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NASA, Engineering Practices & the NGSS Science Standards: A Conversation with Teachers about Integrating NASA STEM EPDC Pedagogical Practices in the Classroom

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Through the use of NASA-unique assets, NASA STEM EPDC's (Educator Professional Development Collaborative) commitment is to conduct research and to equip educators with enhanced knowledge and resources to provide high-quality, engaging STEM PD to all students, with a special emphasis on those groups who have historically been under-represented in STEM fields.

NASA STEM EPDC has a commitment to provide tailored professional learning for educators at every phase of their careers, as well as for those educators who prepare and support the continued professional development of educators.

Historically, serving as an educator has been regarded by many as a noble career. A career of service, generosity, and sacrifice that simultaneously is at the center of much scrutiny, debate, and power struggle. As educators working in partnership with public school educators focusing on STEM education in a non NGSS state such as Texas we have taken special interest in the effects of integrating the engineering design process. For the past four years NASA EPDC Texas State University has been fully committed to serve as a vehicle that provides exceptional NASA-based resources and intellectually rich professional learning experiences to both informal and formal STEM educators at all levels. The purpose of this work is to advance and promote high-quality, diversity focused professional development for STEM educators who will serve to educate the next generation of STEM professionals. This initiative has been implemented a variety of methods of delivery to facilitate STEM teacher learning experiences. These methods are delivered in four different approaches including 1) NASA Face to Face (F2F) Institutes, 2) Partner-delivered Educator Professional Development (EPD), 3) Online EPD, and 4) Community-Requested EPD.

In this preliminary study, we the authors, seek to explore F2F and Partner-delivered Educator Professional Development through the insights and experiences of STEM educators who have participated in the NASA Future Aerospace Engineers and Mathematicians Academy (FAMA). This interest has led us to explore the following questions: How effective are the NASA STEM EPDC professional development sessions highlighting strategies, pedagogies, and content? Are they valued by educators? Should the "E" in STEM be addressed in a non NGSS state? Should engineering content be integrated into curriculum that does not have engineering state standards? In order to gain understanding of the current education system that integrates engineering concepts in a non NGSS state, voices of Texas educators were captured through conversations in professional development sessions, observations, focus group interviews, and semi-structured one on one interviews. The intention of this research was to explore the microlevel impacts on STEM educator practices, perceptions, and experiences through the voices of the teachers.

As part of the inquiry process, we followed up with two educators and engaged both in a conversation centered primarily on their experiences of impact of integrating new content and pedagogical approaches in their classrooms. This approach provided the participants an opportunity to reflect on their own learning, promote individual experiences and share their unique experiences as stewards of educational change.

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"As cliché as it sounds, it's filled with aha moments. They [students] get it and they [respond] oh this is exactly like I have seen it before or now I understand it. Now they [students] are able to relate it to paper and pencil." Mr. Z, 4th grade teacher

The first educator, Ms. X, is a self-contained teacher having taught all four years in 2nd grade all in the same school district. The second educator, Mr. Z, has taught for three years. He started in a self-contained 2nd grade bilingual classroom, then looped with the class to 3rd grade and is currently a Language Arts/ Science 4th grade teacher. He too has taught all three years in the same school district at the same campus.

Noise with Purpose: Nurturing Engaging STEM Learning Environments

Traditionally, teachers have created a classroom environment for student learning by establishing rules that lead to students sitting quietly in their desks working independently most of a student's day. The EPDC participants have shared a different story when it comes to a STEM engaged classroom. These participants have shared a story of empowerment as they create a learning environment that is filled with "*noise with a purpose*" and "*many natural structures*". These statements capture the spirit of the approaches they have embraced and facilitate in their classrooms. When asked: **What does meaningful STEM education and learning look like, feel like, and sound like after you participated in the EPDC PD?** Ms. X, "*it looks like a lot of kids discussing and leading their problem solving and their solutions, and their projects, a lot of passion because they really get involved in whatever they are working on*." When posed with the same question, Mr. Z described a meaningful STEM environment in this way: "A*s cliché as it sounds, it's filled with aha moments. They [the students] get it and they [respond] oh this is exactly like I have seen it before or now I understand it. Now they [students] are able to relate it to paper and pencil*."

In creating STEM classrooms, both participants described their classrooms filled with group activities where students are free to work in groups throughout the room, which helps to create a synergy that enhances student engagement and collective learning. The educators displayed a level of consciousness, confidence, and courage to trust both their intuition and their students and help disrupt conventional notions of what student engagement looks like. This bold approach to teaching fostered organic learning spaces that exposed their students to socially and intellectually learning opportunities that otherwise may have not been possible. Although to some casual spectators it may seem chaotic, unstructured, and even possibly uncomfortable, because students are actively discussing and leading their own problems and possible solutions, as students work on their projects through collaboration and discussions in natural structures, they learn how to work with each other as skill valued in STEM careers. Finally, it promotes the level of students and helps to shift the power dynamics in the educational process.

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Integrating the Engineering Design Process in the Classroom

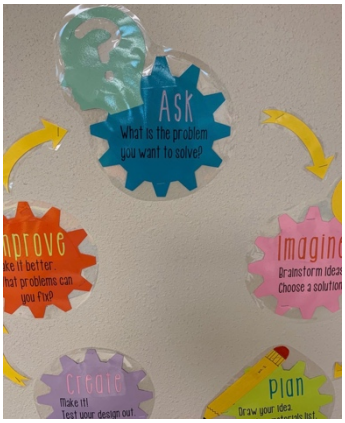

Figure 1

"I've been able to incorporate it [the engineering design process] in the classroom not only into science but the whole problem-solving model in the way kids think and handle all sorts of problems." Ms. X, 2nd grade teacher

Texas is a state where educators follow their own state standards which does not include the engineering design process. As part of the EPDC professional development STEM training, engineering is highlighted through NASA resources. Educators were asked: **How have you been able to integrate Engineering design process into your classroom practice?** Educators talked about how they have easily integrated it into their science lessons but more importantly the engineering design process has become a way of problem solving in other content areas such as reading and math. Mr. Z said "*I give them[students] time to come up with a design, and remind them it's ok to make a mistake, that is how we get better. In reading we formulate a plan on how to attack that question or that text, take it one paragraph at a time and redesign their plan*." This comment helps to illuminate positive changes in instructional practice by adopting a supportive and facilitative role that helps aid in student development and understanding. Furthermore, the teacher works to enact pedagogical approaches that encourage risk taking and help reinforce real-world skills necessary to achieve both personal and professional success.

Posed with the same question as mentioned above, Ms. X makes it a point to refer to the "*wall next to the computer*" (Fig. 1) where a diagram of the engineering design process is posted on a classroom wall. This educator has motions that go with the steps helping the students remember the process which help to reinforce thinking and problem-solving processes. The fact that Ms. X has physically displayed the engineering design process and actively engages her students indicates the value of integrating engineering design thinking skills into the classroom to enhance student learning. The experiences shared by these educators provide exciting possibilities of the positive impact of introducing engineering design skills in professional development in a non-NGSS state can have on teacher perceptions and instructional practice.

Reflection

As educators in a non NGSS state begin to integrate the engineering design process, teachers have communicated their student's ability to integrate it in their daily lives. Students are not only integrating the engineering design process into their science projects but also across discipline and most importantly, into everyday decision making. This preliminary study illustrates that teachers are open to integrating engineering design principles into classroom practice that positively impact levels of student engagement and persistence in problem-solving. With training they are willing to keep revising their plan to come up with a better solution in a collaborative and cooperative way. These skills are utilized in finding solutions to STEM challenges as well as life challenges.

For more information about NASA EPDC visit txstate-epdc.net

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