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Fostering a Culture of Innovation: A Case Study of Elementary School Principals in Costa Rica

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Abstract To help promote a culture of innovation, the Ministry of Education and the Ministry of Science, Technology, and Telecommunication of Costa Rica established a national executive decree requiring all public schools in the country participate in the National Program of Science and Technology Fairs (NPSTF). This case study examines the role of five elementary school principals in Costa Rica in implementing and preparing their schools for the NPSTF initiative. Principals played three significant roles: the motivator of teachers and students; acquirer of NPSTF resources; and the organizer of NPSTF committees and coalitions to help train and finance the initiative. It is recommended the Ministry of Education establish a budget solely dedicated to support infrastructure and professional development for NPSTF while aligning goals with all stakeholders.

Keywords Culture of innovation; NPSTF; Costa Rica

Introduction

Over the last two centuries, the world economy has transformed from many separate and isolated markets to a more centralized and integrated global economy with large international firms that operate and employ workers in multiple countries (Wagner, 2010). Today's global economy has resulted in increased competition for labor and has direct implications for labor forces and educational systems, as individual coun-

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tries participating in the global economy are now competing with workers around the world (Clifton, 2011). In order to compete in the global economy, individual countries must provide an educated workforce at a competitive rate to attract international firms and foreign direct investment in the form of capital, technology, technical, and managerial skills. Countries that are able to attract foreign direct investment have the potential of increasing employment opportunities and quality of life for their citizenry. Attracting foreign direct investment can be a challenge for developing countries. One method of attracting foreign direct investment is by having a workforce with the education and twenty-first-century skills sought by employers (Hanson, 2001; Jensen, 2003; Mughal & Vechiu, 2009). In response to the skills required from human capital as a result of globalization, many developing nations that compete in the global economy and attract foreign direct investment have implemented and are enacting instructional programs such as science fairs to encourage and foster student learning from an early age in areas specifically related to twenty-first-century skills (Loucks-Horsley, Stiles, Mundry & Hewson, 2009; Wagner, 2010).

Science fairs are one type of instructional program used to promote an interest in and culture of science, technology, engineering, and mathematics (STEM) subjects (Bunderson & Anderson, 1996; Intel, 2014). In addition, science fairs provide participants with opportunities to improve and develop STEM skills and be exposed to college and STEM career opportunities. Such opportunities have been shown to increase student interest in STEM fields (Sahin, 2013). To promote an educated workforce, stimulate creativity in students, and encourage a STEM culture with students, Costa Rica has mandated student participation in the National Program of Science and Technology Fairs (NPSTF) beginning at the elementary school level to encourage an interest in STEM at an early age (Valencia-Chacón, 2011).

While much research has addressed the impact of globalization on educational policy, lacking is research examining how school principal leadership impacts participation in the Costa Rican NPSTF. The effectiveness of school leadership plays a vital role in the successful implementation of STEM curriculum and development (Loucks-Horsley et al., 2009). Research has indicated that interest in STEM careers may develop in early elementary school years (Maltese &Tai, 2010). Elementary school leadership plays a crucial role in stimulating students' interest in taking more STEM courses in middle and high school and, possibly, pursuing STEM careers (National Research Council, 2011). The purpose of this case study is to understand the effects of school principal leadership on participation in the NPSTF in five elementary schools in the San Jose metropolitan area of Costa Rica. This case study will identify the role of five elementary school principals in the implementation of the NPSTF initiative. It will also explore how schools may have restructured their educational programs by focusing on the sharing of leadership and teacher training. The research questions guiding this case study are: (1) What role do elementary school principals play in implementing the Costa Rican NPSTF? (2) How have elementary school principals prepared their schools to participate in the NPSTF?

Review of literature

Costa Rica places a great emphasis on education and is considered among the more

successful countries in Latin America at educating students (Bamber & Gereffi, 2013; Suarez, 2008). This small Central American country has long valued education and was one of the first countries in the world to mandate obligatory free public education that is supported by the state (Biesanz, Biesanz, & Biesanz, 1999). In 1949, the Costa Rican constitution abolished its military and reallocated funding to health and education (Biesanz et al., 1999; Palmer, Palmer, Jimenez & Molina, 2004). Over the past several decades, the Costa Rican government has made education an economic priority by investing over 20 percent of its national budget to education (World Bank, 2017). As a result, Costa Rican access to education increased at a faster rate than any Latin American country (Organisation for Economic Co-operation and Development [OECD], 2017). Education for Costa Rica has become an engine for the country's economic development, workforce development, and stable democracy (OECD, 2017; Suarez, 2008).

Despite the high rankings of its education system, the country has not been able to raise the quality of learning to the level that was expected from its rapid growth and overall investment in education (OECD, 2017; World Bank, 2015). Many Costa Ricans recognize a detachment between secondary schooling graduation rates and college and career readiness (Mitchell & Pentzer 2008; Paus & Gallagher, 2008). In 2015, the Programme for International Student Assessment (PISA) examination recorded that Costa Rican secondary students performed two years below their comparative OECD (2017) countries. Furthermore, approximately 30 percent of secondary students in Costa Rica do not graduate and 33 percent lack core competencies (OECD, 2017; Villalobos & Monge-Gonzalez, 2011).

Over 50 percent of Costa Ricans between ages 25–34 have not attained any postsecondary education. Preparing students to pursue postsecondary education and develop the skills necessary to work in a knowledge-based economy has become urgent for the Costa Rican government (Villalobos & Monge-Gonzalez, 2011; World Bank, 2015). As a result, tertiary education has rapidly expanded in the last decade to augment Costa Rica's competitiveness in a global and knowledge-based economy (OECD, 2017). With the influx and expansion of postsecondary institutions, many have teamed with multinational corporations to help support the Ministry of Education and Ministry of Science, Technology and Telecommunications to prepare kindergarten to grade 12 (K–12) students to enter careers in STEM professions (Mitchell & Pentzer, 2008; Weber, 2015).

Although over 25 percent of public education spending has been directed toward tertiary education, the higher-education system has not contributed to generate the skills needed for the STEM workforce, nor has it created a substantial K–12 education system STEM pipeline (World Bank, 2015). Consequently, graduates of higher-education institutions are heavily biased toward social sciences over basic engineering and science (OECD, 2017; World Bank, 2015). Private universities, which contribute over half of the graduates, tend to promote more social sciences because the infrastructure is less costly and thus more profitable. While Costa Rica has considerable high spending for education, it has not resulted in higher level of human capital in the STEM labor force (Villalobos & Monge-Gonzalez, 2011; World Bank, 2015). Although Costa Rica boast a high rate of tertiary enrollment (over 40%),

students are not graduating with degrees in the fields with the greatest and fastest-growing demands (Monge-Gonzalez & Tacsir, 2014). Furthermore, the supply of skills produced by tertiary education has not matched the needs of the labor market (World Bank, 2015).

Costa Rican government authorities as well as educational leaders recognize the discrepancy between education spending, resources, and the lack of STEM workforce (OECD, 2017). As a result, government authorities established policies to fund the necessary investment in infrastructure, human capital, and education that will advance a culture of innovation, increase the STEM workforce, and create a competitive advantage in today's knowledge-based economy (Monge-Gonzalez & Tacsir, 2014; Paus & Gallagher, 2008). One such policy is National Decree no. 31.900: the NPSTF.

Science and technology fairs were established during the early 1980s by universities located in the greater San Jose area. It was not until the mid-1990s that the University of Costa Rica officially organized a national science and technology fair with university students (Valencia-Chacon, 2011). As Costa Rica competed and expanded its economy in the global market, it was exposed to the challenges in its education and workforce development. As a way to combat these challenges, the Ministry of Education and the Ministry of Science, Technology and Communications sought to stimulate a culture of innovation and STEM development through participating and competing in science and technology fairs. The Ministry of Science, Technology and Communications of Costa Rica declared:

> The overall objective of this program is to stimulate creativity and to promote a scientific and technological culture, starting with the development of scientific thinking and knowledge, the development of student's skills and abilities in science and technology, as a stimulus to the new generations of Costa Ricans, through the demonstration and discussion of research projects designed by students. (Cited in Valencia-Chacon, 2011, p. 3)

In 1998, Legislation 7169 was passed, mandating that all public K–12 schools in Costa Rica participate and compete in the NPSTF (Valencia-Chacon, 2011). Today all public schools are provided with guidelines as to how and when the NPSTF is implemented (Valencia-Chacon, 2011). Despite this initiative, research has indicated that teacher professional development within the STEM categories are deficient and inconsistent in Costa Rica (Kodoma, 2016; Sorto, Marshall, Luschei, & Martin, 2009; Weber, 2015). Since all public schools in Costa Rica are mandated to participate in the NPSTF, school leadership and teacher training are essential for its overall implementation and success.

Conceptual framework

The conceptual frameworks of Lee Bolman and Terrance Deal's (2008) four frames were used to help analyze and understand the effects of educational leadership on participation in the NPSTF in five elementary schools in Costa Rica. The multifaceted model (Bolman & Deal, 2008) is comprised of four frames: a) structural, b) human resource, c) political, and d) symbolic (see Table 1).

Table 1. Overview of the four-frame model

Frame	Disciplinary root	Metaphor	Key concepts	Leadership contribution
Structural	Sociology, economics	Factory	Rules, roles, goals, policies, systems	Analysis, architect, design
Human resource	Psychology, organizational psychology	Extended family	Relationships, partnerships, needs,	Catalyst, servant
Political	Political science	Jungle	Power, conflict, competition	Advocacy, negotiator, coalition building
Symbolic	Anthropology, sociology	Temple	Culture, ritual, ceremony, stories	Significance, inspiration, meaning-making

The structural framework of Bolman and Deal (2008) explores the imperative to place people in the right roles and relationships within the right structure in an organization. The essence of the structural framework is based on the common belief that organizations exist mainly to accomplish established goals. When organizational problems occur within the structural framework, they usually originate from inadequate systems and can be rectified through restructuring new ones.

The human resource frame focuses on the social aspects among organizations, leaders, and employees. There are four assumptions underlying the human resource frame: a) organizations exists to serve human needs, b) organizations and people need each other, c) when the organization is poor, both the individual and the organization will suffer, and d) a good fit benefits both.

The political frame views organizations as competitive arenas. Within each organization there are groups and individuals that compete to achieve their own interest in a world of conflicting viewpoints and scarce resources (Bolman & Deal, 2008). The political framework is based on five assumption: a) organizations are coalitions of various individuals and interest groups; b) enduring differences exist among organization members in values, beliefs, interest, and perceptions of reality; c) vital decision-making involves the allocation of scarce resources; d) scarce resources and enduring differences give conflict a central role in organizational culture and make power the most important resource; and e) goals and decisions emerge from negotiations and bargaining for position among stakeholders (Bolman & Deal, 2008).

The symbolic frame views organizations as the embodiment and expression of the organization's beliefs, culture, practices, values, and artifacts that define for members who they are and how they are to perform (Bolman & Deal, 2008). The symbolic frame focuses on the secular myths, rituals, ceremonies, and stories that help employees in the organization to find meaning, purpose, and passion.

Methodology

The methodology used for this study was a case study approach. Case studies are a design of inquiry to help establish an in-depth analysis of an event, activity, or process within an organization or with an individual (Creswell, 2009). Through the case study approach, the researchers sought to understand the role school leaders play in the NPSTF through direct observations, surveys, and interviews with principals

and teachers at their school site (Merriam, 2009). The research team traveled to Costa Rica for 10 days of data collection.

Sample population

School sites were chosen from the Ministry of Education. As such, purposeful sampling was used for this study (Creswell, 2009; Merriam, 2009). All five school sites were elementary schools within a two-hour driving radius of San Jose, Costa Rica. San Jose is the capital and biggest city in Costa Rica and is considered the manufacturing center of Costa Rica (Manufacturing and Production Industries, n.d.). Pseudonyms were used for school names. The following are the five schools of this study: 1) Escuela Vista; 2) Escuela Ventura; 3) Escuela Sacramento; 4) Escuela Fresno; 5) Escuela Central. Table 2 contains a summary of the data collection of the five elementary schools. No socioeconomic demographics were provided to the research team.

Table 2. Summary of data collection of five elementary schools in the San Jose, Costa Rica region

Elementary school	Principal interviewed	Assistant principal interviewed	Teachers surveyed	Teachers interviewed	Students enrolled
Escuela Vista	1	0	20	7	900
Escuela Ventura	1	1	15	5	900
Escuela Sacramento	1	0	40	7	1,050
Escuela Fresno	1	0	16	3	1,812
Escuela Central	1	0	20	6	620
Total	**5**	**1**	**111**	**28**	**5,282**

School description

Escuela Vista is a kindergarten to grade eight school located near downtown San Jose. Out of the five schools participating in this study, Escuela Vista was the only one that went beyond sixth grade. The school is divided into two sections: kindergarten to fifth grade and sixth to eighth grade. Each section or grade levels attend school at different times of the day. Early morning school sessions are offered to lower grade levels, and upper grade levels attend in the afternoon.

Escuela Ventura is located in downtown San Jose. It is considered one of the oldest schools in San Jose. This school building structure, which was once used as an armory shelter, was very dilapidated and is situated on a very busy street corner. The school schedule is divided into two sessions: kindergarten to third grade and fourth to sixth grade. Grade levels alternate schedules through the year to attend early morning or afternoon sessions. According to the principal of Escuela Ventura, this school is located in one of the poorest neighborhoods in San Jose. The principal added that it has one of the highest immigrant populations in the city, with students from adjacent countries, such as Nicaragua, Panama, and Colombia.

Escuela Central is located in the south region of San Jose. This school building, which was considered broken-down and had many electrical problems, was able to change its infrastructure thanks to its principal. The principal of this school was able to obtain the funds necessary to not only renovate the building but also add modifications for the physically disabled. This school serves students from kindergarten to sixth grade.

Escuela Sacramento is located near the west region of downtown San Jose. During the time of the study, the researchers were able to observe the school participate in an actual NPSTF fair. Researchers were able to enter each class and observe how the NPSTF was performed and attend closing ceremonies for the event.

Escuela Fresno is located in the north region of San Jose. The school serves students from kindergarten to sixth grade. Lower grade levels attend school in the morning, while third to sixth grade attend in the afternoon. The school has a focus on foreign language development, particularly English and French. The school also houses a language laboratory with over 35 computers that is open to the community.

Protocols

Observation, interviews, and surveys were conducted at each of the five schools to triangulate different data sources of information by examining evidence from the results and using it to build a coherent justification of themes and validity to the study (Creswell, 2009). Interview protocols were developed for principals (Appendix 1) and teachers (Appendix 2) to examine the role of elementary school principals and how they prepare and support their school for the NPSTF initiative. The interview protocol allowed researchers the ability to gain deeper insight than in a structured approach, while also allowing for some flexibility (Merriam, 2009). Michael Quinn Patton's (2002) guidelines for meaningful questions were used as a base to create the semi-structured interview protocol. Principals at all five elementary schools were interviewed as well as one assistant principal from Escuela Ventura. A total of 28 randomly selected teachers were also interviewed. During the time of study, students were not available for interviews. Each interview was audio recorded and transcribed in its entirety.

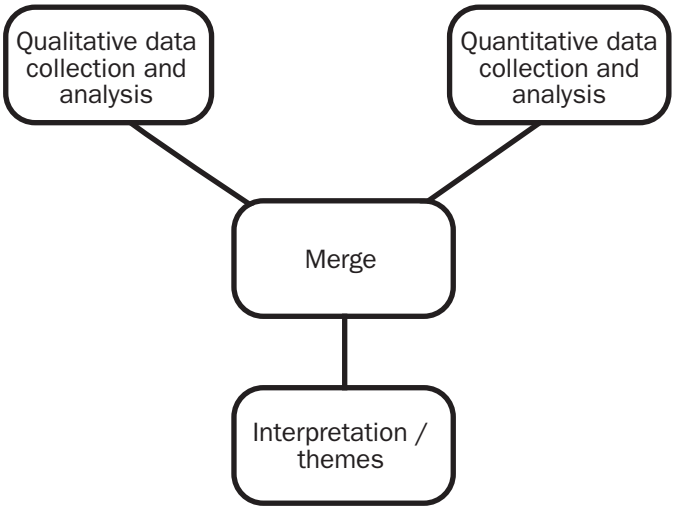
Two different online-based surveys were created with similar protocols. Surveys were developed for teachers (Appendix 3) and students (Appendix 4). A total of 111 selected teachers completed the survey. Furthermore, 322 selected students completed the survey. All of the surveys contain closed-ended questions that are answered using a Likert-type scale. Participants of this study were able to select from strongly agree, agree, disagree, strongly disagree, and not sure for each question. Once surveys were completed, a descriptive analysis was used to evaluate survey results to report the frequency of responses. In addition, the researchers made general field note observations for each school visit. Observations, behavior, and practices were recorded in a natural context (Merriam, 2009).

Research design

A convergent mixed-methods design was used for this study (see Figure 1). A convergent design involves the separate collection and analysis of qualitative and quan-

titative data. Upon completion, the results of the qualitative and quantitative data analyses were merged (Creswell, 2014). After results were merged, the research team examined the extent to which quantitative results confirmed the qualitative results.

Figure 2. Convergent design (Creswell, 2014)



The research team then created common codes to analyze the data. Data were accessed and analyzed by using a qualitative software program that provided acute, detailed analysis. The data analysis was based on John Creswell's (2009) six-step approach: a) organize and prepare data for analysis; b) read through all the data: c) begin detailed analysis with a coding process; d) use the coding process to generate a description of the setting or people as well as categories or themes for analysis; e) advance how the description and themes are represented in the qualitative narrative; and f) make an interpretation of the data by answering the research questions.

Findings

What role do elementary school principals play in implementing the Costa Rican NPSTF?

Although school principals play a vital role in the overall preparation and implementation of the NPSTF, data from this study indicate the specific role of the school principal was twofold: 1) motivator of teachers and students; and 2) acquirer of resources to help execute the NPSTF.

Motivator

The principal of Escuela Sacramento expressed that his role was to meet and supervise teachers closely, especially those who seemed to lack motivation for the NPSTF. He explained, "If during those meetings you see that there is a teacher with a very negative attitude, we try to find the way to motivate them." The principal of Escuela Central noted that many teachers disliked preparing and implementing the NPSTF. He affirmed, "What counts a lot here is personal motivation because there are teachers that don't like this … so we work with the element of motivation." He added, "I have to make sure I'm up to date. I have to transmit knowledge to [teachers], motivating them. That's the principal's responsibility." One teacher who also served as an

assistant principal at Escuela Ventura explained that without administrators motivating teachers and students, the NPSTF implementation "would not exist." When asked if a change in the culture and motivation of teachers in implementing and participating in the NPSTF occurred because of school leadership, the principal of Escuela Sacramento responded:

> Let me tell you this, until now nobody has refused to do anything. They have stayed until late and they never said, "I'll stay late tonight so can I take the day off tomorrow?" Nobody asked for that. But if they had requested for it I would have given it to them, because they have earned it. This means that they are motivated with me and I'm motivated with them, always aimed at the children's benefit.

The principal of Escuela Ventura saw fit to motivate teachers and students with awards declaring, "Internally the school rewards all students, we give them a title to motivate them and the awards are distributed the day we organize the fair." The principal from Escuela Fresno also used awards as a mean to motivate teachers, explaining that the school administration organizes an awards ceremony because "it's part of motivating and rewarding people for their efforts. It is a way of reducing the burden upon the principal's shoulders."

Teachers also viewed motivation as an essential role of the principal. One teacher from Escuela Central noted, "Here it's all motivation. Always—it's easy to motivate children because they always want to learn. It's the adults that you have to work with first. So, the principal motivates the teachers to get them to participate." One teacher from Escuela Ventura observed that the principal is regularly motivating teachers and students about the NPSTF, "constantly encouraging and congratulating teachers." A teacher from Escuela Sacramento recognized the role of the principal as a lead motivator to help students participate in the NPSTF. This teacher observed the principal is "more than anything like a teacher who has to motivate the children to work with them." Another teacher from Escuela Vista affirmed the principal plays a vital role to "realize all the motivation and processes of the school," and that the school principal "motivates teachers so that they participate." One teacher from Escuela Ventura expressed gratitude for the motivating role of the principal, "Thank God, we have always had the support from the administration, economically and motivationally." A teacher from Escuela Fresno noted the school administration generally "motivates the teachers to participate," but the role to motivate teachers is then "delegated to the teacher; in this case to the science teacher." An Escuela Central science teacher, who serves as the school's NPSTF coordinator, observed that together with the principal they "always program to have [teachers] motivated and take [teachers] into account" by providing them with gifts and awards.

Acquirer of resources

In interviews, the principals explained that a local school governing board generally allocates funding for school activities. However, there are no specific funds categorized for or dedicated to the NPSTF initiative. The school principal establishes additional funding and resources for the initiative. These principals acquired resources through various sources. The principal from Escuela Sacramento revealed that "most

of the resources are provided by the parents." The principal from Escuela Fresno added that during the initial stages of the NPSTF, "parents are the ones who contribute," but later explained,

> My role is to ensure that the resources are used in the best possible way and I am in charge of proposing the different projects and of convincing them that the projects are good in order to execute them. My role is also to guarantee that the projects are carried out accordingly.

The assistant principal for Escuela Ventura described how the administration team acquires resources for the NPSTF: "We get some of it from the school board and some from the parents. Our population is pretty poor so the school tries to implement and give them everything they need so they can achieve." The Escuela Ventura principal explained that a parent council was specifically organized to "look for resources" for the NPSTF.

Some principals went beyond the local school board and parents to acquire more resources for the NPSTF. The principal at Escuela Ventura explained that in addition to the parents and local school board, the school was able to leverage help with local businesses stating, "We are blessed to have the contribution from private companies because we are the biggest school in San Jose." The principal of Escuela Central acquired resources for the NPSTF by collaborating with the local city mayor and municipality. The Escuela Central principal described how he worked with the local municipality to help finance the NPSTF:

> The municipality has the obligation to help us. It's the law. When you go to city council meetings and find out that there is a tax on tobacco and alcohol, they are obligated to give us a percentage of that for the schools and nobody goes to those meetings. I've gone to the meetings, and I say, "How much of that is for my school?" "This much"…"I need you to give it to me."

The principal then added that funding received from the municipality was used to "subsidize the costs of school in different fields, that way I don't touch our general budget."

Teachers recognized the efforts of their principals to acquire resources necessary for the execution of the NPSTF. A teacher from Escuela Ventura was thankful for the financial support of the principal and explained "The thing is the administration sometimes has to make miracles to be able to provide us with everything to do with (NPSTF) decoration. The administration has always been in charge of giving us that support." A teacher at Escuela Vista observed that the principal constantly tries "to look for some kind of donations with different institutions." A teacher at Escuela Central recognized that the principal works with the school parent committee and local school board to help "provide us with the materials" for the NPSTF.

At Escuela Sacramento, the principal had organized a council to help finance the initiative. When asked how the school principal obtained the resources to participate in the NPSTF, a teacher revealed,

> Supposedly the board of education should finance it, but that does not happen. So then we plan activities. As a facilitator team, we try to carry out activities with the support of the institution and with

> the support of the parents, we try to carry out activities to raise funds and to be able to finance this activity.

The principal at Escuela Central had also created a school council to help sponsor the NPSTF. A teacher at Escuela Central teacher confirmed that through this NPSTF council "materials are acquired through them most of the time." In one case, a teacher from Escuela Ventura recognized that the principal had personally contributed financially to the NPSTF initiative. This teacher explained, "A lot of time it comes out of the principal's pocket to help the children who can't buy things like posters for the signs, and everything. The principal always looks for a resource to implement that."

Teacher survey responses

Teachers strongly indicated that principals play a critical role in implementing the NPSTF at the school site level. On a survey given to teachers from all five elementary schools, one item was "The school principal plays a critical role in ensuring teachers implement the NPSTF" (see Table 3). Teachers also indicated that it was essential to receive support from school principals to effectively implement the NPSTF initiative. Results indicated 91 percent of teachers agreed or strongly agreed. Teachers also responded to the following survey question: "Teachers need support from the school principal to implement the NPSTF fully and effectively" (see Table 4). Results indicated 94 percent of teachers agreed or strongly agreed.

Table 3. The school principal plays a critical role in ensuring teachers implement the NPSTF

	Strongly agree	Agree	Strongly disagree	Disagree	Unsure
Participating teachers	68%	23%	2%	5%	3%

Table 4. Teachers need support from the school principal to implement the NPSTF fully and effectively

	Strongly agree	Agree	Strongly disagree	Disagree	Unsure
Participating teachers	69%	25%	0%	2%	4%

Teachers were also asked about communication from school principals regarding the purpose and urgency of implementing the NPSTF. Teachers responded to the following survey question: "The school principal communicates the purpose and urgency of the NPSTF" (see Table 5). Teacher survey responses revealed 89 percent agreed or strongly agreed.

Table 5. The school principal communicates the purpose and urgency of the NPSTF

	Strongly agree	Agree	Strongly disagree	Disagree	Unsure
Participating teachers	52%	37%	3%	5%	4%

Both teachers and school leaders revealed the importance of acquiring resources to prepare and successfully execute the NPSTF. Teachers were surveyed the following with the following question: "My school has adequate resources to prepare students

for the NPSTF" (see Table 6). Teacher responses indicated 44 percent disagreed or strongly disagreed, compared to 54 percent who agreed or strongly agreed.

Table 6. My school has adequate resources to prepare students for the NPSTF

	Strongly agree	Agree	Strongly disagree	Disagree	Unsure
Participating teachers	24%	30%	18%	26%	2%

How have elementary school principals prepared their schools to participate in the NPSTF?

Organizer of NPSTF committees

The triangulation of data from surveys, observations, and interviews from this case study reveals school principals helped prepare their schools by establishing a school-wide NPSTF committee. When asked how school principals prepare for the NPSTF, the principals explained that a general NPSTF committee is formed to help train, plan, and organize for the event. As the principal from Escuela Fresno described, "We form a committee which is the one that is going to organize the different activities regarding the science fairs. This committee trains the teachers so that they start the process in the classroom." The Escuela Vista Principal observed that they have a science fair committee "who offer training" to teachers. The principal at Escuela Central also explained the process,

> As administrators, we make a central committee which is integrated by various coworkers of the institution. We are a committee of about eight people in which, as a principal, I'm the general coordinator. Within my agenda as a principal, I meet monthly with different committees, in this case with science fair committee. The science fair committee and I meet to see how the preparation for tickets, registration, the projects, times; everything that has to do with logistics that entails with the development of the event.

The assistant principal from Escuela Ventura also described how a committee is first formed and receives training for the NPSTF. The assistant principal explained that the school administration team works with the committee "with the changes that have been made in the (NPSTF) program and the way it's going to be done this year. Our committee distributes circulars and explains the process step by step." The principal from Escuela Sacramento explained the science fair committee is heavily dependent on the school's science teacher. The principal added, "In February we form committees. We have a person who is a science tutor. She's a teacher and at the same time she is a science tutor. She's the one in charge of the science process and the science fair."

Teachers also reaffirmed how that NPSTF committees were formed. One teacher from Escuela Central observed the organization of the NPSTF committee "comes from the 'top.' Some of my colleagues are in charge of what we call the general science fair committee. They are responsible for training." A teacher from Escuela Ventura explained that the principal "delegates functions so we're divided into groups. So

there are those that coordinate, others that are in charge of the [NPSTF] assembly." A teacher from Escuela Vista indicated that the administration "gives us spaces for us to meet as a committee." Another teacher from Escuela Ventura confirmed that the principal "selects people" to participate on a general NPSTF committee, while another teacher from Escuela Vista explained that the principal creates a NPSTF committee and the teachers "elect who will be on the committee." Teachers from Escuela Central noted that the school principal organized a general NPSTF committee with several subcommittees. One Escuela Central teacher explained that there is a "general committee, review committee, qualification committee, and an awards committee for the science fairs."

One teacher from Escuela Ventura explained, "there is a committee in charge of the fair, so the committee receives information the principal gives because the principal doesn't organize the entire personnel, but calls for the committee." Another teacher from Escuela Vista pointed out that the school principal "is the one who chooses the committee" and sends members to NPSTF training. An Escuela Central teacher observed the principal organizes the committee and makes sure members receive the necessary training to share with the rest of the teachers. This teacher explained that this committee "transmits the new information to the teachers, and the teachers are in charge of transmitting the information to the students. It is a process of sharing the information from the top to the bottom." Another teacher from Escuela Central noted the school principal organizes a NPSFT committee to also "motivate and teach [teachers] what we do in a way that they get excited and want to participate. He appoints us a consultants so we can help those colleagues with no experience."

Teacher survey responses

In addition to interview responses, teachers also revealed through survey responses that they collaborated to implement the NPSTF. Teachers were asked the following survey question, "Teachers at my school work together to plan and prepare for the NPSTF" (see Table 7). Results indicated 79 percent agreed or strongly agreed. Principals involving teachers to take key responsibilities for NPSTF implementation also played a significant role. Teachers were surveyed with the following question, "Teachers are given the leadership capacity to make decisions about projects for the NPSTF" (see Table 8). Teacher responses indicated 75 percent agreed or strongly agreed.

Table 7. Teachers at my school work together to plan and prepare for the NPSTF

	Strongly agree	Agree	Strongly disagree	Disagree	Unsure
Participating teachers	50%	29%	6%	13%	4%

Table 8. Teachers are given the leadership capacity to make decisions about projects for the NPSTF

	Strongly agree	Agree	Strongly disagree	Disagree	Unsure
Participating teachers	37%	38%	4%	14%	4%

Teachers in general received training for NPSTF from both the Ministry of Education and their local NPSTF school committee. Teachers were surveyed with the following question, "I am provided yearly training on NPSTF guidelines" (see Table 9). Results indicated 52 percent of respondents agreed or strongly disagreed. Teachers in the five elementary schools were also asked whether teachers are provided with adequate training to prepare students for NPSTF. Teacher responses revealed 63 percent agreed or strongly agreed (see Table 10).

Table 9. I am provided yearly training on NPSTF guidelines

	Strongly agree	Agree	Strongly disagree	Disagree	Unsure
Participating teachers	31%	21%	12%	27%	9%

Table 10. Teachers are provided with adequate training to prepare students for NPSTF

	Strongly agree	Agree	Strongly disagree	Disagree	Unsure
Participating teachers	33%	30%	9%	23%	5%

In general, teachers revealed a positive culture regarding the NPSTF at their school. Teachers were surveyed the following question, "There is a positive culture at my school regarding the NPSTF" (see Table 11). Teachers' responses revealed 82 percent agreed or strongly agreed.

Table 11. There is a positive culture at my school regarding the NPSTF

	Strongly agree	Agree	Strongly disagree	Disagree	Unsure
Participating teachers	36%	46%	2%	10%	6%

Discussion

Key findings from this case reveal that elementary school principals play a significant role in the implementation of the NPSTF. The data suggest principals played two key roles: the motivator of teachers and students and the essential acquirer of resources for NPSTF participation. The efforts of the elementary school principals to motivate both teachers and students for NPSTF participation appeared to associate with the human resource frame outlined by Bolman and Deal (2008). An essential component of the human resource frame is the ability of a leader to effectively communicate information and build meaningful and positive relationships with the employees through motivation, recognition, achievement, and responsibility (Bolman & Deal, 2008). Principals made the concerted effort to motivate teachers and students throughout the year by recognition, awards, and simply talking to them collectively and individually. Teachers recognized principals for their efforts to acknowledge them during the NPSTF implementation process. When leaders effectively understand how to motivate employees, the organization benefits from a more willing and innovated workforce (Bolman & Deal, 2008). However, extrinsic rewards in the education industry are unlikely to increase teacher and student competence and would likely undermine intrinsic motivation (Deci, Koestner, & Ryan, 2001; Lai, 2011;Salifu & Agbenyega, 2016).

The political frame describes organizations as coalitions with enduring differences that live in a society with scarce resources, which puts power and conflict at the center of decision-making (Bolman & Deal, 2008). Principals and teachers from this case study revealed resources were scarce. Only half of the teachers surveyed agreed that their resources for the implementation of the NPSTF were adequate. None of the schools visited had science labs or sufficient resources necessary to fully engage in NPSTF activities. Many of the STEM experiments observed during data collection did not have the appropriate equipment required.

Principals also played the role of politician. The political frame teaches that it is essential for leaders to obtain the following skills: agenda setting, mapping the political terrain, networking and forming coalitions, and bargaining and negotiating (Bolman & Deal, 2008). Each principal had communicated strategies to help obtain funding. Such strategies included collaborating with the local school board and the establishment of parent committees to help the school allocate additional materials and funding for the NPSTF. Part of mapping out the political terrain is for leaders to identify agents of political influence and network with external and internal players (Bolman & Deal, 2008). Such was evident as principals targeted businesses, politicians, and the local municipality to help leverage resources.

Through the structural frame, leaders increase efficiency and enhance performance through the appropriate delegation of labor as well as creating the right support system for implementation (Bolman & Deal, 2008). The delegation of labor was evident in the data since all of the principals organized a NPSTF committee to help plan, train, and implement the initiative. Principals also provided teachers with leadership opportunities to prepare and design NPSTF activities and training.

The symbolic frame focuses on how organizations make sense or find meaning in the chaotic and changing world in which they live (Bolman & Deal, 2008). Organizations have often relied on rituals, ceremonies, or forms of exhibitions to create order, clarity, and predictability to respond to dilemmas. In this case study, it was both the establishment of the NPSTF and the school principals that gave meaning and direction to their schools. The NPSTF was an attempt to provide the practices, rituals, and ceremonies that gave meaning and direction to how the youth of Costa Rica could prepare to compete in a global knowledge-based economy. By way of the NPSTF, school leaders aimed to create a culture of shared decision-making to help unite and bond the teachers and various committees to respond to the initiative. Often annual conventions or exhibitions renew old ties and revive deep collective commitments (Bolman & Deal, 2008). Through the symbolic frame, events and processes are often more important for what is expressed than what is produced (Bolman & Deal, 2008). For these school leaders, the underlying message expressed was not so much finding the right people and designing an appropriate structure but team building, which, at its heart, is a spiritual undertaking (Bolman & Deal, 2008).

Implications and recommendations

Implementing initiatives at the organizational level tend to expose gaps in knowledge, motivation, and practice. New initiatives often do not guarantee that organizations will have common goals or that support will be appropriately aligned for execution

(Schein, 2010). When initiatives are mandated, organizations typically provide the minimum for compliance and disincentives are realized when standards are exceeded (McDonnell & Elmore, 1987). Similarly, mandating the NPSTF revealed how teachers and school administrators struggled to execute this initiative. It is important to note the impact the NPSTF initiative had on the implied behaviors of the teachers. Interview responses from school principals suggested they had to motivate teachers to fully participate in this initiative. School principals also struggled to find adequate training and resources to comply with this initiative, while approximately half of the teachers believed they had adequate resources for NPSTF execution (see Table 5). One underlying factor that may have influenced their struggle is the overall lack of attention and emphasis Costa Rican education has placed in STEM education. Although Costa Rica has placed a major emphasis on general education, it has not produced sufficient STEM enrollment rates, graduate degrees, and workers to match its labor needs (Monge-Gonzalez & Tacsir, 2014; World Bank, 2015). Often the lack of positive results in building STEM education has been attributed to the absence of infrastructure or stakeholder involvement (Johnson, 2012). In this case, NPSTF stakeholders may need to be more aligned or invested in promoting this initiative beyond the realm of K–12 education and consider a serious partnership with STEM companies to help create career interest, incentives, and pipelines.

Although the NPSTF initiative is intended to stimulate a STEM culture, the major responsibility for assuring compliance rests on the Ministry of Science, Technology and Communications and Ministry of Education. To successfully mandate this initiative, there must be reliable information revealing under what conditions, if any, policies get implemented and work (Honig, 2006). In this case study, the schools visited did not provide such implementable conditions. None of the schools had science labs or the equipment necessary to conduct experiments. Although teachers did receive some training, the data indicate that it was minimal at best, and none of the principals had received any training on how to lead a STEM school. Lorraine McDonnell and Richard Elmore (1987) observed the level of enforcement and support that the initiating government is willing to pay for is a key determinant of the level of compliance it can expect.

For policymakers to help support and ameliorate the NPSTF initiative, it is recommended that they invest in a systematic, focused, and sustained set of supports for STEM teaching and infrastructure, which includes providing schools with science and technology labs. Adding science labs and other STEM-related infrastructure, especially at the elementary level, will not only help build interest at an early age but also invite teachers to create curriculum and innovative approaches to implement such tasks (Nadelson, Callahan, Pyke, Hay, Dance & Pfiester, 2013). Data from this study noted funding for the NPSTF was allocated from a general fund for school fairs. It is recommended the Ministry of Education create a separate budget or account dedicated to the development and infrastructure of the NPSTF. New initiatives should be proposed at the legislative level to help establish a robust plan to fiscally sustain this national directive. Collaborating and seeking donors in STEM fields can also help with revenue and materials for science labs.

Developing a nationwide STEM framework for K–12 education is strongly recommended. In addition, policymakers should consider funding STEM professional development specifically for school principals. School leaders that are involved in STEM professional development should better support teacher STEM instructional strategies, obtain more resources, and redirect appropriate curriculum (Halverson, Feinstein, & Meshoulam, 2011). Because school leadership plays an integral part of the success of this initiative, it is imperative that principals are placed in the right conditions and develop the skills needed to succeed. As more school conditions and funding are appropriately aligned with this initiative, principals will be better able to guide and nurture a STEM culture for teachers and students.

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Appendix 1
School Principal Interview Questions

1. How have you been prepared for the NPSTF?
2. In what ways do you elicit teacher feedback to improve implementation of the NPSTF?
3. How do teachers ensure that all students participate in the NPSTF?
4. How do you acquire resources necessary for participation in the NPSTF?
5. How are teachers recognized for their efforts with regard to implementation of the NPSTF?
6. Please describe how curriculum, pedagogy, or school culture has changed to accommodate for the NPSTF.
7. How does the NPSTF benefit students?
8. What instructional practices do teachers at your school use to prepare students for the NPSTF?
9. How have your teachers been trained to help students to prepare for the NPSTF?

Appendix 2
Teacher Interview Questions

1. How have you been prepared for the NPSTF?
2. In what ways do you elicit teacher feedback to improve implementation of the NPSTF?
3. How do teachers ensure that all students participate in the NPSTF?
4. How do you acquire resources necessary for participation in the NPSTF?
5. How are teachers recognized for their efforts with regard to implementation of the NPSTF?
6. Please describe how curriculum, pedagogy, or school culture has changed to accommodate the NPSTF.
7. How does the NPSTF benefit students?
8. What instructional practices do teachers at your school use to prepare students for the NPSTF? 9. How have your teachers been trained to help students to prepare for the NPSTF?

Appendix 3
Teacher Survey Questions

The School Principal plays a critical role in ensuring that teachers implement the National Programs of Science and Technology Fairs (NPSTF).

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

Teachers need support from the school Principal to implement the NPSTF fully and effectively.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

The School Principal elicits teacher feedback to improve implementation of the NPSTF.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

The School Principal communicates the purpose and urgency of the NPSTF.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

I provide opportunities for students to engage in scientific inquiry as part of my regular instruction.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

I utilize project-based learning (PBL) in my teaching.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

I am provided adequate training to prepare students for the NPSTF.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

My school has adequate resources that allow me to prepare students for the NPSTF.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

I am familiar with soft skills (critical thinking and problem solving, collaboration, communication, adaptability, analysis, curiosity, and imagination).

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

My School Principal talks about the importance of soft skills and their impact on student achievement.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

I have received training on how to integrate soft skills in the classroom.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

Student participation in the NPSTF is recognized throughout my school.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

Teachers at my school work together to plan and prepare for the NPSTF.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

The NPSTF has improved student collaboration in my classroom.

Strongly Agree

a. Agree
b. Disagree
c. Strongly Disagree
d. Not Sure

Teachers are given the leadership capacity to make decisions about projects for the NPSTF.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

There is a school-wide vision for the NPSTF.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

There is a positive culture at my school regarding the NPSTF.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

The School Principal communicates the goals for participation in the NPSTF.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

Teacher training was useful in preparing students for the NPSTF.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

There is a school curriculum plan to help prepare students for the NPSTF.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

I am provided yearly training on the NPSTF guidelines.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

There is a high level of participation in the NPSTF at my school

Appendix 4
Student Survey Questions

My teachers talk about why we are doing science fair projects.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

My teachers often help me learn about the scientific method through science and technology activities.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

My teachers have us work on group projects where we solve problems and work together.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

My teachers help me get my science fair project ready.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

My school has all the things I need to help me with my science fair project.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

I know about soft skills (critical thinking and problem solving, collaboration, communication, adaptability, analysis, curiosity, and imagination).

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

My teachers talk about the importance of soft skills and how they will help me do well in school.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

I can improve my soft skills when I do projects for the science fair.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

My school rewards students who participate in the science fair.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure

People at my school enjoy getting ready for the science fair.

a. Strongly Agree
b. Agree
c. Disagree
d. Strongly Disagree
e. Not Sure