Overcoming Barriers to Implementing an Exemplary STEM Program in a K-12 Building

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Introduction

A K-12 STEM program benefits the long term success of the student body (Daugherty, 2014; Clayton, 2019; Mann, 2011); however, it is most effective if there is support from administration, the Board of Education members and K-12 teachers. The support and buy in from elementary teachers hinges on the teacher's self-confidence level in teaching STEM and ongoing content specific professional development (Robinson, 2014; Shernoff, 2017). A review of several scholarly journal articles points to the importance of early exposure to STEM related opportunities and subjects for all students. (Cotabish, Dailey, Robinson, and Hughes, 2014; Daugherty, Carter, and Swagerty, 2014; Mann, Mann, Strutz, Duncan, Yoon, 2011)

Research from Lesseig, Slavit, Nelson, and Seidel (2016) tells us that inquiry-based learning, peer collaboration, and real-world problem solving not only engages our students in learning but excites them and hooks their interest resulting in improved math and science achievement. Elementary teachers play a significant role in the future of talented STEM innovators; however, they need meaningful content specific professional development on a regular basis in order to be best equipped and have the confidence to provide stimulating lessons. Without the support of administration and the members of the Board of Education, regular professional development is not possible. And as a result a successful STEM program is not viable over time.

Research states STEM in the elementary grades is most beneficial and has the most impact (Daugherty, 2014). I took a deeper dive and looked at the barriers in implementing a STEM program in a K-5 setting. The main driving question I addressed:

(1) Does the success and long term viability of the program require administration support?

Buy-in and Support of K-5 Teachers

Over the past four years we built a STEM program in a K-12 building with the support and encouragement of my then Principal. The first year, we focused on Grades 3 through 6. It began by building positive and supportive relationships with the

classroom teachers. We offered help to reinforce the math and science concepts already being taught within their classrooms. In an effort to ease the pressure from mandated state exams, we collaborated on several projects with the classroom teachers, pulling them into the planning. The projects were presented to the students as Engineering Design Projects which applied the math and science being taught in the classroom. The projects were set in a real-life scenario, the students were given the basic information needed to help design a solution to the problem, and a list of available materials was provided. The students were then guided through each step of the Engineering Design Process beginning with individual brainstorming and moving into team collaboration and finally a prototype build and test. Each project was followed by a reflection assignment in which the students were asked to reflect upon the process and their solution to the problem. They were asked to write a reflection piece discussing their thoughts and what they would do differently next time. The focus was not on the solution, but always on the process. Changes could be made along the way, improvements and re-designs were encouraged after testing. Failure was our friend and teacher.

The second through fourth year we added the K-2 classes. Once again, all the students learned the Engineering Design Process and were guided through each step to create a solution to a real-life problem presented to them. The students looked forward to Technology & Engineering/STEM class. From our observations of the students they enjoyed being engineers and solving the problem. Through a post-survey, we received the following feedback from the teachers:

> “I loved the connections that we made between literacy and the stem projects.”

> “The students were excited and engaged!”

> “I'm not a classroom teacher, but another "specials" teacher. While I don't have hard data to back this up, I believe that in those years, our elementary students began to think differently. They became more comfortable "tinkers", builders, and problem solvers. I observed this in their interactions with Makerspace materials and in the ways that they spoke about STEM and what they were learning during their STEM classes.”

> [What worked well was the] “creativity of the STEM projects that aligned with classroom curriculum and enhanced student's understanding and skill level.”

In year three, in addition to the Technology and Engineering/STEM classes offered regularly for 40 minutes per week to each grade level, we introduced Quarterly STEM Challenges and opened it up to all K-12 students. We encouraged the students to create something on their own time outside of the classroom with their families. During the first year we presented quarterly challenges such as “Make something that floats”, “Make something that rolls”, “Code a game or an app”, and “Make something useful out of trash and recyclables”. The second year included challenges such as “Make an instrument”, “Make an object that helps you focus”, “Make a game”, and “Make something that can be worn”. With each challenge the participation numbers grew. The students began asking for the next challenge before it was released. Teachers were checking in to see when the deadline was to submit a project and how they might be able to support the challenge in their classrooms. Administrators, teachers, parents, and community members all participated in the challenges.

As all this was going on, the Principal was supporting relevant content professional development for the K-5 teachers. He encouraged the teachers to attend workshops that focused on the Next Generation Science and Math Standards. He encouraged teachers to attend annual conferences held by the professional associations of Math, Science and Technology Educators. He brought in Nano-Link for an all day professional development to learn about Nanotechnology and STEM in the K-5 classroom. Overall the STEM program was a success and growing.

Daugherty, Carter, and Swagerty (2014) states, “Given that many elementary teachers feel apprehensive about teaching STEM lessons, a formula for changing the status quo will require the infusion of highly skilled STEM educators who can provide engaging lessons and professional development for other educators within the elementary school.” This point was directly observed in the first four years of the STEM program. Teachers were apprehensive, they looked for help and support to incorporate STEM into their classroom. Teachers’ confidence level in delivering STEM content went up and their apprehension went down only after a highly qualified Technology and Engineering Educator was brought into the program, content specific professional development for the classroom teacher was provided, and a concerted effort was made to add a STEM class to the students’ schedules, allowing classroom teachers to collaborate with a highly skilled STEM teacher and observe well thought out real-world problems.

Administration Support

My school and a neighboring school merged to form a new district. The Principal became the Superintendent of the newly merged district and we were asked to build a STEM program in the K-5/HS building with students who had not previously been exposed to a STEM program.

As the year began, while the STEM program had the support of the Superintendent the program did not have the support of the K-5/HS building principal nor the buy-in from the K-5 teachers. As a result, the program was introduced to the K-2 classes only. We have begun building relationships with the K-2 classroom teachers and offering support. Due to the lack of administration support, many teachers do not understand what a STEM program and subsequently what a highly qualified Technology and Engineering teacher could offer to their students. The classroom teachers and parents asked for the students to learn keyboarding and be given time to sit and practice math facts rather than apply those math facts to a relevant real-life problem which resulted in a hands-on solution and a better understanding of the math skills and facts.

Realizing we did not have the support of the building principal, we turned to plan B, which included introducing the quarterly STEM Challenges that proved to be successful in the first four years at the previous school. We also began to educate our K-2 teachers on how we were reinforcing the Math and Science Standards through the hands-on engineering design projects. With each project, the teachers' confidence began to grow and subsequently their support in the program. With each project and quarterly challenge the students' enthusiasm and engagement increased. We were making progress, albeit baby steps, but we were moving forward.

As the year progressed the building principal quit and moved to another school. An interim building principal who fully supported a K-5 STEM program and understood what a Technology and Engineering teacher could offer started the following day. It was then that our jobs got a little easier and the STEM program began to progress even faster. Teachers began to see the benefit of the additional support to the science and math curriculum. Students forgot about keyboarding and computer games and began looking forward to the hands-on projects and robots. Parents began providing feedback on the projects that their K-2 students could describe and explain to them when bringing the project home (i.e. string telephones and wave theory).

Kennedy and Odell (2014) states, "High quality STEM education programs provide teachers with opportunities to collaborate with one another in unified efforts aimed at integrating the four subjects into one cohesive means of teaching and learning." This was observed to be true and accurate in the first four years of the STEM

program when the building principal supported the program and allowed for collaboration. The effects of the lack of support and collaboration were observed this past year when the principal did not provide time for collaboration and did not see the benefit in implementing a STEM program in the K-5 classes. Without the support of the building principal, a STEM program can suffer and it's success lies in the teachers' hands. With the administration's support it can be made sustainable.

Conclusion

Given the previous research and observations from my action research over the past several years, I have come to the conclusion that it is important to have both the buy-in of the elementary classroom teachers and the support of the administration, but it is not required in order to implement and build a sustainable STEM program on the K-5 level. Once established it will increase school attendance, improve our students' self-confidence, and change the way they think and observe the world.

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