Reflecting on Ten Years of Building a Community of Practice for Teaching Innovations in Fundamental Mechanics Courses

Wayne L Chang, University of Illinois Urbana-Champaign

Dr. Wayne Chang is an assistant teaching professor in the Aerospace Engineering Department at the University of Illinois at Urbana-Champaign. He received his BS, MS, and Ph.D. in Mechanical and Aerospace Engineering from the University of California, Irvine.

Mikayla R Hoyle, University of Illinois at Urbana - Champaign

Mikayla R. Hoyle is a PhD student in the Dept. of Mechanical Sciences and Engineering at the University of illinois Urbana-Champaign (UofI) with interests in bone biomechanics. She holds a B.S. in Mechanical Engineering from the University of Kansas. For the past three years, she as been a part of the Strategic Instructional Innovations Program (SIIP) team in the Mechanical Science and Engineering Department at UofI, contributing to advancing undergraduate engineering education.

Melany Denise Opolz, University of Illinois at Urbana - Champaign

Melany D. Opolz is a PhD student in the Department of Chemical Engineering at the University of Illinois Urbana-Champaign, specializing in equine biomechanics and bone chemistry. She holds a bachelor's degree in Chemistry from Cameron University and a Master of Science in Chemical Engineering from the University of Illinois Urbana-Champaign. For the past two years, she has been a part of the Strategic Instructional Innovations Program (SIIP) team in the Mechanical Science and Engineering Department at the University of Illinois Urbana-Champaign, contributing to educational advancements in engineering.

Jean-Christophe Raymond-Bertrand, University of Illinois at Urbana - Champaign

Jean-Christophe Raymond-Bertrand is an undergraduate student in Industrial Engineering at the University of Illinois Urbana-Champaign, and rising doctoral student at Virginia Tech. His interests are in Operations Research, specifically optimization under uncertainty and Markov decision processes. His current research uses Network Theory and Mixed Integer-Linear Programming (MILP) to determine unintended disparities in the impact of automated traffic law-enforcement on different groups in the city of Chicago.

Nikhil Chandra Admal, University of Illinois Urbana-Champaign

Dr. Admal is a professor of Mechanical Science and Engineering at the University of Illinois Urbana-Champaign. He holds a Ph.D. in Aerospace Engineering and Mechanics and a Master's in Mathematics from the University of Minnesota, Minneapolis. His research focuses on multiscale modeling of materials, particularly the mechanics of defects. Dr. Admal has published over 20 papers in peer-reviewed journals. He is actively involved in engineering education, especially in incorporating real-world examples into existing undergraduate courses in Solid Mechanics and in creating connections between different courses.

Dr. Thomas Golecki, University of Illinois at Urbana - Champaign

I spent 10+ years in industry as an engineer in structural mechanics and structural health monitoring projects, earning professional licensure as PE and SE. My PhD research focused on the structural optimization of dynamic systems including random loading and vehicle-bridge interaction. Now as teaching faculty, I try to connect course concepts to real-world examples in a way that motivates and engages students.

Dr. Kellie M Halloran, University of Illinois at Urbana - Champaign

Kellie Halloran is a Teaching Assistant Professor in Mechanical Science and Engineering at the University of Illinois Urbana-Champaign. She holds a BS, MS, and PhD in Mechanical Engineering from the University of Illinois and is currently investigating ways to engage undergraduate students and encourage curiosity and creativity in larger engineering classes.

Prof. Shelby Hutchens, University of Illinois Urbana-Champaign

Shelby Hutchens is an associate professor in the Mechanical Science and Engineering department at the University of Illinois Urbana-Champaign. She earned her B.S., M.S., and Ph.D. in chemical engineering at Oklahoma State University and the California Institute of Technology, respectively. Her research focuses on soft materials mechanics. Her approach to teaching is one of continued growth and improvement, for herself and her students.

Callan Luetkemeyer, University of Illinois at Urbana - Champaign

Callan Luetkemeyer is an Assistant Professor of Mechanical Science and Engineering at the University of Illinois Urbana-Champaign. She received her MS and PhD in Mechanical Engineering from the University of Michigan in 2020 following a BS in Biomedical Engineering from Saint Louis University. From 2020 to 2022, she was a postdoctoral fellow at the University of Colorado Boulder. She began her tenure-track faculty appointment at UIUC in 2023, where she teaches courses on solid mechanics and conducts research combining nonlinear solid mechanics, imaging, and extracellular matrix biology. In 2020, she received several research awards, including the Schmidt Science Fellowship, the Savio LY Woo Young Researcher Award, and the Ivor K. McIvor Award for Excellence in Applied Mechanics Research. In 2024, she was included in the ”List of Teachers Ranked as Excellent by Their Students” at UIUC.

Dr. Brian Mercer, University of Illinois at Urbana - Champaign

Brian Mercer is a Lecturer in the Department of Mechanical Science and Engineering at the University of Illinois at Urbana-Champaign. He earned his Ph.D. from the University of California, Berkeley, in 2016 and subsequently worked as a research engineer at the Illinois Applied Research Institute before turning to a career in teaching and education in 2018. His technical expertise lies in computational and theoretical solid mechanics, and he teaches a range of courses in these topics, including introductory solid mechanics, machine component design, computational mechanics, and finite element analysis. Brian’s pedagogical research efforts focus on developing and implementing effective teaching strategies for large lecture courses and increasing student literacy in using computational tools such as Python and to aid in performing calculations and simulations relevant to engineers.

Prof. Matthew West, University of Illinois Urbana-Champaign

Matthew West is an Associate Professor in the Department of Mechanical Science and Engineering at the University of Illinois at Urbana-Champaign. Prior to joining Illinois he was on the faculties of the Department of Aeronautics and Astronautics at Stanfo

Prof. Mariana Kersh, University of Illinois at Urbana-Champaign

Mariana Kersh is an Associate Professor in the Department of Mechanical Science and Engineering at The University of Illinois at Urbana-Champaign, Health Innovation Professor in the Carle-Illinois College of Medicine, and Director of the Tissue Biomechanics Laboratory. She also serves as co-chair of the Integrative Imaging Theme of the Beckman Institute for Advanced Science and Technology. Her research focuses on the use of experimental and computational methods to evaluate the interdependence of mechanical, compositional, structural properties of bone, ligament, and tendon to investigate the progression and treatment of musculoskeletal diseases. Her work has been funded by NSF, NIH, and industry/foundation sponsors. She has received awards from the US and Australian Orthopedic Research Societies and the Beckman Foundation in recognition of her scholarship.

Reflecting on Ten Years of Building a Community of Practice for Teaching Innovations in Fundamental Mechanics Courses

Abstract

A community of practice (CoP) in the Grainger College of Engineering at the University of Illinois Urbana-Champaign was formed about ten years ago to promote sustainable adoption of evidence-based pedagogies in three fundamental mechanics courses: Statics, Introductory Dynamics, and Introductory Solid Mechanics. Since its inception, the CoP has dramatically grown in the number of faculty members and innovative teaching projects. This work aims to highlight key initiatives and organizational structures that fostered the growth of the CoP. The college initially supported the creation of the CoP through an instructional innovations funding program, and the CoP has successfully secured further funding for continual development. The CoP is also supported by the department through a course coordinator faculty member who oversees training the course staff team and organizing weekly team meetings. The course staff team is composed of undergraduate course assistants and graduate teaching assistants. The staff team provides support to students via office hours, online discussion forums, and discussion sections, where students work in teams to solve engineering problems. The CoP has greatly benefited students and faculty by facilitating the coordination between courses. This has created standard course policies and languages to reduce student learning barriers. The latest pedagogical innovation endeavors from the CoP are integrating of computational tools and developing of open education resources for introductory mechanics courses. These resources include computational tools, online course reference pages, and a shared project inspired by grand challenges and current engineering events. This work shares the experiences of current CoP members that provide insights into how the community was self-sustaining over the past 10+ years.

Introduction

Communities of practice (CoP) composed of instructors committed to realizing effective teaching practices have been vital for sustainable course and curriculum reforms [1, 2]. This bottom-up collaborative approach places the ownership of the reform on the instructors rather than the institution's leadership. Forming a community is also a long-term strategy that can shift faculty beliefs, motivation, and departmental culture [3, 4]. The growth of the community requires senior members to recruit and mentor peers with a shared interest in personal improvement in teaching and instruction. The sustainability of CoPs needs mutual trust among peers that promotes the adoption of positive attitudes toward teaching innovation, as well as ongoing communication between experts and faculty within the CoP that accelerates and streamlines the implementation

of new ideas.

In 2012, a community of practice centered around redesigning the introductory mechanics course sequence was formed in the Grainger College of Engineering at University of Illinois Urbana-Champaign through a college-level teaching innovation seed grant [5]. The initial funding provided the incentive to create a structure for the CoP, as well as the resources for course reform efforts during the first three years of the community's inception. The CoP structure aimed to support faculty engagement, spread best practices, facilitate continuous assessment, and provide timely training and support for instructors. The CoP had weekly meetings facilitated by a project lead and a staff member from the funding agency who specialized in evidence-based teaching practices.

The courses in the sequence included Statics, Introductory Dynamics, and Introductory Solid Mechanics. This sequence is a critical part of the second-year engineering curriculum, serving approximately 1,500 unique students annually across the engineering college. The original community is composed of a mix of junior faculty members who are enthusiastic about bringing changes, as well as senior faculty members who have the necessary influence to secure future departmental support. The primary goals of the reform were to (1) boost student engagement and enthusiasm, (2) enhance the teaching experience and reduce instructor workload, and (3) maintain and elevate the quality of course content. Unlike short-term reform efforts to improve student grades or immediate learning outcomes, this initiative prioritized creating a sustainable environment for ongoing innovation and long-term improvement.

Before the reforms implemented by the CoP, the introductory engineering mechanics courses followed a traditional lecture-based format, consisting of three hours of lecture per week for approximately 250 students, a one-hour discussion section led by a graduate teaching assistant (TA) for about 30 students with a format of the TA's choosing, and an additional 4 to 6 hours of student work outside of class. Both lectures and discussion sections were typically delivered in a passive, lecture-driven style, with students primarily listening and taking notes. The content emphasized vector mechanics, focusing heavily on derivations and worked examples, with minimal application to real-world problems. The reform efforts introduced several key pedagogical changes, which are:

- Team collaboration discussion sections with a focus on applying course material to real-world scenarios and group-based problem-solving.
- Active learning in lectures that integrated a classroom response system, i>clicker, to increase student participation.
- Online interactive homework platform, PrairieLearn, that provided immediate feedback to enhance learning outside the classroom.
- Online help forums that complemented traditional office hours with digital platforms to offer flexible and collaborative support.

These changes preserved the weekly course schedule and student time commitment, but shifted the instructional model toward a blended learning environment that integrated online and in-person experiences. A collaborative instructional team that included faculty, graduate TA, and undergraduate course assistants (CA) guided and implemented the reforms. The TA and CA

received specialized training in facilitating group work and engaging students through online platforms. The results of these reforms showed improvement in student and faculty engagement and enjoyment in the course sequence [5].

The implementation of the CoP model had its share of challenges. Some faculty members faced difficulties integrating due to the deeply ingrained values of "academic freedom" and an individualistic teaching culture. Additionally, the terminology associated with CoPs has sometimes acted as a barrier to faculty buy-in. Furthermore, it was uncertain whether new faculty would continue to join the CoP and if the structure could be maintained over the long term. This work reviews the successes and challenges of maintaining the community over the past 10+ years since its conception. The current state of the community and the evolution of course sequence policies and structure were examined. In the following sections, individual reflections from current and past team members on their personal experiences being part of the community will also be presented and discussed.

Course Sequence Reform Themes and Objectives

The reform model of the community of practice described by West et al. [5] was grounded in three interconnected transformations, each building on the previous one. The foundation of these transformations drives continuous, iterative instructional improvements. The three levels of instructional cultural transformation are:

Transformation 1: Connecting faculty in Communities of Practice

The CoP sought to foster a collaborative teaching culture, promoting shared ownership of courses at the departmental or community level. This collective responsibility formed the foundation for sustained, scholarly reform and continuous improvement. This contrasted with traditional teaching as an isolated activity, with pedagogical approaches and course content frequently shifting based on individual instructor preferences. The isolationist culture often hinders the diffusion of innovative teaching practices across faculty and the broader campus community.

Transformation 2: Continual improvement via feedback and evaluation

The isolationist culture can also limit the faculty's ability to compare the effectiveness of different pedagogical approaches. This occurs because faculty often teach according to their preferences without systematically tracking and evaluating their performance in the classroom. Alternatively, monitoring and evaluating performance and implementing pedagogical innovations takes time and effort, which may not be an instructor's priority. Furthermore, they may dismiss findings from data they did not gather themselves. By fostering shared ownership of courses, faculty can engage in a continuous implementation-evaluation development cycle. This process starts with identifying areas for improvement, followed by implementing targeted reforms, assessing their impact, and iterating the process to drive ongoing enhancement.

Transformation 3: Organic adoption of evidence-based pedagogy

The formation of a CoP dedicated to teaching innovation enables reform efforts that align with the department's and the college's interests. Rather than relying on a single individual, the CoP

collectively sustains innovations, shares responsibilities, and provides ongoing support, fostering long-term success. Such a collaborative culture and the scholarly implement-evaluate cycle require faculty to engage in continuous dialogue aimed at enhancing student learning and experiences. These discussions allow the CoP to identify areas for focused effort in course reforms and the future direction of the community.

Based on the three levels of transformation, three main objectives of the reform efforts were created:

Objective 1: Improve students' low engagement and enthusiasm while taking the courses.

Objective 2: Improve instructors' experience and reduce their workload while teaching the courses.

Objective 3: Maintain and elevate the current standards for content within the courses.

The CoP was able to make incremental improvements to the mechanics course series over the years, but implementation of large-scale updates was impossible without proper support and resources. Faculty motivation was one of the primary limiting factors, where personal passion, interests, and incentives were simply insufficient for faculty to stay engaged while trying to fulfill research and department responsibilities. Hence, the community recognizes the need to seek external funding sources to support large-scale reforms, another key responsibility of the CoP. These funds can then support instructor work hours as well as student work hours.

Reform Outcomes

Beyond the initial funding that formed the CoP, the community was able to secure ongoing support from the department and two multi-year college grants that resulted in four major reform projects in the past ten years. Namely, the department created a course coordinator position to provide staff training and faculty support for current and future instructors assigned to teach the courses in the fundamental mechanics sequence. From the college grants, three major reform projects were created: improve student computational literacy, enhance accessibility, and strengthen course sequence coherence through shared real-life applications.

Reform Project 1: Department-supported course coordinator

The objective of improving student engagement and faculty experience in large service courses necessitated the creation of support course staff teams of TA and CA. The inclusion of undergraduate CA has been tremendously helpful in reducing the student-to-staff ratio and providing extended hours of in-person and online support. The courses have also benefited from innovations that came out of CA sharing their own success and failure stories while taking the course. These innovations often evolve into research opportunities where enthusiastic CA become productive research assistants. Figure 1 shows the typical course composition of a fundamental engineering mechanics service course. The criteria for the number of CA per course is to achieve a staff-to-student ratio of 1:30.

From the faculty perspective, greater complexity to course management was also introduced. When a new instructor is assigned to the courses that are part of the CoP, they would need to be familiar with the following course elements established over the past decade:

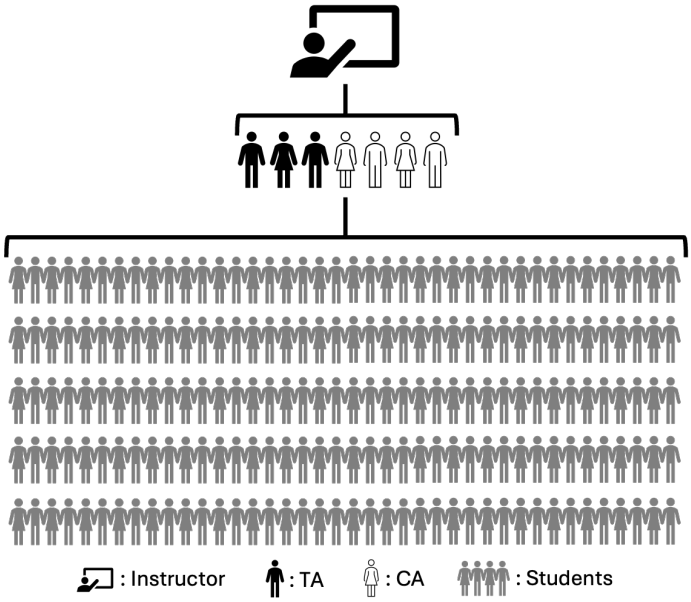

Figure 1: Course staff team is composed of an instructor, graduate teaching assistants (TA), and undergraduate course assistants (CA). The staff team member-to-students ratio is approximately 1:30.

- Collaborative group-work activities facilitated by TA and CA during discussion sections.
- Active learning in lectures using the i>clicker system.
- Online interactive homework using PrairieLearn.
- Proctored online exam by the Computer-Based Testing Facility on campus.
- Online help forums (Piazza or Campuswire).

Furthermore, the instructor would be required to manage the TA and CA staff team. The amount of coordination necessary to join the community has become a barrier for new instructors. To prevent new faculty members from being overwhelmed and to promote sustainable reform among new faculty members, the department created the course coordinator position, which does not change between semesters. The responsibilities of the course coordinator include:

- Hire the undergraduate CA team with a balanced mix of returning and new staff, as well as a diverse representation.
- Train the course staff team at the beginning of the semester for online platform management and student-interaction best practices.
- Facilitate weekly meetings with course instructors for course schedule reviews and previews. Recommendations from the reviews of previous semesters are introduced as preview action items for the current semester.
- Maintain online communication and help channels between all staff members for course logistics and policy-related issues. For example, student late submissions, staff absence

coverage, and academic integrity infractions.

One key function of the coordinator is to ensure the hard lessons learned in student and course management do not get lost with the change of instruction team from semester to semester. Also, contributions from individual instructors can continue to be carried out by future instructors with the coordinator's help. The coordinator is the bridge between courses and between semesters. Students and new instructors have greatly benefited from standard course policies and consistent expectations.

Reform Project 2: Integration of computational tools in collaboration with computer science and math prerequisite courses

The project aimed to modernize essential undergraduate service courses by incorporating meaningful computational tools and exercises. While the focus was initially on Statics, the faculty participating in this project is the core of a broader Python Working Group initiative, with plans to implement similar changes in other courses over time. By integrating hands-on computational tools through practical, application-driven exercises and combining them with modern active and group learning methods, the project sought to improve students' comfort and proficiency with using computers in engineering. This approach provided a strong foundation for student success in subsequent courses.

Key findings from survey-based data collection and analysis highlight the substantial and positive influence of supplementing computational resources on students' learning experiences. Through the intervention introduced in this study, the students became more aware of the importance of computational skills for their future career readiness. The students also reported increased effectiveness in developing these skills and greater confidence and comfort in working with computation tools for solving complex engineering problems. More details on this work can be found in [6].

Reform Project 3: Open-access online interactive reference pages and course resources

This initiative aimed to develop current course resources into open educational tools that other higher education institutions can adapt. This effort not only provided campus students with enhanced learning materials but also extended the benefits to a broader academic community. The project collaborated with the local community college to help improve transfer student readiness. This partnership served as a model for ensuring that transfer students are well-prepared for university-level coursework. Resource production focused on producing online reference pages, computational assignments, and engineering design projects. By making these innovations widely accessible, this project not only advanced educational practices across higher education but also enhanced the preparedness of transfer students entering engineering through early admission programs.

In this work, the research team observed a decline of textbook use by students through course evaluation questionnaires, which further exposed the need to create alternative forms of educational resources for enhancing student engagement with course material outside the classroom and fostering positive learning outcomes. The community of practice provided the structure and support to create a centralized resource for an introductory engineering mechanics course series (Statics, Introductory Dynamics, and Introductory Solid Mechanics). Such

undertaking would not otherwise be possible for individual course instructors. The reference page usage data showed high level of online engagement by students. The online analytics were also helpful for instructors in identifying concepts and topics that needed additional examples and attention from instructors. Namely, the level of complexity of key concepts correlated with the visitor traffic of the webpage, especially during exam periods. For more information on this work, the findings of this work are available in [7].

Reform Project 4: "Real-world" applications and "grand challenges" teaching modules

This reform examined and evaluated students' perceptions of course content, particularly in terms of curiosity, relevance to real-world scenarios, and the perceived value of the material for their future careers. To enhance this value-driven content, course materials were updated, emphasizing student interests and examples drawn from engineering grand challenges identified by the National Science Foundation and the National Academy of Engineering. A formal assessment process was established to collect quantitative data on the impact of course modifications. Reinforced learning was also employed, where the staff team from all courses collaborated to generate cross-course real-life engineering examples, creating a context for how different mechanics areas of study work together. The life of an astronaut on a space station was one of the examples we piloted. In Statics, students learned how harnesses are designed to keep astronauts stationary in a zero-gravity environment and were shown how the different muscles around the knee work together to help astronauts run on a treadmill. Finally, in Introductory Solid Mechanics, students were challenged to analyze the space station as a thin-walled pressure vessel.

A study was carried out between a control section and a test section of the same course, where the test section had a special weekly lecture segment on modern engineering applications of the course topics. At the end of the semester, students in the test section perceived the course content as more valuable than those in the control section. Qualitative survey data revealed that students were looking forward to the weekly applications discussed in lectures throughout the semester. This preliminary study also observed an improvement of how much students valued the course in the context of their academic career, which was motivating to the instructor for future course enhancements by extending the use of these real-world applications beyond lectures and into homework assignments and recitation sessions. More details from this study are presented in [8].

Outcome Evaluations

Over the past ten years, the community of practice had a total of twenty-five faculty members involved over various periods of time. Figure 2 shows the transition of the members over the years, with eight members currently actively involved. Faculty members who were assigned to teach introductory mechanics courses by the department but did not join the CoP after their teaching assignments ended were grouped into the "left CoP" category. Previously active members of the CoP who were no longer interested or unable to teach the introductory mechanics courses were grouped into the "former instructors" category. One member from the formation of the CoP remains active in the current CoP. The faculty ranking of the current members is given in Figure 3.

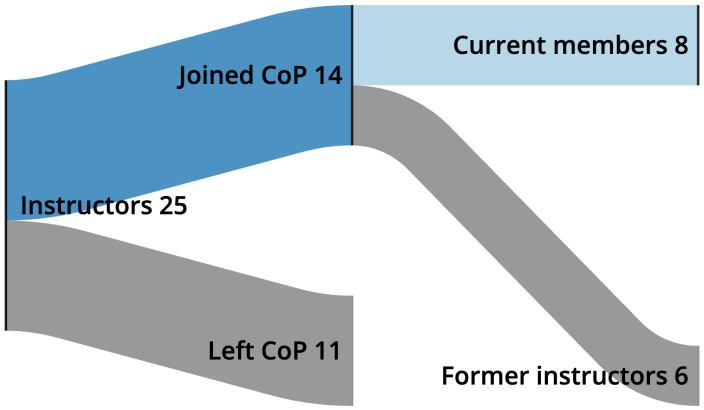

Figure 2: The flow of the number of faculty instructors assigned to teach the fundamental mechanics courses (Statics, Introductory Dynamics, Introductory Solid Mechanics), and the fraction who joined and remained active in the community of practice.

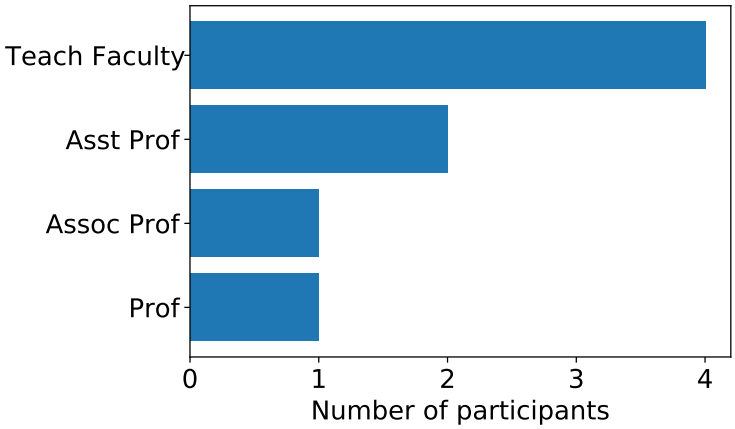

Figure 3: Academic rank composition of currently active community of practice members. The split between tenure-track faculty (assistant, associate, and full professors) and specialized faculty (teaching assistant professors and lecturers) is 50:50.

Current members were interviewed to capture faculty experience and motivation for being part of the community. The interview questions were:

1. How did you first become involved in our community of practice (CoP)?
2. What motivated you to join the CoP initially?
3. What is your involvement in the CoP? How have you been involved?
4. How would you describe your experience being part of the CoP?
5. On a scale of 1–5, with 1 being no noticeable change and 5 being drastic change, how would you rate whether your teaching has been changed by participating in the CoP? Please

describe the change, if any.

6. Will you continue engaging in the CoP independent of your teaching assignment in the upcoming year? If so, what is motivating you to continue? If not, what is the primary reason to pause your engagement?

The interview responses were analyzed to identify patterns and themes for assessing the impact of the community of practice on faculty teaching experience and engagement. Each interview was first anonymized upon submission to a central repository and then inductively coded by a designated member on the research team. The resulting codes were then grouped into major categories. In the category of community growth, the mechanism by which the community gained new members over the years can be grouped into two types: (1) direct invite by current members and (2) department teaching assignments. Faculty members in the department were given opportunities to submit their teaching preferences to the undergraduate office, but preferences were not guaranteed. Hence, sometimes, faculty members were assigned to teach the fundamental mechanics courses without prior notification. This has not been an issue for the health of the community because direct assignments were made for new teaching faculty members, who tended to be more open to participating in the community.

Initial motivation for faculty to join the community can be classified into three groups: (1) available resources, (2) a sense of belonging, and (3) prior personal relationships. Some members noted during their interview that having a course coordinator and a staff team (TA and CA) that had taught the course before had been tremendously helpful for a new instructor. They valued having people answer questions and provide feedback. One member mentioned that having a prior poor experience of isolationism teaching another course that did not have this kind of support; the level of enjoyment teaching the course was a night and day difference. They felt a sense of comradery being developed with people similarly passionate about teaching. In one interview, the motivation for joining the community was simply because the faculty enjoyed working with the members of the CoP in other settings. The trust that was previously established gave the community member a positive outlook for an impactful outcome of participating.

The level of community involvement of the members was proportional to the number of years they had taught the fundamental mechanics courses. Newer faculty tend to focus on learning the course content, structure, and staff team management. On the other hand, more senior faculty had better insight into where improvements could be made. Senior faculty were also the primary drivers of writing grant proposals to fund future large reform projects.

When examining personal experience as part of the CoP, several themes of negative and positive experiences were identified. Some community members felt a sense of powerlessness as individuals in making any significant change personally. They did not see how making changes to the current course structure as an individual could be possible with many moving components and personnel involved. Also, the structure in place has many moving parts that are difficult to decouple. Another member felt that the discussions on future community direction were too heavily driven by project funding and department/college interests. They would much prefer to have methodical development of student-centered teaching innovation. Finally, some members mentioned that the time commitment was high compared to the outcome of the efforts, which was challenging for faculty members working on tenure and promotion. The size of the community

has made it take longer to reach consensus on decisions, further exasperating the time commitment challenge.

On the positive side, the community members have been happy with the alignment of their initial motivation to join the community and their actual experience being part of the community. The positive environment for sharing, the affirming encouragement to invest in teaching, and the excitement to make teaching more rewarding and enjoyable were some of the highlights from the interviews. These positive experiences translated well to other courses the members taught beyond fundamental mechanics. The members felt empowered to try active learning techniques, modify assessment approaches, and even create a community of practice of their own. All members saw a positive change in their own teaching as a direct benefit of being part of the CoP. Based on the one-to-five scale provided (Question 5), the average response was 3.7. Many members were especially pleased with the improvements in student learning outcomes in courses outside of the introductory courses when they incorporated similar reforms as the CoP. Overall, the likelihood of current members returning is high, and intrinsic and altruistic motivation for improving fundamental mechanics courses is the primary reason.

Student researchers were also interviewed for their experience being part of the CoP. They were the central workforce behind course content creation and development, which included group discussion activities, online assignment question database, and online reference pages. They also performed statistical analyses on student survey data to quantify the impact of the reform projects. All students interviewed felt valued and taken seriously, even as academic novices in a community of mainly faculty members. They saw the community as a safe and inclusive space for sharing ideas and feedback. The diversity of the community in rank, gender identity, and ethnicity was another aspect that the students appreciated. As aspiring future academics, they gained a better understanding of the various pedagogical approaches in engineering education through first-hand research experience and mentoring by a faculty team. The students also noted growth in their professional development while having a wonderful time working in the community. Being part of the community has been an invaluable learning experience for the students.

Conclusion

The ability of the CoP that oversees the introductory engineering mechanics courses at the University of Illinois Urbana-Champaign to be self-sustaining over the past ten years is worth a close examination. The commitment to the initial transformation levels of connecting faculty in a CoP, improving faculty teaching, and adopting evidence-based pedagogy remained the primary driving force of CoP growth. The objectives of the reform efforts to improve student engagement in the classroom, faculty experience managing courses, and the standard of course content were met by the various reform projects highlighted in this work. The CoP served as an effective incubator for innovative teaching ideas from faculty members while providing the framework to implement major course transformations. Furthermore, the CoP was the key factor for sustaining significant course makeover efforts, which was evident in the long-term integration of new course elements independent of changing instructors from semester to semester. It is important to note that the presence of undergraduate and graduate research assistants was critical in the development of reform projects, and the building of a research team was made possible by the CoP's ability to leverage support from the department and the college.

The growth and evolution of the CoP also brought new challenges. As the scope of the projects and the size of the support staff team grew, the CoP has lost its initial flexibility that allows faculty to uphold and expand existing course structures voluntarily. Instructors and faculty found it difficult to preserve their individual freedom to adapt and implement changes in their classes from semester to semester. In light of these new challenges, our future work will include new organizational processes and systems that help empower individual community members to adopt sustainable changes in courses without feeling overwhelmed. The continual development of the reflection and evaluation process for the community is another interest of the team. Evaluation tools such as multi-rater feedback assessment for individuals have the potential to promote healthy and thriving growth of a CoP.

References

[1] R. Chang and L. Mann, "Creating an engineering education community of practice within an institutional setting: a blueprint for action research," *Proceedings of the 2010 AaeE Conference*, 1 2010.

[2] J. H. Tomkin, S. O. Beilstein, J. W. Morphew, and G. L. Herman, "Evidence that communities of practice are associated with active learning in large stem lectures," *International Journal of STEM Education*, vol. 6, no. 1, 2019.

[3] C. Henderson and M. H. Dancy, "Barriers to the use of research-based instructional strategies: The influence of both individual and situational characteristics," *Phys. Rev. ST Phys. Educ. Res.*, vol. 3, p. 020102, Sep 2007.

[4] A. L. Beach, C. Henderson, and N. Finkelstein, "Facilitating change in undergraduate stem education," *Change: The Magazine of Higher Learning*, vol. 44, no. 6, pp. 52–59, 2012.

[5] M. West, M. Silva Sohn, and G. L. Herman, "Sustainable reform of an introductory mechanics course sequence driven by a community of practice," vol. Volume 15: Advances in Multidisciplinary Engineering, p. V015T19A020, 11 2015.

[6] W. Chang, S. Ok, M. West, S. Hilgenfeldt, and M. Silva, "Effects of integrating computational tools into an introductory engineering mechanics course," *ASEE Annual Conference and Exposition, Conference Proceedings*, Jun. 2024.

[7] J.-C. Raymond-Bertrand, M. R. Hoyle, M. D. Opolz, N. C. Admal, W. L. Chang, T. Golecki, K. M. Halloran, C. Luetkemeyer, B. Mercer, M. West, and M. Kersh, "TL;DR Students don't read textbooks: designing online reference pages to enhance student learning," *ASEE Annual Conference and Exposition, Conference Proceedings*, Jun. 2025.

[8] T. Golecki, M. R. Hoyle, M. D. Opolz, J.-C. Raymond-Bertrand, N. C. Admal, W. L. Chang, K. M. Halloran, C. Luetkemeyer, B. Mercer, M. West, and M. Kersh, "Fun Friday: Assessing the effectiveness of weekly real-world applications in introductory dynamics lectures," *ASEE Annual Conference and Exposition, Conference Proceedings*, Jun. 2025.