Toward a Globalized Engineering Education: Comparing Dominant Images of Engineering Education in the United States and China

Dr. Qin Zhu, Colorado School of Mines

Qin Zhu is an Assistant Professor in the Ethics Across Campus Program and the Division of Humanities, Arts & Social Sciences at Colorado School of Mines, where he is co-directing the Daniels Fund Program in Professional Ethics Education that provides support for faculty to integrate ethics into applied science and engineering curricula. Qin serves as a graduate faculty member in the Master's Program in Natural Resources and Energy Policy at Mines. Qin is also Associate Editor for International Perspectives at the National Academy of Engineering's Online Ethics Center for Engineering and Science and Book Review and Digital Platforms Editor for the Journal of Engineering Studies. Qin's research interests include the cultural foundations of engineering ethics, global engineering education, and ethics and policy of emerging technologies such as robotics and nanotechnology.

Toward a Globalized Engineering Education:
Comparing Dominant Images of Engineering Education in the United States and China

Introduction

As a rising power in the global economy, China has produced the world's largest engineering education system. However, very limited research has been conducted to understand the professional formation of Chinese engineers and the broader historical, social, and political contexts in which they become who they are. By drawing on the theory of "dominant images" in engineering studies, this paper conceptualizes the most prevalent cultural ideas and practices in the engineering education system in China. This paper employs a comparative approach to the cultural studies of engineering education. In particular, it examines the cultures of engineering education in China by comparing them with those in the American context with which most readers are familiar. Another crucial reason for adopting such comparative approach is that the American model of engineering education has arguably become a "global form" and other countries including China have been challenged by such global form when they struggle with creating engineering education systems sensitive to their own needs and traditions.

This paper advocates for a globalized engineering education that underscores the *globalized* nature of localized engineering education practices. Faculty in American engineering programs are teaching and advising students among whom a considerable percentage are from China. American engineering students will have an increasing chance to work and compete with others influenced by Chinese culture. In a similar way, local Chinese engineering educators and students are frequently challenged by various dominant images of global engineering education that originated in the United States (e.g., student-centered, active learning, problem-solving skills). When they are improving their curriculum and instruction in engineering, it is nearly impossible that they can escape from responding to these global forms of engineering education. In general, this paper should be of particular interest to comparative education scholars, international engineering educators, and education policymakers with a global focus.

Dominant Images and Global Engineering Education

Engineering studies scholars Gary Downey and Juan Lucena have challenged the traditional view of culture that defines culture as "a common set of values, beliefs, norms, and behaviors" shared by "members of a bounded community" [1, p. 5]. Instead, they have proposed a new framework for understanding cultures and individuals. Their framework for cultural studies describes culture as a context in which "individuals living and working in a particular spatial and temporal location are challenged by dominant images" and these dominant images "create expectations about how individuals in that location are expected to act or behave" [1, p. 5]. Individuals connected to a specific culture may respond to the same image differently and they may resist, adapt, or accept such image in various ways. However, dominant images of a culture are meaningful to the people who live in that culture. Their plans, actions, policymaking, reflections, and frustrations all aim to explore possible reactions to the challenges brought by these dominant images.

It is worth noting that the idea of dominant images is not an *empirical* concept. In other words, the dominant image active learning in American engineering education does not necessarily infer that most American engineering schools and programs have adopted or developed active learning well. Rather, dominant images often have *normative* value. Engineering programs and faculty may have different feelings about active learning, but active learning as a social image is relevant to their educational practices. Very few American engineering faculty will find the concept active learning completely foreign. Most American engineering educators are challenged by the image of active learning. Nevertheless, I am not arguing that they all know how to do active learning, or all have resources to implement active learning programs. In the United States, it is less controversial that active learning has somehow become a *normative* criterion for distinguishing effective learning from ineffective learning. Again, it does not necessarily mean that most engineering programs have adopted active learning. Some programs may lack human and financial resources to reform their traditional engineering programs. However, active learning is an ideal these programs may strive to pursue, if they were provided with enough resources to reform their engineering education programs.

Prominent engineering education reformers Jeffery E. Froyd, Philip C. Wankat, and Karl A. Smith have summarized five major shifts in engineering education during the last 100 years in the United States [2]:

1) a shift from hands-on and practical emphasis to engineering science and analytic emphasis;
2) a shift to outcome-based education and accreditation;
3) a shift to emphasizing engineering design;
4) a shift to applying education, learning, and social-behavioral sciences research;
5) a shift to integrating information, computational, and communications technology in education.

Arguably, these shifts could be considered as dominant images in American engineering education, but it does not mean that these shifts have already occurred in all American engineering programs. Let me suggest that the reader consider the following scenario that I hope will be helpful for the reader to better understand the concept of dominant images. Let us imagine a scenario in which a Chinese engineering professor meets an American colleague on a flight. If the Chinese professor is interested in learning more about American engineering education and ask the American professor to summarize some major defining characteristics of American engineering education, it is probably not surprising to imagine that the American professor will talk about concepts such as student-centered, project-based, active learning. Or, if the Chinese professor is more knowledgeable about American engineering education, he/she may directly ask about how to implement active learning well, without even questioning whether active learning is suitable for the Chinese culture. The American professor may complain that his/her school is too small which does not have enough resources to implement the innovative engineering education programs that large universities such as Purdue University have been promoting. However, this scenario does not limit active learning from serving as a dominant image of American engineering education. In summary, a dominant image is not something what a person or program is actually doing but something what such person or program is expected to be doing by others especially those who are familiar with this person or program.

This paper adopts the theory of dominant images as a framework for understanding engineering education in the global context and how engineering education is practiced in different cultures. Particularly, this paper applies the concept of dominant images to compare engineering education ideas, practices, and policies in the United States and China. On the basis of the work by Downey and Lucena, I argue that these dominant images are not limited to a specific culture. In the global context, many of these dominant images have become "global forms" [3] which were derived from one culture but then decontextualized from this culture and traveled to other cultures. For instance, dominant images of American engineering education such as student-centered, active learning, outcome-based assessment, and the entrepreneurial mindset originated in the United States but have become global forms and traveled to other places in the world including China. The global nature of these dominant images also provides a methodological justification that explains why we should learn the dominant images of American engineering education before we discuss Chinese engineering education. A major goal of Chinese engineering educators is to respond to those globalized images of engineering education traveling from the United States. In this sense, engineering education in the United States or China is hardly an isolated localized practice but a globalized practice or a practice in a location but with global significance.

Before we discuss dominant images of engineering education in the United States and China, it is worthwhile to examine the stance and experience of the author himself. Such examination has methodological value. The author of this paper received a BS in Material Engineering at a Chinese university and then pursued his first PhD in Engineering Ethics at the same university. Then he traveled to the United States and received his second PhD in Engineering Education at an American research university with one of the world's first graduate programs in engineering education. Now he is conducting engineering education research as a tenure-track assistant professor at a much smaller research university in the United States which does not have a graduate program in engineering education but has a considerable number of faculty are interested in STEM education research. Arguably, I must admit that some observations in this paper can be anecdotal as they were built on the author's personal reflective observations during the past seven years while visiting, studying, and working at multiple American research universities. These observations certainly need to be further examined by empirical research. Nevertheless, the author has had opportunities to communicate some dominant images of American engineering education informally with engineering faculty from other American universities at multiple conferences.

Engineering Education in the United States: Social Constructivism, Outcome-based Education, and Engineered Learning

This section starts by depicting the dominant images of American engineering education deeply rooted in the ideology of liberal democracy. Extensively influenced by philosophies such as social constructivism, American engineering education tends to value a decentralized, student-centered approach to learning. It has become common knowledge that using classroom strategies that elicit active engagement among students produces increased learning outcomes as compared to traditional teaching methods such as lecturing. Universities across the United States "have been mobilizing efforts to help faculty engage students in active learning" [4]. In this sense, the power dynamic in the classroom is supposed to be liberal and democratic. The traditional dominant role of the instructor is thus challenged, and the teacher plays an equal role as compared to the role of students in the learning process. Students assume a more liberal role in the learning process and are responsible for the construction of their own knowledge through experiential learning and interactions with others. The teacher serves as a facilitator who mainly "scaffolds" student learning. Engineering education research thus places more emphasis on the psychological development of students, that is, the efficiency of individual students in retaining scientific concepts.

Social constructivism as an educational philosophy often calls for student-centered, collaborative (e.g., team-based), active learning which allows students to construct their own knowledge. Social constructivism has become a dominant paradigm in American engineering education. It almost seems to be unnecessary (if not a "taboo") in the community of engineering education to question the effectiveness of active learning. Research that compares active learning with more "traditional" ways of teaching such as lecturing seems to be unnecessary. Nevertheless, institutional resources at American engineering universities may not fully support active learning. For instance, it is relatively easy to see that in many engineering schools large lecture halls do still exist. Engineering faculty are challenged by the tension between the *dominant image of engineering education that focuses on active learning* and the *institutional structures that may hinder active learning* such as large lecture halls, unmovable chairs, and the critical shortage of human and financial resources for group-based, collaborative learning. To respond to such challenge, some universities and instructors have started to explore strategies for promoting and assessing active learning in large science and engineering classes [5]. Instruction, learning, and faculty development centers at some engineering schools such as the University of Central Florida have collected tools for promoting active learning in large classrooms [6].

A second dominant image of American engineering education is that it has a strong emphasis on "pragmatic" goals of learning. The effectiveness of instruction is often assessed in pragmatic ways that are based on student learning outcomes including their competencies for solving problems. A typical example is that ABET's engineering accreditation criteria evaluate the quality of engineering programs by examining whether their graduates meet certain learning outcomes [7]. Such outcome-based, pragmatic approach to understanding the quality of learning and teaching lead to at least two possible conequences. On the one hand, the major concern in engineering education assessment has shifted from whether engineering programs educate competent engineers to whether students meet the learning outcomes, despite that the two concerns are different. It is worth noting that these learning outcomes are simply *minimum standards*. Do engineering educators have any expectations or requirements for students who may exceed these minimum level learning outcomes? Or, is the moral obligation of engineering educators only limited to the fulfillment of these minimum standards? The ABET learning outcomes do not provide any clear guidance on how we can educate good or better engineers. On the other hand, the emphasis on evaluating to what extent engineering graduates meet these learning outcomes turns engineering education into a field of educational science focused on "rigorous," evidence-based inquiry which collects empirical evidence from assessment activities. Teachers then become scholars or at least are encouraged to become "teacher-scholars" in contrast to the traditional role teachers play. As a result, researchers may have more interest in studying how a pedagogy affects students' learning efficiency than in how personal characteristics of the instructor may influence students' self-growth.

Unfortunately, not all ABET's student learning outcomes are easy to evaluate. Some learning outcomes such as ethical responsibility and lifelong learning are less observable and more difficult to assess than others. Therefore, a more fundamental question worth asking is: is ethics assessment indispensable for ethics education? Or, can and should we measure ethical responsibility at all? Engineering education researchers may respond: well, how do you know students are good engineers if you do not collect reliable data by employing valid methods? But let me suggest that we consider some everyday examples: do we often ask our friends or people we are familiar with (those people we might call "good people") to fill out a survey based on DIT-2 (Defining Issues Test, ver. 2) to demonstrate that they are real good people? Or do employers have their engineers complete a DIT-2 or similar ethical reasoning assessment to make sure these engineers are morally reliable professionals? Moreover, ethical reasoning that most engineering education studies often measured can hardly predict ethical behavior. Even moral psychologists such as those who strongly advocate for assessing moral development argue that moral behavior requires moral sensitivity, moral motivation, and moral character, in addition to moral judgment or reasoning [8].

A third dominant image of American education is to conceptualize education as an "engineering" process in which prevalent engineering terminologies such as design, efficiency, functionality, standards, quality control, assessment, and cost-benefit analysis are employed. Philosopher Leonard J. Waks denominates such engineering methodology of education the "technology of learning". In particular, Waks provides a vivid description of how the engineering approach to education shapes the everyday practice of education at American schools [9, p. 5]:

> "Teaching" has been redefined as enforcing a technical regime of instruction, "learning" as the acquisition of predefined and measurable "objectives" – bits and pieces of "knowledge" or "skill." Vast research programs have been committed to determining the efficiency by which standardized instructional treatments and curriculum materials achieve such "objectives." Educational consultants have been recruited as "change agents" to replace more traditional teaching and learning approaches with ever-changing research-based and technologically instrumented means, transferring control over education from teachers to mangers of the bureaucracy.

Therefore, engineering education is considered as a *system* that can be studied, controlled, optimized, and assessed. A classic example in this regard is the "pipeline" metaphor [10] that has been widely used in the United States to understand and tackle the systematic challenges with retaining engineering students and recruiting underrepresented populations. Nearly all engineering education graduate programs in the United States are in engineering colleges, schools, or departments. Arizona State University (ASU)'s Engineering Education PhD Program is another good example that demonstrates such engineering and systematic philosophy. According to the description of ASU's PhD Program in "Engineering Education Systems and Design (EESD)," a major goal of this program is to "increase the understanding and design of engineering education ecosystems, including the multiple inputs, outputs, and interactions within these ecosystems" [11].

To better “engineer” the practical strategies for meeting the learning outcomes, engineering “teacher-scholars” in the United States employ the “backward design” approach proposed by Grant Wiggins and Jay McTighe [12]. The backward design is aligned with the engineering thinking that builds action plans based on the needs of consumers. In this sense, insofar as we can justify that learning outcomes are appropriate, the ways to achieve these learning outcomes will neither matter very much nor carry significant moral values. In this sense, approaches to achieve learning outcomes are value neutral. Unfortunately, not very many studies in engineering education have documented whether and how learners can potentially be influenced by the pedagogical and assessment tools, in addition to whether learners have achieved learning outcomes. In other words, are there any unexpected outcomes generated by the employment of these pedagogical and assessment tools, besides the predetermined learning outcomes? I suggest that there are some valuable resources in the ethics of technology literature that the engineering approach to learning can learn from, if engineering educators are seriously committed to conceptualize education as an engineering or technology. One of the major interests in the ethics of technology is to challenge the idea that technologies are value neutral. Technologies often contribute to the shaping of the perception and behavior of the user and the context in which the technology is deployed.

Engineering Education in China: Education as an Art, Self-reflective Learning, Confucian Hierarchy, and National Development

In contrast to the American classroom, the Chinese engineering classroom is more hierarchical. Influenced by the Confucian culture, the instructor has more power and thus “dominates” the whole class. Learning means starting with finding a “good teacher” and then imitating his/her words and deeds. Engineering education in China today remains more of a “(teaching) *art*” rather than a kind of “(learning) *science*” and it is more interested in “how teachers teach” than “how students learn” [13]. Perception of education is not only an epistemological issue but also an ethical or political issue. In most Chinese universities, newly hired faculty (many of them are engineering faculty) who are recent PhD graduates need to take educational courses and obtain a teacher certificate [14]. In 2003, the Chinese Ministry of Education launched an online program “*jingpin ke* (精品课, China quality course)” (http://www.jingpinke.com/) that showcases the quality courses taught by *exemplar* university lecturers. These exemplar university lecturers are recognized by the government and their universities and are expected to serve as moral exemplars for faculty who are less experienced in teaching. Thus, a fundamental assumption in Chinese engineering education is: it is the quality of the teacher rather than the efficiency of the design of the learning system that matters for cultivating competent Chinese engineers.

In contrast to engineering education research in the United States, engineering education research in China has demonstrated very limited (if any) attention to the learning sciences or neuroscientific theories. In the most recent issue of the flagship journal of engineering education in China *Gaodeng gongcheng jiaoyu yanjiu* (高等工程教育研究, Research in higher education of engineering), among 32 scholarly articles in that issue, there is nearly no single article that explicitly employs learning sciences theories. Many of these articles are centered on topics such as fundamental concepts (e.g., the essence of emerging engineering fields), policy studies,

studies on curriculum structure and pedagogies (e.g., MOOCs), and introduction of ideas and practices from other countries (e.g., the United States, Germany) (See a full table of contents of the most recent issue of the journal: http://navi.cnki.net/KNavi/JournalDetail?pcode=CJFD&pykm=GDGJ).

American engineering educators who have witnessed the development of engineering education as a scholarly field in the past two decades may argue that such limited discussion on learning sciences in China may not necessarily mean that Chinese scholars show no interest in learning sciences. It could be possible that engineering education research in China is still a premature field and will incorporate learning sciences in the process of establishing its own rigorous research paradigm. Such explanation may have some truth in itself. Nevertheless, Wei Yu, a member of the Chinese Academy of Engineering and former Vice Minister of Education, noticed such assumption about education as an art in the Chinese culture in one of her public talks,

> We have been talking about education as an art for a long time in China. I have checked this with a lot of educational researchers at international conferences. However, in other countries, such thought (understanding education as an art) has ceased to exist since many years ago. Education is widely perceived as an art in China. Newspapers used to criticize the view of education as a science. Anyone who claimed that education is a science was to ruin education. Education can only be an art [in China] [15].

Western scholars feel concerned that such Confucian approach may turn students into "passive learners," although such worry deserves further reexamination. Sinologist Don Starr has described the confusion and difficulty that Western teachers frequently encounter when teaching Chinese students:

> Western teachers in China and other Confucian heritage cultures discovered considerable resistance to communicative teaching methods. They viewed Chinese students as "passive" learners addicted to rote learning who were unwilling to engage with peer learning group activities and unwilling to debate with the teacher [16, p. 16].

In educational psychology and comparative education, this situation has further been termed "the paradox of the Chinese learner". Comparative education scholar Robert L. Dehaan provides a concise summary of this paradox:

> Despite large classes, expository instruction, relentless norm-referenced testing, and a teacher-centered classroom climate which, by Western standards, seem not to be conductive to optimal learning, Asian students typically outperform Western students in mathematics and science [17].

Kember and Watkins [18] challenge the Western theory of learning that categorizes all learning approaches into two competing groups of approaches: deep and surface approaches. They have discovered that this model does not work for Chinese learners who use some "intermediate" approaches or approaches that combine both deep and surface approaches. What most Western scholars often observed among Chinese learners was the apparent memorization. In fact, Chinese learners "may have been employing one of the intermediate approaches, thereby reaching some level of understanding as well as committing material to memory” [18, p. 171]. In particular, Kember and Watkins have conceptualized two approaches Chinese learners often employ to flexibly combine deep and surface learning [18, p. 171]:

- When understanding came first, the process involved making conscious efforts to remember that which had been understood;
- When memorization came first, it could be used as an attempt to reach understanding.

Nevertheless, many studies that provided strong evidence for the paradox of the Chinese learner were often conducted in the K-12 setting. It is worth further exploring to what extent the paradox of the Chinese learner is still valid in other fields of learning that often require hands-on, practical experience such as engineering, technology, and medicine at the higher education level. In fact, active learning in the United States is more prevalent at the undergraduate level than at the graduate level. Chinese students in American engineering graduate programs were mostly educated in the Confucian learning environment before coming to the United States. It will be very unlikely that they will receive enough active learning in their graduate programs. Certainly, some of these Chinese students will become faculty members at American universities. Then it becomes an issue how these Chinese faculty will be able to teach courses that will accommodate most American students who are more comfortable with active learning.

Interestingly, within the Chinese culture, students, parents, educators, and policymakers are all challenged by the dominant image of Chinese education that is focused on “rote learning, memorization, examination, constant testing, large classes, competitive motivation, examination, authoritarian and didactic teaching and learning methods, passivity, and compliance” [19, p. 6]. Unfortunately, the positive aspects of Confucian learning (e.g., focusing on deeper-level, self-reflective learning) mainly conceptualized by Western scholars such as David A. Watkins and John B. Biggs [20] are not very much appreciated by the Chinese people.

The Confucian approach to learning is challenged by the *global forms* of engineering education that emphasize teamwork, hands-on, problem-solving skills and the entrepreneurial mindset. These global forms of engineering education traveling from the United States are recontextualized in the Chinese context. It is interesting to see that the dominant images of Chinese engineering education are relevant to these global forms of engineering education. In other words, a major concern held by Chinese engineering educators is a deficit model: why does China lack the global forms of engineering education that have become dominant images in the Western cultures such as the United States? Chinese education reformers feel concerned about the challenges in their own system including large quantity but low quality of engineers, overly theory-driven curriculum, disconnect with the industry, and the lack of practical capabilities and entrepreneurial mindset [21].

Since the 19th century, Chinese social reformers have always been challenged by a “pragmatic myth” that the recontextualization of global (Western) ideas and practices into the Chinese culture is a (if not the) hopeful effort to rejuvenate the Chinese nation [22]. However, such oversimplified pragmatic treatment of global forms of engineering education may potentially miss the opportunities to carefully examine the social, political, and cultural contexts that have supported the development of these global forms but not traveled with the global forms to other cultures.

An ultimate goal of Chinese engineering education is to educate future engineers who are capable of utilizing engineering expertise to serve the strategic goals of national development rather than solely translating innovative ideas into marketable products. Ever since the late 19th century when the modern history of engineering started in China, national development has become a dominant image of Chinese engineering and engineering education. Historian William C. Kirby compared engineering with military in Chinese history. According to Kirby,

> Whereas military professionalism could either support or endanger, or even overthrow, the state, engineering was from its birth a profession in the service of state power, national defense, national unity, and national economic development. At the very least, the relationship between state power and the emerging engineering profession was one of the mutual dependency [23, p. 284].

Early Confucian official-scholar Zhang Zhidong who was one of the major advocates for engineering education made a clear distinction between the modern engineering profession and the traditional profession of craftsman. As pointed out by Kirby,

> Zhang differentiated the modern engineer from the traditional profession of craftsman. Engineering, he [Zhang] wrote, was a profession for intellectuals, for theirs was the responsibility to apply (and explain) the laws of science for practical purposes, and to facilitate reforms; craftsmen were to follow the rules made by engineers [23, p. 284].

Early Confucian reformists such as Zhang Zhidong distinguished engineers and craftsmen by attaching almost the highest social status in the Confucian hierarchy *shi* (士, scholars) to engineers. The Confucian social hierarchy consisted of four occupations: *shi* (士, scholars), *nong* (农, farmers), *gong* (工, artisans or craftsmen), and *shang* (商, merchants). Nevertheless, most recently, the Chinese government and President Xi Jinping advocated that a "spirit of craftsmanship (工匠精神, *gongjiang jingshen*)" is needed in Chinese technological industry. Nevertheless, it is worth noting that to encourage the spirit of craftsmanship is not to downplay the social status of engineers but to revive the ethical ideals held by traditional craftsmen such as quality work, good reputation, and self-sacrifice [24].

Implications and Conclusions: Toward a Globalized Engineering Education

In this paper, I suggest that engineering educators should shift their attention toward a globalized engineering education. It is obvious that engineering educators today need to be aware of the global context of their practice. Future engineers are encouraged to become globally competent engineers. However, what this paper advocates for is that within a specific culture (e.g., American or Chinese culture) engineering education is itself globalized, even some engineers we are educating may have no interest in working in or with other cultures. Here I encourage the reader to think about many examples that we are familiar with. In the United States, a considerable percentage of graduate students are from China and there is a significant chance they may become future leaders in industry or academia. Here, some overlooked questions might include: (1) to what extent American graduate advisors are familiar with or aware of the fact that these students received most their undergraduate education in the Confucian culture which is different from the American context; (2) whether American faculty have ever thought about the frustrations these students may have when adjusting their previous learning habit to meet the American learning culture; and (3) to what extent American faculty have shown sympathy to the learning styles of these Chinese students. It is common that some Chinese students do not speak in class and are not as “active” as their American classmates. It is not because these Chinese students do not think but they may want to reflect on the subjects by themselves before asking the professor. Also, they may feel more comfortable to interact with the professor after class. These questions concerning the experience of Chinese graduate students in STEM programs may also apply to the undergraduate students in STEM fields.

The American image of engineering education that perceives education as a learning science has created opportunities to incorporate learning sciences and neuroscientific theories into educational practice and research. In contrast, Chinese engineering education that perceives education as an art downplays the individualistic developmental psychology that is central to American learning sciences and neuroeducation, whereas it focuses on the charismatic personality or moral influence of the teacher. In the United States, it is almost a social norm that active learning is inherently good. Thus, it seems unnecessary to study the efficiency of active learning anymore. What we can learn from this comparative study of engineering education is that we need to ask ourselves at least three questions: (1) does every practitioner of active learning know how to be a good teacher who can effectively facilitate and promote actively learning? (2) is active learning valuable for every student regardless of their cultural backgrounds (e.g., some students may come from the cultures with the Confucian heritage who are more comfortable with deeper, self-reflective learning)? By assuming every student is the same (everyone gains in active learning), do we bring justice to all students or do we hinder the learning capabilities of some students? And (3) what are some conditions for making an active learning activity a good one? Is active learning always effective and good no matter who implements it? Most supporters of active learning would argue against this question by saying: “anybody who is supportive of active learning would emphasize the facilitation role by the teacher. Vygotsky and Dewey will surely agree.” But I will then ask why so much attention has been paid to students and pedagogies rather than the quality of teachers in most engineering education studies.

In summary, this paper encourages the reader to challenge a prevalent view that global engineering education is and should be achieved by sending engineering students to study, service, or work abroad. Engineering education itself is a globalized practice. Even in a domestic context, the global does matter to faculty, students, and policymakers. The global is more than just “appreciating” other cultures. Not only people but also ideas and practices in engineering education travel across cultures. As discussed earlier, Chinese engineering educators can be challenged by the images about engineering education traveling from the other side of the planet without even visiting there. Hopefully, such globalized approach to engineering education can help American scholars be aware that understanding engineering practice and education in other countries such as China do have implications for their teaching and research, even if their work may not have an explicit focus on the global.

References

[1] J. C. Lucena, Defending the Nation: U.S. Policymaking to Create Scientists and Engineers from Sputnik to the "War against Terrorism", Lanham, MD: University Press of America, 2005.

[2] J. E. Froyd, P. C. Wankat and K. A. Smith, "Five Major Shifts in 100 Years of Engineering Education," *Proceedings of the IEEE*, vol. 100, pp. 1344-1360, 2012.

[3] A. Ong and S. J. Collier, Eds., Global Assemblages: Technology, Politics, and Ethics as Anthropological Problems, Malden, MA: Blackwell, 2005.

[4] T. K. Tolnay, S. Spiege and J. Z. Sherer, "Development and Use of the Engineering Learning Classroom Observation Tool (ELCOT)," in *Proceedings of the American Society for Engineering Education Annual Conference and Exposition*, Columbus, 2017.

[5] S. L. Eddy, M. Converse and M. P. Wenderoth, "PORTAAL: A classroom observation tool assessing evidence-based teaching practices for active learning in large science, technology, engineering, and mathematics classes," *CBE-Life Sciences Education*, vol. 14, no. 2, pp. 1-16, 2015.

[6] University of Central Florida Faculty Center for Teaching and Learning, "Face to face: Large classes," [Online]. Available: http://fctl.ucf.edu/TeachingAndLearningResources/LearningEnvironments/largeclass.php. [Accessed 22 March 2019].

[7] J. Mcgourty, L. Shman, M. Besterfield-Sacre, C. Atman, R. Miller, B. Olds, G. Rogers and H. Wolfe, "Preparing for ABET EC 2000: Research-based assessment methods and processes," *Interntional Journal of Engineering Education*, vol. 18, no. 2, pp. 157-167, 2002.

[8] J. R. Rest, D. Narvez, S. J. Thoma and M. Bebeau, Postconventional Moral Thinking: A Neo-Kohlbergian Approach, Mahwah, NJ: Lawrence Erlbaum Associates, Inc., 1999.

[9] L. J. Waks, Technology's School: The Challenge to Philosophy, Greenwich, CT: JAI Press, 1995.

[10] A. L. Pawley and J. Hoegh, "Exploding pipelines: mythological metaphors structuring diversity-oriented," in *Proceedings of the American Society for Engineering Education Annual Conference and Exposition*, Vancouver, 2011.

[11] ASU Polytechnic School, "Ph.D. in Engineering Education Systems and Design," [Online]. Available: https://poly.engineering.asu.edu/engineering/phd/. [Accessed 4 February 2019].

[12] G. Wiggins and J. McTighe, Understanding by Design, Alexandria, VA: Association for Supervision and Curriculum Development, 2005.

[13] J. Cha and Y. He, Zhongguo gongcheng jiaoyu gaige san da zhanlue (Three Straetgies in Chinese Engineering Education Reform), Beijing: Beijing Institute of Technology Press, 2009.

[14] Q. Gu, "The work, lives and professional development of teachers in China," *Asia-Pacific Journal of Teacher Education*, vol. 41, no. 3, pp. 235-238, 2013.

[15] Y. Wei, "Yingjie jiaoyu yanjiu de xin fanshi: Shenjing jiaoyuxue [Embracing a new paradigm for educational research: Neuroeducation]," 19 December 2012. [Online]. Available: http://www.cae.cn/cae/html/main/col35/2012-12/27/20121227152437045647584_1.html. [Accessed 4 February 2019].

[16] D. Starr, "China and the Confucian education model," *Universitas*, vol. 21, pp. 1-27, 2012.

[17] R. L. Dehaan, "National cultural influences on higher education," in *Education for Innovation: Implications for India, China, and America*, R. L. Dehaan and K. M. V. Narayan, Eds., Rotterdam, Sense Publishers, 2008, pp. 133-165.

[18] D. Kember and D. Watkins, "Approaches to learning and teaching by the Chinese," in *The Oxford Handbook of Chinesse Psychology*, M. H. Bond, Ed., Oxford, Oxford University Press, 2015, pp. 169-186.

[19] K. Morrison, "Paradox lost: Toward a robust test," *The Journal of The Chinese University of Hong Kong*, vol. 34, no. 1, pp. 1-30, 2006.

[20] D. A. Watkins and J. B. Biggs, Eds., The Chinese Learner: Cultural, Psychological and Contexual Influences, Hong Kong, China & Melbourne, Australia: Comparative Education Research Centre (CERC) & Australian Council of Educational Research (ACER), 1996.

[21] M. Carnoy, P. Loyalka, M. Dobryakova, R. Dossani, I. Froumin, K. Kuhns, J. B. G. Tilak and R. Wang, University Expansion in A Changing Global Economy: Triumph of the BRICS?, Stanford, CA: Stanford Univeresity Press, 2013.

[22] Q. Zhu and B. Jesiek, "In pursuit of the Dao in policymaking: Toward a cultural approach to understanding engineering education policy in China," *Technology in Society*, vol. 38, pp. 169-176, 2014.

[23] W. C. Kirby, "Engineers and the state in modern China," in *Prospects for the Professions in China*, W. P. Alford, K. Winston and W. C. Kirby, Eds., Abingdon, UK: Routledge, 2011, pp. 281-313.

[24] L. Wang and S. Wei, "Dali hongyang gongjiang jingshen (Vigorously promoting the spirit of craftsmenship)," 7 August 2017. [Online]. Available: http://theory.people.com.cn/n1/2017/0807/c40531-29452734.html. [Accessed 4 February 2019].