

Workshop Result: Environmental Engineering Faculty Learning Boyer's Model of Scholarship

Dr. Daniel B Oerther P.E., Missouri University of Science and Technology

Professor Daniel B. Oerther, PhD, PE joined the faculty of the Missouri University of Science and Technology in 2010 as the John A. and Susan Mathes Chair of Civil Engineering after serving ten years on the faculty of the University of Cincinnati where he served as head of the Department of Civil and Environmental Engineering.

Workshop Result: Environmental Engineering Faculty Learning Boyer's Model of Scholarship

Daniel B. Oerther

Missouri University of Science and Technology, 1401 North Pine Street, Rolla, MO
65409

Jody Squires

University of Missouri, 8225 Florissant Road, St. Louis, MO 63121

Danny Willis

Saint Louis University, 3525 Caroline Mall, St. Louis, MO 63104

Abstract

As part of the 2021 (delayed until 2022 due to COVID) biennial conference of the Association of Environmental Engineering and Science Professors (AEESP), a pre-conference workshop on the topic of Ernst Boyer's four-pillar model of academic scholarship in higher education (i.e., discovery, integration, engagement, and the science of teaching and learning) was delivered to 32 workshop participants. The workshop had three objectives, namely: 1) raising awareness to Boyer's model of scholarship in higher education; 2) applying Boyer's model to evaluate participants' own work; and 3) leading institutional change by sharing Boyer's model back home. To achieve these objectives, four activities were undertaken, including: 1) pre-conference review of educational materials introducing Boyer's model (view a video and share on a discussion board); 2) on-site expert testimony clarifying Boyer's model (brief lectures by four speakers); 3) on-site hands-on, small-group work (employing career cartography to achieve Boyer's Model); and 4) post-conference sharing, expert-coaching, and peer-encouragement as workshop participants engaged back home. Assessment of the knowledge, skills, and attitudes of workshop participants was undertaken using an on-site, anonymous, voluntary readiness assessment test (RAT) as well as an on-site, anonymous, voluntary comprehension assessment test (CAT0), administered immediately preceding and following the on-site portion of the workshop, respectively. To support the long-term adoption of Boyer's Model, the workshop moderator provided voluntary mentoring/coaching to workshop participants in the months following the completion of the on-site portion of the workshop. The value of this long-term mentoring/coaching was assessed through the collection of additional feedback identifying the Best, Worst, and ways to Improve the workshop. The purpose of this paper is to share: 1) workshop content and format that could be used by other conveners of similar workshops; 2) results of the analysis of the RAT, CAT0, and additional feedback; and 3) the authors' experience with mentoring/coaching workshop participants on Boyer's model of scholarship in higher education, which contribute to suggestions for an educational module that could be used to introduce Boyer's Model and career cartography to graduate students as well as early and mid-career faculty of environmental engineering.

Introduction

The four pillars of Ernest's Boyer's Model of Scholarship in Higher Education – discovery (i.e., basic research), integration (i.e., interprofessional education or science communication), engagement (i.e., extension service or science diplomacy), as well as the science of teaching and learning (i.e., SoTL) – were proposed originally as a means of broadening the impacts of academic institutions to positively benefit the social and environmental conditions beyond the campus [1]. While Boyer's Model has been used extensively in diverse fields such as healthcare and University extension, awareness of and adoption of Boyer's Model is not widespread among faculty of environmental engineering. For example, Boyer's model was not cited during debates about the public benefits of environmental engineering (i.e., [2, 3, 4, 5, 6, 7, 8]). A contributing factor to the lack of widespread use of Boyer's Model may be the lack of a formalized system of career planning among faculty of environmental engineering (i.e., future faculty as well as early and mid-career faculty).

Disseminating the value of Boyer's Model and demonstrating the basic approach to career cartography – a tool of career planning – to a diverse audience of engineering graduate students, faculty, and administrators was the objective of a preconference workshop, which was part of the 2021 (delayed until 2022 due to COVID) biennial conference of the Association of Environmental Engineering and Science Professors (AEESP), which occurred in St. Louis, Missouri. The 2022 workshop leveraged the planning, format, execution, and dissemination of prior workshops. Briefly, the 2022 workshop leveraged the workshop on the topic of “science diplomacy”, which was implemented as part of the 2017 biennial AEESP [9]. Furthermore, the 2022 workshop leveraged the workshop on the topic of “structured literature reviews”, which was implemented as part of the 2019 biennial AEESP conference [10].

In the leadup to the 2022 conference, a total of 32 preconference workshop participants were self-selected from a pool of approximately 750 conference registrants (i.e., by voluntarily opting to participate in one or more preconference workshops advertised to all conference registrants). Before the workshop, participants were invited to complete a voluntary readiness assessment test (RAT). After the workshop, participants were invited to complete two separate follow-up assessments; the first was offered on the same day as the workshop (comprehensive assessment test or CAT0), and the second was a voluntary opportunity to reflect on the Best, Worst, and ways to Improve the workshop administered as part of follow-up to the workshop.

The purpose of this paper is to share:

- 1) details of the workshop, which may be replicated by others;
- 2) results of the analysis of the RAT, CAT0, and additional follow-up data; and
- 3) suggestions for applying the lessons learned in this preconference workshop to an educational module that could be used to introduce Boyer's Model and career cartography to graduate students as well as early and midcareer faculty of environmental engineering.

Methods

Workshop content: background on Boyer's model. Ernest Boyer (b. 1928 – d. 1995) was widely celebrated as a leader in American Higher Education. He served as Chancellor of the State University of New York, President of the Carnegie Foundation for the Advancement of Education, and U.S. Commissioner of Education (now the U.S. Secretary of Education). In 1990, Boyer published, “Scholarship Reconsidered: Priorities of the Professoriate,” arguing that an overlay focused definition of “research” emphasizing competitive Federal research grants and peer-reviewed archival journal publications (i.e., research driven by a reliance on the American military-industrial complex) created artificial limitations on the range of beneficial scholarship that is possible at institutions of Higher Education [1]. In particular, Boyer noted that research at the interface of two or more disciplines could yield benefits of improved understanding. He argued that the knowledge of researchers employed in institutions of Higher Education could be brought from the “ivory tower” to the “common person.” And Boyer argued that the artificial separation of “research” and “teaching” limited faculty from delivering the best possible education to students. Interprofessional education (IPE) – common in healthcare, University extension – common at land-grant institutions – and the proliferation of departments of engineering education across the US, all serve as exemplars of Boyer’s vision.

To translate Boyer’s Model into a framework that supports faculty professional development – from graduate student, to new hire, through mid-career, and distinguished contributors – career cartography – or the mapping of career choices to achieve long-term success – offers much value. Originally described in the profession of nursing, the purpose of career cartography is to, “enable nurses, from all clinical and academic settings, to actively engage in a process that maximizes their clinical, teaching, research, and policy contributions that improve patient outcomes and the health of the public,” [11].

The three learning objectives of the preconference workshop, included:

- 1) raising awareness to Boyer’s model of scholarship in higher education;
- 2) applying Boyer’s model to evaluate our own work; and
- 3) leading institutional change by sharing Boyer’s model back home.

Workshop format and assessments. Founded in 1963, today’s AEESP includes nearly 1,000-members who are faculty, postdocs, and students of environmental engineering and science. The mission of AEESP is to, “assist it’s members in the development and dissemination of knowledge in environmental engineering and science.” One way this occurs is through a biennial conference. In June 2022, the membership of AEESP gathered in St. Louis, Missouri. Conference organizers included Washington University in St. Louis, the Missouri University of Science and Technology, Southern Illinois University Edwardsville, and the University of Missouri. The conference theme was, “Environmental engineering at the confluence,” which was selected to span the breadth of the field of environmental engineering, to explore convergence – where multiple disciplines collaborate to solve complex societal challenges – and to highlight emerging

developments (i.e., new pollutants, new technologies, etc.). As part of the three-day, on-site event, conference participants were invited to apply to attend one or more of 20 different pre-conference workshops.

The complete application submitted by the author for consideration by the conference organizers is provided in Appendix 1. The workshop description provided by one of the authors (DBO) for consideration by the conference participants included,

Boyer's Model of Scholarship in Higher Ed

Contact: Daniel Oerther, Missouri University of Science and Technology

This workshop is organized to obtain three objectives (O), namely: O1) raising awareness to Boyer's model of scholarship in higher education; O2) applying Boyer's model to evaluate our own work; and O3) leading institutional change by sharing Boyer's model back home. To obtain these objectives, four workshop activities (A) will be completed, including: A1) pre-conference review of educational materials introducing Boyer's model (view a video; take a quiz; and share on a discussion board); A2) on-site expert testimony clarifying Boyer's model (brief lectures by four speakers); A3) on-site hands-on, small-group work (employing career cartography to achieve Boyer's model [12]); and A4) post-conference sharing, expert-coaching, and peer-encouragement as workshop participants engage back home (moderated discussion board and one-on-one or small group discussion). The workshop organizers are experts in complimentary aspects of Boyer's model, and collectively the workshop organizers commit to pre-conference, on-site, and post-conference activities such as coaching workshops participants when they engage back home. This workshop directly addresses the theme of the AEESP 2021 conference by providing a conceptual framework for the environmental engineering and science community to assign faculty "credit" when solving societal challenges using transdisciplinary teams (i.e., performing convergence research). And this workshop is responsive to discussions of how to evaluate faculty activities, which are ongoing in the environmental engineering and science literature (i.e., [2, 4]).

A total of 32 individuals registered for this workshop as participants, and a total of 4 individuals, including the author, served as workshop organizers.

A blended format was employed, as participants were provided with educational artifacts to review before meeting in person (i.e., a brief explanatory video available from the University of Colorado Medical Center) (see Appendix 2).

Before the workshop, participants were invited to complete a voluntary readiness assessment test (RAT) (see Appendix 3).

Active learning was employed, including brief expert presentations as well as the opportunity to participants to work in individually and in small groups with summary presentations shared for feedback among all participants (see Appendix 4 for slides, and see Appendix 5 for photographs).

After the workshop, participants were invited to complete two separate voluntary assessments (see Appendix 6); the first was a comprehensive assessment test (CAT0) offered on the same day as the workshop, and the second included open-ended data collected on the Best, Worst, and ways to Improve the workshop, which was administered as part of follow-up to the workshop.

After the workshop, participants were invited to participate voluntarily in mentoring/coaching in the application of Boyer's model of scholarship in their own work and in raising awareness of and promoting the consideration of Boyer's model of scholarship at their home institution.

Human subjects: IRB exemption was provided by the University for this educational activity.

Results

The results of demographic information as well as "attitude" results of the initial RAT and the CAT0 performed immediately preceding and following the on-site workshop are summarized in Table 1. Of the 32 conference participants, a total of 20 completed the voluntary RAT and CAT0. The majority of respondents were faculty with a typical age of approximately 40 years old. Gender was at near parity among respondents. To evaluate the "attitude" of participants, three different pairs of terms were provided. Participants were asked to circle the feeling that was most accurate to their own feeling.

As summarized in Table 1, 14 participants did not provide a response to the RAT, and four participants did not provide a response to the CAT0. Overall, the results reported in Table 1 support the conclusion that a majority of participants felt "excited", "prepared", and "optimistic", with the caveat that a substantial number of participants still felt "cautious" after the completion of the workshop.

The results of "knowledge" and "skills" assessed using the RAT and CAT0 performed immediately preceding and following the on-site workshop are summarized in Table 2. A total of 20 of the 32 workshop participants responded. The number of correct responses defining integration research and engagement research increased dramatically from the RAT to the CAT0, suggesting that many workshop participants learned something new during the workshop. This conclusion is supported by the fact that many workshop participants knew a correct definition of discovery research and a correct definition of the science of teaching and learning both before as well as after the workshop (see Table 2).

It is interesting to note that a large fraction of workshop participants either did not answer/or incorrectly answered the question regarding the three criteria for assessment of discovery research. One possible explanation of this result is that workshop participants focused upon answering the questions related to Career Cartography and may have opted to ignore answering questions about discovery research, which they may have felt they

Table 1. Summary of a total of 20 demographic and “attitude” results of the RAT and the CAT0 performed immediately preceding and following the on-site workshop.

	Age		Gender		Rank
<25	0	Female	10	Student	4
<30	4	Male	9	Postdoc	3
<40	8	Nonbinary	0	Assist Prof	8
<50	7	No answer	1	Assoc Prof	4
No answer	1			Prof	
				No answer	1
RAT					
	First pair		Second pair		Third pair
Nervous	1	Cautious	2	Foolish	0
Excited	5	Prepared	4	Optimistic	6
No answer	14	No answer	14	No answer	14
CAT0					
	First pair		Second pair		Third pair
Nervous	4	Cautious	7	Foolish	1
Excited	12	Prepared	9	Optimistic	15
No answer	4	No answer	4	No answer	4

“already knew”. The substantial shift from no/incorrect response to an expert response on the definition of Career Cartography – as well as correct responses on the four components of Career Cartography is encouraging because it is further evidence of the success of the workshop and indicates participants learned something new. Collectively, the results of the definitions of integration research, engagement research, and Career Cartography all point to substantial learning among the workshop participants (Table 2).

Table 2. Summary of the “knowledge” and “skills” results of the RAT and CAT0 performed immediately preceding and following the on-site workshop. A score of zero indicates that no answer/an incorrect answer was provided. A score of 1 indicates that an answer, acceptable to an expert as correct, was provided. A score of 2 indicates that the preferred answer included in the on-site workshop presentation was provided.

	RAT			CAT0		
	0	1	2	0	1	2
Define Discovery Research	6	8	6	4	1	15
Define Integration Research	15	2	3	4	2	14
Define Engagement Research	16	2	2	6	1	13
Define Science of Teaching and Learning	11	6	3	6	1	13
3 criteria of Discovery Research ^a	15	5	0	9	3	8
Define Career Cartography	17	3	0	4	3	13
4 components of Career Cartography ^b	19	1	0	4	5	11

- The three criteria used to evaluate discovery research include: peer review of impact; clear leadership role of faculty member in work; and novelty to the field.
- The four components of career cartography, include: destination statement; career map; mentoring network; and communication/dissemination.

As part of a follow-up to the on-site workshop, participants were invited to continue to receive mentoring/coaching from the workshop organizer (specifically DBO). While the original intention had been for a majority of workshop participants to actively engage in

follow-up activities, the reality was less than the expectation, which has been reported previously as part of other workshop offered to members of AEESP [9, 10]. A number of workshop participants did engage informally as part of follow-up to the workshop, but there have been no significant reports of workshop participants promoting Boyer’s model at their own home institutions [personal communication].

As part of a summary exercise at the conclusion of the workshop and any mentoring/coaching period, workshop participants were asked to provide their response to three, free-form questions, including: 1) what was the best aspect of the workshop; 2) what was the worst aspect of the workshop; and 3) what would you suggest improving future workshops on this subject? The results of these follow-up data collection are summarized in Table 3.

Table 3. Comments of Best, Worst, and how to Improve.

Best	<ol style="list-style-type: none"> 1. High energy and expert knowledge of workshop leaders 2. Diverse background of workshop leaders (engineering, nursing, extension) 3. Thought-provoking content that really challenged the status quo 4. Exercise of think-pair-share among pairs of colleagues 5. Group discussion among colleagues subdivided by tables 6. Brainstorming my own and sharing our destination sentences
Worst	<ol style="list-style-type: none"> 7. Too much “presented” and not enough “discussing”/”applying” 8. Over emphasis on R1 (versus primarily undergrad institution, PUI) 9. Not enough application to R1
Improve	<ol style="list-style-type: none"> 10. This needs to be mandatory for everyone’s career development! 11. Better connection between Boyer and Career Cartography 12. More content on web shared before the meeting 13. More feedback from colleagues and experts on my sharing 14. Follow-up opportunity to receive coaching after the workshop 15. Avoid presenting Boyer in opposition to traditional research model 16. More inclusive of PUI (in addition to R1)

The most consistent advice from respondents included: 1) working in teams was the best aspect of the workshop; and 2) having limited time to work together was the worst aspect of the workshop. An encouraging comment on how to improve the workshop was the suggestion that “this needs to be mandatory for everyone’s career development!” This suggestion was offered by a tenured Associate Professor with substantial career experience, suggesting that the content of the workshop may be viewed by at least some faculty as very useful to future, emerging, and mid-career faculty in environmental engineering.

Discussion

Boyer originally proposed a new model of academic scholarship in higher education as an alternative means of encouraging academic freedom, specifically to promote opportunities for faculty to conduct academic scholarship in areas beyond the research topics promoted by the military-industrial complex [1]. In 2019, the environmental engineering community published a summary report identifying the “grand challenges” for the profession [13]. In particular, five areas were identified where environmental engineers could make a significant contribution to improving the human condition while

protecting the environment, namely: food and water; climate change; no waste; sustainable cities; and informed decision making [13]. Solving these “grand challenges” will require faculty in environmental engineering to undertake academic scholarship substantially outside of typical discovery research. And solving these grand challenges will require future environmental engineers to work in new ways, which will require faculty to train future environmental engineers with new knowledge, skills, and attitudes [14].

Environmental engineers are unique among the engineering subdisciplines as environmental engineers suffer from a “care penalty” [15]. In other words, environmental engineers undertake work that produces unpaid benefits for others (i.e., “caring work”). Professions such as teaching, social work, and nursing also have been identified to suffer from a care penalty, and therefore, it has been proposed that environmental engineers should learn from and leverage the expertise of other caring professions to improve the training and the professional practice of environmental engineering [15]. In particular, the collaboration of environmental engineers with nursing shows tremendous promise to improve human health as well as protecting the natural resources of planet Earth [16]. One approach to training up future environmental engineers is to leverage service learning and experiential learning opportunities to work alongside professions such as nurses [17] and humanitarian technologists [18].

As part of convergence research – where transdisciplinary collaborations are used to solve grand challenges – the collaboration of engineers and nurses has been described previously as the V-shaped professional [19]. Environmental engineers working with nurses shows promise to undertake all four of the pillars of Boyer’s model of scholarship including discovery, integration, engagement, and the science of teaching and learning [20]. The differences among the professions of nursing (i.e., imagined to be similar to slices of an orange) and of engineering (i.e., imagined to be similar to individual grapes in a cluster) provide unique opportunities for transdisciplinary collaboration with each discipline benefitting from the interactions [21].

As part of the preconference workshop described in this article, nurses shared their approach to academic scholarship – from the clinical environment and into the community where environmental engineers often work [22]. While modern nursing and engineering may not always collaborate, historically, nurses and engineers worked side-by-side on the problems of human poverty and urban crowding such as those experienced during the emergence of London, England as the world’s first “mega city” [23]. Florence Nightingale’s approach to nursing – developed in the mid nineteenth century – offers a theoretical framework for nurses and engineers to collaborate on the grand challenges of environmental engineering including food, water, energy, healthy cities, and others [24]. In particular, nursing has a history of collaborating with University extension programs to create opportunities for faculty of nursing and faculty of University extension to work together in the community [25]. Therefore, future workshops that bring together environmental engineers, nurses, and University extension professionals should consider the framework of the United Nations Sustainable Development Goals as an opportunity to organize transdisciplinary collaboration [26].

Before and during the workshop, participants were assessed to determine both baseline knowledge, skills, and attitudes as well as improvements corresponding to workshop content. A comparison of the results from the RAT and CAT0 showed a significant improvement in the knowledge, skills, and attitudes of workshop participants before and after content delivery. The benefits of active learning were highlighted by participants, and “feedback from peers” was identified as the most rewarding aspect of the workshop. Although the offer for post-workshop follow-up for mentoring was not as successful as hoped, the responses to follow-up about Best, Worst, and ways to Improve combined with the results on the RAT and CAT0 strongly suggested that the workshop was successful in “raising awareness” of Boyer’s Model of scholarship in higher education. Therefore, the results of this workshop show promise for supporting the efforts of environmental engineers both to undertake solutions to the five grand challenges [13] as well as to educate future environmental engineers [14].

Based upon the personal experience of the authors, and informed by the responses of the workshop participants on the CAT0 as well as personal communication from the voluntary mentoring/coaching sessions, recommendations for teaching future workshops on Boyer’s Model of scholarship and the approach to Career Cartography, contribute to the following lessons:

1. A hand-on format that includes both expert knowledge as well as an opportunity to learn by doing through engagement with peers is the best pedagogical approach to use with adult learners;
2. Most faculty already are familiar with the concept of research, teaching, and service, but few faculty are familiar that “scholarly research” may be defined using Boyer’s pillars of basic research, application, engagement, and the scholarship of teaching and learning;
3. Career cartography was appreciated as a useful tool by faculty of engineering, but significant effort is needed to help faculty of engineering understand how to use this tool; and
4. Inertia – specifically a lack of incentives to “change” to Boyer’s model – creates an impediment to successfully raising awareness with others when returning to a home institution.

Conclusion

In conclusion, that adaptation of a technique from professional development in healthcare – namely career cartography – was welcomed by faculty of engineering. Although engineering faculty appreciated the perspective of University extension, it was not immediately clear to faculty how to partner with University extension as part of scholarly research. The major hurdle to the adoption of Boyer’s model “back home” was the lack of incentives to consider additional categories for “scholarly research”. While the results in this article can be described as a “successful” workshop, future effort should explore how to incentivize (or increase the participation in) voluntary follow-up mentoring to ensure the long term dissemination of the benefits of Boyer’s model.

Acknowledgements

The authors wish to thank Dr. Angela Bielefeldt for her active support of this workshop. Furthermore, the authors wish to thank the organizers, students, and staff who provided a safe and successful AEESP conference in 2022 at Washington University in St. Louis!

References

1. D. Boyer, *Scholarship Reconsidered: Priorities of the Professoriate*. Farnham, UK: Jossey-Bass, 1997.
2. D. Sedlak, "Crossing the imaginary line," *Environ. Sci. Technol.*, vol. 50, pp. 9803-9804, 2016.
3. J. Mihelcic, "What line?" *Environ. Sci. Technol.*, vol. 51, pp. 1055, 2017.
4. M.A. Edwards and S. Roy, "Academic research in the 21st century: Maintaining scientific integrity in a climate of perverse incentives and hypercompetition," *Environ. Eng. Sci.*, vol. 34, pp. 51-61, 2017.
5. A.R. Bielefeldt, M. Polmear, N. Canney, C. Swan, and D. McKnight, "Ethics education of undergraduate and graduate students in environmental engineering and related disciplines," *Environ. Eng. Sci.*, vol. 35, pp. 684-695, 2018.
6. D.B. Oerther, L.E. Voth-Gaeddert, and D.D. Divelbiss, "Improving environmental health practice and policy through convergence research: A case study of linked food-water systems enhancing child health," *Environ. Eng. Sci.*, vol. 36, pp. 820-832, 2019.
7. L.D. Montoya, L.M. Mendoza, C. Prouty, M. Trotz, and M.E. Verbyla, "Environmental engineering for the 21st century: Increasing diversity and community participation to achieve environmental and social justice," *Environ. Eng. Sci.*, vol. 38, pp. 288-297, 2021.
8. D.B. Oerther, "Is it time to decenter humans in our discussion of sustainable development?" *Environ. Eng. Sci.*, vol. 39, pp. 863-865, 2022.
9. D.B. Oerther, "Workshop result: Teaching science diplomacy to environmental engineering researchers," in *ASEE Annual Conference & Exposition, Virtual Conference, July 26-29, 2021*. [Online] Available: <https://peer.asee.org/38221>.
10. D.B. Oerther, "Workshop result: Teaching structured reviews to environmental engineering researchers," in *ASEE Annual Conference & Exposition, Virtual Conference, July 26-29, 2021*. [Online] Available: <https://peer.asee.org/38222>.
11. D.S. Wilson, M.S. Rosemberg, M. Visovatti, M.L. Munro-Kramer, and S. Feetham, "Career cartography: From stories to science and scholarship," *J Nurs. Scholarsh.*, vol. 49, pp. 336-346, 2017.
12. S. Feetham and J.J. Doering, "Career cartography: A conceptualization of career development to advance health and policy," *J. Nurs. Scholarsh.*, vol. 47, pp. 70-77, 2015.
13. National Academies of Sciences, Engineering, and Medicine, *Environmental Engineering for the 21st century: Addressing grand challenges*. Washington, DC: The National Academies Press, 2019.
14. D.B. Oerther, D.A. Chin, V.G. Gude, C.N. Haas, A.A. Mackay, F. Ozis, M.K. Marincel Payne, and D.A. Vaccari "The academy, the association, and the society advancing environmental engineering training and credentialing," *Environ. Eng. Sci.*, vol. 39, pp. 923-926, 2021.
15. D.B. Oerther, L. Gautham, and N. Folbre, "Environmental engineering as care for human welfare and planetary health," *J. Environ. Eng.*, vol. 148, pp. 04022029, 2022.
16. D.B. Oerther, "Environmental health professionals: Local interprofessional collaborations require global thinking to meet shared ethical obligations," *J. Environ. Health*, vol. 84, pp. 26-28, 2021.
17. D.B. Oerther and S.E. Oerther, "Improving interprofessional environmental health education using the leave no one behind framework," *Am. J. Public Health*, vol. 112, pp. S250-S252, 2022.
18. D.B. Oerther, "Humanitarian technologists as prototypical V-shaped professionals," in *Global Humanitarian Technology Conference, Virtual Conference, October 19-23, 2021*. [Online] Available: <https://ieeexplore.ieee.org/document/9612473>.
19. D.B. Oerther and M.E. Glasgow, "The nurse+engineer as the prototype V-shaped professional," *Nurs. Out.*, vol. 70, pp. 280-291, 2022.

20. D.B. Oerther and S. Oerther, "From interprofessional to convergence: Nurses educating V-shaped professionals," *Nurs. Educ. Pract.*, vol. 53, pp. 103047, 2021.
21. D.B. Oerther and S. Oerther, "Comparing oranges versus grapes as a metaphor of the nurse+engineer," *J. Clin. Nurs.*, vol. 31, pp. e15-e15, 2022.
22. S. Oerther and D.B. Oerther, "Nurses must collaborate beyond the bedside in education and practice," *Nurs. Educ. Pract.*, vol. 59, pp. 103280, 2022.
23. B.M. Dossey, D.M. Beck, S.E. Oerther, and P. Manjrekar, "Florence Nightingale's legacy: The rationale for an integral worldview in achieving the sustainable development goals," In W.E. Rosa (Ed), *A new era in global health: Nursing and the united nations 2030 agenda for sustainable development*, New York, NY: Springer, 2017.
24. S.E. Oerther and W.E. Rosa, "Advocating for equality: The backbone of the sustainable development goals," *Am. J. Nurs.*, vol. 120, pp. 60, 2020.
25. S. Oerther, "Localizing the united nations sustainable development goals to rural communities in America through university extension programmes," *Nurs. Open*, vol. 6, pp. 662, 2019.
26. S. Oerther, "Global nurses: Transforming health by addressing the united nations sustainable development goals," *J. Adv. Nurs.*, vol. 76, pp. 705, 2020.

Appendix 1. Application for the workshop submitted to the conference organizers.

Workshop title: Boyer's Model of Scholarship in Higher Ed

Time: 1/2 day preferred (we would be willing to expand to a full day, if needed)

Motivation: Everyone knows the four-legged stool of faculty responsibilities, including research, teaching, service, and extension. But how do faculty get "credit" for convergent research involving science diplomacy, interprofessional education, community-based participatory research, or the scholarship of teaching and learning (SoTL)? In 1990, Ernest Boyer introduced a model of "academic scholarship" that includes: 1) discovery; 2) synthesis; 3) application; and 4) SoTL. As environmental engineers and scientist solve societal challenges using transdisciplinary teams, we must adopt validated conceptual frameworks to assign faculty "credit" for convergent research (i.e., to distinguish a "scholarly pursuit" separate from "mere service").

Description of Workshop: This workshop is organized to obtain three objectives (O), namely: O1) raising awareness to Boyer's model of scholarship in higher education; O2) applying Boyer's model to evaluate our own work; and O3) leading institutional change by sharing Boyer's model back home. To obtain these objectives, four workshop activities (A) will be completed, including: A1) pre-conference review of educational materials introducing Boyer's model (view a video; take a quiz; and share on a discussion board); A2) on-site expert testimony clarifying Boyer's model (brief lectures by four speakers); A3) on-site hands-on, small-group work (employing career cartography to achieve Boyer's model (Feetham and Doering, 2015)); and A4) post-conference sharing, expert-coaching, and peer-encouragement as workshop participants engage back home (moderated discussion board and one-on-one or small group discussion). The workshop organizers are experts in complimentary aspects of Boyer's model, and collectively the workshop organizers commit to pre-conference, on-site, and post-conference activities such as coaching workshops participants when they engage back home. This workshop directly addresses the theme of the AEESP 2021 conference by providing a conceptual framework for the environmental engineering and science community to assign faculty "credit" when solving societal challenges using transdisciplinary teams (i.e., performing convergence research). And this workshop is responsive to discussions of how to evaluate faculty activities, which are ongoing in the environmental engineering and science literature (i.e., Sedlak (2016); Edwards and Roy (2017)).

Intended Audience and Size: To facilitate interaction, each of the four organizers will coach between two and four teams of three individuals (i.e., one student/postdoc, one junior/mid-career faculty, and one senior faculty/administrator). This yields a lower bound 24 participants and an upper bound of 48 participants (i.e., 1/3 each of student/postdoc, junior/mid-career, and senior/administrators).

Workshop Organizers:

1. Dan Oerther, Missouri S&T, ortherd@mst.edu, <https://people.mst.edu/faculty/ortherd/index.html>, Fellow AEESP, previously AEESP BOD member, prior workshop organizer in 2017 and in 2019
2. Angie Bielefeldt, University of Colorado, Boulder, Angela.Bielefeldt@colorado.edu, <https://www.colorado.edu/even/people/angela-bielefeldt>, Fellow American Society for Engineering Education, previously AEESP BOD member
3. Danny Willis, Saint Louis University, danny.willis@slu.edu, <https://www.slu.edu/nursing/faculty/willis-danny.php>, Dean, Trudy Busch Valentine, School of Nursing

4. Marshall Stewart, University of Missouri System, stewartmars@missouri.edu,
<https://extension2.missouri.edu/people/marshall-stewart-100245>, Chief Engagement
Officer, Missouri System

Appendix 2. Pre-conference workshop materials included as part of a web site.

1. Review the following online resources, including:
 - a. Faculty Development: Understanding Scholarship, University of Colorado, School of Medicine
 - i. available at: <https://www.youtube.com/watch?v=z1Pjhp2KRIY&t>
 - b. Feetham and Doering (2015) "Career cartography: a conceptualization of career development to advance health and policy"
 - i. available at:
<https://sigmapubs.onlinelibrary.wiley.com/doi/abs/10.1111/jnu.12103>
 - c. Sedlak (2016) "Crossing the imaginary line"
 - i. available at: <https://pubs.acs.org/doi/10.1021/acs.est.6b04432>
 - d. Edwards and Roy (2017) "Academic research in the 21st century"
 - i. available at: <https://www.liebertpub.com/doi/10.1089/ees.2016.0223>
2. Post at least one blog entry that addresses the following:
 - a. What is your name, institution, and current research, teaching, and service?
 - b. What is your current understanding of Boyer's model of scholarship?
 - c. How do you want to expand your own approach to "academic scholarship" through this workshop?
 - d. How will you put your learning into practice after the workshop is completed?
3. Post at least two blog commentaries offering encouragement and thoughtful criticism to two additional workshop participants

Appendix 4. Examples of on-site workshop materials used by the moderators to facilitate group-work by participants.

<p style="text-align: center;"> AEESP 2022 Boyer's Model of Scholarship June 28; 1:30-4:30pm Room 3015 Brauer Hall </p> <p style="text-align: center;"> <small>Facilitators:</small> Daniel Oerther, Missouri S&T; Environmental Engineering Danny Willis, Saint Louis University; Nursing Jody Squires, University of Missouri; Extension Angela Bielefeldt, Colorado; Environmental Engineering </p> <p style="text-align: center;"> https://aesp2021boyersmodel.wordpress.com </p>	<p>Run of show</p> <ul style="list-style-type: none"> • 1:30pm welcome, schedule, readiness assessment test (RAT) • 1:40pm brief self introductions (<1min each) • 2:00pm overview of Boyer's model w/examples • 2:15pm integration • 2:30pm engagement • 2:45pm SoTL • 3:00pm bio break • 3:05pm introduction to career cartography • 3:20pm group exercise 1; self reflection (5min); sharing (15min); reporting (20min) • 4:00pm group exercise 2; self reflection (5min); sharing (10min); reporting (10min) • 4:20pm comprehension assessment test (CAT)
<p>But what if the Intellectual Merit (IM) comes from non-traditional scholarship?</p> <div style="display: flex; align-items: center;"> <div style="border: 2px solid green; border-radius: 50%; width: 40px; height: 40px; display: flex; flex-direction: column; justify-content: center; align-items: center; margin-right: 10px;"> Research Money Reputation </div> <div> <ul style="list-style-type: none"> • "Traditional": <ul style="list-style-type: none"> • discovery research • "Non-traditional": <ul style="list-style-type: none"> • Integration • Engagement • Scholarship of teaching and learning (SoTL) </div> <div style="font-size: 8px; margin-left: 10px;"> <p>Grants and pubs</p> <ul style="list-style-type: none"> - Objective measure of quality - Evidence of impact/importance - Statement of role <p>What's the equivalent?</p> </div> </div>	<p>NSF identifies Convergence Research as having two primary characteristics:</p> <ol style="list-style-type: none"> 1. Deep integration across disciplines. <ul style="list-style-type: none"> • As experts from different disciplines pursue common research challenges, their knowledge, theories, methods, data, research communities and languages become increasingly intermingled or integrated. • New frameworks, paradigms or even disciplines can form sustained interactions across multiple communities. 2. Research driven by a specific and compelling problem. <ul style="list-style-type: none"> • Convergence Research is generally inspired by the need to address a specific challenge or opportunity, whether it arises from deep scientific questions or pressing societal needs. <p style="text-align: right; font-size: 8px;">Text from: https://www.nsf.gov/od/ola/convergence</p>
<p style="text-align: center;">From "I"-shaped to "T"-shaped</p> <div style="text-align: center;"> </div> <p style="text-align: center; font-size: 8px;">Oerther, Yoder-Wise, and Malone. (2020). <i>J. Adv. Nursing</i>, 76(4):920-92</p>	<p style="text-align: center;">But what about something new? "V"-shaped professionals</p> <div style="text-align: center;"> </div> <p style="text-align: center; font-size: 8px;">Oerther and Oerther. (2021). <i>Nurse Education in Practice</i> 53, 10304 Oerther. (2021). IEEE GHTC. doi: 10.1109/GHTCS159.2021.961247</p>
<p>Guidelines before writing your own destination statement (you have this slide)</p> <ul style="list-style-type: none"> • A destination statement is a single sentence that captures the cumulative outcome of a researcher's long-term scientific career. <ul style="list-style-type: none"> • i.e., "To promote health equity in vulnerable mothers and infants by eliminating sleep-related infant death." • Ask yourself: "having all human, financial, and political capital in the world available that could solve a critical health problem, how would the world look different, or what would be better, over time, because of this career?" • Note: A well-intentioned program of research and scholarship that aligns with existing political will and describes advancing the health of the public enables the researcher to gain support from policy makers and potential funders. • Suggestion: Convert the statement into a scrolling marquee on your laptop. <ul style="list-style-type: none"> • i.e., "I am committed to address the critical health challenge of reducing sleep-related infant death." <p style="text-align: center; font-size: 8px;">From: https://sigmapubs.onlinelibrary.wiley.com/doi/10.1111/nu.1210</p>	<p>Words of wisdom!?!?! :)</p> <p>"Good planning is holding gently to a concrete description of the future. Poor planning is clinging tightly to a blurry concept of the future."</p> <p style="text-align: right;">- D.B. Oerther</p> <ul style="list-style-type: none"> - Steps: <ul style="list-style-type: none"> - Think about your future - Record it! (written, oral, image, etc) - Think-pair-listen with 360° mentors (above, peer, below) (give+take, at least annually) - Incorporate feedback into a new recorded version! - Post it where you can see it/hear it/experience it, and evaluate new opportunities as: <ul style="list-style-type: none"> - A) Does this advance me towards my destination? - B) Does this mean I need to change my destination? - ENJOY THE JOURNEY! <ul style="list-style-type: none"> - "And both that morning equally lay: In leaves no step had trodden back. Oh, I kept the first for another day! 'Til knowing how way leads on to way, I doubted if I should ever come back." (from Robert Frost, The Road Not Taken)

<p>Career Cartography: A Conceptualization of Career Development to Advance Health and Policy (Feetham and Doering, 2015)</p> <ul style="list-style-type: none"> • Purpose: The purpose of this article is to propose a conceptualization of career development that emphasizes the interdependence between research, practice, and policy. • Organizing Construct: Career cartography applies three decades of career development experience to lay out a systematic, comprehensive, and iterative approach for planning and communicating the outcomes of science at any career stage. To inform practice and policy, nurse researchers must be clear on the intended destination and trajectory of the science, and be skilled in communicating that science and vision to diverse stakeholders. Career cartography builds on the science of cartography, is developed within the context of public and health policy, and is composed of several components, including a destination statement, career mapping, a supportive career cartography team, and use of communication and dissemination strategies. • Conclusions: The successful utilization of career cartography may accelerate advancement of individual careers scientific impact, and the discipline as a whole by guiding nurse researchers to be deliberative in career planning and to communicate successfully the outcomes of research across a wide variety of stakeholders. Career cartography provides a framework for planning a nurse researcher's program of research and scholarship to advance science, policy, and health of the public. • Clinical Relevance: Career cartography guides nurse researchers to realize their full potential to advance the health of the public and inform public and health policy in academic and practice environments. 	<p>Career Cartography: From Stories to Science and Scholarship (Wilson et al, 2017)</p> <ul style="list-style-type: none"> • Purpose: To present four case scenarios reflecting the process of research career development using career cartography. • Organizing Constructs: Career cartography is a novel approach that enables nurses, from all clinical and academic settings, to actively engage in a process that maximizes their clinical, teaching, research, and policy contributions that can improve patient outcomes and the health of the public. • Methods: Four early-career nurse researchers applied the career cartography framework to describe their iterative process of research career development. They report the development process of each of the components of career cartography, including destination statement, career map, and policy statement. • Conclusions: Despite diverse research interests and career mapping approaches, common experiences emerged from the four nurse researchers. Common lessons learned throughout the career cartography process include: (a) have a supportive mentorship team, (b) start early and reflect regularly, (c) be brief and to the point, (d) keep it simple and avoid jargon, (e) be open to change, (f) make time, and (g) focus on the overall career destination. • Clinical Relevance: These four case scenarios support the need for nurse researchers to develop their individual career cartography. Regardless of their background, career cartography can help nurse researchers articulate the meaningful contributions to science, policy, and health of the public.
<p>Career Mapping for Professional Development and Succession Planning (Webb et al, 2017)</p> <ul style="list-style-type: none"> • Career mapping facilitates professional development of nurses by education specialists and nurse managers. On the basis of national Nursing Professional Development Scope and Standards, our education and professional development framework supports the organization's professional practice model and provides a foundation for the professional career map. • This article describes development, implementation, and evaluation of the professional career map for nurses at a large children's hospital to support achievement of the nursing strategic goals for succession planning and professional development. 	<p>Building a mentoring network (McBride et al, 2017)</p> <ul style="list-style-type: none"> • Background: Mentoring has long been regarded as one of the key components of research training and faculty development. • Purpose: The Robert Wood Johnson Foundation Nurse Faculty Scholars program purposely facilitated scholars' development of a mentoring network by providing each individual with three mentors: a school-of-nursing mentor (primary), a university-based non-nurse research mentor (research), and a nationally-recognized nurse leader at another university (national). • Method: The Mentorship Effectiveness Scale was used to assess the effectiveness of each type of mentor in the first five completed cohorts. Discussion The ratings of mentorship effectiveness for all three kinds of mentors were generally high. Scholars valued most their mentors' support and advocacy; the biggest weakness in deals with all mentors was accessibility. • Conclusion: Even when one mentor proved a poor match, another mentor turned out to be an advocate and helpful, thus reaffirming the benefits of a mentoring network as opposed to only a single mentoring relationship. One lesson learned is the importance of preparing mentors for their role via written materials, in-person or phone orientations, and discussions at the annual meeting.
<p>Launching Successful Beginnings for Early Career Faculty Researchers (Conn et al, 2018)</p> <ul style="list-style-type: none"> • Junior faculty follow a research path replete with challenges as they strive to create knowledge in their area of interest while balancing new responsibilities. Unlike graduate school, where students focus inward on personal development, junior faculty must add responsibilities in ways that hold them accountable as members of a university. • This special article deals with three themes of interest to new junior faculty launching research programs: personal development, collaboration and team development within university settings, and funding advice. Strategies in these areas provide guidance on navigating early careers and finding success in the academic setting. 	<p>Strategies to enhance the success of mid-career nurse scientists (Bourgault et al, 2022)</p> <ul style="list-style-type: none"> • Background: The mid-career nurse scientist, defined as an associate professor with/without tenure, is often faced with a multitude of challenges and opportunities • Purpose: This paper shares strategies to assist mid-career scientists as they juggle required career demands and navigate the mid-career phase in pursuit of the rank of full professor. • Method: A review of the literature was performed on mid-career nurse scientists. • Discussion: A combination of increased research responsibilities, increased institutional teaching and service demands, and dwindling support can result in a sense of overwhelm and burnout. The mid-career nurse scientists must balance several balls in the air at one time to remain successful. • Conclusion: Strategies aligned with the Ecological Framework, focus on intrapersonal, interpersonal, institutional, organizational, and public policy domains to provide a wide scope of strategies that target the mid-career scientist and engage the larger nursing community.

Appendix 5. Examples of photographs from the workshop.



Appendix 6. The Comprehension Assessment Test (CAT0) administered immediately following the on-site workshop.

Voluntary and optional – no identifying information will be released, and all results will be reported in aggregate.

PRE-test of Knowledge, Skills, and Attitudes:

Define Discovery Research:

Define Integration Research:

Define Engagement Research:

Define the Science of Teaching and Learning (SoTL):

List the three criteria used to evaluate Discovery Research (according to the YouTube video):

- 1.
- 2.
- 3.

Define Career Cartography:

List the four components of Career Cartography:

- 1.
- 2.
- 3.
- 4.

With regard to Boyer's Model of Scholarship, from each pair of terms, circle the feeling that is Most Accurate:

First pair: Nervous Excited

Second pair: Cautious Prepared

Third pair: Optimistic Foolish