Discussion and Conclusion

Because the STEM S.O.S. is a novel model that was developed to improve K-12 STEM education, we wanted to see to what extent it is effective with students in terms of its components and benefits for students. After performing the coding process (open, focused, and axial coding), student interviews revealed that hand-on activities including YouTube videos and experiments, and student teaching from Chapter and Year-Long Projects are the main components of STEM S.O.S. teaching in the suggested grounded theory. The effective implementation of these components in the STEM S.O.S. model not only produced two fundamental benefits, Academic, and 21st Century Skills, but also helped circulate the sub-components of these two gains. That is, through the STEM S.O.S. model, students improved their knowledge/conceptual understanding, STEM interest, and research interest in higher education and developed self-confidence, technology, life and career, communication, and collaboration skills; and these skills continued to improve circularly.

Starting from the beginning to elucidate the whole process of grounded theory of the STEM S.O.S. and its components and benefits for students, teachers initially acted as role models by teaching new content in an original way. One of the discussions among teachers is whether they can prepare their students for standardized testing by using active teaching methods like Project-based learning when only standardized testing scores matters for schools (Needham, 2010). But it seems that teachers in the STEM S.O.S. overcame this problem because teachers first teach the content by actively lecturing it. On the other hand, the problem with lecturing is that students' attention begins to wander after 15 minutes of a lecture (Dowd & Hulse, 1996). However, the STEM S.O.S. model solves this problem by engaging students with YouTube videos, hands-on activities, and student teachings as one student put: "Except when he is doing the initial lecture, he doesn't do much talking which is good. Initial lecture, he introduces the ideas, he introduces the chapter or whatever the subject area is. Then we have videos, we have demos, we have student teaching, student all the time" (Student 4). Indeed, the literature says that students learn better when they are at the center of the instruction and they take the responsibility for their own learning (e.g, Blumenfeld, et al., 2011), two central components of Project-based learning (Pearson, Barlowe, & Price, 1999). Therefore, this results in students creating connections between the concept and its real life applications without being forced to memorize numbers or formulas: "… the way he teaches [is] good because instead of making you memorize things, he shows you how every things are connected, he shows us how every laws connected to one another (Student 10). This is parallel with the research on situated cognition indicating that learning is enhanced if the context for learning resembles the real-life context in which the materials learned would be used (Collins & Duguid, 1991).

Chapter and yearlong projects are central to the model. Because students mostly perceive project completion as a fun privilege, they develop ownership of the projects and really take responsibility for their learning. This might stem from students' admiration of their science teachers during classes where they complete hands-on and mind-on experiments, characteristics that make their *science teachers charismatic* as one student described. Also, they get extra credit for anything they do extra for their projects. Therefore, they try their best to do something different and new, thus learning happens concurrently. Also, completion of projects requires many personal and interpersonal skills and technology use. Because research found that high school graduates are not ready for college curriculum (e.g., Anderson, 2013) and college graduates are not ready for workforce in terms of necessary skills (e.g., Grassgreen, 2014), developing personal, interpersonal, and technology skills has become more important than ever.

For instance, students are required to do video a presentation of their assignment. To prepare a video presentation, students have to take pictures of each and every step of the experiment and materials, record the important episodes of experiment, and put them in order in the movie. They also have to insert any graphic that will show the change in measures at the time of, for instance, collision as well as the collision of the cars. They have to collaborate and get help from other students during completion of some projects without any formal requirement. In addition, they have to make a website of the experiment and upload the video presentation to the Harmony You Tube page. What's more, students have to present their products not only in the classroom but also to audiences during school STEM festivals, ISWEEEP competitions, and STEM expos. Then, it is not surprising to see that students develop skills including self-confidence, technology, life and career, communication, and collaboration that are necessary for the 21st century workforce (Pacific Policy Research Center, 2010). As they get positive feedback from participants and viewers, they become more motivated, self-confident, better presenters, and experts in the content they present. Accordingly, this changes their attitudes towards science positively; they may develop STEM interest as in the social learning theory of Albert Bandura, (1977). This is congruent with research findings in which studies reported that student attitudes toward STEM education proved to be a major factor in order to increase student interest in STEM subjects (e.g., Mahoney, 2010). Also, we learned that students mostly cultivate STEM interest during high school years (Archer, DeWitt, & Wong, 2013: Maltese & Tai, 2011) and see daily life connections with hands-on activities (Myers & Fouts, 1992). Therefore, the role of chapter and yearlong projects seem to be very central to the STEM S.O.S. model.

Teachers' role in the STEM S.O.S. model is also phenomenal. They not only teach the content and make teaching engaging, involving, and fun but are also available to their students during the chapter and yearlong project completions. They provide timely feedback and facilitate them when they need help. Teachers' friendly approach to their students make student-teacher interactions two-sided and results in students' learning, great student projects, and positive student attitudes towards science during chapter and yearlong project completion process. This explains why students, especially female students, who chose STEM majors reported that they were inspired and influenced by their science teachers (Microsoft Corporation, 2011).

These aforementioned elements (YouTube videos, Student teaching from Chapter and Yearlong Projects, Hands-on-Activities) suggest the fundamental components of a successful STEM S.O.S. model that can be emulated in other contexts.

Conclusion

Effective STEM instruction depends on teachers' professional and affective abilities to deal with student biases about science including why I do need to learn science, there are lots of formulas and terms, and science is for only geeks. This research described the STEM S.O.S. model and explored how it helped students grow both academic and 21st century workforce skills. The emerging theory suggests that there are two core elements of the model; teacher-led teaching and student-directed and completed chapter and yearlong projects. The study further identified the student benefits as a result of the model; academic and 21st century skills. If students are to gain academic knowledge, develop STEM interest, research interest in higher education, and 21st century skills, then this model should attract the attention of parents, educators, other students, and policy makers to improve the quality of STEM education and increase the number for STEM pipeline. So far, the STEM S.O.S. model seems to accomplish this goal because Harmony schools' STEM matriculation percentage is higher than the national average (66 vs 33) (Sahin, 2013).

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Appendix

Interview Questions

Hi, we are going to ask you some questions about your science experience at your school.

1. Which science course are you taking this year?
2. What other science course have you taken so far?
3. Do you like science classes?
4. How is science, like physics, taught here?
5. What do you say about your science teacher’s teaching?
6. How does he/she start teaching a class with?

7. Is it different?
8. Why do you think it is different?
9. What is your role in your science classroom?
10. What is your teacher's role?
11. How would you describe your science experience at Harmony?
12. What do you do different?
13. In which ways does Harmony PBL or science teaching help you?
14. What skills do you use in completing science assignments?
15. What skills do you think you develop in the end?
16. Where do you think you will use the skills you develop at your school?
17. Is there anything else you want to add about your science experience at Harmony?