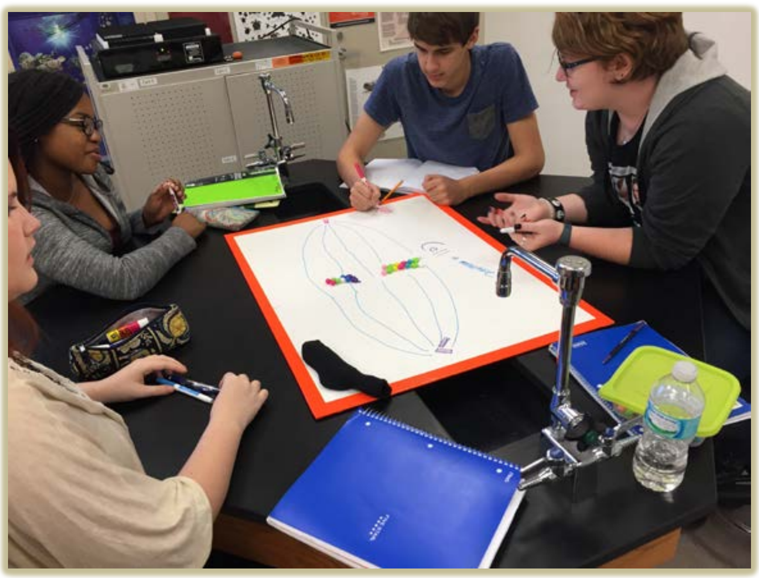
AdvancED®

STEM Certification Review Report

Review Date: November 8-9, 2015



The Florida Southwestern Collegiate High School – Lee Campus
8099 College Parkway
Fort Myers, Florida 33919
Dr. Brian Botts, Principal

Introduction

The purpose of establishing the AdvancED STEM Certification is to provide schools and programs within schools with a research-based framework and criteria for their awareness, continuous improvement, and assessment of the quality, rigor, and substance of a STEM educational program. AdvancED STEM Certification is a mark of distinction and excellence for those institutions and programs that are granted the certification.

The STEM certification process is similar to the AdvancED External Review process yet different in that the STEM certification process primarily focuses on the school or program's STEM education model. In addition to the institution's completion of the STEM specific diagnostics, the STEM Certification Reviewer examines evidence, conducts observations, interviews stakeholders and participates in the External Review Team's deliberations during the on-site phase of the process. AdvancED STEM Certification should reflect an institution or program's ongoing commitment to STEM education. As such, STEM Certification Reviews are intended to observe the institution or program in its natural operational setting. During the on-site visit the review team should observe examples of normal activity rather than a special event created specifically for the evaluation. After considering all of the data gathered during the review, the STEM Certification Reviewer rates institutions and programs based on each of the 11 STEM Indicators. Institutions and programs must earn a minimum average rating of 2.8 across all Indicators with no single indicator rated as a 1 in order to qualify for STEM Certification. Additionally, the school or program must receive an Index of Education Quality™ (IEQ™) score that falls within the range of schools that earn accreditation status. A school cannot be STEM certified unless it is accredited.

The AdvancED STEM Certification process is carried out by highly qualified reviewers who examine the school or program's adherence and commitment to the research aligned AdvancED STEM Standards and Indicators. The STEM Certification Reviewers use the AdvancED STEM Standards and Indicators and related criteria to guide the analysis, looking not only for adherence to the Standards, but also for the ways in which STEM education is provided to the school's students in a manner that embodies the practices and characteristics of a quality, relevant and age-appropriate STEM education.

Part I: STEM Certification Result

The criteria used for conferring the STEM certification require a minimum of a 2.8 overall average with none of the indicators scored as a 1. The 11 Indicator scores for your institution were averaged to acquire an overall STEM certification score of 3.32.

As a result of the STEM Certification Review conducted from November 9-10, 2015, The Florida Southwestern Collegiate High School – Lee Campus has earned the distinction of the AdvancED STEM Certification. This certification is valid for a five-year period if the school renews its application each year. At the end of the five-year period, the school can reapply for a new STEM Certification.

Part II: Findings

STEM Standard and Indicators Ratings

AdvancED STEM Certification Standard

STEM students have the skills, knowledge, and thinking strategies that prepare them to be innovative, creative, and systematic problem-solvers in STEM fields of study and work.

STEM Learner Indicators In accordance with the mission of AdvancED, the student is the most important focus of the STEM Certification. Institutions and programs geared toward providing a strong STEM education should strive to include all learners, paying close attention to those groups often marginalized in STEM fields. Students should regularly engage in activities that meet the diverse needs and styles of learners in ways that foster independent critical thinking as well as transformative collaboration. In keeping with the nature of STEM, students should make regular use of technology throughout the learning process, from enhanced research and data gathering to innovative experiential learning opportunities. Finally, STEM learners should be encouraged to demonstrate their knowledge through both traditional and nontraditional performance-based assessments.			
Indicator	**Description**	**School STEM Self Assessment Score**	**STEM Certification Score**
ST1.1	The STEM school/program supports non-traditional student participation through outreach to groups often underrepresented in the STEM pipeline.	3.13	2
ST1.2	Students work independently and collaboratively in an inquiry-based learning environment that encourages finding creative solutions to authentic and complex problems.	3.83	4

ST1.3	Students are empowered to personalize and self-direct their STEM learning experiences, supported by STEM educators who facilitate their learning.	3.3	3
ST1.4	Students use technology resources to conduct research, demonstrate creative and critical thinking, and communicate and work collaboratively.	3.75	3
ST1.5	Students demonstrate their learning through performance-based assessments and express their conclusions through elaborated explanations of their thinking.	3.3	4

Powerful Practices

Statement

The school philosophy is driven by a clearly articulated instructional design that provides integrated learning experiences with authentic projects that require critical thinking, collaboration, and creative problem solving. (Indicator ST 1.2)

Description of Findings

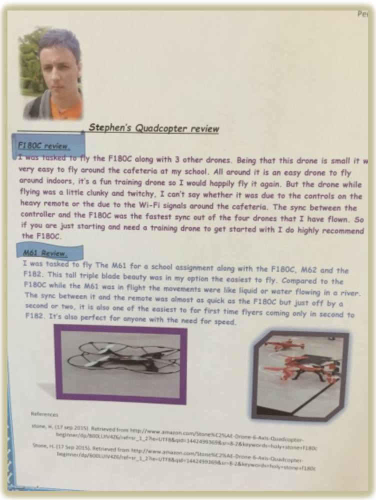
Evidence gathered from classroom observations, interviews, and artifacts including the school website presented a description and demonstration of numerous projects completed by students in various courses. Students are provided numerous opportunities for individual and collective problem-solving. The STEM Review Team observed demonstrations in multiple formats including videos, classroom presentations, as well as student and staff interviews. Collaborative projects that required critical thinking and communication were observed and include the following: building turbines and bridges, ‘Presidents Dilemma’, Of Mice and Men, Food Court, and the rocket project. Students articulated the critical thinking process outcomes and described experiences with the integrated STEM project as follows: “I discovered to that I am capable of more than I thought, I have had the opportunity to fail and find out what I like to do and what I am capable of” and “I really like how they empower you... I have learned how to succeed, and not just how to get a good grade.”

Statement

Student projects are performance based and require articulation and defense in multiple forums, including the classroom and community. (Indicator ST1.5)

Description of Findings

The Review Team observed multiple sources of evidence that provided an in-depth examination of student work, and a defense of the results. This evidence was demonstrated in multiple ways including presentations, interviews with students and staff, videos, and artifacts. Students were actively involved in presentations that required a description of the individual and collective thinking process, as well as the results of the final project. The presentations provided a justification of students work to teachers, peers, and the community. The freshmen class was challenged to create an innovative project to improve quality of life for a developing country. Each presentation described why and how the project could improve the quality of life. Another recent example involved a community presentation at Barnes and Noble bookstore where students made presentations about the Drone Academy. Students described the teachers' most notable question as 'WHY" and illustrated the powerful impact of this work as follows: "Because of continually having to justify my work, I found my voice and my voice has power." Another student stated, "I have developed the self-confidence to defend my ideas and yet be able to work together with a group. I love to be the boss, but I have learned that sometimes I need to be a follower to get the task accomplished."


Stephen's Quadcopter review

F180C review.

I was tasked to fly the F180C along with 3 other drones. Being that this drone is small it w very easy to fly around the cafeteria at my school. All around it is an easy drone to fly around indoors, it's a fun training drone so I would happily fly it again. But the drone while flying was a little clunky and twitchy, I can't say whether it was due to the controls on the heavy remote or the due to the Wi-Fi signals around the cafeteria. The sync between the controller and the F180C was the fastest sync out of the four drones that I have flown. So if you are just starting and need a training drone to get started with I do highly recommend the F180C.

M61 Review.

I was tasked to fly The M61 for a school assignment along with the F180C, M62 and the F182. This tall triple blade beauty was in my option the easiest to fly. Compared to the F180C while the M61 was in flight the movements were like liquid or water flowing in a river. The sync between it and the remote was almost as quick as the F180C but just off by a second or two, it is also one of the easiest to for first time flyers coming only in second to F182. It's also perfect for anyone with the need for speed.

References

Students have the opportunity to participate in a Drone Academy that routinely meets after school to continue the learning process from the research and technology classes. The students worked together through the process to get FAA approval and the insurance and legal status to support the work of the Drone Academy. Because of this approval, students are working with local businesses to develop practical uses for drones.

Opportunity for Improvement

Statement

Develop an intentional process to capture demographic data regarding students that exit the school program, and explore this information as it relates to retaining underrepresented groups in STEM. (Indicator ST1.1)

Description of Findings

As required in Florida, there is a Charter School lottery and subsequent waiting list for student enrollment. This process does not allow for specific recruitment for non-traditional or under-represented populations in STEM. Also, currently there is not a deliberate process to understand why students choose to leave the school and how to retain and support non-traditional students that are typically under-represented in STEM fields.

The school has strong relationships with community and business partners with under-represented groups such as Women in Construction. A need exists to explore all under-represented groups and to provide role models and support programs when needed according to the results of this data collection and analysis. This process may provide opportunities to maximize relationships with the intention to retain students and provide mentors in underrepresented STEM areas. This practice will provide an opportunity to strategically leverage community partnerships, and mentors for the underrepresented at-risk STEM students; and retain students who may be underrepresented in STEM fields.

STEM Educator Indicators To maximize students' STEM learning, educators should regularly engage in collaborative planning to develop an interdisciplinary curriculum that emphasizes high-quality problem-based instruction. Educators should empower students by providing them with learning experiences that prepare them for the types of problem solving skills they will need in order to be successful in their postsecondary endeavors and their future careers. Such high demands on educators can only be met through rigorous, ongoing professional development targeted at continuously improving STEM-based educational practices.			
Indicator	**Description**	**School STEM Self Assessment Score**	**STEM Certification Score**
ST1.6	The interdisciplinary problem-based curriculum includes a focus on real world applications.	3.63	3.63
ST1.7	STEM educators collaborate as an interdisciplinary team to plan, implement, and improve integrated STEM learning experiences.	3.63	3.63
ST1.8	STEM learning outcomes demonstrate students' STEM literacy necessary for the next level of STEM learning and for post-secondary and workforce readiness.	3.63	3.63
ST1.9	STEM teachers and leaders participate in a continuous program of STEM-specific professional learning.	2.71	3

Opportunities for Improvement

Statement

Increase opportunities and formalize a meeting structure for educators to collaborate on a regular basis for planning and adjustments with integrated STEM learning experiences, with particular emphasis on connections and integration of STEM in the humanities courses. (Indicator ST1.7)

Description of Findings

It is evident that there has been an effort to raise awareness among teachers about course assignments and student work load. However, there is a need to increase consistent interdisciplinary integration of STEM experiences. This is highly evident in engineering and technology classes, but not as apparent in other courses. The school has a dynamic structure and approach that integrates multiple areas of STEM in classes specifically related to STEM components, for example the engineering and technology classes place great emphasis on the integration of all STEM areas. The instructional design and its selected projects are teacher driven. Math, science and humanities courses have introduced STEM components; however, the consistent implementation of high levels of integration could be increased in these subjects. As a part of the self-assessment, the lack of scheduled time for faculty to meet and collaborate as a unit was noted. Creating those opportunities could deepen the integration of STEM projects from an interdisciplinary approach. This time could also be used to identify and create strategies for support of students who need extra attention to succeed. A regular meeting time strengthens the faculty as a unit towards the mission of the school.

Statement

Create opportunities for professional learning, and shared best practices between STEM educators by hosting forums in which experts, educators, and all staff participate in order to provide opportunities for all instructional staff to be engaged in professional learning and best practices related to STEM. (ST1.9)

Description of Findings

The school has achieved high levels of STEM applications in most subject areas. The Review Team realizes it is difficult to find formal professional learning opportunities that support next steps in enhancing the curriculum. There are individual staff members that seek out and participate in significant cutting edge STEM professional learning; however, these efforts are sought individually and driven by interest and need. Staff members need to be able to share these experiences with other staff members in order to support and expand teaching and learning best practices for STEM education. One example that could foster this type of dialogue and discussion would be to promote and host a forum designed conference. This event would provide an opportunity for collaboration with STEM partners, enthusiasts, and professional innovators outside of the immediate educational community to come together to share information and ideas that would facilitate an increase in the knowledge and experiences of teachers in their quest to continue to provide cutting-edge experiences for their students.

STEM Experience Indicators A key focus of national policy initiatives to improve STEM education has been the need to prepare today's learners for the information and technology economy. In order to educate students who can compete for jobs in a global market, institutions and programs should partner with businesses, post-secondary institutions, and the community at large to provide students with opportunities to engage in STEM learning in real-world settings. Student learning should be further enhanced through involving families and by arranging learning experiences for students that extend beyond the confines of the normal school day and the physical plant of the institution.			
Indicator	**Description**	**School STEM Self Assessment Score**	**STEM Certification Score**
ST1.10	Community, post-secondary, business/industry partners and/or families actively support and are engaged with teachers and students in the STEM program.	3.5	4
ST1.11	Students are supported in their STEM learning through adult-world connections and extended day opportunities.	3.16	3

Powerful Practice

Statement

The school leadership strategically promotes a STEM community of learners, and develops supportive relationships through outreach activities that engage post-secondary institutions, business/industry partners and families in order to increase opportunities for teaching and learning. (Indicator ST 1.10)

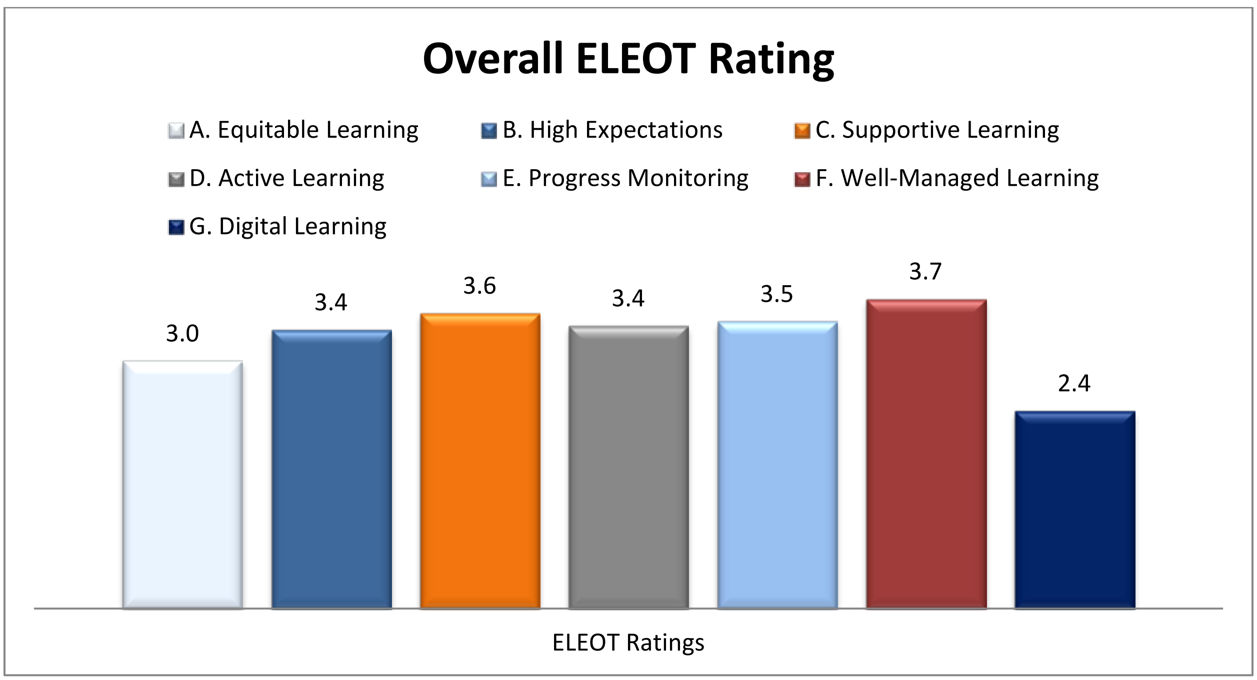
Description of Findings

The principal is an active community member and invites multiple organizations to become involved in the school. Numerous partners are engaged with the school including: STEM Tour, GHD, Florida Gulf Coast University, Pure Florida, ECHO, Chamber of South West Florida, Florida Southwestern College, Tanglewood Elementary School, Super Science, and The National Association of Women in Construction.

Specific examples of involvement include: the STEM Team (monthly meetings with 15 – 20 members), and STEM competitions. The principal's outreach to the Chamber of Commerce provides resources that benefit the school and directly supports student work and experiences. This outreach promotes new opportunities for students including ECHO, farm and research for sustainable agriculture and opportunities for voluntary work and participation. Parents interviewed were very pleased with the educational opportunities provided for students by the school and its partners as evidenced by a quote from one parents, "What they promised to me four years ago, we got it!"

Effective Learning Environments Observation Tool (eleot™)

Results



Every learner should have access to an effective learning environment in which she/he has multiple opportunities to be successful. The Effective Learning Environments Observation Tool™ (eleot) measures the extent to which learners are in an environment that is equitable, supportive, and well-managed, an environment where high expectations are the norm and active learning takes place. It measures whether learners' progress is monitored and feedback is provided and the extent to which technology is leveraged for optimal learning.

Trained and certified AdvancED employees and partners evaluate classrooms based on 20-minute observations. During the review, team members conducted eleot observations in 14 classrooms.

The 14 classroom observations that were conducted at Florida Southwestern Collegiate High School consisted of all STEM content areas and grade levels nine and ten. The learning environment that received the highest average appeared in the Well-Managed Environment (3.7) which is above the AdvancED Network Average (AEN) of 3.13 out of a possible 4.00. Items F2 and F5, within the Well-Managed Environment, received the highest average (3.9) of the 33 items on eleot. Another item with a high average indicative of the students' Well-Managed behaviors is F1 with an average score of 3.8.

The Supportive Learning Environment received an overall average of 3.6; the second highest scoring environment and contextually connected to the Well-Managed Learning Environment. Students generally appeared very positive and enthusiastic about their classes, teachers and peers as evidenced by the average for this environment. All five of the items in this environment received averages of a 3.4 or higher.

Environments High Expectations (3.4), Active Learning (3.4), and Progress Monitoring and Feedback (3.5) also received high marks. The highest rated indicator in the High Expectations environment was B2 at 3.6, Active Learning D1 and D3 at 3.6, and Progress Monitoring and Feedback F2, F3, and F5 all at 3.6. The lowest rated item in the High Expectations environment was B3 with a rating of 2.9. The lowest rated item in Active Learning was D2 with a score of 3.1 and E4 in the progress Monitoring and Feedback with a score of 3.1.

The two lowest rated environments were Equitable Learning (3.0) and Digital Learning (2.4). Although these are the lowest scored areas, both are above the AdvancED Network Averages (AEN) of these environments. Equitable Learning received a score of 3.0 compared to the AEN of 2.29 and Digital Learning with a score of 2.4 compared to the AEN of 1.82. The lowest scored indicator for Equitable Learning was A4 at 2.3 while the highest score in this environment was A2 at 3.6. The lowest scored indicator for Digital Learning was G3 at 2.1 and the highest score in the environment was G1 at 2.6.

Part III: Summary of STEM Certification Process:

Summary

The Florida Southwestern Collegiate High School – Lee Campus is in its sixth year of operation. The school's leadership, staff, and stakeholders are commended for their application of the themes and elements of STEM that were evident in the instructional program and the integration of project based STEM learning opportunities. The school's focus on communication, collaboration, and critical thinking are very evident in all aspects of the school.

Admission to the school is conducted through an open lottery enrollment process which is required for Charter Schools in the state of Florida. The school has attracted student applicants from across the county and there is a waiting list for enrollment. Siblings of present students and children of employees are given preference. Several students interviewed indicated they chose to apply to attend the school due to the STEM focus and the ability to secure a college associate degree during their high school experience as a dual enrolled student. The school only serves ninth and tenth grade students. Junior and senior students are dual-enrollment students, completing their coursework in college classes at Florida Southwestern College. This fact was highlighted as a significant cost savings for students as well as an important start to a successful college experience. One student commented that the dual-enrollment opportunity was her only chance to attend college dual to fiscal limitations.

There are strong business and community partnerships including Florida Southwestern College, GHD, The Village School, Whitaker Center for STEM Education, Children's Museum of Naples, Florida Gulf Coast University, Pure Florida, ECHO, Chamber of South West Florida, STEM Team of Southwest Florida, Imaginarium Science Center, Super Science, and the National Association of Women in Construction. Many of these partners are part of the STEM tour which provides a series of STEM competitions throughout the school year in which students compete and earn points and ultimately prizes. These partnerships and community involvement provides extended opportunities and benefits for the STEM learning community within the school including fundraising. This type of commitment and partnership was evident throughout the school. There is also strong parental support for the school as evidenced by the Parent Teacher Organization raising $25,000 for an outdoor classroom. Several parents commented concerning the positive impact the STEM experience has had on their children, from providing an academic experience that engaged and challenged their students, helping them to become more independent, and ultimately preparing them to succeed in college. Business partners also voiced their appreciation for the STEM experiences afforded students.

The STEM focus is evident throughout the instructional program. The reviewers observed multiple examples of students working collaboratively to create or accomplish a project. This hands-on learning provided opportunities to broaden learning experience while also developing the essential skill of collaboration on a team. Examples of projects include building turbines, bridges, biomes, and rockets. Other projects were the Presidents Dilemma, Of Mice and Men, Food Court project maximizing cafeteria using local produce, and the Odyssey were observed and discussed by students. Several students commented on the cooperation and collaboration skills they developed through these experiences. Students also commented on teachers requiring them to explain their work. One student stated the most common word used by teachers is the word “Why?” This opportunity to justify their decisions and document their processes has instilled confidence in the students while at the same time helping them to deepen their understanding of the content. The ability to defend, expand, and elaborate concerning their learning was noted and much appreciated by the business partner group, specifically one stakeholder who interviews students who have applied for admission to Massachusetts Institute of Technology who stated, “Our students can hold their own with students from anywhere.”

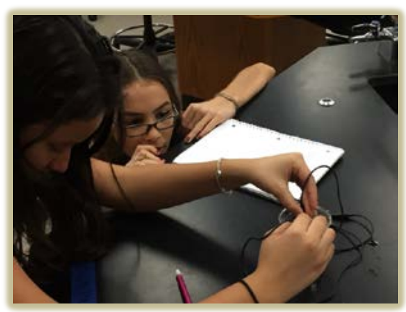
The students were engaged in real-world, interdisciplinary projects requiring varying lengths of time to complete. These projects typically resulted in a presentation to students, staff, or community. These presentations helped students develop their public speaking skills, think quickly, and display their analytical skills as they documented the process used to accomplish the project. Yet another practice required of students is the frequent use of personal reflection in journals in their classes. This assignment requires students to ruminate one additional time concerning their learning and record their thoughts.

One area noted by the team as a result of interviews and observations was the technology available to both teachers and students. Examples of the observed hardware included iPads, laptops, 3-D printers, laser cutter, interactive white boards, Pasco sensors, drones, etc. It was also noted that these “tools” were much used, especially in the STEM specific courses such as science and engineering classes. The school also possesses several software programs such as tinker CAD, SPROUT, and Canvas. The team was especially impressed by the ways teachers used the Canvas Learning Management System, not only for an assignment portal but also for sharing course work content, information, updates and communications with students. It was particularly impressive to observe the students using Canvas for personal reflection at the end of a class period and for recording observations, review and critique by students of other student presentations.

As the school continues to prepare underrepresented populations for careers in STEM, providing supports needed for success of the underrepresented populations is essential. The data analysis of students exiting the school might provide insight into needed supports. The school has strong relationships with community and business partners with under-represented groups such as Women in Construction. It important to explore student retention and underrepresented groups STEM fields in order to understand at-risk groups who may need role models and support programs according to the results data collection related to underrepresentation in STEM for women and minorities.

As previously stated, the interdisciplinary projects designed and completed are quite impressive. It is evident efforts have been made to integrate all subjects into project design. However, in many instances, the subject matter integration seemed more artificial in an attempt to “insert” other subjects rather than naturally ‘fitting” into project design. A hindrance to planning is the fact that teachers do not have the opportunity to meet on a regular basis to collaborate, innovate, plan, and adjust integrated learning experiences. The review team understands the constraints to creating this time but feel this lack of planning time stymies the creation of natural STEM focused interdisciplinary projects.

It is evident the principal and teachers at Florida Southwest Collegiate High School desire to provide a cutting-edge STEM experience for its students. In order for this quest to be accomplished, teachers must continually be stretched to gain greater knowledge, skills, and expertise not only in their subject area, but also in interdisciplinary integration of knowledge. Unfortunately, typical current professional development opportunities are not available to aid the Lee Campus teachers in this pursuit. The review team encourages the school to become a pioneer in STEM professional development by hosting a STEM Forum with a flipped philosophy. In a traditional professional development scenario, a workshop/conference/forum is hosted and attendees attend in order to learn new information/techniques/strategies/etc. For example, the team is not aware of any professional development opportunities for teachers on drones. A flipped philosophy approach would be to host a STEM Forum in which drone enthusiasts/teachers/developers/engineers/etc. would meet not only to learn, but also to share information, ideas, best practices, and strategies about drones. This approach would help to keep teachers “fresh” in these emerging courses.



It is truly remarkable that the school has been able to provide such a rich STEM experience for their students in only its sixth year of existence. Many comments were voiced concerning the leadership, vision, and energy of the principal as the driving force of the school. The principal was quick to give credit to college administration, business partners, parents, students, and teachers as the impetus for the school’s successes. In reality, the successes are due to the collaboration, work, and support of all of the just mentioned individuals and groups. It was truly refreshing for the team to visit a school that has forgone the status quo evident in so many schools in order to provide unique STEM experiences for its students. All staff members appear to be fully committed to a STEM educational model and the students they serve. The Lee Campus of Florida Southwestern Collegiate High School has the components in place to continue its pursuit to provide an optimum STEM experience through focusing on the tenets of communication, collaboration, and critical thinking.

Final Thoughts

The AdvancED STEM Reviewers thoroughly enjoyed their experiences at The Florida Southwestern Collegiate High School – Lee Campus; the STEM staff, students, and parents were positive, pleasant, accommodating, and inspiring. The STEM Reviewers sincerely appreciate the school's interest in AdvancED STEM Certification and their allowing AdvancED to learn from at The Florida Southwestern Collegiate High School's STEM educators, program, and students. It will be advantageous to AdvancED to remain connected to this excellent team of educators, through engaging in professional dialogues and sharing resources and research about this rapidly changing and evolving educational model: STEM.

About AdvancED

AdvancED is the world leader in providing improvement and accreditation services to education providers of all types in their pursuit of excellence in serving students. Our mission is to lead and empower the education community to ensure that all learners realize their full potential.

We have been experts in accreditation and school improvement since 1895 and bring this 100+ years of experience and expertise through three US-based regional accreditation agencies — the North Central Association Commission on Accreditation and School Improvement (NCA CASI), the Northwest Accreditation Commission (NWAC) and the Southern Association of Colleges and Schools Council on Accreditation and School Improvement (SACS CASI). AdvancED serves as a trusted partner to more than 32,000 schools and school systems—enrolling more than 20 million students—across the United States and 70 countries.

The AdvancED Accreditation Process, a protocol embraced around the world, is a clear and comprehensive program of evaluation and external review, supported by research-based Standards and dedicated to helping schools, systems and education providers continuously improve.

AdvancED's position as a leader in education continues to expand as we provide a national and international voice to inform and influence policy and practice on issues related to education quality.

Addendum

STEM Stakeholder Interviews

Stakeholder	Number Interviewed
Administrators	1
STEM Teachers	8
Students	40
Parents	11
Community Members	11
Counselor	1
Total Number of Stakeholders’ Interviewed	72

STEM Review Schedule

STEM Certification Review Schedule
November 9-10, 2015
Florida SouthWestern Collegiate High School

Time	Event	Location	Who
8:00-8:30 a.m.	Reception	Commons	All
8:30-9:10 a.m.	Interviews- Round 1 • Business partners • Parents • Dual-enrolled students	Conference Room Teacher Work Room T-107	Reviewer A Reviewer B Reviewer C
9:15-9:40 a.m.	Eleot Observations-Round 1 • World Cultural Geography • Research 2 • Engineering Technology	T-133 T-138 J-102	Reviewer A Reviewer B Reviewer C
9:45-10:25 a.m.	Interviews- Round 2 • Science team • Freshmen students • Sophomore students	T-131 Conference Room Teacher Work Room	Reviewer A Reviewer B Reviewer C
10:30-11:00 a.m.	Eleot Observations-Round 2 • Algebra 2 • Biology • World History	T-106 T-130 T-134	Reviewer B Reviewer A Reviewer C
11:00- 11:30 a.m.	Interviews-Round 3 • Engineering Technology & Research (11-11:40) Eleot Observations- Round 3 • English 1	Conference Room T-137	Reviewers B & C Reviewer A
11:30 a.m.- 12:20 p.m.	Lunch	Conference Room	Review Team

eleot Results

A. Equitable Learning Environment						
Indicators	**Average**	**Description**	**Not Observed**	**Partially Observed**	**Evident**	**Very Evident**
A.1	**2.6**	Has differentiated learning opportunities and activities that meet her/his needs	21%	21%	36%	21%
A.2	**3.6**	Has equal access to classroom discussions, activities, resources, technology, and support	0%	7%	29%	64%
A.3	**3.5**	Knows that rules and consequences are fair, clear, and consistently applied	0%	0%	50%	50%
A.4	**2.3**	Has ongoing opportunities to learn about their own and other's backgrounds/cultures/differences	29%	36%	14%	21%
Overall rating on a 4 point scale:		**3.0**				

B. High Expectations						
Indicators	**Average**	**Description**	**Not Observed**	**Partially Observed**	**Evident**	**Very Evident**
B.1	**3.5**	Knows and strives to meet the high expectations established by the teacher	7%	0%	29%	64%
B.2	**3.6**	Is tasked with activities and learning that are challenging but attainable	0%	0%	43%	57%
B.3	**2.9**	Is provided exemplars of high quality work	7%	21%	43%	29%
B.4	**3.4**	Is engaged in rigorous coursework, discussions, and/or tasks	0%	7%	43%	50%
B.5	**3.4**	Is asked and responds to questions that require higher order thinking (e.g., applying, evaluating, synthesizing)	0%	14%	36%	50%
Overall rating on a 4 point scale:		**3.4**				

C. Supporting Learning						
Indicators	**Average**	**Description**	**Not Observed**	**Partially Observed**	**Evident**	**Very Evident**
C.1	**3.6**	Demonstrates or expresses that learning experiences are positive	0%	0%	36%	64%
C.2	**3.6**	Demonstrates positive attitude about the classroom and learning	0%	0%	43%	57%
C.3	**3.5**	Takes risks in learning (without fear of negative feedback)	0%	7%	36%	57%
C.4	**3.6**	Is provided support and assistance to understand content and accomplish tasks	0%	0%	36%	64%
C.5	**3.4**	Is provided additional/alternative instruction and feedback at the appropriate level of challenge for her/his needs	0%	0%	57%	43%
Overall rating on a 4 point scale:		**3.6**				

D. Active Learning						
Indicators	**Average**	**Description**	**Not Observed**	**Partially Observed**	**Evident**	**Very Evident**
D.1	**3.6**	Has several opportunities to engage in discussions with teacher and other students	0%	7%	29%	64%
D.2	**3.1**	Makes connections from content to real-life experiences	7%	14%	43%	36%
D.3	**3.6**	Is actively engaged in the learning activities	0%	0%	43%	57%
Overall rating on a 4 point scale:		**3.4**				

E. Progress Monitoring						
Indicators	Average	Description	Not Observed	Partially Observed	Evident	Very Evident
E.1	**3.4**	Is asked and/or quizzed about individual progress/learning	0%	14%	36%	50%
E.2	**3.6**	Responds to teacher feedback to improve understanding	0%	0%	36%	64%
E.3	**3.6**	Demonstrates or verbalizes understanding of the lesson/content	0%	0%	43%	57%
E.4	**3.1**	Understands how her/his work is assessed	0%	7%	71%	21%
E.5	**3.6**	Has opportunities to revise/improve work based on feedback	0%	0%	43%	57%
Overall rating on a 4 point scale:		**3.5**				

F. Well-Managed Learning						
Indicators	**Average**	**Description**	**Not Observed**	**Partially Observed**	**Evident**	**Very Evident**
F.1	**3.8**	Speaks and interacts respectfully with teacher(s) and peers	0%	0%	21%	79%
F.2	**3.9**	Follows classroom rules and works well with others	0%	0%	14%	86%
F.3	**3.6**	Transitions smoothly and efficiently to activities	0%	7%	29%	64%
F.4	**3.6**	Collaborates with other students during student-centered activities	7%	7%	7%	79%
F.5	**3.9**	Knows classroom routines, behavioral expectations and consequences	0%	0%	14%	86%
Overall rating on a 4 point scale:		**3.7**				

G. Digital Learning						
Indicators	**Average**	**Description**	**Not Observed**	**Partially Observed**	**Evident**	**Very Evident**
G.1	**2.6**	Uses digital tools/technology to gather, evaluate, and/or use information for learning	43%	0%	7%	50%
G.2	**2.4**	Uses digital tools/technology to conduct research, solve problems, and/or create original works for learning	50%	0%	14%	36%
G.3	**2.1**	Uses digital tools/technology to communicate and work collaboratively for learning	50%	7%	21%	21%
Overall rating on a 4 point scale:		**2.4**				

eleot™ - STEM Certification Worksheet

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Please use this worksheet to input the item ratings for each observation conducted during the STEM Review. Pre-set formulas automatically will calculate the mean score for each environment. These scores automatically will be labeled and displayed at the top of the spreadsheet.

	A. Equitable Learning				B. High Expectations					C. Supportive Learning					D. Active Learning			E. Progress Monitoring					F. Well-Managed					G. Digital Learning		
	3.0				3.4					3.6					3.4			3.5					3.7					2.4		
	2.6	3.6	3.5	2.3	3.5	3.6	2.9	3.4	3.4	3.6	3.6	3.5	3.6	3.4	3.6	3.1	3.6	3.4	3.6	3.6	3.1	3.6	3.8	3.9	3.6	3.6	3.9	2.6	2.4	2.1
	A.1	A.2	A.3	A.4	B.1	B.2	B.3	B.4	B.5	C.1	C.2	C.3	C.4	C.5	D.1	D.2	D.3	E.1	E.2	E.3	E.4	E.5	F.1	F.2	F.3	F.4	F.5	G.1	G.2	G.3
Classroom #1	3	4	4	2	4	4	3	4	4	4	4	4	4	4	4	4	4	3	4	4	3	4	4	4	4	4	4	4	4	3
Classroom #2	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4
Classroom #3	4	3	4	3	4	4	4	4	4	4	4	4	3	4	2	4	3	3	4	3	4	4	3	4	3	4	3	1	1	1
Classroom #4	3	4	4	2	4	4	2	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	1	1	1
Classroom #5	3	4	3	4	4	3	3	3	3	4	4	4	4	3	4	3	3	2	4	4	3	4	4	4	4	4	4	4	1	1
Classroom #6	1	4	4	1	4	4	4	4	3	4	4	3	4	3	4	1	4	4	4	3	3	4	4	4	4	4	4	4	3	3
Classroom #7	3	4	4	1	4	3	4	3	4	4	4	4	4	4	4	3	4	3	4	4	3	4	4	4	4	4	4	4	4	4
Classroom #8	1	4	3	1	3	3	2	3	2	3	3	4	4	3	4	3	3	4	3	4	2	3	4	4	2	4	4	1	1	1
Classroom #9	1	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	3	4	4	4	4	4	4	4	4	4
Classroom #10	2	3	3	1	3	3	1	2	2	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	1	1	1
Classroom #11	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	4	4	3	4	4	4	4	4	1	1	1
Classroom #12	2	3	3	2	3	3	2	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3	1	4	1	1	1
Classroom #13	2	2	3	4	1	4	3	3	3	3	3	2	3	3	3	2	4	4	4	3	3	3	4	4	4	2	4	4	4	2
Classroom #14	4	4	3	2	4	4	3	4	4	4	3	3	4	3	4	2	4	3	3	4	3	3	4	4	3	4	4	3	3	3

STEM Standards Research

ST1.1– The STEM school/program *supports non-traditional student participation* through outreach to groups often underrepresented in the *STEM pipeline*.

Bargerhuff, M.E. (2013). Meeting the needs of students with disabilities in a STEM school. *American Secondary Education, 41*(3), 3-20.

Clark, C. J., Ardley, T. W., & Black, J. T. (2015). The program of excellence in STEM: Involvement of traditionally underrepresented students in STEM education through research and mentoring at Florida A&M university. In *Integrated STEM education conference (ISEC;* pp. 159-163). IEEE. doi:10.1109/ISECon.2015.7119915

Duran, M., Höft, M., Lawson, D. B., Medjahed, B., & Orady, E. A. (2014). Urban high school students' IT/STEM learning: Findings from a collaborative inquiry- and design-based afterschool program. *Journal of Science Education and Technology*, *23*(1), 116-137. **(Link to ST1.2, ST1.4, and ST1.8)** doi:10.1007/s10956-013-9457-5

Espinosa, L. (2011). Pipelines and pathways: Women of color in undergraduate STEM majors and the college experiences that contribute to persistence. *Harvard Educational Review*, 81(2), 209-240.

Ghosh-Dastidar, U., & Liou-Mark, J. (2014). Bridging pathways through research and leadership for underrepresented students in STEM. *Mathematics and Computer Education*, *48*(3), 214.

Hernandez, P., Schultz, P., Estrada, M., Woodcock, A., & Chance, R. (2013). Sustaining optimal motivation: A longitudinal analysis of interventions to broaden participation of underrepresented students in STEM. *Journal of Educational Psychology*, *105*(1), 89-107. doi:10.1037/a0029691

Izzo, M. V., Murray, A., Priest, S., & McArrell, B. (2011). Using student learning communities to recruit STEM students with disabilities. *Journal of Postsecondary Education and Disability*, 24(4), 301-316. **(Link to ST1.8)**

Lam, P., Doverspike, D., Zhao, J., Zhe, J., & Menzemer, C. (2008). An evaluation of a STEM program for middle school students on learning disability related IEPs. *Journal of STEM Education: Innovations and Research*, *9*(1/2), 21.

Myers, C., & Pavel, D. (2011). Underrepresented students in STEM: The transition from undergraduate to graduate programs. *Journal of Diversity in Higher Education*, *4*(2), 90-105. doi:10.1037/a0021679

Newman, J. L., Dantzler, J.,& Coleman, A.N. (2015). Science in action: How middle school students are changing their world through STEM service-learning projects. *Theory Into Practice*, *54*(1), 47-54. **(Link to ST1.10)**
doi:10.1080/00405841.2015.977661

Wright, B.L. (2011). Valuing the “everyday” practices of African-American students K-12 and their engagement in STEM learning: A position. *The Journal of Negro Education*, *80(*1), 5-11. **(Link to 6.2)**

ST1.2– Students *work independently and collaboratively* in an <u>inquiry-based learning environment</u> that encourages *finding creative solutions* to authentic and complex problems.

Crippen, K. J., & Archambault, L. (2012). Scaffolded inquiry-based instruction with technology: A signature pedagogy for STEM education. *Computers in the Schools*, *29*(1-2), 157-173. **(Link to ST1.8)**

Duran, M., Höft, M., Lawson, D. B., Medjahed, B., & Orady, E. A. (2014). Urban high school students' IT/STEM learning: Findings from a collaborative inquiry- and design-based afterschool program. *Journal of Science Education and Technology*, *23*(1), 116-137. **(Link to ST1.1, ST1.4, and ST1.8)**
doi:10.1007/s10956-013-9457-5

Govaerts, S., Cao, Y., Vozniuk, A., Holzer, A., Zutin, D. G., Ruiz, E. S. C., ... & Gillet, D. (2013). Towards an online lab portal for inquiry-based stem learning at school. In J.F. Wang & R. Lau (Eds.), *Advances in web-based learning–ICWL 2013* (pp. 244-253). Heidelberg: Springer-Verlag

Maiti, A., Maxwell, A. D., Kist, A. A., & Orwin, L. (2014). Integrating enquiry-based learning pedagogies and remote access laboratory for STEM education. In *Global Engineering Education Conference (EDUCON), 2014* (pp. 706-712). IEEE. **(Link to ST1.4)**
doi:10.1109/EDUCON.2014.6826171

Strimel, G. (2014). Authentic education by providing a situation for student-selected problem-based learning. *Technology and Engineering Teacher. 73*(7), 8-18. **(Link to ST1.3 and ST1.6)**

ST1.3– Students are empowered to <u>personalize and self-direct their STEM learning experiences,</u> supported by STEM educators who facilitate their learning.

Ejiwale, J. A. (2012). Facilitating teaching and learning across STEM fields. *Journal of STEM Education: Innovations and Research*, *13*(3), 87.

General Reference Center GOLD. (2013, March 4). Personalized career readiness system from WIN Learning helps high school students stick with STEM classes. *PRWeb Newswire*. Retrieved from http://go.galegroup.com/ps/i.do?id=GALE%7CA321018897&v=2.1&u=gain40375&it=r&p=GRGM&sw=w&asid=e152a4cdd53a86c4049b05b17874ec93 **(Link to ST1.6)**

Nugent, G., Barker, B., Grandgenett, N., & Adamchuk, V. (2009). The use of digital manipulatives in K-12: Robotics, GPS/GIS and programming. In *Frontiers in Education Conference, 2009. FIE'09 39th IEEE* (pp. 1-6). IEEE. **(Link to ST1.4)**

Strimel, G. (2014). Authentic education by providing a situation for student-selected problem-based learning. *Technology and Engineering Teacher. 73*(7), 8-18. **(Link to ST1.2 and ST1.6)**

ST1.4– Students use <u>technology resources</u> to *conduct research, demonstrate creative and critical thinking, and communicate and work collaboratively*.

Capraro, R. M., Capraro, M. M., & Morgan, J. R. (Eds.). (2013). *STEM project-based learning: An integrated science, technology, engineering, and mathematics (STEM) approach* (2nd ed.). Rotterdam: SensePublishers.

Duran, M., Höft, M., Lawson, D. B., Medjahed, B., & Orady, E. A. (2014). Urban high school students' IT/STEM learning: Findings from a collaborative inquiry- and design-based afterschool program. *Journal of Science Education and Technology*, *23*(1), 116-137. **(Link to ST1.1 and ST1.2)** doi:10.1007/s10956-013-9457-5

Maiti, A., Maxwell, A. D., Kist, A. A., & Orwin, L. (2014). Integrating enquiry-based learning pedagogies and remote access laboratory for STEM education. In *Global Engineering Education Conference (EDUCON), 2014* (pp. 706-712). IEEE. doi:10.1109/EDUCON.2014.6826171

Nugent, G., Barker, B., Grandgenett, N., & Adamchuk, V. (2009). The use of digital manipulatives in K-12: Robotics, GPS/GIS and programming. In *Frontiers in Education Conference, 2009. FIE'09 39th IEEE* (pp. 1-6). IEEE. **(Link to ST1.3 and ST1.10)**

ST1.5- Students demonstrate their learning through <u>performance-based assessments</u> and *express their conclusions through elaborated explanations* of their thinking.

Capraro, R. M., Capraro, M. M., & Morgan, J. R. (Eds.). (2013). *STEM project-based learning: An integrated science, technology, engineering, and mathematics (STEM) approach* (2nd ed.). Rotterdam: SensePublishers. **(Link to ST1.4).**

Harwell, M., Mareno, M., Phillips, A., Guzey, S.S., Moore, T.J., &Roehrig, G.H. (2015). A study of STEM assessments in Engineering, Science, and Mathematics for elementary and middle school students. *School Science and Mathematics*, *115*(2), 66-74. doi:10.1111/ssm.12105

International Association for the Evaluation of Educational Achievement. (2007). TIMSS 2007 assessment frameworks. TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College, MA. Retrieved from http://files.eric.ed.gov/fulltext/ED494654.pdf

Lambert, L. (2014). *Middle school STEM curriculum: Connect the learning*. Retrieved from ProQuest Digital Dissertations. (1620742648)

Smith, K.A., Douglas, T.C., & Cox, M.F. (2009). Supportive teaching and learning strategies in STEM education. *New Directions for Teaching and Learning*, *117*, 19-32.

ST1.6– The *interdisciplinary problem-based curriculum* includes a focus on <u>real world applications.</u>

Branson, J.& Thomson, D. (2013). Hands-on learning in the virtual world. *Learning and Leading with Technology*, *40*(5), 18-21. **(Link to ST1.10)**
Capraro, R. M., Capraro, M. M., & Morgan, J. R. (Eds.). (2013). *STEM project-based learning: An integrated science, technology, engineering, and mathematics (STEM) approach* (2nd ed.). Rotterdam: SensePublishers.
General Reference Center GOLD. (2013, March 4). Personalized career readiness system from WIN Learning helps high school students stick with STEM classes. *PRWeb Newswire*. Retrieved from http://go.galegroup.com/ps/i.do?id=GALE%7CA321018897&v=2.1&u=gain40375&it=r&p=GRGM&sw=w&asid=e152a4cdd53a86c4049b05b17874ec93 **(Link to ST1.3)**
Hoachlander, G., & Yanofsky, D. (2011). Making STEM real. *Educational Leadership*, *68*(6), 60-65. **(Link to ST1.8)**
Madden, M. E., Baxter, M., Beauchamp, H., Bouchard, K., Habermas, D., Huff, M., . . . Plague, G. (2013). Rethinking STEM education: An interdisciplinary STEAM curriculum. *Procedia Computer Science*, *20*, 541-546. doi:10.1016/j.procs.2013.09.316
Strimel, G. (2014). Authentic education by providing a situation for student-selected problem-based learning. *Technology and Engineering Teacher. 73*(7), 8-18. **(Link to ST1.2 and ST1.3)**
Wright, B.L. (2011). Valuing the "everyday" practices of African-American students K-12 and their engagement in STEM learning: A position. *The Journal of Negro Education*, *80(*1), 5-11. **(Link to ST1.1)**

ST 1.7– STEM *educators collaborate* as an <u>interdisciplinary</u> team to *plan, implement, and improve integrated STEM learning* experiences.

Becker, K., & Park, K. (2011). Effects of integrative approaches among science, technology, engineering, and mathematics (STEM) subjects on students' learning: A preliminary meta-analysis. *Journal of STEM Education: Innovations and Research*, 12(5/6), 23.
Bissaker, K. (2014). Transforming STEM education in an innovative Australian School: The role of teachers' and academics' professional partnerships. *Theory Into Practice, 53,* 55-63.
Brown, J., Brown, R., & Merrill, C. (2011-2012). Science and technology educators' enacted curriculum: Areas of possible collaboration for an integrative STEM approach in public schools. *Technology and Engineering Teacher*, *71*(4), 30-34.
Ejiwale, J. A. (2012). Tools for collaboration across STEM fields. *Journal of Education and Learning*, *6*(3), 177-184. doi:10.11591/edulearn.v6i3.161
Fulton, K., & Britton, T. (2011). *STEM teachers in professional learning communities: From good teachers to great teaching*. Washington, D.C.: National Commission on Teaching and America's Future.
Gillespie, N. (2015). The backbone of STEM teaching. *Phi Delta Kappan, 96*(6), 38-44. **(Link to ST1.9)**
Johnson, C. C. (2013), Conceptualizing integrated STEM education. *School Science and Mathematics*, 113: 367–368.
doi: 10.1111/ssm.12043

ST1.8 – STEM *learning outcomes demonstrate* students' <u>STEM literacy necessary for the next level</u> of STEM learning and for *post-secondary and workforce readiness*.

Cantrell, P. and Ewing-Taylor, J. (2009), Exploring STEM career options through collaborative high school seminars. *Journal of Engineering Education*, 98, 295–303.
doi: 10.1002/j.2168-9830.2009.tb01026.x

Crippen, K. J., & Archambault, L. (2012). Scaffolded inquiry-based instruction with technology: A signature pedagogy for STEM education. *Computers in the Schools*, *29*(1-2), 157-173. **(Link to ST1.2)**

Duran, M., Höft, M., Lawson, D. B., Medjahed, B., & Orady, E. A. (2014). Urban high school students' IT/STEM learning: Findings from a collaborative inquiry and design-based afterschool program. *Journal of Science Education and Technology*, *23*(1), 116-137. **(Link to ST1.1, ST1.4, and ST1.11)** doi:10.1007/s10956-013-9457-5

Hoachlander, G., & Yanofsky, D. (2011). Making STEM real. *Educational Leadership*, *68*(6), 60-65. **(Link to ST1.6)**

Love, T. S. (2015). *Preparing safer STEM-literate citizens: A call for educator collaboration*. Ann Arbor: Prakken Publications, Inc.

Izzo, M. V., Murray, A., Priest, S., & McArrell, B. (2011). Using student learning communities to recruit STEM students with disabilities. *Journal of Postsecondary Education and Disability*, *24*(4), 301-316. **(Link to ST1.1)**

ST1.9– STEM <u>teachers and leaders</u> participate in a *continuous program* of <u>STEM-specific professional learning</u>.

Avery, Z.K., & Reeve, E.M. (2013). Developing effective STEM professional development programs. *Journal of Technology Education*, *25*(1), 55-69.

Baker-Doyle, K. J., & Yoon, S. A. (2011). In search of practitioner-based social capital: a social network analysis tool for understanding and facilitating teacher collaboration in a US-based STEM professional development program. *Professional Development in Education*, *37*(1), 75-93.

Gillespie, N. (2015). The backbone of STEM teaching. *Phi Delta Kappan, 96*(6), 38-44. **(Link to ST1.7)**

Hamos, J. E., Bergin, K. B., Maki, D. P., Perez, L. C., Prival, J. T., Rainey, D. Y., ... & VanderPutten, E. (2009). Opening the Classroom Door: Professional Learning Communities in the Math and Science Partnership Program. *Science Educator*, *18*(2), 14-24.

Rhea, M., Slagter van Tryon, P.J., & Mensah, F.M. (2015). Mathematics and science teachers professional development with local business to introduce middle and high school students to opportunities in STEM careers. *Science Educator*, *24*(1), 1-11. **(Link to ST1.10 and ST1.11).**

Rockland, R., Bloom, D. S., Carpinelli, J., Burr-Alexander, L., Hirsch, L. S., & Kimmel, H. (2010). Advancing the "E" in K-12 STEM education. *The Journal of Technology Studies*, *36*(1), 53-64.

ST1.10– *Community, post-secondary, business/industry partners and/or families* <u>actively support and are engaged with teachers and students</u> in the STEM program.

Branson, J.& Thomson, D. (2013). Hands-on learning in the virtual world. *Learning and Leading with Technology*, *40*(5), 18-21. **(Link to ST1.6)**

Lehman, J.D., WooRi, K., & Harris, C. (2014). Collaborations in a community of practice working to integrate engineering design in elementary science education. *Journal of STEM Education*, *15*(3), 21-28.

Newman, J. L., Dantzler, J.,& Coleman, A.N. (2015). Science in action: How middle school students are changing their world through STEM service-learning projects. *Theory Into Practice*, *54*(1), 47-54. **(Link to ST1.1)**
doi:10.1080/00405841.2015.977661

Nugent, G., Barker, B., Grandgenett, N., & Adamchuk, V. (2009). The use of digital manipulatives in K-12: Robotics, GPS/GIS and programming. In *Frontiers in Education Conference, 2009. FIE'09 39th IEEE* (pp. 1-6). IEEE. **(Link to ST1.3, ST1.4, and ST1.11)**

Rhea, M., Slagter van Tryon, P.J., & Mensah, F.M. (2015). Mathematics and science teachers professional development with local business to introduce middle and high school students to opportunities in STEM careers. *Science Educator*, *24*(1), 1-11. **(Link to ST1.9 and ST1.11).**

Watters, J.J., & Diezman, C.M. (2014). Community partnerships for fostering student interest and engagement in STEM. *Journal of STEM Education*, *14*(2), 47-55.

Xie, Y. (2014). Advancing STEM Career and Learning through civic engagement. *Journal of Technology Education, 26*(1), 47-63.

ST1.11– Students are *supported in their STEM learning* through adult-world connections and extended day opportunities.

Cantrell, P. and Ewing-Taylor, J. (2009), Exploring STEM Career Options through Collaborative High School Seminars. *Journal of Engineering Education*, *98*, 295–303. doi: 10.1002/j.2168-9830.2009.tb01026.x

Duran, M., Höft, M., Lawson, D. B., Medjahed, B., & Orady, E. A. (2014). Urban high school students' IT/STEM learning: Findings from a collaborative inquiry- and design-based afterschool program. *Journal of Science Education and Technology*, *23*(1), 116-137. **(Link to ST1.1, ST1.4, and ST1.8)** doi:10.1007/s10956-013-9457-5

Nugent, G., Barker, B., Grandgenett, N., & Adamchuk, V. (2009). The use of digital manipulatives in K-12: Robotics, GPS/GIS and programming. In *Frontiers in Education Conference, 2009. FIE'09 39th IEEE* (pp. 1-6). IEEE. **(Link to ST1.3, ST1.4 and ST1.10)**

Rhea, M., Slagter van Tryon, P.J., & Mensah, F.M. (2015). Mathematics and science teachers professional development with local business to introduce middle and high school students to opportunities in STEM careers. *Science Educator*, *24*(1), 1-11. **(Link to ST1.9 and ST1.10).**