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Concerning Professional Licensure for Civil Engineering Faculty: A Matter of Best Practice

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Abstract

Professional licensure is expected in some engineering fields (civil engineering), but is superfluous in some other engineering fields. Professors may describe the importance of taking the Fundamentals of Engineering exam before students graduate as the first step towards the goal of licensure, but then describe how licensure is not useful to professors. As a result, engineering students may receive mixed messages about the importance of professional licensure.

In the Civil Engineering department at Rose-Hulman Institute of Technology, professional licensure and/or significant engineering design experience for faculty is traditionally highly valued. ABET requires that design courses be taught by faculty who are professional engineers, or who have qualification by degree and experience. This paper discusses the ethics of teaching technical content without licensure from the perspective of senior practicing civil engineers, and through personal reflection. This paper also shows initial survey data of the percent of faculty with professional licensure.

To discern the ethics of licensure among faculty and whether or not faculty licensure plays a role in students' ability to be hired, the Board of Advisors for the Civil and Environmental Engineering department at Rose-Hulman Institute of Technology was surveyed. Overall, practitioners agreed that it is ethical for faculty to teach without licensure. To determine the priority of licensure among faculty, civil engineering department heads were asked to report their percent of faculty with licensure. Initial survey data suggested that there is no consensus in terms of licensure expectations across universities. However, from the perspective of educators aiming to serve as role models for students, it is best practice, and not harmful, for faculty members to obtain licensure.

Introduction

Background

The engineering profession first implemented licensure as a result of construction and infrastructure failures in the late 1800s and early 1900s. These catastrophes and a need to restrict surveying and engineering work to those trained in these areas (not lawyers, prospectors, etc.) led California to pass surveyor requirements in 1891, and Wyoming to adopt an engineering statute in 1907. The remaining United States adopted similar statutes over the next 40 years [1]-[3]. In the 1950s and 1960s the National Council of Examiners for Engineering and Surveying (NCEES), working with state boards, developed national exams. While it took until 1984 for all state boards of examiners to use uniform Fundamentals of Engineering (FE) and Principles and Practice of Engineering (PE) exams, the need and motivation remain for licensure of the engineering profession: to safeguard all life, health, property and to promote the welfare of the public [4].

Obtaining licensure requires satisfying a combination of requirements that include education, exams, and experience, sometimes referred to as the three-legged stool of licensure [2]. The addition of continuing professional competency qualification for licensure renewal is becoming a fourth leg of this licensure stool as states continue to require professional development hours or continuing education units for renewal [1]-[3]. Professional licensure criteria varies from jurisdiction to jurisdiction (the jurisdictions include the 50 US states plus five US territories). To become a professional engineer, typically, a person must have a baccalaureate degree from an ABET accredited engineering program, pass the FE examination, obtain engineering experience under the supervision of a licensed professional engineer, and pass the PE examination. Alternate routes exist, but vary by jurisdiction [2], [5].

The purpose of engineering licensure is to uphold public safety by restricting practice of engineering to qualified engineers (professional engineers). In fact, the vision and mission statements of NCEES both include statements describing commitments to safeguard and protect the "health, safety, and welfare of the public" [5]. An engineer is "a person who designs, builds, or maintains engines, machines, or structures" [6]. Put another way, the product of a practicing engineer is the design of infrastructure, devices or systems. Civil and environmental engineers hold the majority of all professional engineering licenses [2]. In the civil and environmental engineering professions, practitioners deliver plans and recommendations for their implementation. Every day, the public drives on these roads and bridges; lives, goes to school and works in these structures; and relies on safe drinking water and proper wastewater treatment. According to the NSPE Code of Ethics for Engineers, "Engineering has a direct and vital impact on the quality of life for all people" [4]. As such, practicing engineers have an incredible responsibility to "Hold paramount the safety, health, and welfare of the public" [6]. Licensure of the engineering profession is highly warranted and suits society and the profession well.

Given that one of the requirements of the professional licensure process is graduation from a four-year ABET accredited program, it is of interest to consider how experienced or practice-oriented the educators comprising these programs are. Like professional engineers, engineering programs must obtain certification through the appropriate accreditation board, ABET. Eight general criteria plus program-specific criteria must be met for accreditation [7]. Program-specific criteria are comprised of curricula and faculty criteria. Programs must demonstrate that they meet the Body of Knowledge (BOK) for their discipline. For civil engineering faculty, according to the 2016-2017 ABET Criteria for Accrediting Engineering Programs, and the Civil Engineering Program Criteria and the American Society of Civil Engineers (ASCE) BOK2, programs must make evident that "faculty teaching courses that are primarily design in content must be qualified to teach the subject matter by virtue of professional licensure, or by education and design experience" and that the program "is not critically dependent on one individual" [7], [8]. From this perspective, professional licensure is being used as a measure of experience to ensure instructors have sufficient experience or are being supervised by individuals that do.

Motivation

Given the respected status of engineering as a licensed profession, and the sensible, accepted and time-tested framework of professional engineering licensure, it is interesting to ask, "Is it ethical for university engineering faculty to teach technical subject matter to engineering students without obtaining professional licensure?" "Since a professional engineer does have ethical obligations to the "Hold paramount the safety, health, and welfare of the public" [5], should an engineering educator be held to those same standards?" "Will faculty with licensure teach better and produce more practice-minded graduates?" These questions are of interest to the Civil Engineering department at Rose-Hulman Institute of Technology where faculty's engineering practice experience and professional licensure is traditionally highly valued. As an engineering discipline, civil engineering greatly values professional licensure and most licenses are held by civil and environmental engineers [2]. This paper explores these questions by sharing the opinions of senior practicing engineers, data on percent of faculty from 12 universities, and personal reflection from the author.

Methods

To address these questions, practitioners' opinions on the importance of licensure, and the percent of faculty with PE licensure from a sample of civil engineering departments at 12 universities were analyzed for the civil engineering discipline.

Since licensure is required for advancement for most practicing civil engineers, civil engineering practitioners were surveyed regarding the necessity of licensure and/or work experience for faculty members. The Board of Advisors at Rose-Hulman Institute of Technology is composed primarily of practicing civil and environmental engineers with substantial consulting, managing, and hiring experience. This group of practitioners was chosen as the collection of practitioners for the survey. These engineers are mostly regionally located in IN, IL, WI and KS, with a few in FL, CO and CA. Practitioners answered a variety of questions (Table 1) designed to discern practitioners' opinions about the importance of faculty licensure from both ethical and practical perspectives. From a practical perspective, one might ask, will faculty with licensure teach better, and as a result, generate better-prepared engineers that are more desirable? Since these questions are difficult to measure, the survey asks if the licensure of faculty factors into the hiring process, and the degree to which practitioners might be willing to support opportunities for faculty to gain practical experiences. Questions were either of a yes or no choice format and/or open-ended. Following internal review board requirements, informed consent was obtained from each participant prior to participation in the survey.

To discern the priority of professional licensure among civil engineering faculty, the percent of faculty with PE licenses was determined for 12 universities. Visiting and adjunct faculty were included as part of the faculty. These 12 universities self-reported the percent of faculty with PE licenses by responding to a post on the American Society of Civil Engineering Department Head Forum.

Table 1. CE Board of Advisors survey questions

1	In your current role, do you have the ability to make hiring decisions?
2	Is it ethical for university engineering faculty to teach technical subject matter to engineering students without **professional licensure**? Describe below.
3	Is it ethical for university engineering faculty to teach technical subject matter to engineering students without **design work experience**? Describe below.
4	How do you think design work experience compares to licensure? Describe below.
5	Does the coverage of licensure for faculty in an engineering program/institution impact your perceptions of the engineering program/institution? Describe below.
6	Does the coverage of licensure for faculty in an engineering program/institution impact your perceptions of an applicant during hiring decisions? Describe below.
7	Choosing between two candidates, if the GPAs are similar and both candidates interviewed well, would you consider the licensure for faculty when hiring students? Describe below.
8	Would you support opportunities for faculty to gain design work experiences at your current worksite?
9	Do you think there are ways to make gaining design work experiences beneficial to your company (in addition to the faculty member)? How? Describe below.

Results

The findings from the all surveys are summarized and interpreted in the following sections.

Civil Engineering Board Survey

A majority (69%) of the CE Board of Advisors and Board of Associates members thought that it is ethical for faculty to teach technical subject matter without professional licensure or design work experience (Table 2). Noting that 92% of these practitioners have the ability to make hiring decisions, 85% reported that they would give more credence to a program where instructors are professional engineers rather than not. However, the percent of professional engineers on the faculty would not impact their hiring decisions at the individual candidate level (only 15% responded YES). That is, the practitioners felt that they would have a more positive view of a program as a whole where more professional engineers are members of the faculty, and likewise might be interested in interviewing more students from that university, but faculty members' licensure status would not impact whether or not specific students are viewed favorably or not.

Table 2. Results of CE Board of Advisors survey (Yes or No questions; *N* = 13)

Questions		# YES	% YES
1	In your current role, do you have the ability to make hiring decisions?	12	92
2	Is it ethical for university engineering faculty to teach technical subject matter to engineering students without **professional licensure**?	9	69
3	Is it ethical for university engineering faculty to teach technical subject matter to engineering students without **design work experience**?	9	69
5	Does the coverage of licensure for faculty in an engineering program/institution impact your perceptions of the engineering program/institution?	11	85
6	Does the coverage of licensure for faculty in an engineering program/institution impact your perceptions of an applicant during hiring decisions?	2	15
7	Choosing between two candidates, if the GPAs are similar and both candidates interviewed well, would you consider the licensure for faculty when hiring students?	2	15
8	Would you support opportunities for faculty to gain design work experiences at your current worksite?	13	100
9	Do you think there are ways to make gaining design work experiences beneficial to your company (in addition to the faculty member)? How?	13	100

Several of the survey questions asked for further explanation. Below are summaries of some of the more common or insightful excerpts.

2. Is it ethical for university engineering faculty to teach technical subject matter to engineering students without professional licensure?

Responses fell into two camps, as described in the numbers in Table 2. The general consensus was that teaching students does not put public health or safety directly at risk and thus it is ethical for faculty to teach technical subject matter without professional licensure. In other words, licensure is required to stamp plans and be in responsible charge of engineering work, not teaching. Several practitioners mentioned that while licensure does not supersede knowledge, it is a good idea to be licensed to set a good example for the students. One practitioner suggested that faculty have educational or peer-reviewed research product requirements instead of licensure requirements.

Alternatively, a couple of practitioners were less certain of the ethics and thus, need for licensure for faculty members. They noted that since licensure establishes a minimum level of demonstrated competency, teaching without licensure is a slippery slope.

3. Is it ethical for university engineering faculty to teach technical subject matter to engineering students without design work experiences?

Overall practitioners felt that as long as faculty are knowledgeable in a subject, they can ethically teach without design experience. This was especially the consensus for teaching basic design

practices, design theory and calculations. They note that while design work is helpful to contextualize fundamentals and add to design teaching, it is not necessarily required. Several point out that there are many aspects to engineering and technical subject matter beyond design work. Interestingly, one practitioner describes that someone could study and pass the exams for licensure without actually having designed anything. While this is not the intent nor expectation of licensure, it highlights that knowledge can be gained in multiple ways.

A couple of practitioners disagreed because design work is the application of engineering principles and as such, faculty should have direct experience in applying engineering principles to instruct students.

4. How do you think design work experiences compares to licensure?

Practitioners described the difference between design work experience and licensure similarly: that design work is applying engineering knowledge and licensure allows an engineer to certify such application. Put another way, design work makes engineers useful, but licensure makes them profitable. Many practitioners reflected that design work experience is much more important than licensure in their businesses. They note that to design properly, an engineer must have practical experience lessons learned. A license is required to control the engineering deliverables.

5. Does the coverage of licensure for faculty in an engineering program/institution impact your perceptions of the engineering program/institution?

Practitioners' responses were mixed with this question. Some expressed that an institution that promotes licensure of graduating students should have faculty that believe it is important for themselves to become licensed, and that faculty members should be licensed or on the track for licensure. These practitioners noted that perception is reality and that recruiters like to know students are taught by professionals with credibility that licensure provides. However, other practitioners note that licensure among faculty does not impact their perception of a program; the quality of students the program produces is of utmost importance.

6. Does the coverage of licensure for faculty in an engineering program/institution impact your perceptions of an applicant during hiring decisions?

Practitioners stated that their perceptions are more heavily based on the prestige and reputations of the universities from which students graduated, and the technical and communication skills of the students during interviews.

7. Choosing between two candidates, if the GPAs are similar and both candidates interviewed well, would you consider the licensure for faculty when hiring students?

Practitioners stated that most hiring managers would not even think to consider licensure of faculty when choosing between two candidates, and if they did, it would be a low priority item in hiring successful employees.

9. Do you think there are ways to make gaining design work experiences beneficial to your company (in addition to the faculty member)?

Practitioners were supportive of the idea of having faculty gain design work experience in their companies. They note that the faculty could produce real design work for lower cost, even if their work is reviewed and directed by a P.E. for good business practice. For some practitioners, faculty members' work was assumed to be lower cost because these experiences would be a learning experience for the faculty member like an internship, and thus not be compensated as a full employee. However, others note that they have outsourced some design to faculty members and found the relationship very fruitful. Most practitioners felt that allowing faculty to gain experience would build closer relationships between industry and faculty, and ultimately students. These experiences could improve the quality of education that future graduates/hires receive.

University Survey

The 12 civil engineering department heads who responded to the call for information were from universities predominantly located in the Midwestern and Eastern United States. Six of the universities enroll 10,000 or fewer students, and for four of these same universities, the highest degree granted is a Masters (Table 3.). Five of the universities are private institutions. In the reported data, there were not any trends relating the percent of faculty with PE licenses to university size (Figure 1), majority funding source, nor highest degree awarded. It should be noted that this study was limited in sample size and to universities who self-reported data by responding to a survey request.

Table 3. Percent of faculty with PE licenses in the civil engineering departments at various universities, organized by percent of faculty with PE licenses (enrollment includes both undergraduate and graduate students rounded to the nearest 1000 students, CE is civil engineering)

University	Enrollment	Public?	PhD granting?	CE Faculty with PE	Total CE Faculty	% CE Faculty with PE
1	7,000	no	yes	2	28	7%
2	38,000	yes	yes	7	51	14%
3	4,000	no	no	8	20	40%
4	45,000	yes	yes	12	24	50%
5	6,000	no	yes	4	7	57%
6	10,000	no	no	4	7	57%
7	9,000	yes	no	8	13	62%
8	28,000	yes	yes	28	41	68%
9	11,000	yes	yes	11	15	73%
10	2,000	no	no	7	9	78%
11	30,000	yes	yes	16	20	80%
12	24,000	yes	yes	15	18	83%

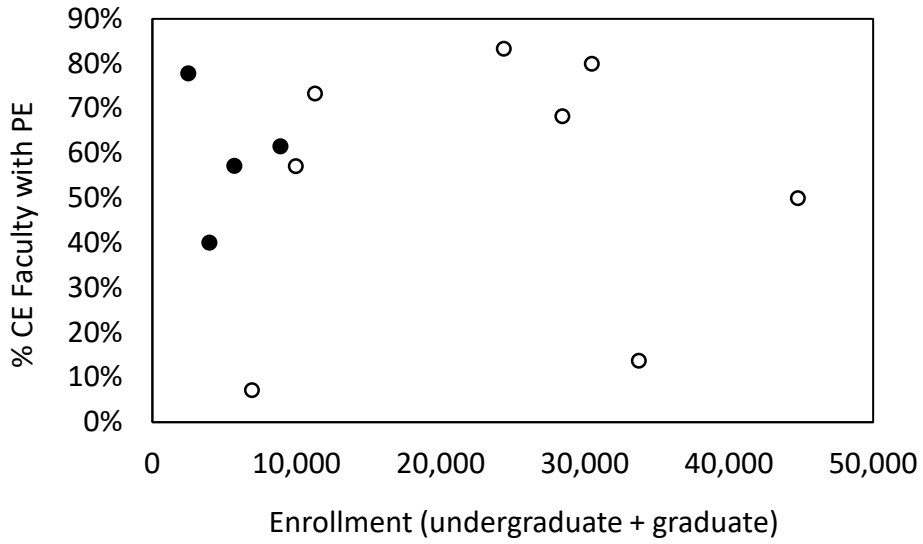

Figure 1. Percent of CE faculty with PE licenses at various universities (solid points denote universities where the highest degree is a Masters, CE is civil engineering)

Discussion

The ABET Program Criteria for Accrediting Civil Engineering Programs states that a "program must demonstrate that faculty teaching courses that are primarily design in content are qualified to teach the subject matter by virtue of professional licensure, or by education and design experience" [8]. For tenure-track faculty members currently without licensure, this means that they must establish teaching mentors who are licensed professional engineers and willing to provide regular input and evaluation of subject matter and its delivery. It is also prudent that they seek professional development activities that provide practical experience. For example, research experiences can also be structured to involve practitioners. As a result, both faculty and students will benefit from these experiences.

An educator is "a person who provides instruction or education; a teacher" [6]. As such, the products of educators are students, albeit students who are competent technically and professionally. In many cases, these graduates of accredited engineering programs will go on to work under the direction of licensed professional engineers, especially in the civil and environmental engineering fields. Interestingly, all together, the standards for engineering faculty mirror the requirements for licensure: education (undergraduate and graduate courses), experience (doctoral and post-graduate research – typically includes experimental or model design work), exams (PhD defense / ABET accreditation), and professional development (continuing contribution to engineering field). Faculty who achieve tenure are likely successfully meeting these requirements. Junior faculty have met or are working to meet all of these requirements, similar to Engineering Interns. In the survey of practitioners, it is interesting that many distinguished between skills and experience. They note that while it is true that engineering skills can be gained from books and/or experience, they contend that experience can only truly be gained by the school of hard knocks. However, it is rare that a Ph.D. could be obtained without serious setbacks and

challenges. Finally, a faculty member without significant engineering design experience could work hard to obtain perspective by interviewing practitioners, or including them as guest speakers or co-developers of courses.

Since the engineering field has strict requirements for those engaging in engineering practice, rightly justified by the need to uphold public safety, it is intriguing that professors can teach without any training or experience in teaching. This is likely due to the intense focus on research productivity in graduate school. However, some universities are beginning to offer voluntary teaching certificate programs to arm future professors with both skills and experience related to college teaching [9]. Considering the question of whether faculty who have licensure would be better equipped to prepare student-engineers, one can assume that by way of their Ph.D. degree they have achieved mastery of engineering content in their area of specialty. The question then becomes: what additional aspects can experience provide? Based on the survey responses from the Rose-Hulman Institute of Technology Board of Advisors, faculty with experience might be able to provide context to fundamental and design content of courses. Additionally, some of the practitioners note that there are aspects to engineering beyond technical subject matter. These additional aspects might include the ability to communicate with a variety of audiences (clients, contractors, engineers and the general public); make multifaceted decisions that may require weighing economic realities, cultural expectations, and environmental considerations; and above all, the ability to make ethical decisions that uphold public safety and welfare. Years of design experience undoubtedly would provide context and memorable lessons learned for faculty to impart to their students. However, licensure does not ensure that faculty provide these learning opportunities to their students in the same way that a Ph.D. degree does not ensure that faculty are good teachers.

Personal Reflection

While I believe that unlicensed faculty members who put controls in place to evaluate teaching and work with licensed consultants and university colleagues are ethical and can be effective engineering educators, however, I think that it is beneficial for faculty members to seek licensure as a model for their students. Specifically, professors may describe the importance of taking the FE exam before they graduate as the first step towards the students' assumed goals of licensure, but then describe how licensure is not useful to professors. As an educator I am aware that I am, at least at times, a role model for my students as one of the first engineers with whom they may interact. As this important representative of the engineering profession, I have a responsibility to gain their respect and pass on the technical, professional, ethical and societal aspects of engineering. By obtaining licensure, faculty emphasize the importance of this standard for their students and society. I believe that if academics prioritize licensure, we will advance the stature of the engineering profession and its licensed status by demonstrating consistency across all avenues of engineering practice.

As a tenure-track faculty member currently without licensure, I have secured mentors for all of my design classes. My mentor for teaching *Water Resources Engineering* is licensed and has years of

practice experience. We meet regularly to develop my syllabus and discuss specific content or general best-practice design questions. Through these interactions, my mentor provides me with practical context of water resources engineering. In developing an *Appropriate Technology for Developing Countries* course, I worked with an alumnus who has over 40 years of civil and environmental engineering consulting experience and many years as an Engineers Without Borders mentor to develop course content. Given that most faculty members do not have practice experience equivalent to 40 years, this model may be beneficial even when faculty members are themselves licensed professional engineers. Not only did the students benefit from our collaboration, I learned much from the experience.

Lastly, my involvement with our senior capstone design course is as part of a faculty team. I have the ability to unpack and discuss design decisions with my more experienced, licensed colleagues. This co-teaching experience provides not only a rich learning experience for the students; I again learn much from the process. Little do the students know how much homework I do. Senior design pushes me beyond what I know every year. Even a colleague with consulting experience reflected that this is the case for him as well. With a mentor (academic and/or practitioner) to vet approaches and assumptions, I think each capstone project is the ultimate learning experience for all parties involved. I become a better engineer every term that I teach.

Conclusion

Years of practice experience would certainly be beneficial for every engineer, whether a practitioner or faculty member. The general consensus of the Rose-Hulman Institute of Technology Civil Engineering Board of Advisors is that lack of licensure or design experience for engineering faculty isn't a matter of ethics and does not factor into hiring decisions. While they agree that licensure provides accountability and credibility in the engineering field, they note that design experience is most important in their businesses. In fact, all of those surveyed believed that engineering experience was important enough that they were willing to discuss opportunities for faculty to gain experience through their firms.

A survey of the percent of faculty with PE licenses at various universities indicates no consensus on priority of or best practice regarding professional licensure across universities. While this survey was voluntary and limited in sample size, there was no correlation between licensure and university size nor highest degree awarded.

From the perspective of an engineering educator, faculty have the opportunity to serve as a model for students. Taken as a whole, it is ethical for faculty to teach without licensure, or even work experience, but licensure is recommended to demonstrate its importance to students and to conform to the engineering industry.

Educators have the responsibility to prepare students to be proficient in the technical, professional, ethical and societal aspects of engineering. The tenure-track process helps ensure that faculty have the education and professional development to serve students. Engineers have a responsibility to

serve the public by protecting their health, safety and wellbeing. Professional licensure helps ensure that this essential engineering mission is achieved. While it is not a matter of ethics at the university level, I believe that engineers – practitioners, educators and students – should continue to uphold the licensed status of the engineering profession. As such, I contend that academics should join in this great work by obtaining and maintaining licensure as well, and thereby serve as role models to further encourage students to revere and pursue licensure. Thus, while it is ethical to teach without licensure due to the controls in place at the student and faculty levels, I put forward the following charge to my academic colleagues: if we want our students and the greater society to value licensure, we should put greater emphasis on obtaining our own licensure. After all, engineering and education are both professions of practice.

Future Work

A larger survey of the percentage of faculty with licensure at various types of universities would lend better insight into the importance of licensure for faculty. More data might reveal trends across various types or locations of institutions.

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References

1. D. McGuirt, "The Professional Engineering". *The Magazine for Professional Engineers, National Society of Professional Engineers*, pp. 24-29, 2007.

2. C. N. Musselman, J. D. Nelson, and M. L. Phillips, "A Primer on Engineering Licensure in the United States," In Proc. American Society for Engineering Education Annual Conference 2010.

3. National Council of Examiners for Engineering and Surveying (NCEES), "The History of NCEES: 1920-2015," NCEES, Clemson, SC, 2015.

4. National Society of Professional Engineers (NSPE), "Code of Ethics for Engineers," NSPE, Alexandria, VA, 2007.

5. NCEES, 2015. "Model Rules," [Online]. Available: http://ncees.org/wp-content/uploads/2012/11/ModelRules-20151.pdf. [Accessed March 15, 2018].

6. Oxford Dictionary, 2017. [Online], Available: https://en.oxforddictionaries.com. [Accessed February 28, 2017].

7. Engineering Accreditation Commission, *Criteria for Accrediting Engineering Programs: Effective Reviews During the 2016-2017 Accreditation Cycle*, Baltimore: ABET, 2015.

8. Body of Knowledge Committee of the Committee on Academic Prerequisites for the Professional Practice, *Civil Engineering Body of Knowledge for the 21st Century: Preparing the Civil Engineer for the Future*, 2nd ed., Reston: American Society of Civil Engineers, 2008.

9. Inside Higher Ed, 2010. [Online], Available: https://www.insidehighered.com/news/2010/10/15/mit. [Accessed March 15, 2018].