Developing Attitudes and Support

Evidence-based strategies for cultivating positive attitudes and promoting engagement among stakeholders in STEM Education.

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The strategies articulated in this paper represent a synthesis of Kennedy and Odell's "Elements of Engaging STEM Education Programs" (2014, p. 255), Bouwma-Gearhart et al.'s "main characteristics/strategies associated with successful postsecondary STEM education improvement initiatives" (2014, p. 42), and Chapman and Vivian's "strategies for promoting the engagement of girls in STEM education and STEM pathways" (2017, p. 50). The underlying principles involved have, where necessary or appropriate, been transferred to the context of teaching integrated STEM Education at the secondary level (with a focus on physics) through the thematic study of unmanned aerial vehicles (commonly referred to as drones). While the ten strategies that follow are not presented in any particular order of priority, connections between them have been emphasised where appropriate.

10 strategies for promoting higher levels of stakeholder engagement in STEM

Strategy 1: Leverage diverse community STEM expertise in the classroom

This strategy refers to any use of scientists, engineers, business leaders or any other relevant STEM career role model in the capacity of guest speaker and/or mentor – or essentially in any situation where they visit students at school, whether virtually or in person. The qualifier "diverse" is important here so as not to perpetuate the dominant culture idea that STEM careers are mostly something chosen by white males. In order to achieve this, it will likely be necessary to use services such as "Skype a Scientist" to connect students and experts remotely. In the context of the educational use of drones, "community STEM expertise" could include anyone from a drone hobbyist to an engineer working for a drone transport startup.

Strategy 2: Provide new STEM educators with quality STEM teaching role models

To encourage inexperienced STEM teachers to take risks, move away from textbooks and adopt non-traditional pedagogical approaches, they must be given a clear pathway for doing so, in a STEM-specific context. As Bouwma-Gearhart et al. put it, STEM instructors are more likely to commit to educational innovation if the trainers who are proposing said innovations can translate "education research and theory into forms usable by STEM faculty and instructors", and "speak and unite the languages of both STEM and Education" (2014, p. 43). In the author's anecdotal experience, school-based professional development initiatives are usually not led by or tailored for STEM instructors, and thus in most school contexts it will likely be necessary to seek outside expertise, possibly remotely (and indeed, it is for this very reason that the author decided to enroll in this course!). If relatively inexperienced STEM teachers are expected to adopt the use of drones, consider purchasing training and resources from an educational drone company.

Strategy 3: Foster interdisciplinary collaboration among STEM faculty

For STEM learning to become truly integrated and authentic, it is not enough to simply add some engineering and technology-related learning experiences into one's current science and mathematics curricula. Science and mathematics teachers must be given time to collaboratively plan with design and technology teachers in order to get students using and applying science and mathematics in authentic ways. In the context of a thematic science unit based on the study of drones, digital design teachers are an excellent resource for supporting students and fellow teachers with the programming aspect of drone operation. Those with experience in engineering materials can guide students through the typical calculations required when attempting to define the specifications for a new drone application idea. Ideally, input would also be sought from professionals working in the drone industry (as per Strategy 1).

Strategy 4: Use the lenses of the design cycle and computational thinking to frame learning

This strategy can be seen as one that naturally follows the adoption of Strategy 3. For example, the design cycle can be applied to many situations in practical experimentation during science lessons, and students might even be asked to decide whether a design cycle approach or a scientific method approach would be more suited to a particular problem or situation. Students can use iterative and algorithmic methods as alternative ways of solving mathematics problems. The design of a drone application authentically integrates both approaches.

Strategy 5: Strive towards a culturally responsive STEM pedagogy

Strategy 1 (at least the diversity aspect of it) can be seen as one (very important) element of the broader goal of ensuring that a student's entire STEM education experience is free of cultural biases and that it equitably presents diverse stakeholder groups. In the context of an integrated STEM drones unit, this could mean presenting a diverse range of stories of people working with and using drones in diverse ways, presenting a balanced view of the benefits and drawbacks associated with the proliferation of drone technology, or possibly even surveying the local community to learn about their needs, desires and viewpoints as they relate to the use of drones in the surrounding area.

Strategy 6: Use technology that promotes the development of 21st century skills

Project-based learning using technology is important to developing the 21st century skills required by our future workforce (Krishna, 2010). 21st century skills such as collaboration, innovation, critical thinking and problem solving (University of Houston, 2022) can all be developed during a project in which students design their own drone application. Up until the prototyping phase, such projects can be carried out with mostly free software applications that run on standard educational use laptops.

Strategy 7: Challenge and inspire students to innovate and invent real-world solutions

This is connected with Strategy 6. Accelerated by the Covid-19 pandemic, social entrepreneurship curricula are becoming increasingly popular in high schools, and there is increasing recognition that high school students are capable of coming up with world-changing ideas too (Freestone, 2022). While not always the case, social entrepreneurship ventures will often have a STEM connection or require STEM expertise. The emerging field of drone transportation is a perfect example of this. By engaging in a project to design a drone transport application, students can see that there is a clear motivation for the things they are learning and can feel that their hard work on the project might even lead to something more.

Strategy 8: Promote STEM programs in a way that is relevant to diverse groups of learners

While Strategy 5 is about ensuring that the STEM learning experience itself is culturally responsive, we also need to find ways to attract more diverse groups of learners to those STEM courses in the first place. As such, school administrations and STEM program managers need to be careful not to perpetuate stereotype threat (University of Colorado Boulder, 2022) by the way that the programs are promoted. If the fact that drones are featured in a particular STEM course is used as a way to entice non-dominant culture students to enroll in it, then the messaging that surrounds drone use and why it might be desirable needs to be carefully considered, so that diverse perspectives are represented in the promotional material.

Strategy 9: Support parents to develop a positive and unbiased attitude to STEM at home

A school’s best efforts in the areas of culturally responsive STEM pedagogy and inclusive STEM program recruitment still run the risk of being sabotaged if STEM learning is viewed by parents and guardians as something out of reach or to be avoided. In the context of educational drone use, some parents may hold negative perceptions towards drones, and finding ways to support them with participating in their child's learning about drones might help to alleviate this. Ideally, students would be able to sign out a drone for home use, but if this is not possible, parents could be invited to an information session at the beginning of the unit.

Strategy 10: Take STEM learning beyond the classroom walls

Field trips have long been recognised as an essential part of a well-rounded and authentic education experience, and the study of drones is no different (Behrendt and Franklin, 2014). While Strategy 1 brings the outside world into the classroom, this strategy is about extending learning beyond it and providing students with opportunities to apply what they have been studying in the real world. If a class set of drones is available, then students can be chaperoned somewhere off campus that would allow them to test their drone application ideas in meaningful ways (just be mindful of the regulations related to drone flying in your area). If the unit of study has been entirely theoretical and hypothetical, then perhaps a trip to a local drone club could provide some much-needed enrichment.

Conclusion

Widespread stakeholder support for the use of drones in integrated STEM education will require careful management of the applicable departments' relationships with students, parents, school leadership and the school community. While it might be obvious to STEM educators that learning through the project-based use of drones represents authentic, best practice, integrated STEM pedagogy, additional work will need to be done to convince other stakeholders of this, given the potentially high financial cost of implementation. Making the improved student engagement and educational outcomes that result from the project-based use of drones in the STEM classroom explicitly visible to diverse community stakeholders is the first step towards fostering their increased engagement and positive attitudes towards STEM learning.

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