

An Introductory Course on Research in Engineering Education- An experiment in training faculty in India

Dr Prathiba Nagabhushan
Department of Humanities & Social Sciences
St Mary MacKillop College
Canberra, Australia
prathiba.nagabhushan@mackillop.act.edu.au

Dr Sohum Sohoni
Department of Electrical Engineering and Computer Science
Milwaukee School of Engineering
Milwaukee, Wisconsin, USA
sohoni@msoe.edu

Abstract—This Innovative Practice Full Paper reflects on a pilot experiment aimed to fill a perceived need for training faculty and to sustain systematic and rigorous research in the area of engineering education in India. The pilot was carried out in the form of a year-long online course with thirteen webinars, taught by two faculty members, one from the United States and one from Australia. One of the faculty is a computer engineer who has published research in engineering education outlets in the past decade, and the other faculty member is a psychologist who has extensive experience in conducting human subjects research. The participants in the course are faculty teaching in engineering institutions in India. Some have a PhD while others have a master's degree in an engineering discipline. The course was designed to cater to an audience that had no prior experience with human subject research and no prior experience in action research. The content covered are the significant components of a research framework, which includes problem definition, research design, methods of data collection and analyses, ethical issues in research and report writing. The long-term goal for this course is to spread awareness of best practices and to increase the overall quality of papers in this area. A survey was administered to the 40 participants in the course, and information was obtained that is deemed helpful to future offerings of the course. This paper summarizes the findings and aims to present them to an international audience with the intent of soliciting inputs from the audience and engage in a discussion that might inform future efforts in this direction in other countries where engineering education might be a nascent discipline.

Keywords - innovative practice, engineering education, research, online learning

I. INTRODUCTION

A. Broader Context of the Scholarship of Teaching and Learning

Teaching well, teaching using research-proven pedagogical techniques, and reflecting on one's teaching are important for the future of higher education. Over the years, scholarly teaching and the scholarship of teaching and learning [1-6] have been part of the conversation at conferences like the Frontiers of Education. A recent book on empowering professional teaching in the area of engineering [7] provides novel ideas as well as a

rich historical context on engineering education. The question of how to empower faculty to try new ways of approaching the teaching and learning process is an important one. Equally important is how the community of educators within a discipline and/or within a geographic range such as a country might share the results of these innovations. Boyer's Scholarship Reconsidered [1] provides guidance, as do various efforts undertaken by various organizations (for example, American Society for Engineering Education's Virtual Communities of Practice). At the core of such sharing is an educator's ability to gather evidence to support their theory. To think about how to gather such evidence requires an educator to be aware of the methods associated with research in education. This paper describes a pilot study aimed at empowering faculty in Indian engineering institutions so that they may practice the scholarship of teaching and learning.

Another direction from which such a program has been approached in the past, is a direct capacity-building exercise for the field of engineering education research. From 2003 to 2010, the Center for the Advancement of Engineering Education (CAEE) [8], worked with approximately 50 faculty and graduate students as part of the Institute for Scholarship on Engineering Education (ISSE) [9]. Just like our effort in India, their project was shaped by the idea of building a community of practice [10]. Their program was much more comprehensive and had in-person kick-off and graduation events. With our geographic and budget constraints, we attempted a fully online model as compared to their week-long in person workshop followed by an online community building exercise culminating with a leadership summit.

B. History and Specific Motivation for Offering the Course

India has 3,166 engineering colleges that employ a total of 417,000 faculty (number from AICTE website, obtained April 2, 2020 [11]). Of the hundreds of thousands of students that graduate from these institutions, very few are deemed as employable [12-14]. The authors of this paper have been engaged in a non-profit organization, IUCEE (Indo-Universal Collaboration for Engineering Education) that has brought

together experts from around the world to improve the engineering education ecosystem in India. The organization has primarily served in the capacity of teacher training. In its early years, more than a decade ago, this was done through in-person multi-day workshops. Over the past few years, a rigorous, internationally recognized certification program has become the primary means of faculty development conducted by the organization. As part of the certification, several innovative pedagogical practices are introduced to the participants, who try these out in their classrooms and report their experiences. In part, this has spawned a grass-roots movement of going beyond traditional “chalk and talk” methods of teaching to techniques that have been shown in the literature to be more effective. A natural consequence of this movement is to share best practices with colleagues within and across institutions. The authors have been closely involved in this whole process, and in January 2019, they decided to launch a pilot online course that would introduce faculty to the basics of research in engineering education, with a strong emphasis on the scholarship of teaching and learning, and on action research.

C. Literature that guided the course contents

Details of the course are provided in the next section. In this sub-section we describe the philosophy behind our choice of contents for the course. Since the course was designed to connect engineering education practice with engineering education research [15], it was shaped by Borrego and Bernhard’s paper describing the emerging field of engineering education research [16]. The Cambridge Handbook of engineering Education Research [17] served as the basis for selecting the qualitative and quantitative methods that are most commonly used in this field.

II. COURSE DETAILS

This section provides details of the course on Engineering Education Research (EER), such as, the intended audience, course objectives, content, pedagogy and assessment and research questions.

A. Intended Audience

Faculty members at engineering institutions in India who are engaged in trying out alternative pedagogical techniques in their classrooms.

B. Objectives

The course had the following objectives-

1. To develop an understanding of the basic framework of the research process
2. To develop an understanding of different research designs and techniques
3. To develop an understanding of how to conduct and write a literature review
4. To develop an understanding of the ethical considerations of engineering education research
5. To develop an appreciation of the different aspects of scholarly writing and evaluate its quality
6. To review grammar and writing guidelines as appropriate for scholarly writing

C. Course Content

This is a practical-oriented course where the participants would learn about the scientific approach to research and the methods and techniques of academic research in an engineering education context. The participants would examine and be practically exposed to the significant components of a research framework, which includes problem definition, research design, methods of data collection and analyses, ethical issues in research and report writing. Once equipped with this knowledge, participants would be confident to undertake research in their chosen area and contribute their research findings to peer-reviewed journals. The content of the course included the following:

- Introduction to Scientific research
- Features of Academic Writing
- Conducting a Literature Review
- Research Questions, Variables and Hypotheses
- Research design: Experimental and non-experimental
- Descriptive, Cross-sectional and Longitudinal research designs
- Statistical Analyses: Measures of Central tendency and Measures of Variance, Correlation and Regression
- Reporting the results
- Significance of a discussion section in a paper
- Research Implications, limitations and recommendations
- The art of writing an empirical research report and
- Referencing style and its formatting.

D. Pedagogy

This course was delivered entirely online through CANVAS and GoToMeeting webinars and the teaching methods included readings, lectures, power-point presentations, discussions, exercises and ongoing assignments that would eventuate in the production of a research paper.

Canvas is a Learning Management System that allows educators to build the digital learning environment. It simplifies teaching and elevates learning through various facilities, such as, conducting discussions and conferences, uploading audio and video files and submission and grading of assignments, all online. GotoMeeting is a software that enables screen sharing, video conferencing, meeting recording and transcription for a huge audience anywhere in the world through the internet.

The course was conducted over a period of 12 months, with an average of just over one webinar per month (13 webinars total). The webinars were initially spaced 2 weeks apart for the first 3 months, when the focus was on information transfer. Later in the course, when most participants were collecting data and analyzing the data, the frequency of the webinars was once in two months. Participants were grouped based on their interests, and the course faculty met individually with these groups instead of conducting webinars during the latter half of the course. Initial assignments were individual, but a large majority of the assignments for the course were group assignments.

E. Assessment

The overall evaluation of the participants was on the basis of the final deliverable, which is a draft research paper. The assignments were thus partitioned into different aspects of conducting research and writing a research paper, such as conducting a literature review, composing a research question, setting up the experiment, gathering data, analyzing results and writing a discussion and conclusion section.

F. Research Question

The research question this study aims to answer is, “What aspects of the course were deemed effective by the participants, and what aspects need improvement?”

III. METHODS

This section provides the details of our research methodology.

A. Participants

The purpose of this research was to examine the experiences of the participants in the process of design, delivery, assessment and finally, the overall completion of the EER course. To address this research investigation, we focused on collecting data from all the participants, who were the faculty members teaching engineering courses (N=41) in the academic year 2019-2020. These participants were all from India, mainly working in private engineering colleges. Although the dataset included all the 41 participants, only 30 participants responded to the questionnaire that was exclusively designed to examine the effectiveness of the online delivery of the course.

B. Material

The questionnaire used in this research included both qualitative and quantitative questions about the design, delivery, assessment and overall completion of the course. The qualitative part of the questionnaire consisted of eight questions (e.g., i) *Describe the top three things that you believe you got out of this course;* ii) *Describe the most significant challenge related to group work that you faced and how you addressed them*). The quantitative part of the questionnaire included ten questions pertaining to the course which were on a Likert Scale ranging from 1 to 7, where 1 = strongly disagree and 7 = strongly agree. Some sample questions under the quantitative category were i) *“The content covered in the webinars were of appropriate amount for me to understand and apply the concepts to my own research;* ii) *“I was confidently able to complete my course assignments”;* iii) *“I found the inclusion of Mechanics of English in this course useful” and iv) “The course has enhanced my skills in designing, conducting and reporting research”. Along with qualitative and quantitative types of questions, the background information of the participants was also collected based on the questions such as, i) “Your position in the faculty”;* ii) *“Your teaching experience in an engineering college”;* iii) *“Do you have a PhD?” and iv) “How many total research papers in peer-reviewed journals have you published?”.*

C. Procedure

The questionnaire was presented to the participants as a Google Form and they were informed that they needed to respond to the questionnaire in a fortnight’s time. We reminded

the participants twice to return their responses back to us, once by email and once through WhatsApp. Considering that 30 participants completed the questionnaire, we decided to base our analyses on the available data, because that was nearly 75% of the population.

IV. RESULTS

A. Demographic Data

As shown in Table 1, more than half the cohort consisted of Assistant Professors, but more than three quarters of the cohort had more than 10 years of teaching experience. From a research experience standpoint, less than 40% had a PhD and less than 33% had published in a peer-reviewed journal. These demographics are not unusual in the context of Indian engineering institutions, and are actually quite representative of the broader engineering faculty in India.

TABLE I. THE BACKGROUND INFORMATION OF THE PARTICIPANTS IN THE COURSE

	%
The position of the participants in the institution	
Assistant Professor	54.8
Associate Professor	32.3
Professor	12.9
Years of teaching experience	
6-10 years	22.6
More than 10 years	77.4
Participants holding a PhD degree	38.7
Participants not holding a PhD degree	61.3
Participants who have not published papers in engineering education	67.7
Participants who have published engineering related papers in peer-reviewed journals	32.3
Participants who have not published any paper in peer-reviewed journals	25.8

B. Qualitative Results

Except two participants, each of the participants was in a group where the members were from other institutions.

There were varied responses from the participants to the open-ended questions asked in the survey. They are summarized below:

The participants expressed the reasons for their enrolling into the course as the following:

- Personal interest in learning to write a good research paper for publication
- To learn the scope for research in engineering education and to learn from peers.
- To understand the basics of engineering education research and action research

The participants also listed varied challenges that they came across during their enrolment into the course. They are as follows:

- Differences in course and curriculum structure in different institutions

- Lack of coordination, communication and agreement related to the topics, data collection procedure and data analysis
- Balancing between administrative work requirements, teaching commitment in the institutions and research work required of the course

The participants also expressed how they endeavoured to address the challenges they faced in the process of conducting research for the course collaboratively. They are as follows:

- Sharing the responsibilities based on the convenience of the members in the group
- Communicating through Whatsapp on their phones. Google forms and Canvas on their laptops

A very small percentage of participants expressed that they did not have any challenge as they all worked in the same institution, and very few mentioned that they tried to address the challenges in many different ways but in vain.

The top three things that emerged from the participants' perspective of having gained from the course are as follows:

- Understanding the steps involved in scientific research
- Understanding the mechanics involved in the process of reporting research and
- Confidence in conducting and reporting research and working in teams.

The participants also suggested the following for the improvement of the course in the future:

- Institution-based grouping of members for research
- More opportunities for group discussions and quizzes
- Dissecting and discussing a published paper about its design, structure and effectiveness
- More number of face-to-face sessions of teaching and learning

While commenting on the impact of the EER course and future plans related to research, the participants expressed the following:

- Gaining a lot of confidence in conducting and reporting engineering education research
- Interest in enrolling into a PhD program
- Implementation of different pedagogical procedures to teaching of engineering courses and conducting research with an aim to publishing the findings in different journals

C. Quantitative Results

As shown in Table 2 below, the strengths of the course were marked highly by the participants. Particularly, while 80.7% of the participants found the feedback to be constructive provided to them during the course on course assessments, 80.6% of the participants found the inclusion of English Mechanics into the course highly useful. 54.8% of the participants expressed that they were confidently able to complete the course assignments. 61.3% of the participants were satisfied with the grading process

and had a clear understanding of each of the sections of a research article.

TABLE II. PERCENTAGE OF RESPONSES TO THE ITEMS RELATED TO THE EER COURSE

Questionnaire items	Agree and Strongly agree (%)	Disagree and Strongly disagree (%)
The webinars were presented in a clear manner	67.8	6.5
The content covered in the webinars were of appropriate amount for me to understand and apply the concepts to my own research	71	9.7
By the end of the course, I had a clear understanding of each of the sections of a research article	61.3	6.5
I was confidently able to complete my course assignments	54.8	9.7
I was satisfied with the grading process	61.3	3.2
The feedback given to my assignments was constructive	80.7	3.2
I found the inclusion of Mechanics of English in this course useful	80.6	6.5
I was able to adapt myself to the technical requirements for the course	67.7	6.5
I will recommend this course to my colleagues and friends in other institutions	71.1	3.2
The course has enhanced my skills in designing, conducting and reporting research in the area of Engineering Education Research	71.1	3.2
The course has enhanced my skills in designing, conducting and reporting research in general, not just in Engineering Education Research	64.6	3.2

D. Reflection from the Authors

Prior to launching this course for the Indian audience, one of the authors had taught a few iterations of a much shorter, information-centric course on this topic. These short courses would typically be a series of 6-7 one-hour webinars, with one webinar done each week. Thus, the model was to provide information on human subjects research, themes in engineering education research and the typical methods used to conduct and report such research. Most iterations of this short course had some lightweight assignments to engage the participants, but there was no accountability.

Our vision for this longer-term in-depth course was to create an environment for those seriously interested in taking up engineering education research in India to get access to not only information and tools that would help them, but also to connect with others at other institutions to establish a community that would flourish over the years. Collaboration across institutions in India is almost non-existent, in contrast to own experience in the United States. We believed that this course would serve to break those barriers and get people to think about working on research questions that went beyond their classroom or their institution. Finally, one of the potential outcomes for the course was to prepare those who might be interested in pursuing a PhD in engineering education to gain enough familiarity with the field to make a well-informed decision.

While our expectation for the class size was a maximum of 25, we ended up enrolling 41 participants, as some institutions insisted on sending a large cohort. This meant that the original idea of splitting the class into 5 or 6 groups, each of which would work on one research paper, would have to be scaled up. This scaling up was not very successful, as there were too many groups, and some groups were too large. We were unable to provide the time and the guidance that we believed we should have provided. Some participants in the larger groups felt excluded. This was especially true in cases where a group had a majority of participants from one institution and just one participant from a different institution. On the positive side, some of the groups performed extremely well, both in terms of the draft paper that they put together as well as in terms of teamwork and collaboration. There was clear evidence that the seeds of collaboration across institutions have taken root, and in some cases even borne fruit in terms of multi-author papers that will be submitted to conferences and journals in this calendar year. Overall, we feel that the pilot was successful.

V. DISCUSSION

The main purpose of this research was to examine the effectiveness of the engineering education research course delivered to the engineering faculty in India, mainly focusing on what aspects of the course were deemed effective by the participants, and what aspects needed improvement. The overall results paint a very positive picture of the course delivered; however, there are some pertinent insights that are drawn from the results, which would not only inform the researchers about the areas that need further improvement and the audience the procedure, practicality and effectiveness of the course for their future considerations.

A. Demographic Data

As mentioned in the results, the demographics reflect a fair representation of the faculty in Indian engineering institutions. Over the past several decades, engineering institutions were primarily tasked with educating undergraduates, with little to no focus on research. A PhD was not required to qualify for a teaching position. Over the last decade, All India Council for Technical Education (AICTE) has mandated a PhD for certain ranks of the teaching faculty, and several mid-career faculty are caught in a situation where they need a PhD for rank advancement, but they neither have the research training nor access to facilities to conduct world-class research. As research in engineering education typically does not require expensive

equipment, and the scholarship of teaching and learning usually does not require large infrastructure, it can serve as a vehicle for such faculty to conduct useful research that might also propel them towards getting a PhD. This course aimed to attract such a demographic, and it is clear from the results that this was indeed the make-up of the first cohort.

B. Results of Qualitative Research

Most of the challenges expressed by the participants stemmed from difficulties in collaborating with their peers. For example, the latter half of the course focused on data collection, and some institutions had their terms align well with this timeline, whereas others did not. Although the instructors explained to the participants that data need not be collected at every site, there seemed to be a strong desire for each participant to collect data from their own classes. From the perspective of the outcomes for this course, it is evident in hindsight that the desire to collect their own data was an experience that each participant should have had.

A second point of dissatisfaction was with the topic of research adopted by each group. These groups were formed by polling the participants on their interests, followed by a literature review assignment whose aim was to provide each participant with enough knowledge of the topic area to make an informed decision. However, the groups were vastly different in size, and the larger groups had to be split into smaller groups. In this overall process, a few of the participants ended up joining a group that was exploring a topic that was not their first choice. A smaller cohort would have helped resolve this issue.

The biggest challenge arose from collaboration, especially across institutional boundaries. This was exacerbated by the time commitment that individuals faculty could make for this course. As with any group, there were some participants that did not contribute much to their group, and even caused delays in completing assignments. Once again, a smaller cohort would have enabled the instructors to provide more oversight and more interaction; furthermore, changing the evaluation to include more individual work is recommended for the next cohort.

Participants provided useful suggestions for improving the course, although we disagree with one of their suggestions, which was to form groups based on institutions. There are two reasons for not agreeing with this recommendation. One, we would like to foster inter-institution collaboration, and two, we had an imbalance with respect to representation from institutions- several institutions had only one person taking the course, while three institutions had a number of participants. Based on the actual enrollments, this would have resulted in 18 groups, of which most would have been individuals, and two groups with more than 6 participants. All the remaining suggestions made by the participants will be incorporated in the next iteration of the course. These include more webinars and more contact hours between the instructors and the participants, more opportunities for supervised discussion in Canvas or another platform, quizzes and other forms of individual accountability, and the inclusion of more papers that will be analyzed as part of the instruction.

C. Results of Quantitative Research

The very fact that more than 60% of the participants have expressed their satisfaction with the content and clarity of delivery of the course, suggests that imparting engineering education research course on an online environment is not only feasible but also effective. This tends to project a positive scenario where a greater number of engineering faculty members and students could be educated about the nuances pertaining to the conduct and reporting of engineering education research. In particular, 64.1% of the participants have expressed that the course has enhanced their skills in designing, conducting and reporting research in general, not just in Engineering Education Research. This result indicates that conducting such online courses would have a positive impact on publishing quality research articles in the engineering education journals, and also, enhancing the quality of research articles across a wide spectrum of engineering journals, in general.

It is noteworthy that about 80% of the participants have reported that the feedback given for their assignments was constructive and the inclusion of Mechanics of English in this course was useful. This reiterates the importance of feedback in the learning process, as Hattie and Timperley [18] mentioned that feedback is one of the most powerful influences on one's learning and achievement. The findings also suggest that including a unit on Mechanics of English in the research course is imperative to enable the researcher write as he intends his readers to understand what he wants to convey through his writing. This feature of the course is all the more essential, especially for the learners from backgrounds other than English.

About 9% of the participants disagreed to the statement of understanding of the content covered in the course and the translation of the same onto their own research, in addition to confidently able to complete the assignments. These results are from a very small percentage of participants, for which many factors can be attributed, such as, their time management skills, personal life situations and individual differences across different perspectives.

D. Implications of the study

The current research has the following implications:

1. This study has highlighted the significance of the EER course, which has been found to be beneficial for the teaching faculty in the engineering colleges.
2. Understanding the methods and reporting of research conventions and the mechanics of English to be observed in the process of writing would enhance the quality of research conducted and reported.
3. The in-depth insight into different aspects of research methodology and research reporting tend to prepare the faculty engage in research in engineering education.
4. This research has also provided an introduction to and a taste of working collegially and collaboratively in research endeavors.

5. The participants in this research can extend their knowledge and understanding of the know-how of research in education acquired from this course to their colleagues in their respective institutions during the faculty development program. This ripple effect would enhance the quality of research and research papers towards their publication in engineering education journals.
6. It is pertinent that a teacher keeps evolving in their profession through life-long learning so that he/she strives to better their skillset and caters to the needs of students' individual differences in the learning process and the societal changes. This current research based on the effectiveness of the EER contributes to and affirms that this can be achieved.
7. This action research has also facilitated the evolution of the individuals' professional social networks and basic relationship between peers.

E. Limitations

The study had a small sample size, and less than 100% of the population participated in providing feedback.

F. Recommendations

Based on the results, we make the following recommendations for the next iteration of our course, as well as for anyone else who would like to offer a similar course.

1. Attempt to strengthen the online course with an in-person workshop and an in-person event that coincides with a relevant conference. This recommendation is based on our observations, as well as the model followed by the Institute for Scholarship of Engineering Education (ISSE) in the USA [9].
2. Limit class size to 25. Until a more scalable model with additional mentors (see next point) can be designed, the next iteration of the course should be capped at 25.
3. Offer a teaching assistantship to a select few from the first cohort to share the mentoring responsibilities with the course faculty.
4. Enforce balanced groups in terms of the split across institutions as well as prior experience. An in-person workshop at the beginning of the course can significantly improve the formation of more effective teams.
5. Form groups later in the course to make sure that each group has a sufficient number of people who are serious about the course. This will also enforce individual accountability at the beginning, which should be maintained throughout the course.
6. Include a module on publication outlets earlier on, so that specific conferences or journals may be targeted by each group and improve the participants' motivation
7. Make smaller groups.
8. Include more activities that involve the dissection of engineering education research papers to illustrate various methods and techniques.
9. Increase the contact hours between instructors and participants, through more webinars.

10. Provide more support for participants in terms of office hours and resources to successfully complete their assignments for their course.
11. Once topics are selected, invite guest speakers from the broader engineering education research community to discuss their work with the participants.

G. Reflections from a capacity-building and community-building perspective

Beyond functioning as a course, the broader goals from this project were taking an initial step towards capacity-building and community-building for Engineering Education Research, which is a budding area of research in India. From the participants' inputs as well as from the instructors' observations, it is clear that there is a strong need for both capacity and community building. The conclusions regarding this aspect of the project agree with those from the ISSE from the USA [9], and can be summarized as follows: Faculty have very little local support and recognition for research in engineering education. While a wide national community is important, a local community is a more urgent necessity for faculty who are new to this area of scholarship. Faculty are largely unfamiliar with methods for human subjects research, and the new terminology in this discipline is also a barrier for them to overcome. As described in a paper published in India [19], a network of discipline-based education research ambassadors can be an effective solution for helping novices in this area become familiar with the norms and the terminology.

VI. CONCLUSIONS

The initial results from this pilot course are promising. Interestingly, the challenges faced by the faculty in India are not too different from those faced by faculty in the USA as seen by data from the Institute for Scholarship of Engineering Education (ISSE) [9]. Despite the challenges of collaboration and a larger than anticipated pool of participants, it is clear that not only did some groups succeed, but the overall level of satisfaction among the participants was high. We recommend this model for others who might want to provide this service in India or in other places that could benefit from it. It will be interesting to see how an in-person implementation of such a course will fare.

REFERENCES

- [1] Boyer, E. L. (1990). *Scholarship reconsidered: Priorities of the professoriate*. Princeton University Press, 3175 Princeton Pike, Lawrenceville, NJ 08648
- [2] Hutchings, P., & Shulman, L. S. (1999). The scholarship of teaching: New elaborations, new developments. *Change: The Magazine of Higher Learning*, 31(5), 10-15.
- [3] Richlin, L. (2001). Scholarly teaching and the scholarship of teaching. *New directions for teaching and learning*, 2001(86), 57-68.
- [4] Huber, M. T. (2005). The advancement of learning: Building the teaching commons.
- [5] Richlin, L., & Cox, M. D. (2004). Developing scholarly teaching and the scholarship of teaching and learning through faculty learning communities. *New directions for teaching and learning*, 2004(97), 127-135.
- [6] Rüttnann, T., & Saar, M. (2017). Scholarly teaching and scholarship of teaching and learning in teaching engineering. *IEEE Global Engineering Education Conference (EDUCON)*, Athens, 2017, pp. 213-218
- [7] Heywood, J. (2018). Empowering Professional Teaching in Engineering: Sustaining the Scholarship of Teaching. *Synthesis Lectures on Engineering*, 12(1), 1-245.
- [8] <https://depts.washington.edu/celtweb/caee/index.html>, Center for Advancement of Engineering Education, Accessed May 26, 2020.
- [9] Adams, R., & Bell, P., & Allendoerfer, C., & Chen, H., & Leifer, L., & Fleming, L., & Maring, B., & Williams, D. (2006, June), *A Model For Building And Sustaining Communities Of Engineering Education Research Scholars* Paper presented at 2006 Annual Conference & Exposition, Chicago, Illinois. <https://peer.asee.org/1003>
- [10] Wenger, E., McDermott, R., & Snyder, W. M. (2002). Cultivating communities of practice Harvard Business School Press. *Cambridge, MA, USA*.
- [11] <https://www.aicte-india.org/> All India Council for Technical Education, Accessed, April 2, 2020
- [12] <https://economictimes.indiatimes.com/jobs/employability-survey-2019-jobs-slip-away-from-the-ill-equipped-indian-engineer/articleshow/68559686.cms> The Economic Times, published March 25, 2019, Accessed April 11, 2020.
- [13] <https://www.aspiringminds.com/blog/research-articles/why-are-indian-engineers-unemployable/> Aspiring Minds study, published April 16, 2019, Accessed April 11, 2020
- [14] <https://www.deccanherald.com/opinion/panorama/why-aren-t-engineers-employable-790612.html> K.V. Chandramouli, published January 2020, Accessed April 11, 2020.
- [15] Jesiek, B.K., Borrego, M. and Beddoes, K. (2010), Advancing Global Capacity for Engineering Education Research (AGCEER): Relating Research to Practice, Policy, and Industry. *Journal of Engineering Education*, 99: 107-119.
- [16] Borrego, M. and Bernhard, J. (2011), The Emergence of Engineering Education Research as an Internationally Connected Field of Inquiry. *Journal of Engineering Education*, 100: 14-47.
- [17] Johri, A., & Olds, B. M. (Eds.). (2014). *Cambridge handbook of engineering education research*. Cambridge University Press.
- [18] Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of educational research*, 77(1), 81-112.
- [19] Sohoni, S., Craig, S. D., & Vedula, K. (2017). A blueprint for an ecosystem for supporting high quality education for engineering. *Journal of Engineering Education Transformations*, 30(4), 58-66.