

Can training for ethics in STEM benefit the workforce?

The ethics in science, technology, engineering and mathematics (E-STEM) programme is a National Science Foundation (NSF) funded project at Gwynedd Mercy University, Greater Philadelphia. Dr Michelle Kulp McEliece and her colleagues, Dr Christian Hellings and Tara White Hines, created the programme in response to research which suggests that a focus on ethics in STEM can foster the ability of students to become part of the STEM workforce. E-STEM uses evidence-based modules that incorporate ethics, study skills, peer mentoring and social events to promote recruitment in STEM subjects, boost academic success, and improve student retention rates.

Studies suggest that to achieve academic improvement for academically promising students, there is a requirement for study skills development supplemented with social support programmes. It has also been shown that increased retention and overall academic success can be achieved by placing focus on emotional development alongside academic curricula. More specifically, students taking science, technology, engineering and mathematics (STEM) majors can benefit from combined academic support, social or emotional support, and exposure to an interdisciplinary curriculum. Additionally, a focus on ethics in STEM has been shown to foster analytical skills with a verbal focus, and dilemma-based problem solving has been shown to increase students' understanding of fairness and equality.

THE E-STEM PROGRAMME

In response to this evidence, the ethics in science, technology, engineering and mathematics (E-STEM) programme has been developed to offer a modular

approach for capacity development. The ultimate goals of the project are to increase the number of students pursuing STEM fields, increase retention in STEM majors, and ensure more students go on to enter the STEM workforce.

The programme, which was funded by the National Science Foundation (NSF), began in 2014 at Gwynedd Mercy University, Greater Philadelphia. Dr Michelle Kulp McEliece leads the programme alongside colleagues Dr Christian Hellings and Tara White Hines.

A significant portion of the NSF grant supports scholarships for students pursuing a STEM major of biology, computer information science, or mathematics at Gwynedd Mercy University. The scholarships are designed to increase the number of students undertaking STEM degrees at the university by reducing the associated financial burden. E-STEM is also open to students that have not been awarded scholarships, and it has attracted a number of such students.

E-STEM ACTIVITIES

In addition to scholarship aid, the E-STEM programme also supports students through activities. These include a living-learning community, coaching on STEM study-skills, and peer tutoring. Ethics modules cover the foundations and the importance of ethics in STEM fields, using ethics scenarios, small group discussions, evaluation of ethical questions including how to dissect ethical questions, and research involving human subjects. Study skills modules include tutorials on note taking, test taking, and reading scientific texts. This module also includes examinations and evaluations of study habits and learning styles. In addition, guest speakers give participants an opportunity to learn from and increase professional connections with industry representatives and returning alumni.



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Peer mentoring based in collegiate development theory includes team building, study support, mentor-mentee sessions, and counselling training. The programme also includes social events which are designed to promote team building and stress management.

Dr Kulp McEliece, who earned her Ph.D. in molecular biology from Lehigh University, is an Associate Professor of Biology at Gwynedd Mercy University. She and her team devised the E-STEM programme with three major goals in mind.

STEM RECRUITMENT INITIATIVES

E-STEM aims to increase enrolment in STEM subjects at their institution by 10% by providing scholarships to academically talented students with demonstrated financial needs. Each student must meet citizenship, major, and GPA requirements to be accepted into the programme, and they must submit an application with letters of recommendation and an essay. Dr Kulp McEliece and her team are focusing on students interested in pursuing bachelor degrees in Gwynedd Mercy University's three STEM programmes: biology, computer information sciences, and mathematics.

A promotional campaign has been developed to accomplish E-STEM's recruitment goal, and a major objective of the programme is to implement at least three new recruitment activities to reach an increased number of academically talented students interested in STEM professions. Activities which accomplished this objective include the distribution of marketing materials, promotion

of E-STEM at University Open Houses, outreach by the university's admissions department and direct correspondence with accepted students.

INCREASING STEM RETENTION

The project also intends to increase degree completion rates by 90%, while preparing STEM students for the workforce. E-STEM

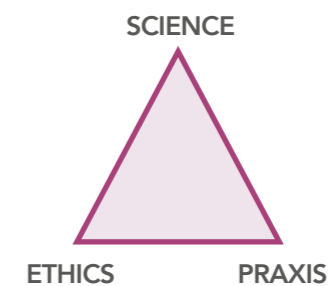
of supportive services with ongoing training in ethics. E-STEM implements joint and split cohort activities designed to accommodate new and continuing E-STEM students, peer mentor training and in-person and online one-to-one conversations between participants and the academic coach. In addition, E-STEM students are given exposure to

E-STEM aims to ensure that at least 85% of students are employed or enrolled in a graduate programme within two years of graduation.

set a goal of increasing retention and graduation rates in the three targeted STEM disciplines from the baseline six-year graduation rate of 50% and the baseline one-year retention rate of 78%. E-STEM also set out to implement at least four new and four improved student support activities, such as academic coaching, peer mentoring, and the creation of an established living-learning community.

These objectives were achieved by creating a comprehensive programme

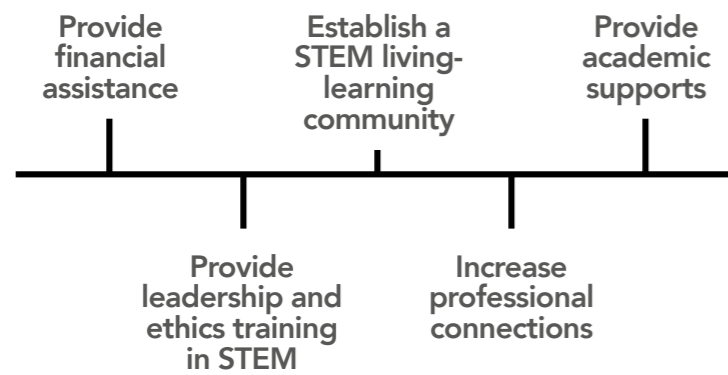
E-STEM Programming



- Ethics training modules
- Study skills
- Guest speakers
- Peer monitoring
- Social events

The pillars of the E-STEM programme were a combination of science, ethics, and practical application and their subsequent interactions.

Strategies to Achieve Programme Goals



A multi-faceted approach for supporting students in the E-STEM programme was used. This included scholarships to decrease the known financial burden for students, as well as connection building and leadership opportunities to foster a holistic network of benefits for the programme and beyond.

that employers seek. This training is especially important to international employers because of the cultural importance of ethics. This aspect of the programme is intended to inspire within graduating students not only strong knowledge and competencies in their subject but also a sound understanding of ethics in STEM.

This is achieved by developing and implementing ethics training modules and required senior and mentor participation

students understand their own ethical principles. The primary focus has shifted year-to-year to cover training on how to dissect ethical questions, support for decision-making, and the deconstruction of real-life ethical scenarios such as authorship disputes and data sharing.

OUTCOMES OF ETHICS IN STEM

Outcomes of the E-STEM programme are measured qualitatively via surveys, interviews, and focus groups, and quantitatively via surveys, university

data, and national data. Data from the programme suggests that it has been effective in increasing ethical awareness in its participants. It also shows that the

cohort model has benefitted participants and that every E-STEM alumnus is now employed or in a graduate programme.

In 2018, the division saw a 21% uplift in applications from the previous academic year, and an average of 30.5% students indicated that the E-STEM scholarship was a factor in their attending or continuing at Gwynedd Mercy University.

E-STEM achieved a 78.6% fall-to-fall retention rate for scholarship recipients, and participant satisfaction rates are consistently high across each completed year of the programme, with 100% indicated perceived value of the mentor-mentee relationship.

Student success rates have been proven to be positive. Normative scores of E-STEM students and students attending Gwynedd Mercy University are indicated to be statistically significantly higher than the national average. Self-reporting indicates "STEM employment readiness improvement" and "increased ethics capacity," which suggests that E-STEM is contributing to workforce needs. This is particularly evident in biology and information technology in the Greater Philadelphia region.

PRELIMINARY CONCLUSIONS

The E-STEM programme has been shown to provide high academic advantages at low operational costs and is a model that could be applied to numerous academic programmes. Dr Kulp McEliece and her colleagues have also found that the development of cohort identity has been crucial to the reported increase in academic achievement.

E-STEM graduates are shown to display higher moral and ethical development scores than their comparative peers, and it is evident that the programme promotes employment preparedness, academic retention, and self-reported value.

Looking more broadly, the programme has strengthened relationships with local schools and employers. In addition, E-STEM's strong focus on ethics education also serves as a model for similar institutions in the region and beyond.

For more information visit www.gmercyu.edu/academics/e-stem-program

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Research Objectives

The Ethics in Science, Technology, Engineering, and Mathematics (E-STEM) programme at Gwynedd Mercy University started in 2014. An NSF-sponsored S-STEM grant programme scholarship, the initiative aims to increase the number of students pursuing and succeeding in STEM fields and, thus, participation in the STEM workforce.

Detail

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Bio

Michelle Kulp McEliece, Ph.D., Associate Professor of Biology, Gwynedd Mercy University. Dr Kulp McEliece earned her BS in biology with a concentration in genetics and developmental biology from the Pennsylvania State University and her PhD in molecular biology from Lehigh University. Before joining the GMercyU faculty, Dr Kulp McEliece was a post-doctoral fellow at Fox Chase Cancer Center.

Christian Hellings, Ph.D., Associate Professor of Mathematics, Gwynedd Mercy University. Dr Hellings earned a Bachelor's degree with a dual major in mathematics and physics from La Salle University and a PhD in mathematics from the University of Virginia.

Tara White Hines, MSPH, Healthcare Data Analyst, Bermuda Health Council. Tara Hines earned a BS in Biology with minors in microbiology, chemistry, and mathematics from Gwynedd Mercy University and her MS in Public Health, International Health with a Vaccine Sciences certificate from Johns Hopkins University, where she also worked as a mixed methods analyst at the Berman Institute of Bioethics.

Funding

The National Science Foundation

References

Gwynedd Mercy University E-STEM Program; Ethics and STEM Capacity Building (2016). Michelle Kulp McEliece, Christian Hellings, Tara White. Poster Presentation, 2016 AACU STEM Education conference.

Personal Response

Why is it important for more students and prospective students to enrol in STEM subjects with an aim to enter the STEM workforce?

Michelle Kulp McEliece: Advancing and bettering society depends upon understanding the natural world around us. It also requires us to understand how to harness and develop the technology that will allow us to do that. Students tend to avoid STEM disciplines because they view them as being too difficult, so it is important to show them how interesting STEM fields are and that they can be successful in them. Great feats of engineering, medical discoveries, improvements to the environment – those are the results of STEM education. It is equally important for that education to include ethical methods in both research development and application.

Tara White: The STEM discipline is one of the fastest growing and most dynamic fields to study in. As careers become more technologically advanced, students with STEM backgrounds will be instrumental in every facet from engineering of a new system to understanding how to improve existing ones. A STEM degree can lead to positions in public policy, traditional research, education, business, healthcare, and beyond. It is an opportunity for people to find a passion that can change as the world does.

The E-STEM programme provides high academic advantages at low operational costs.

in leadership activities. Monthly ethics sessions are held where discussions range from generalised ethics education and its importance to activities designed to help

