# Making the Case for Applying Athletic Coaching to Support and Propagate Instructional Practices in Engineering Education*

RENEE M. CLARK, SAMUEL J. DICKERSON and MARC CHRISTIAN
University of Pittsburgh, Benedum Hall, 3700 O'Hara St., Pittsburgh, PA, USA, 15261. E-mail: rmclark@pitt.edu, dickerson@pitt.edu, mc2438@georgetown.edu

Leading scholars have indicated a lack of knowledge on *how* to propagate and sustain evidence-based instructional practices, such as active learning. However, they have identified social interactions as key for dissemination. Interestingly, the instructional coaching literature has drawn a direct connection between propagation of research-based practices and effective coaching of teachers. The authors have worked to propagate active learning and educational scholarship among instructors in their school of engineering. Their support model for this was informed by the change framework of Henderson and colleagues and consists of learning-community events, instructional coaching, classroom observation, student feedback, and instructor follow-up. Interestingly, the social focus of their model, including one-on-one coaching, was identified as a strength by the participating instructors. Preliminary results from this support program have been promising with respect to instructor participation, propagation of active learning and educational scholarship, and valuation by instructors. In this article however, the authors make a new argument for the infusion of athletic coaching to their support model for potential transformative outcomes. Despite the shared mission of athletic coaches and academic instructors to educate young adults, there is often little-to-no collaboration between them. However, given the origin of coaching in athletics, shouldn't instructional coaching be looking to athletic coaching for transformative insights and support? Along with making an argument for this unique paradigm, the authors suggest an exploratory case study approach for assessing the impact of athletic coaching within an engineering instructional support and propagation program. Our ultimate objective is to inspire and support other educators in adopting this potentially transformative model.

Keywords: coaching; instructional; athletic; interdisciplinary; propagation

## 1. Introduction and Background

Although effective pedagogies in STEM have been rigorously studied, the research on *how* to propagate and sustain their use is only in its early stages, according to leading scholars of instructional change [1]. These scholars have identified **social interactions** as key to disseminating and propagating instructional innovations [1]. Thus, the most promising avenues to propagating educational change may be interpersonal networks, conversations among colleagues, faculty communities, one-on-one coaching during change efforts, and other highly social approaches. This is in contrast to more traditional approaches that characterize the "develop and distribute" change strategy, including "sit-and-get" workshops without any follow-up by the workshop providers [1–3]. Change scholars indicate that more research is needed on developing change strategies that utilize social interactions to promote sustained change, including guiding instructors in appropriately adapting innovations to their needs [1–3]. The authors previously successfully supported a pilot group of engineering instructors from 2018–2019 by serving as coaches in their use of active learning in the classroom [4].

Interestingly, the literature has drawn a direct connection between the propagation of evidence-based teaching practices and professional-development-based instructor coaching [5]. Instructional coaches assist teachers in learning evidence-based practices in a "partnership between equals." [6]. In some public school districts, a teacher may be coached by both a content coach (e.g., for literacy or math) as well as a change coach [7]. Although coaching began in athletics, it now describes a relationship involving support and feedback to an individual taking self-directed action to achieve a goal [8–10]. Actually, athletic coaching has a very rich history and represents an "opportunity" that should not be "missed" by any domain to enhance performance, given the abilities, strengths, and qualities that a professional athletic coach has to offer [11]. In fact, Read et al. have strongly advocated for the application of athletic coaching to business coaching, including understanding how business and service organizations can learn from athletic coaching methods [11].

Unfortunately, although athletics and academics are considered pillars of a university and despite their shared mission to develop young adults, there is often little-to-no collaboration between them. As

**Fig. 1.** Convergence of Opportunities & Proposed Methods in Instructional Coaching

previously stated, "Except as fans, the street between academe and sport is seldom crossed by professors on any campus." [12, pp. 119]. Yet, revered UCLA basketball coach John Wooden was considered a "master teacher" [12]. Given these similarities in mission as well as current needs and opportunities, *can (and should) methods used in athletic coaching inform and propel coaching of instructors to promote propagation of proven instructional practices and scholarly research on teaching and learning?* Instructional coaching is a growing field, and the literature has called for more empirical investigation of it, including specific reasons why and how coaching works [13]. Interestingly, the literature has also identified a gap in "how to train instructional coaches." [5, 9]. *Therefore, could athletic coaching offer transformational insight to traditional instructional coaching?*
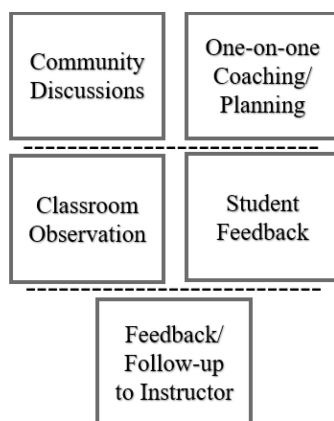


**Fig. 2.** Components of Propagation Program.

Together, an athletic coach and a traditional instructional coach could offer a novel blend of coaching, not unlike the concept of change and content coaching in K-12 districts [7]. John Wooden, the greatest college coach in history, provided leadership in achieving excellence through enthusiasm, cooperation, confidence, and team spirit, and his leadership style was arguably *transformative* [14–16]. Under the theory of Transformational Leadership, followers are propelled beyond their expectations, with the leader appealing to the followers' higher ideals and needs and encouraging group success [17]. President Abraham Lincoln's leadership style has likewise been called *transformative* [18]. The convergence of the opportunities and theory that support this proposed approach is shown in Fig. 1.

### 1.1 Pilot Propagation and Support Efforts

The first and second authors, who are engineering instructors, received one-year internal (i.e., University) funding in 2018 to propagate active instructional techniques within their school of engineering. They successfully worked with a pilot group of instructors from 2018–2019, serving as "coaches" to support them in adopting, expanding, and even publishing on their use of active learning in the classroom [4]. Such publications are within the realm of the Scholarship of Teaching and Learning (SoTL) [19]. The implementation model and methods used for this propagation program are shown in Fig. 2, with the components typically occurring (time-wise) from top to bottom. In addition, with the sudden onset of remote instruction due to COVID-19, the first author implemented the framework in Fig. 2 during the summer 2020 as a means of providing "supportive assessment" during this fully remote semester [20].

The upper level of Fig. 2 depicts planning support via community-based discussions and/or one-on-one coaching sessions with participating instructors. The middle layer of Fig. 2 shows additional support via structured classroom observation using the COPUS protocol and the collection of student feedback data via interview or survey [21]. In the final layer of Fig. 2, the observational and student feedback data are shared with the instructor, leading to follow-up conversations, gathering of instructor perspectives via interview, and future planning. The "social" focus of the framework in Fig. 2, including one-on-one coaching, community discussions, and classroom observation, was determined to be a strength in the eyes of the pilot instructors [4]. The authors considered their pilot work in 2018 to be innovative because it did not "end with the workshop" as many professional development efforts do. Rather, it involved one-

on-one coaching to support and encourage implementation of the active-learning techniques. The literature indicates that even in today's school districts where large expenditures are made on professional development, teachers receive "sit-and-get" professional development with little planning or follow-up [22].

The authors' pilot work with the propagation of active learning was informed by the change strategy framework of Henderson, Beach, and Finkelstein within STEM education [23, 24]. Their model consists of the following known change strategies: (1) disseminating curricula and pedagogy, (2) enacting policy, (3) developing reflective teachers, and/or (4) developing a shared vision [23, 24]. The authors' pilot work targeted strategies 3 and 4 (i.e., the emergent outcomes of a shared vision and reflective instructors), in line with recommendations from the literature [1, 25].

### 1.2 Significance and Novelty

The National Science Foundation (NSF) has been highly supportive of efforts to propagate and scale research-based educational innovations on a broad national level, with multiple awards having been made since 2012, or possibly earlier, including workshop training grants (Awards 1821709, 1915574, 1122416, 1544449, 1355391, and 1355431). The proposed approach is unique in that it is focused on the propagation of evidence-based teaching practices and related scholarship activity via a highly social, interpersonal approach involving instructional coaching by an athletic coach. This is important because more research is needed in utilizing social interactions to promote sustained change [1–3].

## 2. Literature and Theoretical Framework

### 2.1 Change Framework & Cross-Disciplinary Approach

Beach and Henderson's model for enacting change in STEM education served as the theoretical framework and support for this approach [23, 24]. In addition, the professional development, instructional coaching, and athletic coaching literatures informed the proposed work as well. Beach and Henderson's change model consists of the following four types of change strategies: (1) disseminating curricula and pedagogy, (2) enacting policy, (3) developing reflective teachers, and/or (4) developing a shared vision [23, 24]. Strategies 1 and 2 tend to be prescribed strategies for individuals and environments/groups, respectively. Strategies 3 and 4 tend to be emergent strategies for individuals and environments/groups, respectively [23]. Communities have been a successful emergent strategy

for developing a shared vision as well as reflective instructors who use their experiences to improve [23]. Here, ideas are shared and support for individual change is provided [23]. The professional development (PD) literature also identifies communities of teachers as necessary for effective professional development [13].

The PD literature also indicates that adult professional learning must be personalized and sustained, including support (1) with upfront planning, (2) during classroom implementation, and (3) with evaluation [13, 22, 26]. Likewise, Beach, Henderson, and Finkelstein identified coordinated efforts over an extended period of time (i.e., one semester to an academic year) as important to disseminating pedagogy, along with strategies for changing instructor beliefs [23, 25]. The literature therefore supports ongoing, one-on-one coaching of instructors, including classroom observation and collection of student assessment data for evaluation. Having colleagues observe one's classroom for formative feedback and improvement is beneficial, if not essential [27–28]. Classroom observation and subsequent feedback provide informative support and development and are necessary elements of instructor coaching [5, 9, 13, 26, 29]. Based on the model of Henderson, Beach, and Finkelstein, performance evaluation and feedback are also important elements for enacting change, including both prescribed and emergent change [23].

Interestingly, Henderson and colleagues say that change strategies that span traditional boundaries across disciplines are likely promising and fruitful avenues, including working with change agents in *other disciplines*, suggesting the promise of this athletic-inspired instructional coaching [25]. Likewise, in their book on multimethod research, social scientists Brewer and Hunter suggest that different disciplines can and should learn from one another, saying, ". . . cross-overs of theories, or applications of a theory developed in one subfield to another may provoke new questions, and provide useful insights, and suggest new ways of looking at phenomena" [30, p. 74]. In short, the proposed approach presents itself as well grounded.

The sports world has indeed provided inspiration and models for other domains. For example, Notre Dame football coach Lou Holtz has used his coaching experience and leadership talents to support businesses and organizations through his motivational speech and writing, including his book *Winning Every Day* [31]. Business managers can learn techniques for motivation and collaboration building from sports teams [32]. Katz suggests that time should be set aside from performance of job duties to develop new skills, self-evaluate, and reflect, similar to how sports teams utilize practice,

half-time, and debriefing/video analysis sessions, respectively [32]. Interestingly, Katz suggests trying to understand the aspects of athletic practice sessions that lead to learning and development for replication in other domains, which suggests that traditional, disciplined-based instructional coaching may have something to "learn" from athletic coaching [32].

Without question, this type of faculty professional development is likely a resource-intensive effort [5]. However, evidence suggests that the effectiveness of instructor professional development, including coaching, is positively associated with the intensity of the support [33]. Therefore, the proposed approach, although potentially requiring a greater time investment, is more likely to be highly effective, with sustained results. Athletic coaches often seek other campus ventures or educational activities (e.g., sports camps) to supplement income during the off season. Thus, recruiting athletic coaches for such an initiative may not be highly difficult nor necessarily expensive.

## 2.2 Athletic Coaching

The athletic coaching literature discusses coaching in a generalizable way as a "people" business, a "helping" profession, an "educational relationship," and "caring leadership" [34, 35]. Coaching has become a universal practice for propelling not only athletes, but business executives and instructors as well [13, 36]. An athletic coach has much to offer, and the list below enumerates the abilities, strengths, tasks, and qualities that a good athletic coach can bring [11, 37–39].

- Encouragement & confidence-building.
- Engaging & motivating.
- Feedback: praise & corrective (direct).
- Growth mindset.
- Mental/psychological skills training & preparation (e.g., overcoming obstacles).
- Performance analysis & improvement.
- Personal support.
- Skills demonstration & instruction.
- Supportive climate.

We propose that these types of abilities could be brought to bear in instructional coaching with the input of an athletic coach, including psychological training, performance analysis, and confidence building. Read et al. identified three athletic coaching capabilities as particularly promising for business and service organizations given their relative absence there: skills demonstration, mental training, and deliberate practice, based on an analysis of interview and survey data from athletic and organizational coaches [11].

Research has shown a direct link between coaching behaviors and athletes' performance and psychosocial development, suggesting the effectiveness of solid athletic coaching [40]. Coaching leadership style and feedback patterns have been well studied with respect to coaching effectiveness [40]. The research has shown that items such as amount of time spent by the coach on learning activities, types of learning activities, ability to identify skill errors, and frequency and quality of the feedback can directly affect athletes' skill development and performance [40].

## 2.3 Transformational Leadership

Transformation Leadership (TL) aims to develop followers into leaders through inspiration, confidence-building, motivation, optimism, and alignment of individual and group goals for synergistic outcomes [41]. The three dimensions of Transformational Leadership include (1) charismatic and idealized influence, (2) individualized consideration, and (3) intellectual stimulation [17, 41, 42]. Using charismatic and idealized influence, the leader is able to build followers' respect and trust, possibly by virtue of the leader's previous successes or history, and to motivate by promoting a vision and expressing optimism and encouragement in achieving it. Individualized consideration recognizes each follower's unique needs and provides coaching, relationship-building, and one-on-one communication to reach the person's full potential. With intellectual stimulation, the leader challenges followers to problem solve, think critically, and reflect on their values, beliefs, and assumptions. TL is relationship-oriented and goes beyond lower-order exchanges between the leader and follower, or "transactional" leadership [42]. TL has been applied within sports management, with a strong positive association with athletic coaching outcomes [42].

## 2.4 Research-Based Teaching Practices: Topics for Coaching

Active learning is a desirable instructional practice because of its documented positive impact on learning, and it should be used *to some degree*, in particular in STEM courses [43, 44]. However, despite the known benefits of active learning, lecture is still the prominent approach in STEM courses, with active learning reportedly propagating at a slow rate [45–47]. Closely related to active learning is learner-centered teaching (LCT) with its focus on the learner. Specifically, the instructor serves as a *facilitator* of learning (versus solely a disseminator of content) and shares power and control whereby students actively participate and take responsibility *for* their learning [48–52]. In addition, there is learner collaboration, higher-

order skills development, and evaluation for learning purposes. In addition to practices such as active learning and LCT, other proven practices that can be enhanced via coaching include: (1) classroom management and community building, (2) rigorous content planning, and (3) formative assessment [6, 33]. These practices have been dubbed the "Big Four" for instructional excellence [1, 33].

## 3. Methods

The model and methods for our program for the propagation and sustainment of evidence-based teaching practices were shown in Fig. 2 and are summarized in Table 1. They will be discussed more fully in the following subsections in relation to the proposed infusion of athletic coaching so other educators may adopt our proposed approach. The program components and methods (Table 1) additionally enable an exploratory case study approach for assessing the impact of athletic coaching within an instructional support and propagation program.

### 3.1 One-on-One Parallel Coaching

Parallel coaching offered during approximately the same timeframe can enable a comparison of athletic coaching with traditional, discipline-based instructional coaching and an identification of the differential aspects and features that an athletic coach can offer. Thus, the athletic coach might hold a coaching session with the instructor first, followed shortly thereafter by a coaching session with the instructional coach, or vice versa. This enables providing both types of coaching to the instructor.

Initial coaching sessions should include planning discussions to gather information and determine necessary actions. Information gathered might include existing experiences and practices of the instructor, goals of the instructor, and/or potential barriers to adoption of pedagogical practices. Discussions about desired coaching frequency, instructor training needs, and personalized assessment can inform necessary actions and activities. An instrument published by the authors as part of their pilot work can be used to gather baseline data from instructors [4]. Based on experiences from the pilot work, the following are fruitful topics for

**Table 1.** Propagation Program Components

| |
|---|
| 1. Upfront planning & individualized, parallel coaching by an athletic coach and an instructional coach. |
| 2. Community discussions and teaming events with instructors. |
| 3. Classroom observation and formative feedback to instructors. |
| 4. Assessment of student perspectives for formative feedback to instructors. |
| 5. Follow-up interviews with instructors for assessment. |

coaching/planning conversations: (1) student resistance or other perceived barriers to change, (2) preparation of instructional materials, (3) instructional technology use, (4) execution of active learning or learner-centered instruction in the classroom, (5) use of student formative feedback, and (6) student assessment.

### 3.2 Community and Social Events

In the pilot work, community luncheons at a campus restaurant were effective in promoting discussions on active learning and other teaching practices among the participating instructors and authors. The following are potential additional social events for enhancing community:

- Social gathering at a local venue with a private room for engaging the instructors in relevant case study discussions, teaching-practices discussions, transformational leadership discussions, paired team-building exercises, and additional activities.
- Attendance at sporting events whereby instructors can observe the athletic coach in action and/or gain familiarity and comfort with the coach by interacting with him/her.

### 3.3 Classroom Observation and Parallel Feedback

As part of one-on-one coaching and support, coaches can observe an instructor's classroom on a periodic basis, possibly using a structured observation protocol such as the COPUS (i.e., Classroom Observation Protocol for Undergraduate STEM) [21]. If needed, an observation protocol has been developed for addressing student resistance to active learning [53]. Classroom observation can be followed by parallel, separate feedback by the athletic coach and the instructional coach, allowing for a comparison of the feedback provided by each and enhanced understanding of coaching mechanisms.

### 3.4 Collection of Student Perspectives

Student feedback data can be collected via survey, focus groups, and/or interviews for formative and summative feedback to the instructor. For example, the StRIP (Student Response to Instructional Practices) survey may be used to assess the degree of student acceptance and positive response towards active learning [54].

### 3.5 Feedback to and Follow-up with Instructor

Following the collection of data from students and/or classroom observation sessions, feedback to and follow-up with the instructor is a desirable next step. For example, a follow-up discussion might take the form of an interview with the instructor to investigate the research questions and/or gain

insight into the mechanisms by which the various forms of coaching work. For example, the following are potential interview questions for investigating these issues, including the impact of athletic coaching:

1. Compare the coaching you received from the instructional versus athletic coach.
2. Did you obtain particular assistance, direction, or encouragement from one coach that you didn't obtain from the other?
3. Do you feel any particular coaching practice, method, or style has been particularly beneficial in achieving your goals?
4. Discuss your views on the parallel-style coaching and feedback, including why you think it was effective or ineffective.
5. Compare feedback you received from the athletic versus instructional coach in terms of usefulness and actionability.

In addition, a summative-style, instructor-specific interview might allow for discussion of the following types of topics: instructor growth, achievement, and strengths; program impacts on the instructor; and areas for improvement. For example, the following items related to the coaching program could be explored: instructor accomplishments towards his/her goals; educational scholarship activities, both completed and future; changes or anticipated changes in practice; barriers overcome; student perspectives and outcomes realized; and future instructional and academic goals.

### 3.6 Case Study Evaluation Approach

An exploratory case study approach can be used to gather data for an assessment of the coaching outcomes and the impact of an athletic coach. Case study research involves qualitative analysis of data from an individual or group, with an exploratory case study serving as a preliminary analysis for exploring important hypotheses and understanding a phenomenon [55]. The following questions could guide a case study to assess the impact of athletic coaching within an instructional support and propagation framework:

1. *To what extent does the combination of athletic coaching and traditional instructional coaching impact propagation and sustainment of evidence-based teaching practices and educational scholarship, and by what (potentially symbiotic) mechanisms does this occur?*
2. *Are there differential advantages that athletic-inspired coaching can offer in an education setting relative to traditional instructional coaching, and what can be learned to enhance instructional coaching going forward?*

The elements of the case study research approach used in the pilot work included structured classroom observation, observation of coaching and feedback sessions and community events, semi-structured instructor interviews, and qualitative and quantitative analysis of program documentation and data (e.g., field notes, interview transcripts. participation metrics, student feedback and outcomes data, etc.) [56]. Permission was granted by our school's research protection's office to conduct this case study research (PRO18070081, STUDY20060227). Based on lessons learned from our pilot work, a minimum two-year timeframe for assessing program outcomes is desirable. Using a qualitative content analysis of various documentation collected from coaching sessions, community discussions, and instructor interviews, the following metrics and outcomes for assessing effectiveness (among others) could be determined:

- Number of instructor "touchpoints" during the coaching program.
- Number of propagation program components each instructor participated in.
- Number of instructors who pursued Scholarship of Teaching and Learning (SoTL).
- Number of instructors who plan to continue evidence-based practices or SoTL into the future.
- Comparison of benefits of athletic-inspired instructional coaching and traditional instructional coaching.

## 4. Preliminary Results and Research Data

The promising preliminary results from the authors' work with the propagation of evidence-based teaching practices and instructional support are presented next. The preliminary work was based on the support model in Fig. 2.

### 4.1 Active-Learning Propagation Program (2018–2019)

The first and second authors received an award in 2018 to propagate active instructional techniques throughout their school of engineering using the approach in Fig. 2, starting with a pilot group of volunteer instructors. This pilot work with coaching exhibited very promising results and was described fully in a previous publication [4]. A brief summary of assessment results is provided here to demonstrate the value derived. Based on the instructor interviews, the "people" focus, in particular one-on-one interactions between the authors and the instructors and the "community" discussions, were identified as strengths of the program. Additional favorable outcomes included educational scholarship activity, notable cases of

new or enhanced uses of active learning, and continuing partnerships between the authors and several instructors. Instructor participation was tracked with respect to attendance at community luncheons, occurrence of planning and coaching sessions, and classroom observation. The following are sample participation results:

- Seven of the nine volunteer instructors (78%) participated to the end of the one-year program, including granting of a post-program interview.
- All seven instructors used active learning. This was confirmed via classroom observation of six instructors and a post-program interview with the remaining instructor. Both first-time and established users employed active learning, with some established users implementing more complex forms of active learning.

With the first author's direct involvement and coaching, three instructors submitted engineering education conference papers to the American Society for Engineering Education (ASEE) during the one-year program. Each paper described the instructor's use and assessment of active learning. For two instructors, this was their first ASEE conference paper. Two instructors also submitted engineering education proposals during the program period with the direct involvement of the first author, although these two instructors had submitted engineering-education proposals previously. Thus, three of the nine instructors participated in educational scholarship activity. All participating instructors were interviewed to assess the impact of the program. Based on their responses, the instructors valued active learning and found the propagation program to be particularly supportive for their adoption, use, and/or future use of active learning. A sample interview response demonstrating this is as follows:

> "Although I had been sold on active learning just before this project started, participating in the project showed me there is a larger community around me. This is huge to keep going with active learning. I talk with one of the other participating instructors about best practices in the flipped classroom because he flips his classroom too. Before this project, I didn't know that anyone else was doing active learning, and now I do. I think we need to build a 'library' of best practices among more peers."

### 4.2 Remote Instruction Assessment Program (2020)

The first author's "supportive assessment" program during the remote instructional period of COVID-19 in the summer of 2020 also utilized the propagation framework in Fig. 2. Support and coaching were provided remotely via Zoom. Of 31 summer engineering instructors, 16 (52%) willingly

volunteered to participate. This participation metric was noteworthy given that the program was a voluntary-based *assessment* program. It demonstrates what is possible with a voluntary program that has a "support" focus – namely instructor willingness to participate and subsequent promotion of desirable teaching practices. An anonymous survey indicated an average rating of 3.9 on a 5-point scale regarding the helpfulness and usefulness of the classroom observation and other formative feedback. In the words of one instructor, "*I got a professional review of my strategy for remote teaching, and a check on my early implementation. Assessment provided me with a positive reinforcement that gave me assurance and encouraged me to move forward. I was offered a broad range of helpful support that reassured me that I could rely on opportune help when needed. I do appreciate it very much!*" In the words of another instructor, "*. . . Also, just the act of being evaluated makes me reflect more on my teaching methods.*"

### 4.3 Instructor Coaching Needs (2020)

To gain insight into current coaching needs, engineering instructors whom we had supported previously were sampled in the fall 2020. We posed the following question to them: *If you could enhance anything about your teaching (and could have a coach to support you in doing so), what would that be?* A small sample of engineering instructor responses is shown in Table 2, along with the combined responses of an instructional and athletic coach (i.e., second and third authors).

## 5. Discussion

The authors recently implemented a highly social, individualized approach for the propagation of evidence-based instructional practices and supporting fellow instructors in their school of engineering. Scholars have proposed that social-based approaches may be best for promoting *sustained* change and that more research is needed in this area [1–3]. Preliminary results from this socially driven instructional support and propagation framework have been promising with respect to perceived value, use of active learning (including during the remote instructional period of COVID), and promotion of educational scholarship.

Taking it a step further, however, the authors aimed in this article to make the case for "cross pollination" of instructional coaching and athletic coaching within their existing support and propagation framework. In support this argument, the instructional coaching literature has called for more empirical investigation of coaching, including the specific reasons why and how coaching works and

**Table 2.** Current Needs/Requests and Coaches' Responses

| | Current Coaching Request or Need | Coaching Response |
|---|---|---|
| 1 | I find myself getting impatient with younger engineers (sophomore level). I remember how I was trained, the guys that trained me, and compare myself to the students today. No way could they handle what I went through. So its *generational comparisons* that will *beat me up mentally* and it ultimately leads to me *"giving up"*. I find that as the years roll over, I think training would be useful on the instructor's *psychological mindset*. | Each generation learns (and learned) in different ways. It's up to teachers to meet students where they are, and challenge them along the way. Kids still do not want to let their teachers down. Additionally we have to be creative in how we connect. This all comes down to connection. By the teacher showing sincere interest, I think breakthroughs can happen. Professors are seeking validation from students as well – they want to know they make impacts and are helping to inspire the next generation. Find those moments and you will get the fuel you need. |
| 2 | The things I wish I could enhance: *classroom interactivity and engagement* and *content creation*, more specifically how I can make the class part of a cohesive learning experience considering other related classes. In general how to be a *good orator*. Things I wish I had in a mentor/coach: someone who is active in my career development (audits lectures once in a while, checks in on things, can provide *advice and guidance*). | I will talk about being a better orator – as a coach we have to speak in front of the team quite a bit. It is about being prepared (knowing what you want to say), how you want to say it (what tone, importance), and setting the stage (prompting students what is important and what is not). Regarding content, there is so much existing content nowadays that's available to instructors and can be adopted and used, enabling the instructor to focus in other areas. |
| 3 | Is it a better practice to *push the students* beyond their limits to stretch their learning as much as possible and then curve the class grade knowing that most of the class would do poorly or is it better to teach at the median level of the class? | We always say that you need to coach to your best athletes, I would say that needs to be the same in the classroom. This allows the best students to be pushed to the highest levels of learning, and it will force those at the median level to adapt and learn new skills to manage their learning. This may put more onus on the professor to lend a helping hand to those in the middle, but that might even happen if you teach to that level. I push students (but not to an overwhelming degree), and students recognize the learning experience as valuable. Remind students why you are pushing. |

"how to train instructional coaches" [5, 9, 13]. The authors' proposed approach involving the infusion of athletic coaching within an engineering education setting can contribute to this call made by the literature. To assess the use of athletic coaching within their support framework, the authors recommended a case study approach and suggested research and instructor interview questions for this. The ultimate objective of this article is to inspire and support other educators in adopting this potentially transformative paradigm. The literature tells us that disciplines can (and should) learn from one another, since ". . . cross-overs of theories, or applications of a theory developed in one subfield to another may provoke new questions, and provide useful insights, and suggest new ways of looking at phenomena" [30, p. 74].

## 6. Conclusion

Instructional coaching is a growing field, and the literature has called for more investigation on it. Likewise, leading scholars have called for research on social-based approaches for propagating instructional practices. Thus, based on support from the literature and our promising preliminary experience with social-based approaches to propagating evidence-based instructional practices, this article has aimed to make the case for a unique model involving infusing athletic coaching into an instructional support and propagation framework in STEM. Given coaching's origin in athletics, we feel the field of instructional coaching should look to athletic coaching for insight and inspiration. Given the uniqueness of the proposed approach, it has the potential to provide transformative insights to instructional coaching and the propagation of evidence-based teaching practices. These transformative insights hold the promise for broad academic impacts within our schools and colleges and ultimately for our students.

## References

1. M. Dancy, C. Henderson and C. Turpen, How faculty learn about and implement research-based instructional strategies: The case of peer instruction, *Physical Review Physics Education Research*, **12**(1), pp. 1–17, 2016.
2. K. Foote, X. Neumeyer, C. Henderson, M. Dancy and R. Beichner, Diffusion of research-based instructional strategies: the case of SCALE-UP, *International Journal of STEM Education*, **1**(1), pp. 1–18, 2014.
3. M. Dancy and C. Henderson, Pedagogical practices and instructional change of physics faculty, *American Journal of Physics*, **78**(10), pp. 1056–1063, 2010.

4. R. Clark, S. Dickerson, M. Bedewy, K. Chen, A. Dallal, A. Gomez, J. Hu, R. Kerestes and L. Luangkesorn, Social-driven propagation of active learning and associated scholarship activity in engineering: A case study, *International Journal of Engineering Education*, **36**(5), pp. 1667–1680, 2020.
5. C. Connor, Commentary on the special issue on instructional coaching models: Common elements of effective coaching models, *Theory Into Practice*, **56**(1), pp. 78–83, 2017.
6. J. Knight and C. van Nieuwerburgh, Instructional coaching: A focus on practice, *Coaching: An International Journal of Theory, Research and Practice*, **5**(2), pp. 100–112, 2012.
7. E. Guiney, Coaching isn't just for athletes: The role of teacher leaders, *Phi Delta Kappan*, **82**(10), pp. 740–743, 2001.
8. A. Barkley, Academic coaching for enhanced learning, *NACTA Journal*, **55**(1), pp. 76–81, 2011.
9. C. Gallucci, M. Van Lare, I. Yoon, and B. Boatright, Instructional coaching: Building theory about the role and organizational support for professional learning, *American Educational Research Journal*, **47**(4), pp. 919–963, 2010.
10. D. Stober and C. Parry, Current challenges and future directions in coaching research, in M. Cavanagh, A. Grant, and T. Kemp (eds), *Evidence-Based Coaching Volume 1: Theory, Research and Practice from the Behavioural Sciences*, Australian Academic Press, Samford Valley, Queensland, pp. 13–19, 2005.
11. M. Read, M. Colgate, V. Corwin and S. Tax, Helping create service 'experts': The opportunity for an athletic approach to coaching in service organisations, *The International Journal of Mentoring and Coaching*, **X**(1), pp. 24–37, 2012.
12. R. Gallimore and R. Tharp, What a coach can teach a teacher, 1975–2004: Reflections and reanalysis of John Wooden's teaching practices, *The Sport Psychologist*, **18**(2), pp. 119–137, 2004.
13. L. Desimone and K. Pak, Instructional coaching as high-quality professional development, *Theory Into Practice*, **56**(1), pp. 3–12, 2017.
14. K. Edelhauser, John Wooden's pyramid still standing, *Entrepreneur*, 2007 March 27, https://www.entrepreneur.com/article/176282, Accessed 29 October 2019.
15. Coach John Wooden Pyramid of Success, https://www.thewoodeneffect.com/pyramid-of-success/, Accessed 29 October 2019.
16. John Wooden, Coach & Teacher, http://www.coachwooden.com/pyramid-of-success, Accessed 29 October 2019.
17. A. Kent and P. Chelladurai, Perceived transformational leadership, organizational commitment, and citizenship behavior: A case study in intercollegiate athletics, *Journal of Sport Management*, **15**(2), pp. 135–159, 2001.
18. D. Goodwin, Lincoln and the art of transformative leadership, *Harvard Business Review*, **96**, pp. 126–134, 2018.
19. C. Bishop-Clark and B. Dietz-Uhler, *Engaging in the Scholarship of Teaching and Learning*, Stylus Publishing, LLC., Sterling, VA, pp. xi, 1, 4–6, 49–50, 2012.
20. R. Clark, M. Besterfield-Sacre and A. Dukes, Supportive classroom assessment for remote instruction, *Advances in Engineering Education*, **8**(4), pp. 1–6, 2020.
21. M. Smith, F. Jones, S. Gilbert and C. Wieman, The classroom observation protocol for undergraduate STEM (COPUS): A new instrument to characterize university STEM classroom practices, *CBE-Life Sciences Education*, **12**(4), pp. 618–627, 2013.
22. A. Rodman, *Personalized Professional Learning: A Job-Embedded Pathway for Elevating Teacher Voice*, ASCD, Alexandria, VA, pp. 1–9, 2019.
23. A. Beach, C. Henderson and N. Finkelstein, Facilitating change in undergraduate STEM education, *Change: The Magazine of Higher Learning*, **44**(6), pp. 52–59, 2012.
24. C. Henderson, N. Finkelstein, and A. Beach, Beyond dissemination in college science teaching: An introduction to four core change strategies, *Journal of College Science Teaching*, **39**(5), pp. 18–25, 2010.
25. C. Henderson, A. Beach, and N. Finkelstein, Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature, *Journal of Research in Science Teaching*, **48**(8), pp. 952–984, 2011.
26. C. Rhodes, M. Stokes and G. Hampton, *A Practical Guide to Mentoring, Coaching and Peer-Networking: Teacher Professional Development in Schools and Colleges*, Routledge, London, pp. 25, 29–30, 2004.
27. L. Braskamp and J. Ory, *Assessing Faculty Work*, Jossey-Bass Inc., San Francisco, p. 202, 1994.
28. L. Keig and M. Waggoner, Collaborative peer review: The role of faculty in improving college teaching, *ASHE-ERIC Higher Education Report No. 2*, The George Washington University, School of Education and Human Development, Washington, DC, pp. 41–42, 1994.
29. L. Reddy, C. Dudek and A. Lekwa, Classroom strategies coaching model: Integration of formative assessment and instructional coaching, *Theory Into Practice*, **56**(1), pp. 46–55, 2017.
30. J. Brewer and A. Hunter, *Multimethod Research: A Synthesis of Styles*, Sage Publications, Inc., Newbury Park, CA, p. 74, 1989.
31. L. Holtz, *Winning Everyday*, HarperCollins, New York, pp. xi–xvi, 1998.
32. N. Katz, Sports teams as a model for workplace teams: Lessons and liabilities, *The Academy of Management Executive*, **15**(3), pp. 56–67, 2001.
33. M. Devine, C. Houssemand and R. Meyers, Instructional coaching for teachers: A strategy to implement new practices in the classrooms, *Procedia-Social and Behavioral Sciences*, **93**, pp. 1126–1130, 2013.
34. R. Martens, *Coaches Guide to Sport Psychology*, Human Kinetics Publishers, Champaign, IL, pp. 13, 34, 1987.
35. F. Wikeley and K. Bullock, Coaching as an educational relationship, in R. Jones (ed), *The Sports Coach as Educator*, Routledge, London, pp. 14–24, 2006.
36. A. Kurz, L. Reddy and T. Glover, A multidisciplinary framework of instructional coaching, *Theory Into Practice*, **56**(1), pp. 66–77, 2017.
37. J. Greenberg and R. Baron, *Behavior in Organizations*, Prentice Hall, Upper Saddle River, NJ, p. 496, 2003.
38. J. Zhang, B. Jensen and B. Mann, Modification and revision of the leadership scale for sport, *Journal of Sport Behavior*, **20**(1), p. 105, 1997.
39. R. Tharp and R. Gallimore, What a coach can teach a teacher, *Psychology Today*, **9**(8), pp. 75–78, 1976.
40. T. Horn, Coaching effectiveness in the sport domain, in T. Horn (ed), *Advances in Sport Psychology*, Human Kinetics Publishers, Champaign, IL, pp. 312–314, 326–327, 2002.
41. F. Walumbwa, B. Avolio and C. Hartnell, Transformational leadership theories, in J. Levine and M. Hogg (eds), *Encyclopedia of Group Processes & Intergroup Relations*, Sage Publications, Thousand Oaks, CA, pp. 1–5, 2010.

42. A. Doherty and K. Danylchuk, Transformational and transactional leadership in interuniversity athletics management, *Journal of Sport Management*, **10**(3), pp. 292–309, 1996.
43. S. Freeman, S. Eddy, M. McDonough, M. Smith, N. Okoroafor, H. Jordt and M. Wenderoth, Active learning increases student performance in science, engineering, and mathematics, *Proceedings of National Academy of Science*, **111**(23), pp. 1–6, 2014.
44. M. Owens, et al., Classroom sound can be used to classify teaching practices in college science courses, *Proceedings of National Academy of Science*, **114**(12), pp. 1–6, 2017.
45. C. Wieman, Large-scale comparison of science teaching methods sends clear message, *Proceedings of National Academy of Science*, **111**(23), pp. 8319–8320, 2014.
46. M. Stains, J. Harshman, M. Barker, S. Chasteen, R. Cole, S. DeChenne-Peters, M. Eagan, J. Esson, J. Knight, F. Laski, M. Levis-Fitzgerald, C. Lee, S. Lo, L. McDonnell, T. McKay, N. Michelotti, A. Musgrove, M. Palmer, K. Plank, T. Rodela, E. Sanders, N. Schimpf, P. Schulte, M. Smith, M. Stetzer, B. Van Valkenburgh, E. Vinson, L. Weir, P. Wendel, L. Wheeler and A. Young, Anatomy of STEM teaching in North American universities, *Science*, **359**(6383), pp. 1468–1470, 2018.
47. P. Shekhar and M. Borrego, After the workshop: A case study of post-workshop implementation of active learning in an electrical engineering course, *IEEE Transactions on Education*, **60**(1), pp. 1–7, 2017.
48. M. Weimer, *Learner-Centered Teaching: Five Key Changes to Practice 2nd Edition*, John Wiley & Sons, San Francisco, CA, pp. 10–11, 13–15, 24, 60, 63, 72, 77, 81, 83–84, 94, 113, 119, 123–126, 167, 169, 2013.
49. M. Weimer, Is my teaching learner-centered, *Faculty Focus*, 2018, https://www.facultyfocus.com/articles/teaching-professor-blog/teaching-learner-centered/.
50. M. Weimer, Five characteristics of learner-centered teaching, *Faculty Focus*, 2012, https://www.facultyfocus.com/articles/effective-teaching-strategies/five-characteristics-of-learner-centered-teaching/.
51. M. Weimer, *Learner-Centered Teaching: Five Key Changes to Practice*, John Wiley & Sons, San Francisco, CA, pp. xvi–xix, 125, 2002.
52. D. Jeffrey and R. Clark, Supplementing western perspectives of learner-centered instruction with a Daoist approach towards authentic power sharing in the classroom, *International Journal of Contemporary Education*, **2**(1), pp. 9–16, 2019.
53. P. Shekhar, M. Demonbrun, M. Borrego, C. Finelli, M. Prince, C. Henderson and C. Waters, Development of an observation protocol to study undergraduate engineering student resistance to active learning, *International Journal of Engineering Education*, **31**(2), pp. 597–609, 2015.
54. M. DeMonbrun, C. Finelli, M. Prince, M. Borrego, P. Shekhar, C. Henderson and C. Waters, Creating an instrument to measure student response to instructional practices, *Journal of Engineering Education*, **106**(2), pp. 273–298, 2017.
55. G. Privitera and L. Ahlgrim-Delzell, *Research Methods for Education*, SAGE Publications, Thousand Oaks, CA, pp. 320–321, 2019.
56. R. Yin, *Case Study Research Design and Methods*, SAGE Publications, Newbury Park, CA, pp. 47, 84–95, 1989.

**Renee M. Clark**, is a research assistant professor of Industrial Engineering in the Swanson School of Engineering and Director of Assessment in the Engineering Education Research Center (EERC) at the University of Pittsburgh. Her research interests are in active and experiential learning, the professional formation of engineers, and instructional coaching within engineering education. She received the MS in Mechanical Engineering from Case Western and the PhD in Industrial Engineering from the University of Pittsburgh while working for Delphi Automotive. Renee currently serves as Associate Editor for *Advances in Engineering Education.*

**Samuel J. Dickerson**, received the PhD in electrical engineering from the University of Pittsburgh and is currently an Associate Professor in the Department of Electrical and Computer Engineering at the University of Pittsburgh. His general research interests lie in the areas of integrated circuits and embedded systems and is currently focusing on techniques to improve learning outcomes for electrical and computer engineering undergraduate students. Dr. Dickerson received the 2019 IEEE Education Society Mac E. Van Valkenburg award for early career innovations in electrical and computer engineering education. .

**Marc Christian**, is currently a consultant working within the sports landscape to provide solutions to organizational challenges and also holds adjunct positions at Georgetown University and the University of Pittsburgh. He is a former Division I NCAA swimming coach with 10 years' experience coaching sprint, middle distance and distance student-athletes and has worked with athletes at the highest levels of swimming – coaching an Olympian, NCAA Champion, and World Championship qualifiers. Christian has also developed student-athletes to break over 150 varsity records and attain several prestigious NCAA, ACC and IVY academic awards. Dr. Christian studies athletics directors, organizational culture, and hazing in college sports and received the EdD in Higher Education from the University of Pennsylvania.