Delivering K-12 Invention & Entrepreneurship to Rural Areas: Programming, Teacher Experiences, and Student Outcomes in a Partner Hub

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Abstract

The K12 InVenture Prize program has been creating the next generation of engineers and entrepreneurs through invention education since 2013. Its key components include teacher professional development, a semi-structured curriculum, an online platform for students to receive periodic feedback on their inventions, and a culminating state competition event at the Georgia Institute of Technology (Georgia Tech).

The program is actively trying to reach more rural areas by engaging urban and small-town hubs located within rural counties. A total of 35 schools, 55 teachers, and over 200 students from a new hub were involved in the program during the 2018-2019 school year. We found that the use of a regionally-centered, in-person event catalyzed participation in the region more than any previously attempted recruitment efforts, including offers of financial support and meetings with school leaders.

Surveys were administered to a subset of participating teachers and students in the region, allowing for insights into how participants experienced the program in this setting. Outcomes assessed in the student survey include math interest, science interest, self-efficacy for schoolwork, and creative problem solving. Outcomes assessed in the teacher survey include perceived impact of the program on students, motivation for participating in the program, and self-efficacy for teaching engineering and entrepreneurship. Barriers and supports to the expansion of the program into this area, along with results from the student and teacher surveys, will be presented in this paper. Preliminary findings suggest similar positive experiences among students and teachers as those seen previously in settings located close to the hosting institution, suggesting that creation of hubs with local competitions may be a scalable strategy. This is an important early finding given the potential benefits of extending the rich, contextualized educational experiences engendered by K-12/university partnerships to K-12 institutions that have limited geographical access to major universities.

Introduction

Invention and entrepreneurship are at the core of the American spirit and economy. Our global quality of life depends on inventions that will ultimately solve grand challenges, as well as simple inventions that delight and improve quality of life. These claims are supported by the recent STEM Education Strategic Plan published by the White House, which cites innovation and entrepreneurship as critically important to U.S. competitiveness and security [1].

However, U.S. patent holders typically come from high-income families, with few patents belonging to women and minorities [2]. This study coins the phrase “lost Einsteins”—children who may have become inventors if they had been exposed to innovation growing up, where a disproportionate number of these “lost Einsteins” are from lower income brackets, rural areas, and underrepresented minorities. As a result, the 2018 Study of Underrepresented Classes Chasing Engineering and Science Success (SUCCESS) Act directed the U.S. Patent and Trademark Office to report the number of patents obtained by women and minorities, and to provide recommendations to increase the number of patent applications from these groups [3].

Educational programs that promote invention and entrepreneurship activities are being initiated worldwide at both the collegiate and K-12 levels, with the goal of expanding and diversifying the pipeline into STEM-related jobs, patents, and other innovative activities. At the K-12 level specifically, over 120,000 US students participate annually in invention education programs that lead to participation in local, state, and national competitions. Invention Convention™ is now a worldwide program, with a flagship national competition held annually at the Henry Ford museum in Dearborn, MI, attracting 500 top K-12 inventors annually. Students qualify for this competition through dozens of different state-level programs, including K12 InVenture Prize.

Program History and Offerings

The K12 InVenture Prize program has been in existence since 2013, and now reaches approximately 5,000 K-12 students annually. It is a university-based outreach program whose mission is to create the next generation of engineers and entrepreneurs by making invention education accessible to all students and teachers in Georgia and beyond. This program was inspired by its collegiate-level predecessor, which is an undergraduate invention competition with a live TV show airing on Georgia Public Broadcasting [3].

The K12 InVenture Prize is unique in its focus on developing innovative teachers as well as students. Teacher workshops are facilitated by experienced invention teachers, called Master Teachers, who also develop curriculum and present at education conferences. Teachers may implement invention lessons where they see fit, and they often collaborate with teachers in other disciplines to do so. The curricular offerings have been used in Gifted classes, after-school programs, AP science and math courses, and even English classes, because of the heavy communication requirements.

Event offerings include teacher professional development workshops, a virtual (online) mock pitch day for students to receive feedback on their ideas, and the state finals competition in spring. Schools host local or county-level competitions to determine their top teams for state finals. State finalists are judged by university faculty, industry professionals, government representatives, and members of the education community, and a subset of state-level winners advance to a national competition.

The program boasts high participation of females (~ 50%), underrepresented minorities (~30%), and Title 1 schools (~30%), but most of the participants come from the metropolitan area in which Georgia Tech, the university hub (and host of the state finals competition), is located. The lack of participation from the more rural areas prompted organizers to consider innovative strategies to make invention education accessible and welcoming to schools and students that may not normally engage with programming offered by K12 InVenture Prize For the purpose of this paper, “rural” is defined using the definitions put forth by the National Center for Education Statistics, which uses schools’ proximity to urban clusters and size of urban clusters to categorize a school’s rural designation [4]. Our approach is to use smaller urban clusters as hosts for local competitions, that can reach schools in the 5-25+ mile range (constituting a rural school), as well as the schools in the urban clusters that are not the primary metropolitan area within the state.

Motivating Rural Expansion

The invention process is a tight coupling of engineering design with entrepreneurial thinking. A good invention process considers the end users, the market, and the stakeholders; this entrepreneurial thinking enables students to identify opportunities for innovation. Specifically, invention includes the act of problem *finding*. While most engineering programming asks students to *define* a problem, some version of a problem is generally given. Finding the right problem to tackle is an entrepreneurial endeavor that students do not often experience [5]. Teaching problem finding has two major advantages: 1) students can choose a problem to solve in which they have a vested interest, and 2) students and teachers are empowered to define place-based problems that are relevant to their communities. Teachers report that students in invention education often discover real-world relevance and applications of topics they learn in school while inventing [6].

Entrepreneurial thinking brings value to rural communities in at least two ways. First, established businesses value innovative thinking. The National Academy of Engineering reports that students with entrepreneurial training are better prepared to collaborate effectively and support their business as innovators [7]. Second, entrepreneurial thinkers are equipped to start businesses that are likely to be successful. While perhaps counter-intuitive, rural areas have *higher rates* of self-employed business proprietors than metropolitan areas, and those businesses have higher five-year survival rates than their metropolitan counterparts [8]. If rural and small-town areas are already entrepreneurial, then inclusion of invention and entrepreneurship in K-12 education would not be a radical departure from cultural norms, but rather a way of strengthening and improving what is already a way of life.

It is well documented that 'outmigration'—the departure of young people from rural areas to pursue educational and job opportunities elsewhere—significantly plagues rural communities. However, like people everywhere, rural youth experience place-attachment, and often would prefer to stay in the communities in which they grew up if jobs are available [9], or return to these communities after pursuing higher education or other opportunities, a phenomenon known as 'return migration' [10]. In a study of over 300 return-migrants, self-employment was cited widely as a way of making a living in rural labor markets.

In order to address the vicious cycle of outmigration and the recruiting issues of existing businesses in rural regions, curriculum, pedagogy, and policy in rural schools should support students in learning how to contribute to the economic base of the local community and contribute to the conditions that make returning to the local community viable and attractive [11]. Targeting rural areas for programs that work to bolster invention and entrepreneurship may positively impact both students and teachers in their personal and professional growth and also influence the well-being of rural communities more broadly.

Despite the symbiosis between rural areas and entrepreneurship, past attempts to expand the K12 InVenture Prize program to rural regions have not been successful. A first strategy attempted was to provide travel stipends for students to travel to Georgia Tech for the state finals. This offering, however, did not address the anxiety that students and teachers have about presenting a project at an elite university. The leap from school competition to state competition felt too large for many schools. A second strategy was to bolster infrastructure at these schools, providing funds for computers and other prototyping supplies. Still, infrastructure alone does not build confidence in students and teachers. Another strategy still was to bring professional development offerings directly to rural areas or nearby urban areas. However, after the professional development ended, teachers did not have a support network or partners to implement what is a truly challenging curriculum, in part due to its open-ended nature.

These unsuccessful efforts led to the need for more local partners and regional competition events that might provide an easier on-ramp for teachers and students into invention education and that might ultimately create supportive STEM ecosystems in areas outside of major metropolitan areas and areas close to major universities.

Regional Hub Model

Based on prior experience on the part of K12 InVenture Prize program staff, the key components needed for a successful regional hub model are:

- Low cost annual professional development opportunities to encourage teacher buy-in
- Strong relationships with district level leadership and early adopting teachers
- On-ground staff support within the region
- A high-quality, locally-hosted regional competition with a focus on student recognition
- Local community and business engagement

Specific Regional Offerings

To build higher levels of engagement with the invention-based competition, year-round local support is needed from a partner in the region. The partner serves as both a local point of contact and a competition facilitator. In this case, the partner led meetings with district leadership to inform them about the program and associated resources.

In addition, local professional development workshops were offered, instead of suggesting that teachers attend trainings in a larger metropolitan area of the state, which lowered the financial and time barriers to entry. The training sessions were led by Master Teachers who shared experiences and perspectives on how to teach the K12 InVenture Prize program content and mentor a successful invention team.

A regional competition was organized to select teams for the state finals competition. The competition location and timing allowed all participating schools to travel to and from the competition location within a single school day, keeping costs for the schools to a minimum. The regional competition mirrors the student experience at a state level competition as closely as possible, creating a positive experience and building confidence in students and teachers so that schools want to come back and compete year after year.

Creating a culture and ecosystem where invention and entrepreneurship can thrive is reliant on having professionals from local businesses interacting with the students through the judging process. These interactions aid in building support around the competition that goes beyond the schools. Local community members can see the benefits of invention education through the competition paradigm, where students apply their knowledge to real world problems. In order to attract a strong judging pool, the regional partner presented to various community-based organizations such as rotary clubs and alumni associations.

Overall, the regional hub model resulted in 62 teachers trained from 42 schools across 8 districts, and 54 student participants at the regional qualifier. 18 students from the regional went on to attend state finals at Georgia Tech. We focused our research efforts on students and teachers from one school district within the focal region; 39 teachers and 26 schools from this school district participated in the K12 InVenture Prize program in some capacity during the 2018-2019 school year.

Methods

Student Survey

Instrument

A variety of outcomes of interest potentially related to students' experiences with K12 InVenture Prize were measured through an online survey. Outcomes were selected based on prior research on teachers [6, 12] as well as limited prior research with K12 InVenture Prize students [13]. Some outcomes in the student survey were selected to explore student alignment with teachers' views on how competition participation impacted their students.

A total of 26 survey items were used to measure six unique constructs. Survey items and scales were pulled from a previously validated instrument used in similar research efforts with comparable student populations. A list of constructs and the number of survey items used to measure each is presented in Table 1. Students responded to these items on a 4-point response scale, with 1 = Strongly Disagree, 2 = Disagree, 3 = Agree, and 4 = Strongly Agree. This four point response scale was selected for simplicity due to survey participants being elementary school students.

Table 1. Student survey constructs.

Construct	# items
Math Interest	3
Science Interest	7
Self-Efficacy	5
Creative Problem Solving	1
Teamwork & Collaboration	6
Creativity & Communication	4

Participants

Twenty-two total surveys from student participants in our focal region of interest were received. Survey respondents were split between two schools in the focal region. 18 (82% of) survey respondents attend School 1 while 4 (18% of) students attend School 2. School 1 is a K-8 school focused on the arts; students in grades K – 5 at this school are selected via a lottery. The K12 InVenture Prize program was implemented at this school in a STEM lab in which all 4th and 5th grade students across the school participate. School 2 is a traditional elementary school where students attend based on their home location. All survey respondents are in 4th or 5th grade, with 8 (36% of) survey respondents in 4th grade and 14 (64% of) survey respondents in 5th grade. Roughly 60% of respondents are female (n = 13). Just over 70% of respondents are White (n = 16), roughly 15% are multi-racial or Other, unspecified (n = 3), and roughly 5% each are African American (n = 1), Asian (n = 1), and Hispanic/Latino (n = 1).

Data Collection

Teachers were invited via e-mail to assist with this classroom research effort. Participating teachers were visited by a local research staff member, and were provided with copies of all study materials. After teachers obtained signed consent and assent forms and administered the survey to their students, the research staff member visited the schools again to collect all materials. The data collection was carried out from December, 2018 to February, 2019.

Teacher Survey

Instrument

The survey instrument used for this research was informed by our prior research with K12 InVenture Prize teachers [6, 12, 14]. All constructs measured in this version of the survey had been used in prior versions of the survey with K12 InVenture Prize teachers. The survey included items on teacher demographics and teaching experience, details of teachers' program implementation, and the extent to which teachers perceived that K12 InVenture Prize participation was associated with a variety of student outcomes. Additionally, modified versions of previously validated instruments were used to measure teachers' motivation for participating in the K12 InVenture Prize program [15] and teachers' self-efficacy for teaching engineering and entrepreneurship [16].

Participants

A total of six teachers from our focal region began the survey. Of these, two discontinued the survey during the demographics and teaching background sections; a total of four respondents completed the survey. All four teachers who completed the survey are women, and all four teachers are White. For all four teachers, the 2018-2019 school year was their first year implementing the K12 InVenture Prize program. Two teachers implemented in a gifted program, one implemented in a research class, and one implemented in a STEM lab. Both teachers who implemented in a gifted class worked with small groups of students (9 and 14 students), while the teachers implementing in the research class and STEM lab worked with larger groups of students, 125 and 250 students, respectively.

Data Collection

All teachers implementing the program in our focal region were invited via e-mail to participate in the survey. A link to the online consent form and survey, administered via Survey Monkey, was included in the invitation e-mail. A reminder e-mail was sent roughly two weeks after the initial e-mail invitation.

Results

Student Survey

Mean response values on all scales are well above the scale midpoint of 2.5; mean responses are also above the 3.0 "Agree" response option on all but one of the scales. These results suggest that K12 InVenture Prize students responding to this survey have a relatively high standing on all of these constructs near the end of their experience with the program. Descriptive statistics on all scales are shown in Table 2.

Table 2. Descriptive statistics on student survey constructs.

Variable	Sample Size	Min	Max	Mean	SD
Math Interest	22	1.33	4.00	2.98	0.72
Science Interest	22	2.00	4.00	3.19	0.50
Academic Self-Efficacy	22	2.60	4.00	3.36	0.44
Creative Problem Solving	22	2.00	4.00	3.45	0.67
Teamwork & Collaboration	22	2.00	4.00	3.10	0.57
Creativity & Communication	22	2.25	4.00	3.23	0.49

A more compelling result would be to show increases in students' standing on these variables over time; unfortunately, time delays with securing both county and institute level IRB, coupled with a time lag in enrolling schools in the program, resulted in a post-only survey design being implemented. In future years, we will attempt a pre-post survey design in order to determine whether students' standing on these scales increases over the duration of the program. Prior student research in which a pre-post survey design was utilized showed minimal changes across program participants on most constructs measured, with the notable exception of Creativity & Communication, on which students showed an average increase of nearly ½ point on a four point response scale from the pre to the post survey time point [13]. Additional student research utilizing both larger sample sizes and a pre-post design would be valuable for further investigation of how K12 InVenture Prize participation impacts students.

Group Comparisons on Outcomes of Interest

School comparison

A simple comparison was conducted to check for trends in the data in terms of potential differences across schools. Across all outcomes of interest, students at School 2 provided higher mean responses as compared to students at School 1. The mean difference between the two school groups ranges from roughly ¼ point (on science interest) to nearly one whole point (on teamwork & collaboration). These results are shown in Table 3. This finding is notable both due to the consistency in the finding across all outcomes of interest, as well as the large magnitude of the difference in several cases (i.e., roughly ½ point or greater on five out of the six outcomes of interest).

This finding illustrates the potential differences in students' experiences across different implementations. Future research is needed to tease out the key factors of an implementation that influence students' experiences; we have not yet investigated variability in implementation across classroom settings and how such variations might impact student experiences and benefits. These preliminary results indicate that students' experiences in the program may vary. However, given that these are post-only data, these findings could be driven to some extent by preexisting and/or external differences unrelated to the program.

As noted earlier, a pre vs. post comparison could potentially shed more light on this area of research. Because teachers implement on their own schedule, there is no clear “beginning” of the program across implementations, making it difficult to pinpoint the start of implementation and administer a true pre survey. The post survey is far easier to administer, given that the state finals competition marks a clear end to the program each year.

Gender comparison

A simple comparison was conducted to check for trends in the data in terms of potential gender differences. Gender differences are consistent in direction, with female students scoring higher than male students on five out of the six outcomes of interest; these differences vary in magnitude. The most notable finding with respect to gender is that female students scored roughly ½ point higher on both math interest and science interest as compared to male students. Female students also scored higher than male students on self-efficacy, creative problem solving, and creativity & communication, although these differences are smaller in magnitude, ranging from 1/5 to 1/3 point. These results are presented in Table 4. This is an area that warrants further investigation in order to determine the differential impacts, if any, of program participation on male and female students.

Table 3. School comparison on student survey outcomes.

School Comparison							
Variable Name	School 1			School 2			Mean Comp.
	N	Mean	SD	N	Mean	SD	
Math Interest	18	2.85	0.68	4	3.58	0.63	0.73
Science Interest	18	3.15	0.51	4	3.38	0.45	0.24
Self-Efficacy	18	3.28	0.39	4	3.75	0.50	0.47
Creative Problem Solving	18	3.33	0.69	4	4.00	0.00	0.67
Teamwork & Collaboration	18	2.94	0.49	4	3.83	0.24	0.90
Creativity & Communication	18	3.08	0.40	4	3.88	0.25	0.79

Table 4. Gender comparison on student survey outcomes.

Gender Comparison							
Variable Name	Female			Male			Mean Comp.
	N	Mean	SD	N	Mean	SD	
Math Interest	13	3.21	0.66	9	2.67	0.71	-0.54
Science Interest	13	3.37	0.36	9	2.92	0.57	-0.45
Self-Efficacy	13	3.49	0.42	9	3.18	0.43	-0.31
Creative Problem Solving	13	3.54	0.66	9	3.33	0.71	-0.21
Teamwork & Collaboration	13	3.10	0.65	9	3.10	0.48	-0.01
Creativity & Communication	13	3.31	0.52	9	3.11	0.44	-0.20

Teacher Survey

These teachers varied in their utilization of program resources and activities; Table 5 shows each teacher's pattern of resource utilization/participation in activities. This variety illustrates how well-suited the program is to adaptation for specific needs and time constraints.

Table 5. Use of program components by teacher.

	Attended PD	Used curriculum	Participated in Online Pitch Day	Hosted a school-level or local competition	Attended regional competition	Attended K12 InVenture Prize State Finals
Teacher A	Yes	Yes	No	No	No	No
Teacher B	No	Yes	No	Yes	Yes	Yes
Teacher C	*Blank*	Yes	*Blank*	Yes	Yes	Yes
Teacher D	Yes	Yes	No	No	Yes	No

The first set of survey items relates to teachers' perceptions of the impact of program participation on their students. Teachers' mean response was at a level of 4.0 or higher (corresponding to "Slightly Agree" on a six-point response scale) for all ten items on student impact, indicating that teachers perceive many student benefits to participation in inventing. These results match findings of similarly high ratings of positive program impacts on students from prior research with program teachers [6, 12-14]. Table 6 provides the student impact items as well as descriptive statistics for each.

Table 6. Teachers' perceived impact of K12 InVenture Prize participation on students.

	Sample Size	Mean	Min.	Max
Participating in K12 InVenture Prize has increased my students' enthusiasm for learning about engineering.	4	5.25	5.0	6.0
Participating in K12 InVenture Prize has increased my students' enthusiasm for learning about entrepreneurship/innovation.	4	5.00	4.0	6.0
Participating in K12 InVenture Prize has increased my students' ability to clearly present their ideas to others.	4	5.00	5.0	5.0
Participating in K12 InVenture Prize has increased my students' ability to work effectively in teams.	4	5.25	5.0	6.0
Participating in K12 InVenture Prize has increased my students' confidence with engineering concepts.	4	5.00	5.0	5.0

Participating in K12 InVenture Prize has increased my students' confidence with entrepreneurship concepts.	4	4.50	3.0	5.0
Participating in K12 InVenture Prize has increased my students’ knowledge of the engineering design process.	4	5.75	5.0	6.0
Participating in K12 InVenture Prize has increased my students’ knowledge of how products are made.	4	5.00	5.0	5.0
Participating in K12 InVenture Prize has increased my students’ knowledge of how to design an effective sales pitch.	4	5.25	5.0	6.0
Participating in K12 InVenture Prize has increased my students’ understanding of how to start a business.	3	4.00	3.0	5.0
Participating in K12 InVenture Prize has increased my students' confidence with science concepts.	3	4.67	4.0	6.0
Participating in K12 InVenture Prize has increased my students' confidence with math concepts.	4	4.50	4.0	5.0

Teachers’ motivation for participating in the program was assessed with a modification of an existing scale for assessing teachers’ motivation for a variety of work tasks [15]. This scale assesses five types of motivation, two of which are thought to be largely positive (Intrinsic Motivation, in which the task or experience is in and of itself pleasing or rewarding to the individual; and Identified Regulation, in which the task or experience aligns with the individual’s personal values or goals), and three of which are thought to be largely negative (Introjected Regulation, in which avoidance of guilt or other negative feelings serves as a motivator; External Regulation, in which an obligation or demand from work or elsewhere serves as a motivator; and Amotivation, where the individual is unsure of why he/she is doing something, and is unable to articulate a motivating factor) [15]. As has been the case with several other groups of program teachers, respondents provided high levels of agreement with statements reflecting the two more positive types of motivation (Intrinsic Motivation, mean = 5.08, and Identified Regulation, mean = 4.41), and provided low levels of agreement with statements reflecting the three more negative types of motivation (Introjected Regulation, mean = 2.25; External Regulation, mean = 1.25, Amotivation, mean = 1.33) [12].

These low mean scores on the three more generally negative types of motivation reflect positively on teachers’ motivation to participate in the K12 InVenture Prize program, in that these low scores reflect that these teachers, on average, do not experience feelings of not knowing why they chose to participate (Amotivation), nor do they feel motivated to participate by feelings of obligation (External Regulation) or guilt (Introjected Regulation). Table 7 shows the five motivation subscales (each comprised of three survey items) and descriptive statistics for each.

Table 7. Motivation for K12 InVenture Prize participation.

	Sample Size	Mean	Min.	Max.
Intrinsic Motivation	4	5.08	4.67	5.67
Identified Regulation	4	4.42	3.67	5.00
Introjected Regulation	4	2.25	1.00	4.67
External Regulation	4	1.25	1.00	2.00
Amotivation	4	1.33	1.00	2.00

Teachers' self-efficacy for a variety of tasks related to teaching both engineering and entrepreneurship was assessed. Self-efficacy for teaching engineering was measured using an existing, validated instrument, the Teaching Engineering Self-Efficacy Scale (TESS) [16]. Self-efficacy for teaching entrepreneurship was measured with a subset of the TESS items modified to address entrepreneurship related content and activities. The TESS has four subscales, which will be reported on below, while the entrepreneurship items are considered individually, as they do not comprise a validated scale.

The TESS content knowledge subscale relates to a teacher's belief that he/she possesses the necessary knowledge about engineering to be able to teach it effectively and enable student learning. The TESS student engagement subscale reflects a teacher's belief in her/her ability to engage students in engineering content and activities during engineering lessons. The TESS discipline subscale reflects a teacher's belief in his/her ability to discipline students effectively and maintain a well-disciplined classroom environment during engineering lessons. Lastly, the TESS outcome expectancy subscale reflects a teacher's belief in his/her ability to directly impact student achievement and growth with respect to learning engineering content as a result of his/her teaching [16].

Teachers provided high levels of agreement on the four TESS subscales, with mean agreement levels falling well above the "Slightly Agree" (4.0) response option. Teacher responses on the self-efficacy for teaching entrepreneurship items showed slightly more variability (with the lowest mean response across the self-efficacy for teaching entrepreneurship items appearing for the item on spending time necessary to plan entrepreneurship lessons, mean = 3.8), but all mean responses were above the scale midpoint of 3.5. In general, teachers expressed high levels of self-efficacy for teaching both engineering and entrepreneurship, and self-efficacy was somewhat higher in general for teaching engineering as compared to teaching entrepreneurship. The single item with the lowest mean response within both the TESS and self-efficacy for teaching entrepreneurship sections related to having sufficient time to plan lessons, which may or may not be unique to invention curriculum. These results mirror similar findings on these subscales from prior research with program teachers [6, 12, 14]. Subscales (TESS) or individual items (self-efficacy for teaching entrepreneurship), along with descriptive statistics for each, are presented in Table 8.

Table 8. Teaching Engineering Self-Efficacy Scale (TESS) subscales, and TESS items modified for entrepreneurship.

TESS Subscale or TESS item modified for entrepreneurship	N	Mean	Min.	Max.
TESS: Content Knowledge Subscale (9 items)	4	4.72	4.33	5.11
TESS: Student Engagement Subscale (4 items)	4	5.31	5.00	5.75
TESS: Discipline Subscale (5 items)	4	5.20	4.60	5.80
TESS: Outcome Expectancy Subscale (5 items)	4	4.73	4.50	5.00
I can discuss how business and entrepreneurship affects my daily life.	4	4.50	4.00	5.00
I can help my students understand how different products appeal to different audiences.	4	5.00	5.00	5.00
I can spend the time necessary to plan entrepreneurship lessons for my class	4	3.75	3.00	4.00
I can employ entrepreneurship activities in my classroom effectively	4	4.25	3.00	5.00
I can craft good questions about entrepreneurship for my students	4	4.25	3.00	5.00
I can discuss how design requirements for an engineering project relate to customer satisfaction and business success	4	5.25	5.00	6.00
I am comfortable providing feedback about pricing and marketing aspects of student projects	4	4.75	4.00	5.00
I can gauge student comprehension of the entrepreneurship concepts that I have taught	4	4.50	4.00	5.00
I can assess my students entrepreneurial thinking through activities, quizzes, class discussions, etc.	4	4.75	4.00	5.00
I feel it is valuable to teach entrepreneurial thinking to my students	4	4.75	4.00	5.00

Conclusion

Engaging in invention and entrepreneurship education-related activities confers a variety of benefits to K-12 students. The opportunity to participate in such programs should be available to students across all geographic areas, not just those that are near large cities and universities. This paper highlights a specific strategy for broadening the reach of an invention-focused K-12 educational opportunity housed within a large research institution in a major city. Key components driving the success of this expansion relate to people and place.

The people components include building and maintaining positive relationships between program staff and school leadership and teachers within the focal region, the presence of staff support within the focal region, and a means to provide affordable and local professional development to teachers taking on program implementation. For this specific expansion effort, our institution had a staff member present in the region to assist with program activities for the first year. It remains to be seen whether such an expansion can be facilitated without the presence of local staff from the institution.

The place components refer to ways of replicating parts of the program experience in the focal region, to avoid the cost and time associated with travel to the program's home institution. This was accomplished primarily through the creation of a regional competition in the focal region. Holding regional competitions in distal areas serves both the goal of expanding access to the program and its more meaningful components to a large group of students and teachers without the need for them all to travel to Georgia Tech, and also the goal of winnowing down the field of competitors prior to the state finals event hosted at Georgia Tech.

Data collected from both teachers and students participating in the program's expansion to the focal region largely mirror those collected from participating teachers and students located within the metro area of the home institution. These preliminary results suggest that students and teachers participating in locations both near and far are experiencing a similar set of benefits as a result of their participation. Further research is needed to determine how a remote program experience differs from a proximal one, and whether these differences have a meaningful impact on student and teacher experiences with the program. It will also be crucial to implement the newly developed regional hub model in other regions in order to determine its generalizability and likelihood of success across regions, which each carry their own set of strengths and challenges for program implementation.

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