educational force.

According to a 2015 article in the *International Journal on New Trends in Education and Their Implications*, Finland's educational system is largely based on two major components: collaboration and communication. Finnish educators use several methods to create collaborative

learning environments in the classroom. Some of these methods include the following: blogs, social media, group work, learning café, aquarium strategy and pitching (Sislian, Gabardo, Macedo, & Ribeiro, 2015). Many educators have students create personal blogs as a method of getting to know the students personally. They then use this information to equitably group the students in their classes. In several cases, teachers had blogs created specifically for the course in which assignments were posted, along with various notes and imperative information (Sislian, Gabardo, Macedo, & Ribeiro, 2015). These blogs allow for communication between teacher and students, as well as, communication between classmates. In addition, the blogs are utilized as an effective format of maintaining documents in a single place (Sislian, Gabardo, Macedo, & Ribeiro, 2015). An interesting note is that many of the class groups effectively utilized Facebook as a collaboration tool. The students use this social media outlet to comment on each other's tasks. In some classes, students generated private community groups on Facebook that they used to work on projects together, as well as, classroom tasks (Sislian, Gabardo, Macedo, & Ribeiro, 2015).

Educators created discussion groups on various topics using the Learning Café. In this strategy, students are introduced to and given practice with the role of being a mediator during group discussions. The students used the ideas from the discussions to create posters to be presented to other members of the class (Sislian, Gabardo, Macedo, & Ribeiro, 2015). The students learned how to create a network of ideas that can be later combined to build arguments for larger concepts. All of this was achieved in a collaborative setting.

The educational process In Finland is a complete group effort involving all of the stakeholders in the educational system. Not only is there collaboration with the students, but the educators must also collaborate to make the educational system so effective (Darling-Hammond,

2010). As a result of collaborative efforts being viewed as imperative in Finland's educational system, schools have taken on the task of providing adequate time for teachers to collaborate regarding issues of instruction. Teachers do not have to simply find the time to work together; they are provided specific time frames for this collaboration to take place. These collaborative efforts have resulted in higher students achievement gains (Ronfeldt, Farmer, McQueen, & Grissom, 2015). It is important to acknowledge that collaboration is not seen as an option, but instead it is a requirement of educators. "Teachers in Finnish schools meet at least one afternoon each week to jointly plan and develop curriculum, and schools in the same municipality are encouraged to work together to share materials. Time is also provided for professional development within the teachers' workweek" (Darling-Hammond, 2010). Therefore, time is set aside to ensure there are no obstacles to prevent collaboration from taking place.

The STEM Connection

STEM fits into all areas of a school's curriculum. It is not something that has to be squeezed into an already crowded schedule. It should be infused into the existing reading, writing, and mathematics curriculum (Roberts, 2013). STEM is a problem-solving approach to instruction that ties a curriculum together rather than being an additional set of standards. STEM can foster curiosity and creativity within students if a problem-solving approach is used (Roberts, 2013). Making problem solving take on a global perspective is not as challenging as it might sound. Pollution, food production, and energy are topics that can be explored through STEM inquiry projects and are relevant worldwide. These issues can be used as platforms for problem-solving lessons with which students from anywhere can relate. When students are able to make a relatable connection then learning becomes more personal and more concrete (Dalimonte, 2013).

The students in Finland seem to be making that connection and are able to apply what they have learned in an integrative manner (Geller, Neumann, Boone, & Fischer, 2014). These students are expected to use inquiry and research in their studies. Teachers are not just given professional development in how to use inquiry; they spend a year at a university school working on how to teach inquiry. Finnish teachers are explicitly trained how to participate in and set up problem-solving groups in science (Schleicher, ed., 2012). Science at all grade levels is taught through inquiry, not just through demonstrations or experiments that have been conducted multiple times before. The students show rapid growth in comprehensive and integrative knowledge as evidenced by their consistently high performance in science on the PISA, a test used to measure achievement levels in science, math, and reading (Geller, Neumann, Boone, & Fischer, 2014).

In addition to inquiry science there is also a craft curriculum that was first put into place in 1866. This curriculum was modified over the years and in 2004 the decision to include technology as a part of the craft curriculum was made. Finland requires both boys and girls to be part of the craft curriculum (Thorsteinsson, Olafsson, & Autio, 2012). The goal of the curriculum is to help empower students by giving them the skills to design and create products. They use experimentation, the design process, and problem-based learning to create their products (Thorsteinsson, Olafsson, & Autio, 2012). This emphasis on problem-based craft and technology along with inquiry science has resulted in a strong STEM curriculum and consistently excellent scores in science on the PISA.

The world is more interdependent and information is easier to exchange. There is a need for people to be able to synthesize information and make use of it in creative and innovative ways (Schleicher, ed., 2012). The Asia Society put together a matrix for global competencies that

includes four stages: investigating the world, recognizing perspectives, communicating ideas, and taking action (Byker, 2013). In comparison, STEM lesson models include having students identify an issue or challenge, conduct an investigation, design a solution, test and evaluate the solution, and communicate the results (Roberts, 2013). The overlap between global competencies and STEM is clear, by combining the two students develop the creativity, inquiry, collaboration, and communication skills they need to become aware of global issues and perspectives and to be a part of creating solutions to existing and future challenges (Dalimonte, 2013).

In a global society, literacy encompasses more than just reading and writing; it includes all the skills necessary for building a better world. Students must be able to conduct investigations, recognize different perspectives, collaborate with others, communicate their ideas, and take action if they are going to be global citizens (Byker, 2013). The Finnish recognize that being more global will increase their technology pioneering, a competitive workforce, and help build a sustainable future for their citizens (Andreotti, Biesta, & Ahenakew, 2014). These correspond with the goals set forth by the International Council of Associations for Science Education (ICASE). These goals included a need to prepare students to become global citizens, encourage progress by recognizing that the four STEM disciplines are interrelated, and to reduce the STEM skills gap (Kennedy & Odell, 2014). There is a need for students to be prepared for and to want to pursue STEM careers. These students have to understand that STEM is not all fun and games; they have to be willing and able to take on the challenges presented by an ever-evolving future world (Pittinsky & Diamante, 2015).

Conclusion

Educational reform in the United States cannot be a simple mirror image of those strategies adopted by Finland or any other single country. All countries are different in a vast number of ways. However, there are key elements of reform that could be adopted. One from Finland is the professionalization of teaching. Teachers must be trained to effectively use inquiry and problem solving lessons (Schleicher, ed., 2012). The curriculum should also be evolved so that STEM is an interdisciplinary approach to teaching, as opposed to four separate tracks. If students are well versed in how to use science, technology, engineering, and math to create innovative solutions to problems, then they will be prepared to enter STEM careers (Kennedy & Odell, 2014). The world is changing; the future holds unknown careers and unknown problems. Students must be taught to be creative thinkers, innovators, problem-solvers, collaborators, and communicators if they are going to be ready for the challenges they will face.

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