

What Role Should Character Education Play in Engineering Education? A Special Session to Rethink How We Educate the Whole Engineer

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Abstract — The complexity of engineering practice requires engineers to make decisions for the betterment of society and public welfare. What role should character education play in engineering education? How might we better prepare engineers to tackle the complexity of real-world practice with virtues like integrity, humility, courage, purpose, empathy, practical wisdom, curiosity, creativity, justice, resilience, authenticity, etc.? In this special session, we invite engineers and engineering educators to rethink how we might educate the whole engineer holistically leveraging what we know about character education. The goals for the session will enable participants to: (1) Gain a common understanding of character education. (2) Reflect on the role that character education should play in engineering education. (3) Brainstorm ways upon which one might integrate character education in one's engineering course. (4) Develop some shared visioning for collective impact as engineering educators.

Keywords – character education, engineering ethics, virtues.

MOTIVATION AND INTRODUCTION

When we think about character education and virtues, we may perceive such a topic to be relevant to philosophers, religious studies scholars, ethicists, and psychologists. We may not ever connect character education with engineering education, yet in this special session that is exactly what we will do. What role does character education play in engineering education? Is character education important for engineers? If so, why and how might engineering educators infuse character education in engineering curricula? These are just some of the guiding questions that will be discussed during this special session.

Engineering is a profession essential to the advancement of society via technological advancements. This societal responsibility is ever more important now. Professional engineering practice involves complexity with technical decisions and complexity of human dimensions and decision making. Are engineers making decisions that reflect integrity, courage, humility, practical wisdom, empathy, critical thinking, curiosity, purpose, hope, authenticity? This is a list of just some of the virtues that we might consider to be relevant to engineers and engineering practice.

Virtues are enduring dispositions that serve to ground how we think, how we feel, and how we ultimately act in ways that are morally good and lead towards morally good ends [1-4]. Character education is grounded in virtue ethics, an ethical lens that goes beyond consequentialism (optimizing the good effects of our actions) or beyond deontology (optimizing categorical rules and duties) [5]. Character education is thus grounded on cultivating stable dispositions and framing virtues to drive the way we behave, the way we think, and the way we feel in order to do the right thing, for the right reasons, in the right ways [6-9]. “An engineer who has developed the virtue of courage, for example, will have the wisdom and discernment to recognize situations where courage is needed and will be reliably disposed to resist the vices of cowardice and rashness by thinking, feeling, and acting in morally appropriate ways.” [5]

We may think that character education is only connected to ethical reasoning, but the reality is that virtues can be mapped to all seven ABET Student Outcomes that all engineering programs strive to attain for accreditation. Table 1 showcases an initial set of virtues relevant to the seven ABET Student Outcomes. This comprehensive and holistic approach to learning outcomes in engineering curricula empowers students and future engineers to better navigate the complexity of real-world ethical decision-making and develop the virtues needed to serve the greater good.

Table 1: Relevant Virtues Mapped to ABET Student Outcomes.

ABET Student Outcome	Relevant Character Virtues
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	Critical thinking, creativity, curiosity, perseverance/resilience
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	Creativity, curiosity, empathy, critical thinking, service, purpose
3. an ability to communicate effectively with a range of audiences.	Empathy, honesty, teamwork, zest
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	Practical wisdom, authenticity, creativity, curiosity, service, purpose, courage, justice
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.	Teamwork, empathy, creativity, practical wisdom, service, perseverance/resilience, courage, authenticity
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	Curiosity, critical thinking, creativity, humility
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	Purpose, practical wisdom, curiosity, creativity, resilience, authenticity

This session reflects a collaboration between engineering faculty and leading scholars in character education at Wake Forest University, where there is both an institutional commitment and programmatic commitment to infuse character education across the engineering curriculum. To date, virtue modules focused on teamwork, resilience, curiosity, creativity, humility, empathy, courage, practical wisdom, and authenticity have been infused across the WFU engineering curriculum. These virtue modules complement engineering knowledge instruction and reveal for the students a richer and broader perspective of understanding professional practice.

SESSION GOALS & ANTICIPATED AUDIENCE

The goals for the session will enable participants to:

- (1) Gain a common understanding of character education.
- (2) Reflect on the role that character education should play in engineering education.
- (3) Brainstorm ways upon which one might integrate character education in one's engineering course.
- (4) Develop some shared visioning for collective impact as engineering educators.

We expect this session to be attractive to a diverse group of engineering educators and engineers who are interested in student preparedness and holistic engineering education.

SESSION DESCRIPTION

Although the special session will be interactive to enable participants to reflect together, the team of Wake Forest University educators will take some time to present on institutional efforts, lessons learned, and share resources that have been developed to support the WFU engineering faculty. Such resources include virtue definitions, a virtue handbook for engineering faculty, theoretical foundations of character education, and effective pedagogical approaches to teaching virtues. We will share virtue modules that we have developed and engage in a rich conversation with the audience to discuss the relevance of these efforts towards professional practice and ABET accreditation efforts. The special session will be interactive to ensure engagement and inclusive collaboration with attendees.

SESSION AGENDA

The 80-minute session will be interactive and follow the structure outlined in Table 2 below:

Table 2: Session agenda details.

Activity	Time Duration
Welcome and Introduction	10 mins
Why is character education important to engineers? (interactive activity)	15 mins
What is character education and what strategies are most effective? (WFU team presentation)	10 mins
What virtues are most relevant to engineers? (interactive activity)	15 mins
What pedagogical approaches in engineering education could support character education? (interactive activity)	15 mins
Large group discussion, next steps, and closing remarks	15 mins

The interactive activities will involve individual, small group, and large group brainstorming strategies and knowledge sharing. Themes that emerge from the session will be captured and shared with the participants after the session.

EXPECTED OUTCOMES & FUTURE WORK

The primary expected outcome of this session is a nucleus of innovative work on the emerging domain of character education in the context of engineering practice and engineering education. There is potential for this session to impact the future work of engineering educators in transformative ways towards a more holistic education that can even enhance the cognitive domains of engineering practice. Further, this work will inform on-going research and publications emerging from WFU.

Since we do not anticipate having time to fully discuss and share the results of the group work during the special session, we plan to collect the results of the group work, organize them, and send them to session attendees and other interested colleagues after the conference.

FACILITATORS

Olga Pierrakos is the Founding Chair and Professor of the Wake Forest University (WFU) Engineering program that graduated the inaugural cohort of graduates in May 2021. She is proud of building and leading an engineering team at WFU deeply committed to Educating the Whole Engineer and grounded in liberal arts engineering education, which showcases (a) curricular agility in support of occupational fluidity, (b) authentic integration of engineering fundamental in support of preparing graduates for the complexity of engineering practice, and (c) an intentional focus on an inclusive and innovative culture in support of human flourishing. As a national thought leader for engineering, education, and innovation, she serves on several boards to the raise the status of engineering as a profession. As a biomechanical engineer and engineering education in engineering, she conducts research in cardiovascular fluid mechanics with a goal to develop novel hemodynamic performance metrics for assessing cardiac function. As an engineering education researcher, she conducts research on engineering identity development, complex problem solving, and character education in engineering, and student motivation. She is currently the PI on a Kern Family Foundation KEEN award to infuse character education (in partnership with the WFU Program for Leadership and Character) and entrepreneurial education across the WFU Engineering curriculum. Prior to WFU, she served as Program Director in the Division of Undergraduate Education at the National Science Foundation. Being her second time as a founding faculty of a new engineering department, the first time at James Madison University, she brings a wealth of insight around building new programs, leading pedagogical innovations, fostering a collaborative and entrepreneurial

culture, and facilitating change towards inclusion and equity. Olga has BS and MS degrees in Engineering Science and Mechanics from Virginia Tech, and a PhD in Biomedical Engineering from the joint program between Virginia Tech and Wake Forest University.

Adetoun Yeaman is an Engineering Education Postdoctoral Fellow in the Department of Engineering at Wake Forest University. She received her doctorate from Virginia Tech, where her research focused on understanding empathy in the experiences of undergraduate engineering students in service-learning programs. She has an M.S. degree in Mechanical and Nuclear Engineering and a B.S. degree in Biomedical Engineering, both from Virginia Commonwealth University. She has a strong interest in the ways that people interact and the role that engineering and technology play in society. To this end, she continues to promote social competencies, such as empathy, within engineering education and practice. Her research spans a variety of areas including empathy in engineering, character education and design education.

Michael Gross is a Founding Faculty and Associate Professor of Engineering and the David and Leila Farr Faculty Director of the Center for Entrepreneurship at Wake Forest University. He has played a vital role in planning, developing, and delivering the new Engineering program at Wake Forest, a program viewed as an opportunity to break down silos across campus and creatively think about reimagining the undergraduate engineering educational experience, integration and collaboration across departments and programs, and how to achieve the motto of Wake Forest University: Pro Humanitate ("For Humanity"). Michael received his B.S. in Chemical Engineering at Bucknell University, and his Masters and PhD in Chemical and Biomolecular Engineering at the University of Pennsylvania. In addition to his broad research interests in materials and composite processing and design for energy applications and gas adsorption, he also has a passion for designing educational experiences that support student intrinsic motivation and character.

Jesse Pappas is a Research Scientist and Capstone Design Instructor in the Department of Engineering at Wake Forest University. When he is not synthesizing engineering and social science in the classroom, he studies identity development, situational aspects of character, and the organizational culture of engineering education. He received a Ph.D. in Social Psychology from the University of Virginia, an M.A. in Psychological Science from James Madison University, and a B.S. in Psychology from Virginia Tech. Jesse has taught in Central and South America, India, and Europe, and his work has been published in journals such as Social Psychology Quarterly, Journal of Personality, and the Journal of Cleaner Production. He is also a part-time entrepreneur, serving as Cofounder and Chief Data Officer at The Lupulin Exchange, the leading hops marketplace in the craft brewing industry.

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