ASEE TELPhE Division as a Community of Transformation

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Abstract*—This innovative practice work in progress paper presents an initial review of the emerging role of the American Society for Engineering Education (ASEE) Technological and Engineering Literacy and Philosophy of Engineering (TELPhE) Division from the perspective of a community of transformation. The group seeks to reframe, redesign, and reposition technological and engineering literacy as a central pillar of engineering education. With a philosophical perspective and a critical view of education that connects engineering education to the liberal arts, the group has been moving forward to make an impact in the engineering education community. The goal of the group via all of the collective efforts, discussions, papers, articles, special reports, publications, special sessions, and workshops has been focused on providing a new forum and platform for discussions, debate and dialogue in advocating public awareness of technological and engineering literacy. As an ASEE Division, TELPhE has grown in attracting and engaging practitioners of engineering education, technological and engineering literacy, and philosophy in an ongoing examination of engineering philosophy, the scope of engineering education, and the impact of engineering and technology. Thus far the group has evolved organically but now seeks a theoretical framework to inform strategic planning and goal setting. To this end, the development of the group is framed as a community of transformation. The paper briefly reviews the evolution of the group from the Technological Literacy Constituent Committee and the internal and broader-based discussions and growth into the Technological and Engineering Literacy and Philosophy of Engineering Division. By starting to review the evolution and metamorphosis of the ideas that were developed by the group members and associates, the paper begins an analysis of TELPhE as a community of transformation to inform effective avenues for future activities to impact engineering, engineering education, and technological and engineering literacy.

Keywords—community of transformation, engineering literacy, technological literacy, philosophy of engineering

I. Introduction

This innovative practice work in progress paper initiates an analysis of the ASEE Technological and Engineering Literacy and Philosophy of Engineering (TELPhE) Division. The TELPhE Division has grown from an intial group of 20 interested people to an ASEE division with more than 600 members. The groups seeks to reframe, redesign, and reposition technological and engineering literacy as a foundational principle of engineering education. With a philosophical perspective and a critical view of education that connects engineering education to the liberal arts, the group has been moving forward to engage and impact the engineering education community.

The division seeks to continue to increase the scale and results of divisional activities. It seems appropriate to try to adopt a theoretical model to guide this effort. After a review of several models of achieving broader impact from educational innovations as described in the next section, the community of transformation framework was identified as a promising approach. It was decided that considering the TELPhE Division as a case study of a community of transformation could both be a potentially informative application of the recently-developed community of transformation model, and provide guidance for the division as it seeks to scale up and sustain its impact. A research question to guide this effort is: to what extent does the community of transformation model describe the ASEE TELPhE Division and how can this model inform future priorities for the group's efforts?

II. Models for Sustained Impact

The need to scale up and sustain educational innovations is a critical need in Science, Technology, Engineering and Mathematics (STEM) education. The National Science Foundation (NSF) merit review criteria for funding of proposals specifically mandates that funded proposals promise broader impacts defined as "the potential to benefit society and contribute to the achievement of specific, desired societal outcomes [1]."

The goal of educational innovators to influence a greater body of students, and the emphasis on potential broader impacts from funding agencies, leads to considerations regarding activities or plans that innovators should adopt to achieve sustained and wider impacts. Several groups have

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specifically studied the scaling and sustaining of educational innovations and have developed recommendations for innovators.

The Increase the Impact group studied propagation strategies used by NSF Transforming Undergraduate Education (TUES) projects to promote adaptation and implementation of innovative developments in STEM education. They developed a series of recommendations that others may use to increase the impact of intended projects. These recommendations center on identifying potential future adopters early in the project cycle and developing project attributes as an on-going dialogue with potential adopters [2-7]. While the Increase the Impact recommendations were dervived from data that included projects with very large numbers of participants, these recommendations focus primarily on characteristics of projects rather than features of the communities that may thrive around those projects.

The National Science Foundation and the American Society for Engineering Education developed the NSF Innovation Corps for Learning (I-Corps L) approach to promote the scaling and sustaining of educational innovations resulting from NSF supported projects [6]. I-Corps L is derived from NSF's experience in promoting the commercialization of intellectual property by the principal investigators of NSF awards. I-Corps L advocates development of an entrepreneurial mindset and the seeking of adopters of educational innovations in a manner similar to how traditional high tech entrepreneurs view customers. Alignment between the needs of potential users and the problem solved by the innovation, networking within an appropriate educational ecosystem, and an integrated strategy that includes dissemination channels a means for scaling up, are prominent features of the I-Corps L approach to expanding the impact of educational innovations [7-9]. Similarly to "Increase the Impact," the I-Corps L model appears well-aligned with the issues involved in broadening adoption of a particular innovation compared to expanding the role of an interest group within an educational ecosystem such as TELPhE.

Recently Kezar and collaborators have conducted an empirical study of four STEM projects that have achieved sustained adoption and scale up [10-14]. They have developed the Communities of Transformation model to explain how new developments in STEM education can expand from initial efforts to sustained broad-based adoption. Kezar argues that the community of transformation model is distinct from a community of practice and may be particularly relevant to issues in STEM education. The basic framework for this model cites three elments central to the community: an engaging philosophy, a focus on critical reflection and new practices, and relationships that sustain the community. These characteristics are considered in more detail below. The community focus of Kezar's model is consistent with the primary goal of increasing the sustainability and scale of the ASEE TELPhE Division.

III. Motivation and Background Discussion

A case study of the ASEE TELPhE Division as a community of transformation can serve multiple purposes. The study will be of use to the TELPhE Division itself in helping to devise a strategic vision for future efforts and the allocation of limited divisional resources. The study can also provide information to the wider engineering education community about the extent to which the community of transformation framework appears to apply to engineering-related innovations. The current study will be an application of Kezar's framework in a STEM discipline that is not in one of the basic sciences. All four of the communities studied by Kezar were in the sciences, two were primarily in the biological sciences and one was in chemistry. Since the community of transformation model is advocated as applicable STEM, a case study of a development primarily in engineering education is warranted.

IV. The Process of Formation: A Brief History of the Division and Activities

This section is included to provide some background on the TELPhE Division relevant to the study. The current ASEE TELPhE Division was formed at the 2005 ASEE Annual Conference as the Technological Literacy Constituent Committee. This event was promoted by a meeting held at the National Academy of Engineering (NAE) in April 2005. The NAE convened this meeting to address the issue of what the non-STEM professional public should know about engineering and technology as part of the NAE Technically Speaking initiative [15].

It is significant that the participants in the NAE meeting included engineering educators that had already been active in teaching engineering concepts to non-engineers [16-25] but were operating independently. The NAE meeting also included a range of non-engineers including historians of technology; science faculty; science, technology, and society (STS) scholars, and representatives of business. A key issue of the meeting was the need to establish an institutional home for all of those concerned about the broader understanding of technology by the general public. A constituent committee at the ASEE was deemed both appropriate to the topic and likely to be welcoming to a broad range of individuals and perspectives. This question of an environment welcoming to broad perspectives was seen in ASEE's wide range of members that include not just one specific scholarly discipline but both engineering and non-engineering members [26].

The Technological Literacy Curriculum Committee quickly grew organically in ASEE and reached 200 member status necessary to become a permanent ASEE Division. This took place in 2009. As a growing and active community, the ASEE Technological Literacy Division sponsored more than 17 events including: 10 technical sessions with 56 presentations, 2 pre-conference workshops, and 3 panel discussions. The Technological Literacy Division also cosponsored technical sessions with the Liberal Education Division, the K-12 Division, and the First Year Programs Division. The Division-led effort resulted in National Academy of Engineering

member Dr. John Lienhard giving one of the Distinguished Lectures at the 2009 ASEE Conference.

By the 2012 ASEE annual conference the Technological Literacy Division had grown to nearly 500 members. The expanding membership brought a range of issues into the group's efforts and discussion. One segment within the membership advocated for a renaming of the group to more specifically include the word "Engineering" since, through historical usage, the term "technological literacy" was interpreted by many as an ability to use computer and information technology applications. This group felt that engineering was a better term to use. Even setting aside the narrow interpretation of technological literacy as information technology, discussions arose around the need to more clearly distinguish engineering as a discipline from technology or the many human-built products upon which our society and culture depend. Several conference sessions were devoted to clarifying engineering versus technology and the dimensions of engineering and technological literacy.

Dialogues within the division unearthed long-buried assumptions about the nature of engineering education and resulted in division members drawing attention to the fact that the underlying philosophy of engineering is comparatively less-developed than that of science. Division members organized and contributed to workshops, sessions, and panel discussions on the philosophy of engineering. These efforts inlcuded a special session and preconference workshops on the philosophy of engineering at the 2011 and 2012 Frontiers in Education conferences. Attendess inlcuded international participants with several established scholars providing background and insights [27]. This issue arose, in part, because the debates about engineering literacy, or what should everyone know about engineering, reached the point that progress was impeded by the currently ill-defined philosophy of engineering. A segment of divisional members coalesced around work on this issue.

Inclusion of engineering literacy and the recognition of the central issue of the philosophy of engineering resulted in the divisional membership deciding on a change of name. The new name for the division was agreed upon as: the Technological and Engineering Literacy / Philosophy of Engineering Division (TELPhE). A name change request and bylaws revision was transmitted to the ASEE Board of Directors and subsequently approved in 2014.

With the link established between achieving the goal of broader engineering literacy and articulating and promoting the philosophy of engineering, the TELPhE Division stepped into roles contributing to other issues in engineering education. The ASEE national leadership requested that the TELPhE division contribute a response to the study by Erin Cech that identified a "culture of disengagement" in engineering education in which students' commitment to public welfare declines over the course of an undergraduate engineering program [28]. The division was also called upon to organize a panel discussion to address a study that claimed that engineers were over-represented among violent terrorists [29-31]. Similarly the division membership contributed to an ASEE panel on the intention of ABET to redefine student learning outcomes including the "understanding the impact of engineering solutions in a global and societal context." Division members demonstrated an approach to the assessment of critical thinking in a sociotechnical context [32]. The TELPhE Division teamed with Sheila Tobias, author of *They're not Dumb, They're Different, Breaking the Science Barrier*, and *Overcoming Math Anxiety* to provide content for a Teagle Foundation sponsored effort to highlight successful courses that introduce engineering concepts for the benefit of non-engineers [33].

Current TELPhE Division membership exceeds 600 registered members. A significant new initiative of the group is reframing of engineering education to address the question of whether or not engineers themselves are technologically literate in the broad sense. The division exists to promote the understanding of engineering and technology broadly defined by all citizens. A concern is that engineering education is too narrowly specialized and focused on contrived quantitative problems in engineering science and artificially constrained design problems to result in degreed engineers that are innovators and technological leaders. In particular, despite some few exceptions, the characteristics of empathy, critical thinking, reflection, and a grasp of the sociotechnical nature of engineering are not sufficiently addressed. To this end the TELPhE division membership contributed to the ASEE Transforming Engineering Education (TUEE) effort [34].

V. Application of Community of Transformation Model

At this stage of this work-in-progress we briefly examine the ASEE TELPhE Division in light of the three central characteristics of a community of transformation identified by Kezar. The goal is not to establish definitive conclusions but rather to start the process of a more in-depth study. Three key characteristics of a community of transformation are [10-11]:

1. An engaging, well-articulated, and clear philosophy that creates a disorienting dilemma, grounding people in a paradigm-altering value system, and guiding novel behavior, especially when they are in isolation and trying to learn and practice alone day to day.

2. To help people embody a practice different from current practices within their own institutions, living or embodying these practices is crucial. The community of transformation must help individuals to engage in critical reflection and inhabit new practices.

3. Relationships formed within the community help to maintain innovative practices when they return to their campuses. The community of transformation has a core of individual volunteers who provide mentorship and ongoing communication. These mentoring relationships develop organically.

Preliminary data from a sample of members indicates these characteristics are met to varying degrees. More comprehensive survey work is planned.

VI. Navigating Challenges

Communities of transformation face similar challenges and the model provides guidelines for negotiating these challenges based on the experience of the paradigmatic groups. Specific challenges identified include: obtaining on-going funding to sustain group efforts, staleness, drift, leadership too heavily concentrated in a small group of individuals, excessive emphasis on projects rather than development of the community and changing demands on faculty participants.

The TELPhE division managed to address the issue of funding that can eventually lead to the dissolving of communities. Since the group developed organically from the start rather than from an initial grant or award, self-sufficiency and sustainability of funding was an element of group activities from the earliest stages. As an ASEE division, TELPhE benefits from the organizational infrastructure provided by the ASEE national organization. The group budget is membership-driven based on a prescribed fraction of ASEE membership dues. As such the growth of the division is self-funded through membership. Commensurate with this is the group leaderships' vigilance in keeping the scope of activities within the available membership-driven resources.

Kezar identified the sense of staleness that can occur in a community after the initial waves of enthusiasm in the work faded. TELPhE was not immune to this affliction. To a large extent the group was able to avoid debilitating staleness by continuing to evolve and respond to new member-driven directions. At the same time, these new directions such as engineering literacy, philosophical issues, and the technological literacy of engineers remained within the general boundaries of the original founding vision of the group to serve as forum for those seeking to improve the broad understanding by all citizens of all aspects of technology and of the role of engineering in the creation and management of technology. Staying within this broad boundary helped to avoid the related problem of shifting focus that can also lead to a dissipation of interest and migration of initially interested participants away from the group.

Diversification of the core leadership has similarly been a challenge faced by TELPhE. This condition has been aggravated by the increasing expense of attending national conferences in an era of reduced institutional support for conference attendance as faculty development in higher education. It has been increasingly difficult for active group members to find travel resources while at the same time, the annual ASEE conference remains as a center of gravity the group activity.

VII. Future Considerations

While this case study is a work-in-progress, some guidance for strategic planning by TELPhE can be considered. The studies that identified communities of transformation also argued that communities of transformation are underutilizing their potential as change agents in higher education. Increased work in connecting with centers for teaching and learning, providing resources for academic leaders, and efforts to drive systemic change in disciplinary norms are possible.

VIII. Conclusion

This innovative practice work in progress paper initiates an analysis the ASEE Technological and Engineering Literacy and Philosophy of Engineering (TELPhE) Division as a community of transformation. The ultimate goal of this work is to provide strategic guidance to the division as it seeks to scale up in size and expand its impact in engineering education. Since formation, the division has been growing organically in membership but future directions and priorites might benefit from embracing a specific theoretical framework such as the community of transformation. Initial work shows that division is showing some characteritics of a community of transformation and further analysis is expected to clarify the group's vision for an expanding reach and impact in engineeing education.

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References

[1] National Science Foundation, Merit Review Criteria, https://www.nsf.gov/bfa/dias/policy/merit_review/overview.pdf. accessed 1May 2018.

[2] Increasing the Impact, Western Michigan University, http://www.increasetheimpact.com/. accessed 1May 2018.

[3] Henderson, Charles, Courtney Stanford, Debra Gilbuena Friedrichsen, Raina Khatri, Jeff Froyd, Renee Cole, "Designing educational innovations for sustained adoption," (2015).

[4] Froyd, J. E., Henderson, C., Cole, R. S., Friedrichsen, D., Khatri, R., & Stanford, C. (2017). From dissemination to propagation: a new paradigm for education developers. *Change: The Magazine of Higher Learning*, 49(4), 35–42. https://doi.org/10.1080/00091383.2017.1357098

[5] Stanford, C., Cole, R., Froyd, J., Henderson, C., Friedrichsen, D., & Khatri, R. (2017). Analysis of propagation plans in nsf-funded education development projects. *Journal of Science Education and Technology*, 26(4), 418–437. http://doi.org/10.1007/s10956-017-9689-x

[6] NSF 15-050, Dear Colleague Letter: I-Corps L - Stimulating Innovation in STEM Education. https://www.nsf.gov/ehr/Pubs/I-Corps_L2.pdf. accessed 1May 2018.

[7] Chavela, R. (2014, March-April). Educators and entrepreneurs. *ASEE Prism*, 23(7), 47.

[8] Chavela Guerra, R.C., & Smith, K.A. (2016). I-Corps ™ for Learning: Sustaining and scaling stem education innovations for impact. Special session presented at the *ASEE/IEEE Frontiers in Education Conference* (October, 12-15, 2016).

[9] Chavela Guerra, R.C., Smith, K.A. McKenna, A.F., Swan, C., Korte, R., Jordan, S., Lande, M. and MacNeal, R. (2014). Innovation Corps for Learning: Evidence-based entrepreneurship™ to improve (STEM)

education. *Paper presented at the ASEE/IEEE Frontiers in Education Conference* (October, 22-25, 2014).

[10] Kezar, Adriana and Sean Gehrke. "Communities of transformation and their work scaling STEM reform." *Pullias Center for Higher Education* (2015). https://pullias.usc.edu/wp-content/uploads/2016/01/communities-of-trans.pdf. accessed 1May 2018.

[11] Adrianna Kezar, Sean Gehrke & Samantha Bernstein-Sierra (2018) Communities of transformation: creating changes to deeply entrenched issues, *The Journal of Higher Education*, DOI: 10.1080/00221546.2018.1441108.

[12] Kezar, A. & Gehrke, S. Strategies for achieving scale within communities of practice aimed at pedagogical reform in higher education. *Journal of STEM Education.* Volume 18 • Issue 1 January-March 2017.

[13] Bernstein-Sierra, S. & Kezar, A. Identifying and overcoming challenges in stem reform: a study of four national stem reform communities of practice. Innovative Higher Educucation (2017) 42: 407. https://doi.org/10.1007/s10755-017-9395-x.

[14] Gehrke, S. & Kezar, A. (2016). STEM reform outcomes through communities of transformation. *Change*, 48(1), 30-38.

[15] *Technically speaking: Why all Americans need to know more about technology*, Greg Pearson and A. Thomas Young, editors, National Academies Press, (2002).

[16] Baish, J.W., and T.P. Rich, "Design as a liberal art," Proceedings of the 2001 American Society for Engineering Education Annual Conference (2001).

[17] N. A. Byars, "Technology literacy classes: the state of the art", J. Engineering Education, Jan, 1998, pp. 53-61.

[18] George, C., "Fuel cells and discovery-oriented teaching," Proceedings of the 2004 American Society for Engineering Education Annual Conference (2004).

[19] Anonymous for purposes of blind review (1997).

[20] R. Kuc. Teaching the non-science major: EE101 - The most popular course at Yale. Proceedings of the 1997 American Society for Engineering Education Annual Conference (1997).

[21] Korzeniowksi, K.A. and D. Mechtel, "Teaching engineering to non-electrical engineering majors," Proceedings of the 1998 American Society for Engineering Education Annual Conference (1998).

[22] Ollis, D., "Technology literacy: connecting through context, content, and contraption," Proceedings of the 2005 American Society for Engineering Education Annual Conference (2005).

[23] Rosa A.J., P.K. Predecki, and G. Edwards, "Technology 21 – a course on technology for non-technologists," Proceedings of the 2004 American Society for Engineering Education Annual Conference (2004).

[24] A.R. Sarfaraz, and T.A. Shraibati, "Responding to the expectations of non-technical students," Proceedings of the 2004 American Society for Engineering Education Annual Conference (2004).

[25] Krupczak, J.J "Demystifying Technology," *American Society for Engineering Education PRISM*, October (1997) 30-34.

[26] Krupczak, J.J., D. Ollis, R. Pimmel, R. Seals, G. Pearson, and N. Fortenberry, (2005) "The Technological Literacy of Undergraduates: Identifying the Research Issues," *Proceedings of the 35th ASEE/IEEE Frontiers in Education Conference*, October 19 – 22, 2005, Indianapolis,

[27] Steven L. Goldman (2013) Why we need a philosophy of engineering: a work in progress, Interdisciplinary Science Reviews, 29:2, 163-176, DOI: 10.1179/030801804225012572

[28] Cech, Erin A. "Culture of disengagement in engineering education?." *Science, Technology, & Human Values* 39.1 (2014): 42-72.

[29] Diego Gambetta and Steffen Hertog, *Engineers of jihad: the curious connection between violent extremism and education*, Princeton University Press, Princeton, NJ 2016.

[30] Berrett, Dan. "Does engineering education breed terrorists?." *The Chronicle of Higher Education* (2016).

[31] Are Engineers Authoritarian? A Dialogue on Engineering Education and a Terrorist Mindset, Panel, ASEE Annual Conference (2016).

[32] Special Session: Yes, We Can! Assessing the Threatened ABET Outcomes, ASEE Annual Conference (2016).

[33] Tobias, Sheila, Engineering Enhanced Liberal Educaiton, https://www.asee.org/engineering-enhanced-liberal-education-project/introduction. accessed 1May 2018.

[34] Transforming Undergraduate Engineering Education (TUEE) Phase IV, http://tuee.asee.org/phase-iv/. accessed 1May 2018.