Engaging One-Health Role-Models to Increase STEM Competency and Motivation in Middle School Students

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Introduction/Need for Innovation or Idea

Across the nation, we have shown an inability to achieve STEM diversity in higher education (Estrada, et al., 2016). Further, the Pew Research Center consistently finds that American students lag behind other countries in science, regardless of the test used (Desilver, 2017). Compounding these difficulties, science is not among the most liked subjects in school even though STEM plays a critical role in society (Jones, 2022). Many scientific and educational organizations recommend that efforts to interest students in STEM majors and careers begin at the middle school level, a time when students are developing their interests and recognizing their academic strengths (Kier, et al., 2018). One approach to encourage interest in STEM is to introduce students to STEM role models, individuals who can positively shape a student's motivation by acting as a successful exemplar (Gladstone, et al., 2021).

This five–year project is part of a NIH-SEPA funded grant (https://nihsepa.org) which has developed student-centered online modules designed to teach science standards in the context of One-Health (the integration of human, animal, and environmental health). Each module also incorporates case studies focused on real-world issues designed to be of interest to students (Drymiotou, et al, 2021). This project addresses student motivation as well as science competency by incorporating relevant problem-based learning facilitated by near-peer role models who introduce middle school students to science and the scientific community and who can, according to research by Cooper, et al., 2023, promote intellectual interest, provide intellectual autonomy and authority to address problems, build self-efficacy, and normalize the process of science to minimize potential performance anxiety.

Methodology

The project addresses both student science competency and motivation via One Health case studies and near-peer role models. A multidisciplinary team including teachers, scientists, and faculty developed seven bilingual One Health modules and accompanying case studies which adhere to Next Generation Science Standards (NGSS) and incorporate multiple learning styles. Each case study includes a detailed leader's guide, comprised of background information, connections to learning elements from the associated One Health module, delivery strategies, and a relevant capstone project designed to capture student interest. Graduate and professional students were recruited by faculty based on their commitment to underserved youth, their knowledge and experiences in One Health and STEM fields, and their ability to connect with youth in dynamic ways. Prior to engaging with students, a veteran middle school teacher provided instruction in and modeling of classroom effectiveness, engaging diverse populations, and appropriate relations, boundaries, and communication. Role models facilitated One Health learning experiences at schools and camps with high populations of at-risk and underserved students.

Results to Date

A cohort of teachers, scientists, and STEM faculty created case studies associated with the

existing One Health modules. These case studies are aligned to each module as follows: Antibiotic Resistance – Ecology, Antioxidants and Cancer - Cell Biology, Avian Influenza - Infectious Disease, Diabetes – Stress & Homeostasis, Middle East Respiratory Syndrome – Genetics, Pharmaceuticals - Clinical Trials, West Nile Virus - Zoonotic Disease.

Tracking of student engagement and learning outcomes is achieved through Sharable Content Object Reference Model (SCORM) packages hosted on our university based LMS (Moodle). This data aids in determining level of engagement with the module and assessing learning gains. Currently, 185 teachers have classes registered for the One Health curriculum on Moodle. Initial pre and posttest scores indicate an increase in concept knowledge.

Over the past two years 12 graduate and professional students from the colleges of Agriculture & Life Science, Veterinary Medicine, and the School of Public Health, led "One Health Learning Experiences" for over 800 K-12 students from across six school districts, four science summer camps, and a Poultry Science Day. A total of 131 direct contact hours were achieved through these events. Utilizing a One Health case study, students practiced problem-based learning to develop a response to a real-world issue. Middle school students were encouraged to lead the capstone projects, supported by the role-models, thereby strengthening scientific confidence, and promoting intellectual autonomy and authority. Final projects included mock press conferences, poster sessions, and Google Slide presentations. Reflections from role-models and students (noted below) indicate an increase in student interest in and understanding of STEM topics.

> "Man, I wish we learned more stuff like this in school. Maybe I would actually pay attention." – [School] ISD Student Participant
>
> "Although the participants were very young, they were quite inquisitive about One Health" – Agriculture & Life Science PhD Student Leader
>
> "The students began to display a genuine interest in science concepts such as zoonotic diseases and careers in STEM" – Veterinary Student Leader

Future plans/advice to others

Our next phase includes comparison of learning outcomes for students engaged with the modules to similar students who did not use the modules as well as assessing attitudes towards STEM before and after engaging with case studies led by role-models. Longitudinal studies examining whether participating students pursue and persist in STEM fields are also under development. Others who want to implement a similar program are encouraged to engage with stakeholders throughout the process and include an interdisciplinary team of researchers who represent areas of interest to students. Use of the One Health curriculum may also prove beneficial in agriculture education classes. The case studies within the curriculum are of agricultural significance and may promote collaboration between future agriculture leaders and other science professionals.

Costs/resources needed

Those wishing to replicate these learning experiences may access the NIH-SEPA funded One Health curriculum free of charge. Mobile devices or computers with internet access are required as well as staff and faculty engagement and technical support in the form of server space and LMS creation.

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