CIAMTIS

U.S. DOT Region 3 University Transportation Center

Professional Engineer Licensure Preparatory Course: An Evaluation and Analysis of CIAMTIS MSU Outreach

February 5, 2024

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16. Abstract

From the Spring 2020 to the Spring 2023, with the support of the Center for Integrated Asset Management for Multi-modal Transportation Infrastructure Systems (CIAMTIS): Region 3 University Transportation Center, and in collaboration with the Morgan State University Civil Engineering Department, engineering outreach and training was carried out in the form of Civil PE Training and High School engineering outreach programs (Introduce Baltimore to Civil Engineering). Data analytics and information were gathered and assessed from both professional and prospective engineers. PE pre-assessment exam questions were administered and two PE training sessions were held to prepare candidates to undertake the Civil PE exam with answers and readiness feedback gathered in numerous forms of data. Engineering outreach programs were held at Morgan State University Campus for minority Baltimore high school students with activities and mentoring involved as well as assessing the interest of high school students in a career in engineering using feedback forms and surveys.

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CHAPTER 1

Introduction

BACKGROUND

The 2018 United States Bureau of Labor Statistic projects a 1.2% increase in the demand for qualified or licensed transportation engineers with capability to perform engineering duties in planning, designing, and overseeing construction and maintenance of building structures, and facilities. Current measures taken by Morgan State University to increase the supply of competent transportation engineering (TE) undergraduate students pool to Maryland workforce include 1) ensuring that majority of students admitted to the program will complete the program of study and graduate; 2) ensuring that the pass rates on the National Council of Examiners for Engineering and Surveying – Engineers-in-Training (NCEES-EIT) will meet or exceed the state or national rate; and 3) improving the employability of students and meaning contribution to the field. MSU sees a responsibility to give back to the Baltimore community in ways that enrich and deepen the relationship through her products.

Morgan is a public historically black university (HBCU) located in Baltimore, MD, designated by state statute as Maryland's "Public Urban University" and leads the state in graduating African American engineers at the bachelor's level in several disciplines. With shrinking resources to improve its recruiting pipeline and Baccalaureate attainment for "at risk" transportation engineering students who lack industry-readiness to solve real-world problems which require different skills set from the typical academic problems, this would inadvertently have direct implications on Maryland's economic growth, and prosperity. Prominent is the significant challenge replacing retiring licensed engineers in Maryland as there is not a strong training pipeline to educate and equip a new generation of talent with the skills, they need to attain licensure, practice on a long-term, secure high paying jobs and improve their competitiveness as part of a skilled infrastructure workforce in the state. Alongside, the State of Maryland government agencies and private sectors in the field are requiring that they hire and contract only with licensed professional engineers. This is a trend that is almost certain to continue in the future. Given the current job market in Maryland, there is a significant challenge replacing retiring PE engineers.

With the employment of transportation engineers in the state of Maryland projected to grow by more than 4.0 percent from 2018 to 2024 (adding about 65,000 new jobs), more licensed engineers will be needed to offer engineering work for public and private clients. These cohorts of engineers are expected to possess construction and design, engineering and management, and project control expertise, among others, by following technical guidelines for promoting safety, reliability, productivity, and efficiency in civil engineering. The goal of this project is to increase the PE licensed engineers in the transportation field in Maryland and present findings. A professional engineer licensure preparatory course was provided to staff and employees of MSU and MD Department of Transportation employees by affiliated experts. These organizations through their employees have expressed a need for this training and similar continuing education modules. The training was designed to allow easy comprehension by these "at risk" engineers to efficiently and successfully engage their employees for PE licensure, exchange best practices or strategies for the PE exam and handle the responsibilities of a licensed professional engineer.

The NCEES Principles of Engineering (PE) is required for licensure for practice as an engineer in the industry. With the growing need for PE engineers across the United States, the State of Maryland is stepping up its efforts to produce more PE licensed engineers in the industry to replace the current ones, many of whom will soon be retired. The project objectives include (1) Assessing the effectiveness of the Principles and Practice of Engineering (PE) exam training program for At-Risk-Engineers in preparing license candidates for the NCEES administered PE exam.

CHAPTER 2

Literature review

INTRODUCTION

Professional engineering licensure

The engineering profession first implemented licensure as a result of construction and infrastructure failures in the early 1900s. These failures resulted in the need to enforce surveying and engineering work to those trained in the field of engineering [1]-[3]. In the late 1950s, the National Council of Examiners for Engineering and Surveying (NCEES), working with state boards, developed the national exams. The state boards of examiners in the 1980s required all engineering fields to use uniform Fundamentals of Engineering (FE) and Principles and Practice of Engineering (PE) exams with the goal 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 vary 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.

Aging engineering practitioners

The US science and engineering workforce is aging rapidly. This is a potential problem for two reasons: (i) older scientists may not retire at a fast enough rate to free up positions for younger researchers to establish independent careers (1–4), and (ii) scientific creativity is thought to peak at a relatively young age (5–9), although the evidence is in fact somewhat mixed. The aging of the scientific workforce has been called a crisis (10). Policy proposals have focused on directing more research support to new and early-stage investigators to maintain the quantity and quality of scientific research and the sustainability of the scientific workforce (11, 12). However, we are

not aware of rigorous analyses of the causes of the aging of the scientific workforce, and the implications of current trends for the long-run age distribution of scientists. This article develops and simulates a demographic model of the scientific workforce to (i) determine the causes of the recent aging trend and (ii) predict the long-run effects of these factors on the age distribution. First, we show that "demographic momentum" in the form of the aging of the large baby boom cohort has driven much of the recent rapid aging of the scientific workforce, and will continue to do so for the next two decades as the later cohorts of the baby boom pass through their 60s and early 70s. However, sharp declines since 1993 in the rate at which scientists retire from employment can account for 8% of the increase in the mean age of scientists. The decline in retirement was most likely triggered by the elimination of mandatory retirement at universities in 1994. We also find that the aging of the workforce as a whole (due to lower fertility) accounts for 13% of the increase in the mean age of the scientific workforce.

Case Studies

In her Journal entry for the Institute of Transportation Engineers titled "Advancing yourself through certification," Michelle Birdsall (2015) highlights the various means by which licensure and certification can help to advance professionalism, value and public safety within the transportation sector. She makes reference to the National Society of Professional Engineers, NSPE's definition of engineering licensure as "the highest standard of competence and assurance of quality" [9] (NSPE, 2022). She then builds on this by referring to a case study from 1907 which represents the first-time engineering licensure was signed into law in the state of Wyoming. This was advocated and proposed by then Wyoming State Engineer Clarence T. Johnston who had observed individuals without the proper training working as engineers and surveyors on the state's water distribution system. This event would serve as the springboard for national reform when it came to engineering licensure and qualification assessment [10] (Birdsall, 2015,). Before the landmark case of 1907, anyone could seek and gain employment as an engineer even at the cost of safety and efficient engineering work being produced. Such has been the growing relevance and awareness of proper engineering accreditation and licensing since this first law was passed that more avenues are being created to ensure engineers have a critical pathway to obtaining professional licensure.

In the publication "Earning PE Certification; A career strategy worth pursuing," Nayak and Agrawal (2011) states that obtaining a PE license affords one certain professional abilities and privileges that otherwise would not be available. Only PE license holders are permitted to stamp or seal engineering drawings, designs or documents which holds them legally responsible for

those specifications. In some cases, in the U.S, projects cannot be approved without such a stamp of authorization from the Professional Engineer. Through licensure, the professional reputation is also elevated and it ensures license holders are competent to perform their jobs at the level they have been certified. Licensed PEs also earn more on average than non-licensed PE's and this tends to remain the case even after many years of job experience [11] (Nayak & Agrawal, 2011,).

CHAPTER 3

Findings

Training evaluation and effectiveness models such as Kirkpatrick's four-dimensional measurement typology (i.e., reactions, learning, behavior, results) and the Holton's model concept were leveraged in the program evaluation. The training program was then designed to give each participant the opportunity to acquire and develop valuable resources in the form of strategies, abilities, and knowledge to pass the PE exam. Research into training program effectiveness was carried out to assist in the development of a successful program. It was found out that a fundamental issue for the development and acceptance of any training program concerns the attitudes of the program participants. It was expected that each individual participant in the training would appraise events cognitively as well as emotionally, these in turn will relate to important outcomes, such as retention during the training period. See Figure 1. It was designed to include lecture, practice of various problem-solving techniques or strategies, and assessment. It also engaged trainees in conversation geared to enhance PE license applicant support after the training. The training evaluation was able to measure the program's success or failure with regard to content and design, and changes in learner's behavior.

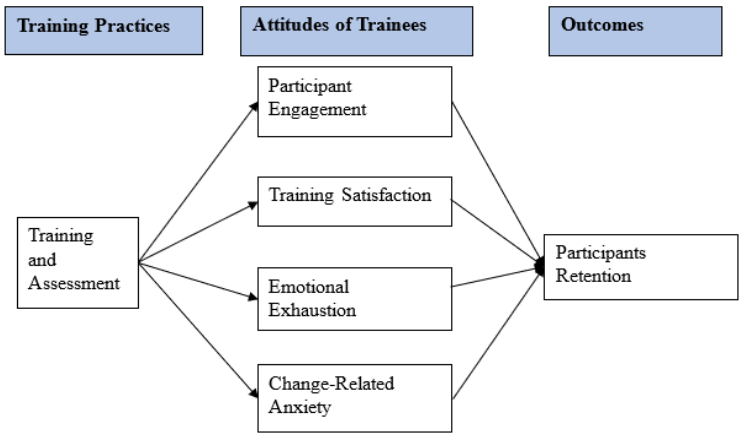


Fig. 1. trainees' attitudes and intention to stay

(3) Instruction delivery and development of diagnostic test or simulated exam

This training represents a key instrument of providing proactive and adaptive response to the needs to pass the licensure exam. The training cycle consists of four steps as shown in Figure 2:

1. Training needs assessment: Systematic analysis of the current state and defining a way of changing it. 2. Design or training program development: Determining training objectives and training program development on the basis of previously collected data mentioned above. 3. Training implementation: Implementation of training using various methods 4. Evaluation:

Measuring training results, observing the changes upon the training in the area of knowledge, skills, attitudes and behavior.

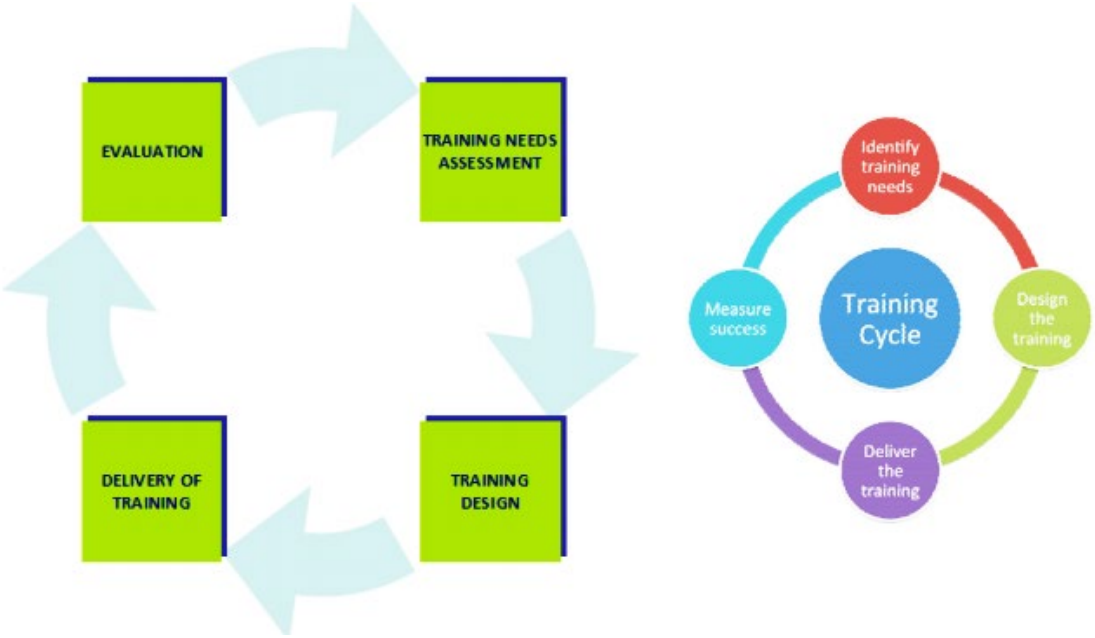


Fig. 2: Training Cycle

Multiple Choice Questions (MCQs was used to measure the most important outcomes - knowledge, understanding, judgment and problem solving. The blueprint or diagnostic test plan was first developed to assist in the creation of a balanced examination which is representative of the NCEES administered PE exam. A list of the competencies of each subject area of the PE civil exam obtained from the NCEES website (ncees.org) and topics (with specified weight for each) that should be tested on an examination was covered. The instructional design concept for the PE licensure training is shown in Figure 3.

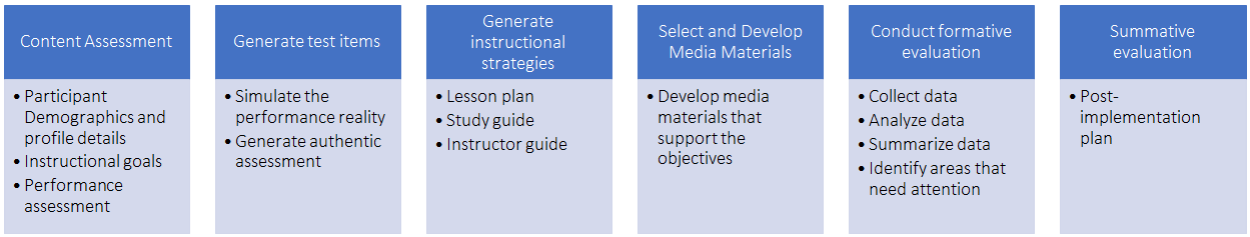


Fig. 3. instructional design for the training program

A sample of the output of the simulated exam from the blueprint plan are shown in Figures 4 and 5.

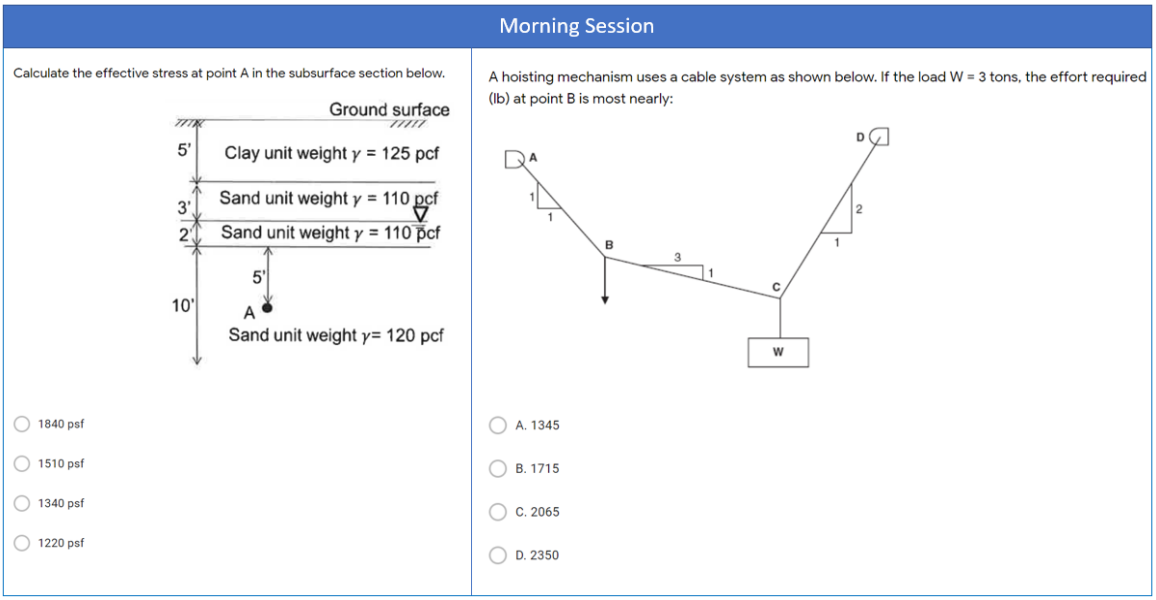


Fig. 4. Sample simulated exam interface for the morning session of the PE civil exam

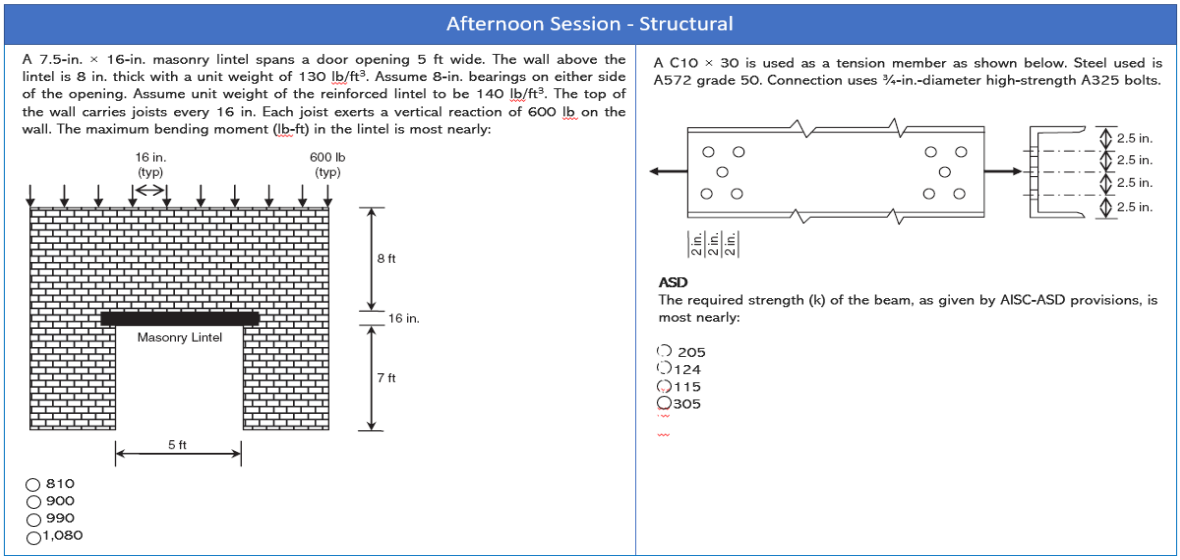


Fig. 5. Sample simulated exam interface for the afternoon session of the PE civil exam

Training Methodology

The PE training models a variety of effective training methodologies, including demonstration, practice, discussion, and brainstorming. The process of delivery of training included training sessions, group work exercises, group discussions and review sessions. Considering all relevant and available information about the training subject and participants, we decided to use following methodology:

• Teamwork and group work: Since the participants of the training were adults the team and group work chose to guide the participants through the training content and particular themes during the sessions. The participants are provided with the opportunity to discuss their challenges and problems related to the concepts.

• Interactivity: This approach might be more suitable for participants familiar with the chosen themes, rather than for real beginners, since beginners would not possess adequate knowledge, and as such should be more supported and guided by trainers. However, regardless of their previous inadequate knowledge, participants and trainers must cooperate in order to achieve desirable goals.

• Practical examples: considering the fact that the trainers were experienced practitioners in their chosen fields, one of the best ways to clear some uncertainties on subject areas was drawing attention to the previous NCEES administered problems.

• Practical work: after topic presentation and explanation, the participants were provided with an opportunity to do some practice. Practicing while referencing the civil engineering reference manual (CERM) and design standards to help participants in their preparation.

• Participants' evaluation: to receive qualitative participants' feedback, we formulated a comprehensive evaluation questionnaire in the format of questions seeking information on the extent to which the learners felt that they had learned in each key objective area. It was explained to the participants that the evaluations were completely anonymous, thus they could be used as a relevant indicator of participants' opinions and impressions.

(4) Analyzed the pre-test and post-test performance of the license applicants in two morning and evening sessions of simulated exams used in preparing license candidates for the NCEES licensure exam.

The pre-test and post-test performance of the license applicants were analyzed to determine if comprehension levels increased test scores. The participants for this study took the simulated exam during the training and the test score data were analyzed by comparing the pre-training, mid-training, and post-training performance of the participants.

2.1 Recruitment of Participants

During the 2020 PE Exam Training Session which ran from April 1, 2020 to October 31, 2020, 15 candidates registered for participation and this was recorded in the Semi-Annual Progress Report written by the Principal Investigators from Morgan State University in April 2021. Some of the critical data from the Semi-Annual Progress Report is included in this publication for reference and comparison with the 2021 data. A Pre-Assessment PE Civil exam was given as a means of evaluating current knowledge of the PE exam material before commencement of the

training sessions. The results and data analyzed from the pre-assessment are given below under "2020 PE Training & Summer 2020 PE Pre-Assessment Data.

The 2021 PE training sessions took place during two periods; the July-August refresher sessions and the August to October review sessions. Although 17 participants were officially recorded as having partaken in the PE training and courses, only 15 provide responses which can be seen in the analytics and data given below under "2021 PE Training Review and Feedback Data**."**

2.2: 2020 PE Training & Summer 2020 PE Pre-Assessment Data

Sex	%
Male	86.7
Female	13.3

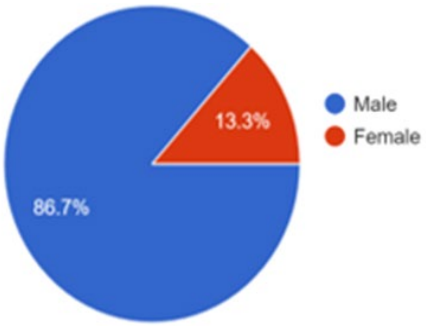


Fig. 6: Distribution of License Applicant with respect to sex/gender.

In figure 6 above, there were more male applicants than female applicants with the former recorded at 86.7% while the latter recorded 13.3% participation.

Industry	%
Education	40
State Government	40
Private Government	13.3
Personal Business	6.7

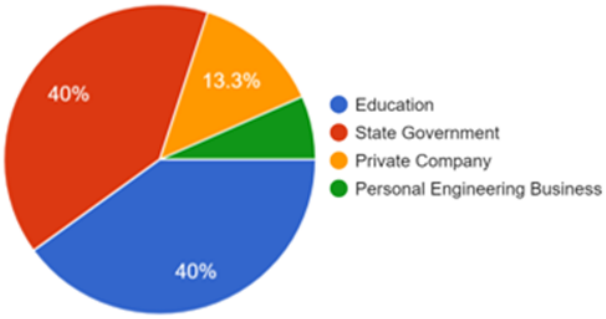


Fig. 7: Distribution of License Applicant with respect to Industry

In figure 7 above, the majority of applicants belonged to the education and state government industries; both registering 40% of the total number of applicants. Private government industry registered 13.3% of total applicants while those in personal businesses were the least registered at 6.7%.

Industry	%
Structural	26.7
Construction	13.3
Transportation	13.3
Water ad Environmental	13.3
Geotechnical	13.3

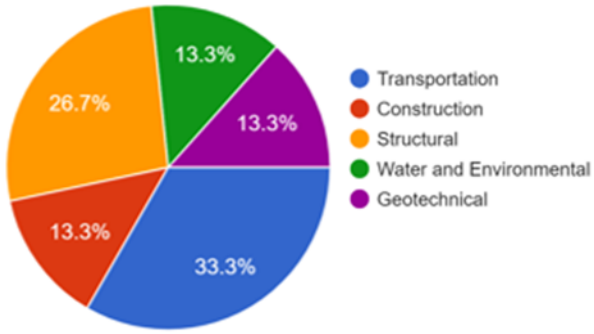


Fig 8: Distribution of License Applicant with respect to Sector

In figure 8, the structural sector was the largest sector represented at 26.3% of the total candidates, while the remaining sectors of construction, transportation, geotechnical and water & environmental all had an equal number of represented candidates at 13.3% each.

Number of Attempts	%
0	33.3
1	66.7
2	0
3	0

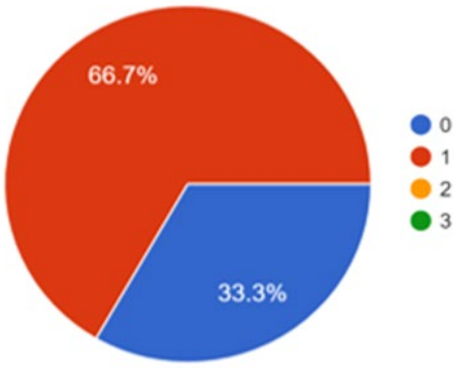


Fig. 9: License Applicant Number of Attempts on the NCEES Civil PE Exam

Figure 9 shows that 33.3% of candidates will be first time takers, 66.7% will be taking it for the second time while no other candidate had taken it twice or three times before.

Of the 15 registered candidates, only 10 participated in the PE pre-assessment; unsurprisingly, this led to a difference in biographical data compiled when compared to the data for all 15. Figure 10 is a bar graph that shows the total points distribution of all 10 participants in the PE pre-assessment over a total of 40 points. The average, median and range score of all 10 candidates is also listed. Figures 11, 12 & 13 show pie charts detailing the candidate's PE civil area of interest, registered candidates for October 20, 2020 PE exam and number of first time or retake candidates of the PE exam respectively.

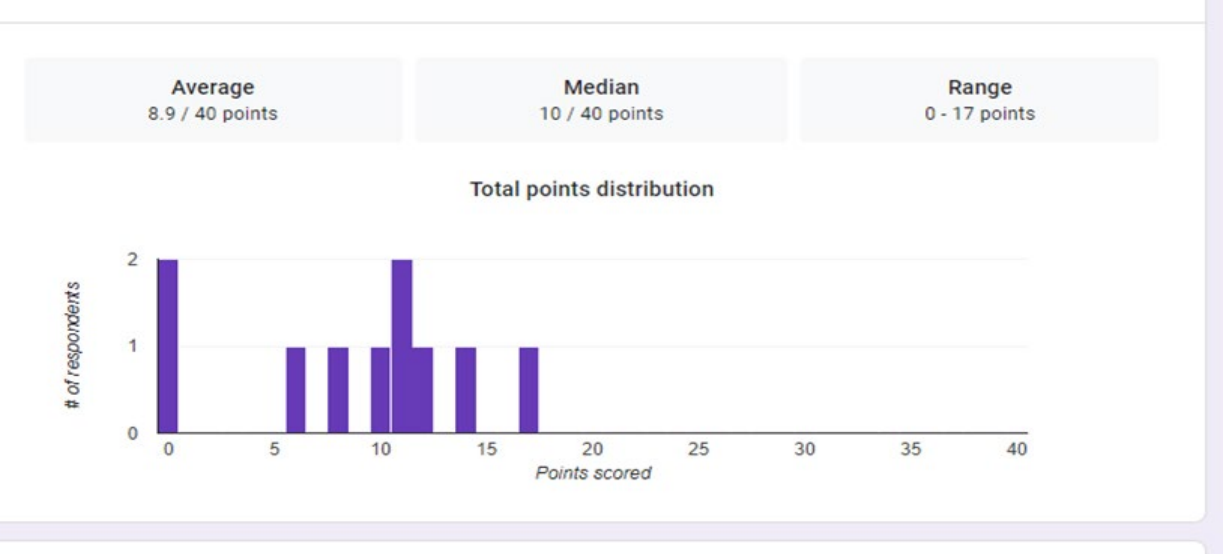


Fig. 10: Total Points Distribution of responsive participants

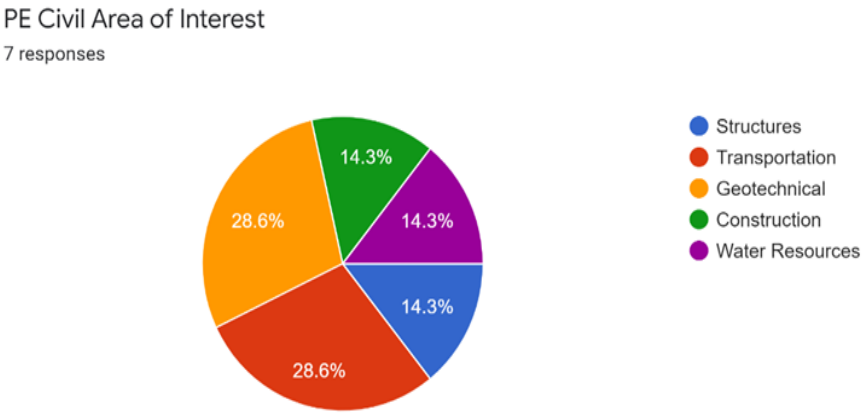


Fig. 11: Participants PE Civil Area of Interest

In figure 11, 28.6% of candidates indicated a civil area interest in transportation and geotechnical engineering respectively. 14.3% indicated an interest in the area of structures, water resources and construction engineering respectively.

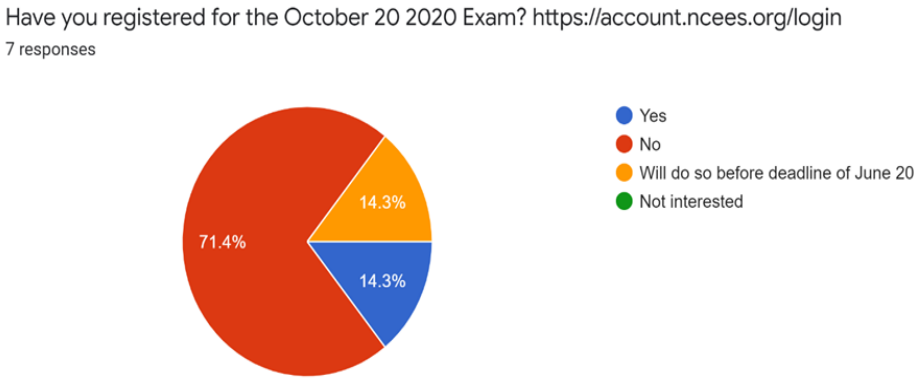


Fig. 12: Participants registered for October 20 2020 PE Exam

In figure 12 above, approximately 71.4% of the candidates indicated they have not registered for the PE Exam on October 20, 2020. 14.3% indicated they have registered while the other 14.3% indicated they will register before the deadline on June 20, 2020.

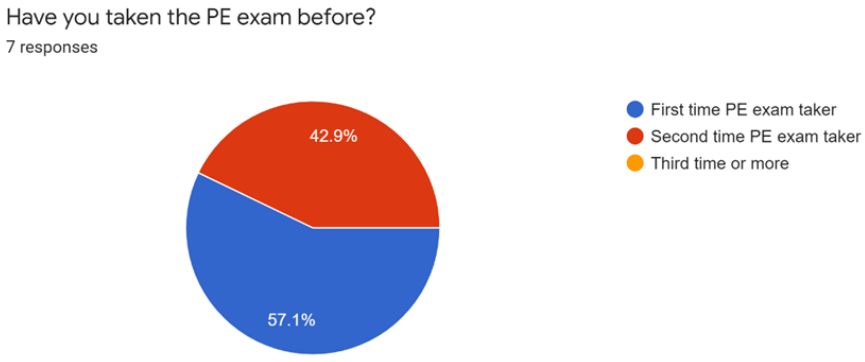


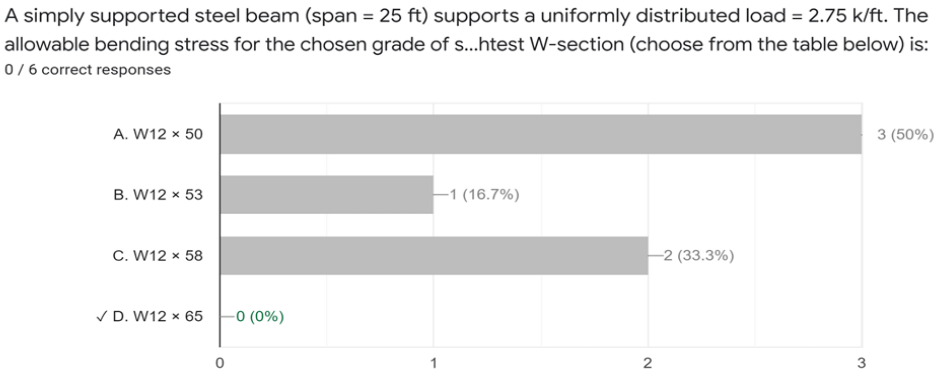
Fig. 13: Pie Chart showing first, second and third time takers of PE Exam

For figure 13, 57.1% of candidates will be first-time takers of the PE exam. The remaining 42.9% are second-time takers while there were no third-time takers of the exam recorded.

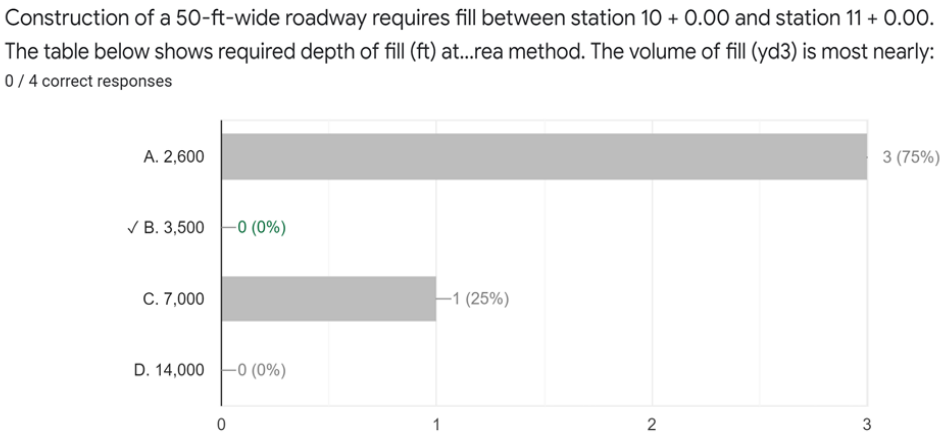
Sample Questions from PE Civil Breadth Pre-Assessment

Below are some of the sample PE multiple choice questions (figures 14A, B, C & D) that were given to the participating candidates in the Pre-Assessment. The Bar graphs show the percentage of candidates that selected the corresponding answer option on the y-axis/vertical axis as the answer to the multiple-choice question (A, B, C or D) with the highlighted green bar representing the actual correct letter option/answer. The horizontal/x-axis shows the number of candidates that selected a particular answer option. It should be noted for future exam review and analytical references only questions that had the fewest number of candidates selecting the right answer are shown in this report.

2.3: Sample PE Questions from 2020 PE Training



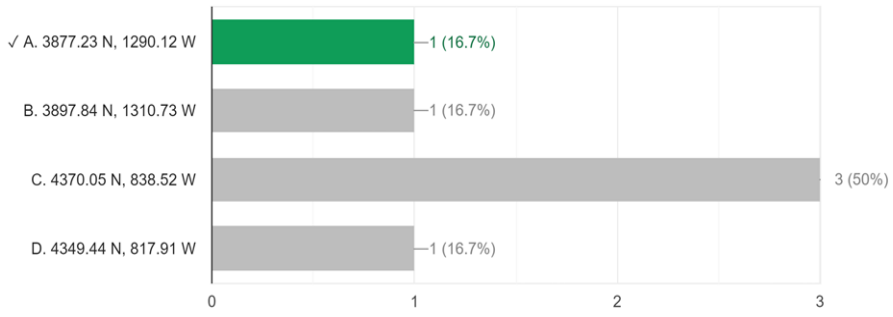
A



B

A horizontal circular curve has PC at coordinates (ft) 4123.64 N, 1064.32 W. Curve radius = 1,030 ft. The tangent at the PC has bearing S42°30′W. The len... curve = 646.35 ft. The coordinates of the PI are:

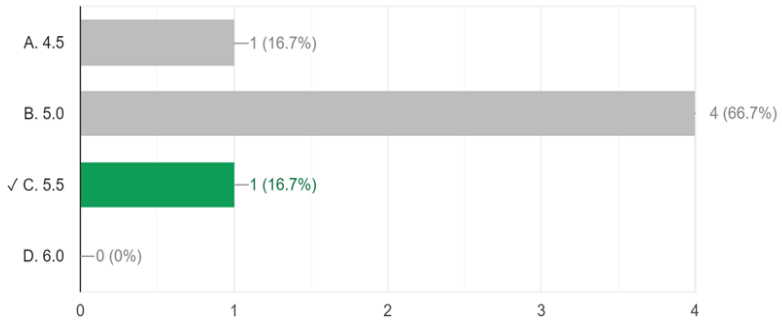
1 / 6 correct responses



C

A square footing is embedded 3 ft in a sand layer as shown. The concentric column load is 150 k. A water table is located 10 ft below the bottom of fo... minimum footing size required (ft) is most nearly:

1 / 6 correct responses



D

Fig. 14: Sample PE Questions from 2020 Training (A-D)

2.4: 2021 PE Training Review and Feedback Data

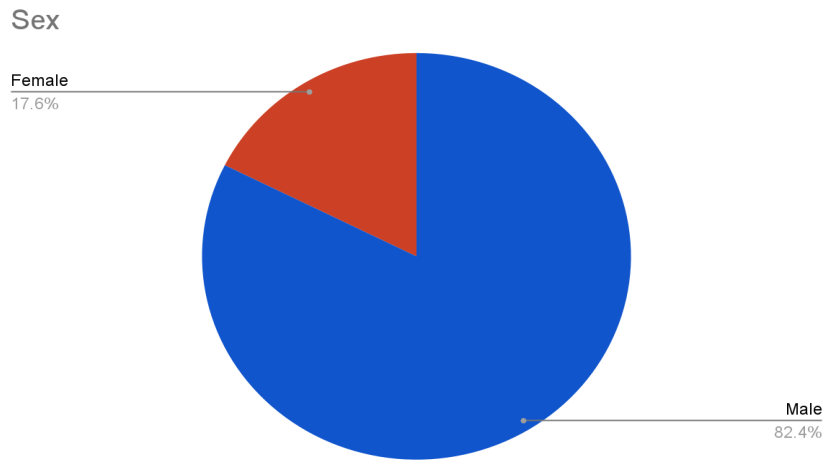


Fig. 15: Distribution of License applicants with respect to sex/gender

In figure 15, 17.6% of candidates in the 2021 PE training were fe male while the remaining 82.4% of candidates were male.

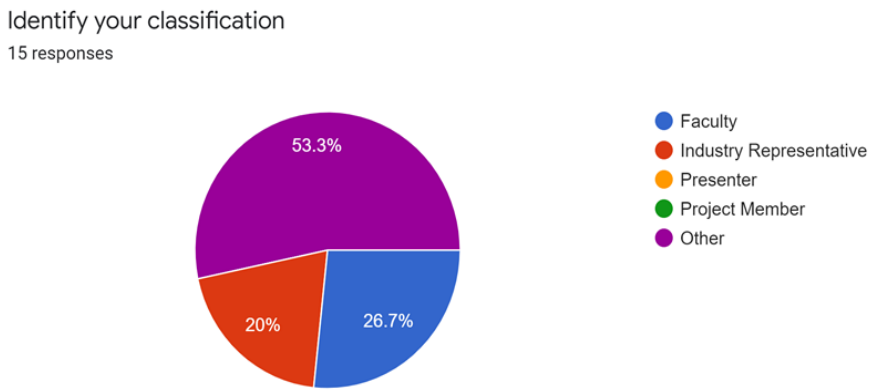


Fig. 16: Classification of participants

Figure 16 above shows a pie chart above shows the classification of the 15 recorded participants. The classification of "other" was the most common, taking up approximately 53.3% of participants. Faculty and Industry Representative were the next two largest classifications at 26.7% and 20% respectively.

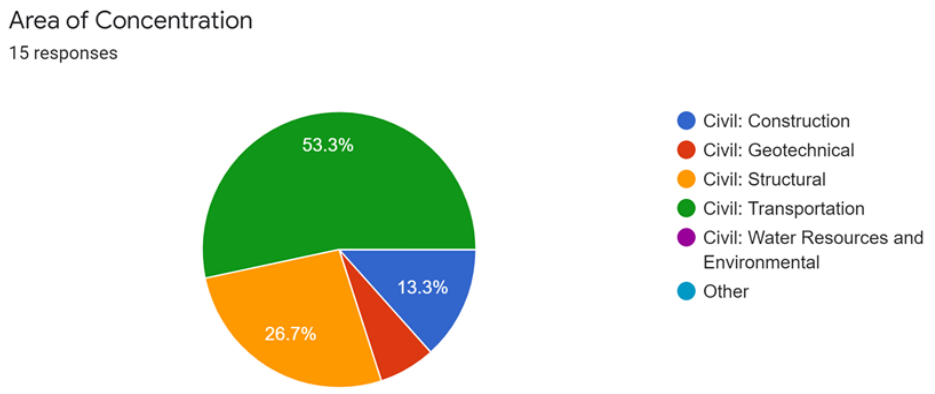


Fig. 17: Area of Concentration of participants

Figure 17 shows the majority of participants have a background in transportation (53.3%). This is ideal as the focus of the PE prep courses and analysis is geared towards that civil engineering sector. Structural was the next largest with 26.7% followed by those in construction at 13.3%. Geotechnical was the fourth largest while the other disciplines were not represented in the responses.

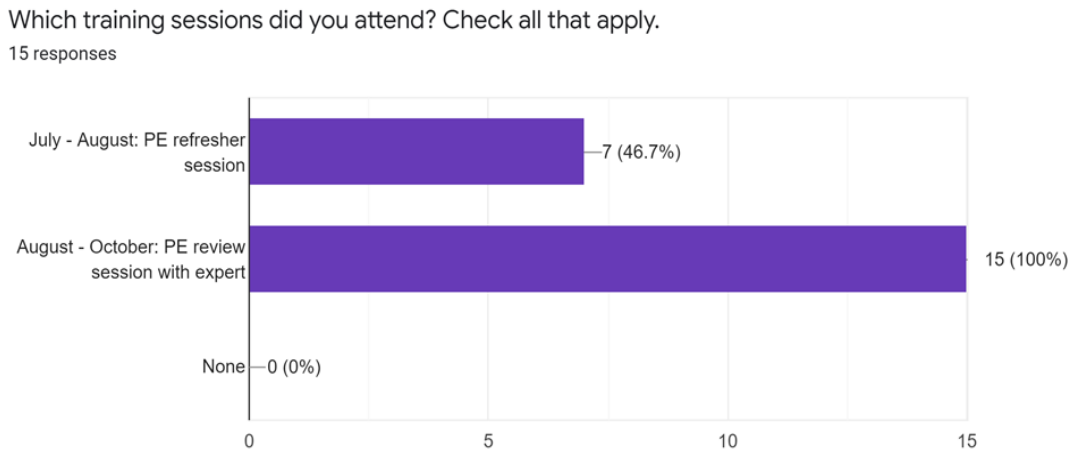


Fig. 18: Training Sessions attended by participant

Results and Discussions

Two training sessions were held during this study. The review sessions from August to October were attended by all 15 participants (100%) while the refresher training sessions from July to August were attended by just under half (46.7%).

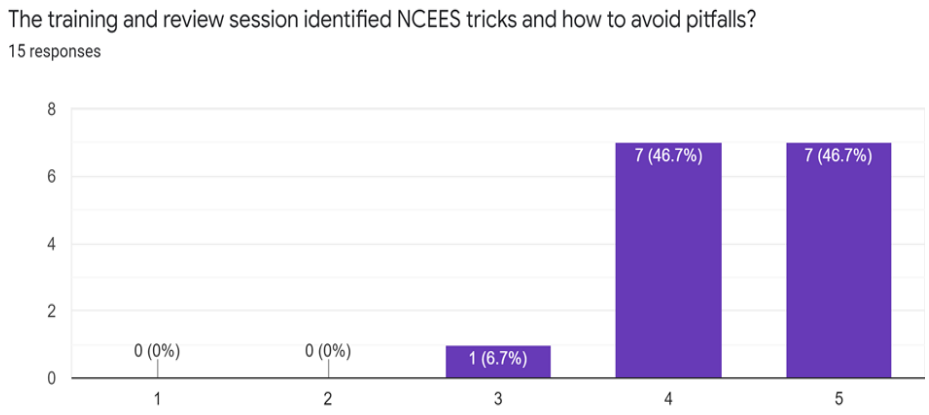


Fig. 19: Identification of NCEE tricks and pitfalls by training and review sessions.

In terms of feedback to the review sessions, 7 participants each responded with a 4 rating which is “agree” or a 5 rating which is “strongly agree ’that the PE training and review sessions helped them identify and the skills needed to avoid pitfalls in the PE exam. Only 1 participant gave a response of 3 which is considered “neither agree or disagree.” That being said, it is clear the feedback for this question overall is a positive one.

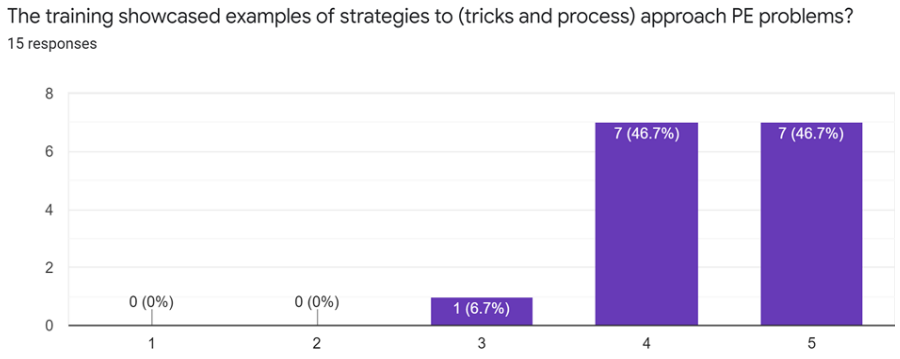


Fig. 20: Strategies showcased to approach PE problems during the training

7 candidates responded each with a rating of “agree” and “strongly agree" when it came to feedback on if the training gave examples of strategies to use when approaching the PE questions. Again, this was an overwhelming positive response.

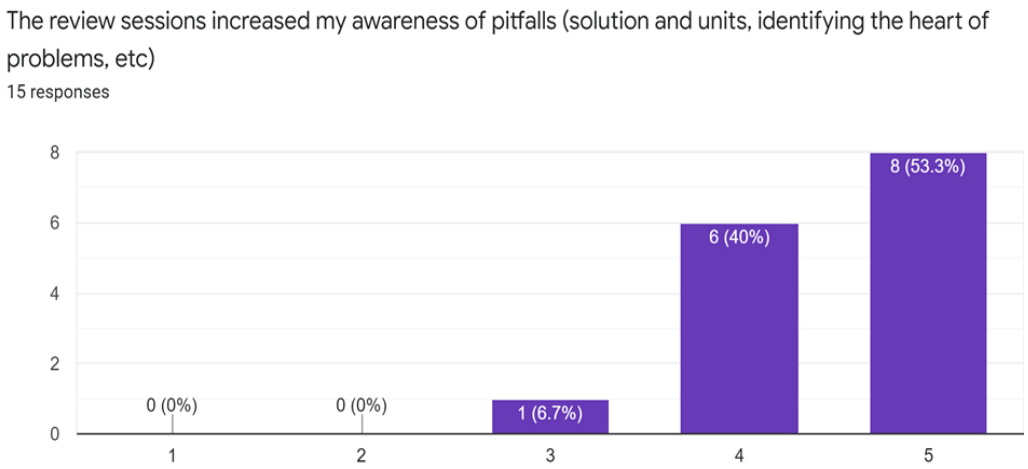


Fig. 21: Adequacy of review sessions in increasing awareness of pitfalls in the PE

More than half of participants strongly agreed that the review sessions increased their awareness of various pitfalls they could face in the PE exam. 4 felt they agreed while only 1 had a neutral view to provide as feedback.

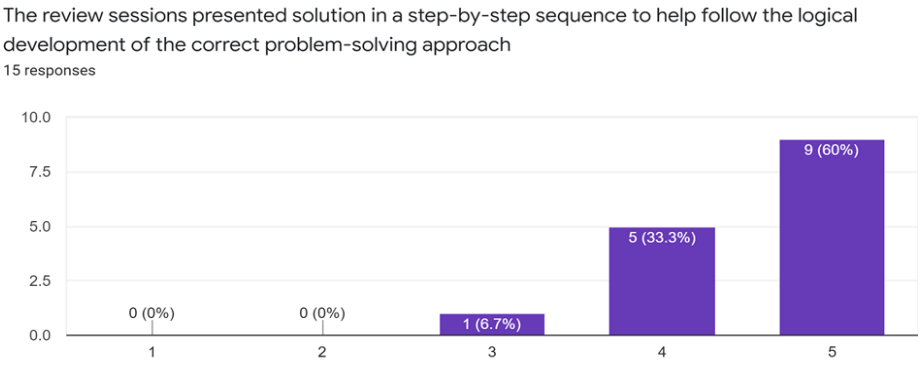


Fig. 22: Presentation of solutions in the correct problem-solving approach

60% of participants strongly agreed that the review sessions equipped them with solutions that were detailed in their development and explanation. 33.3% (5 candidates) agreed that solutions were presented in a solid and sequential manner while only 1 was neutral.

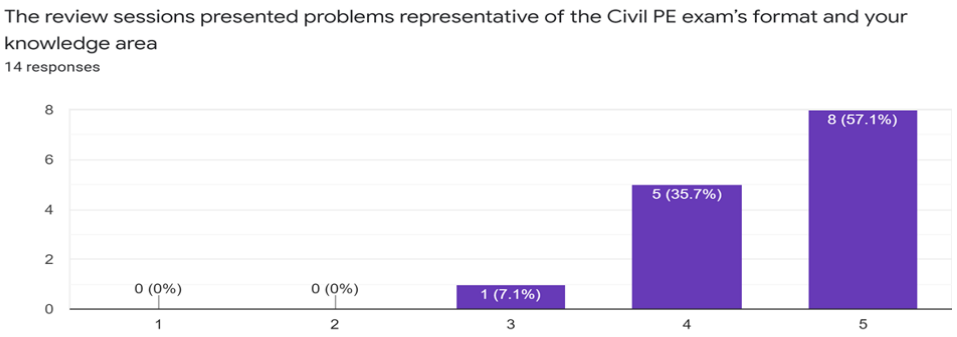


Fig. 23: Presentation of problems representative of Civil PE exam format during the review sessions.

Figure 23 saw 57.1% (8 candidates) strongly agreed that the review sessions presented review problems that were typical of the standard PE format. 35.7% also agreed to this assessment and once again only one candidate was neutral in his view of this area.

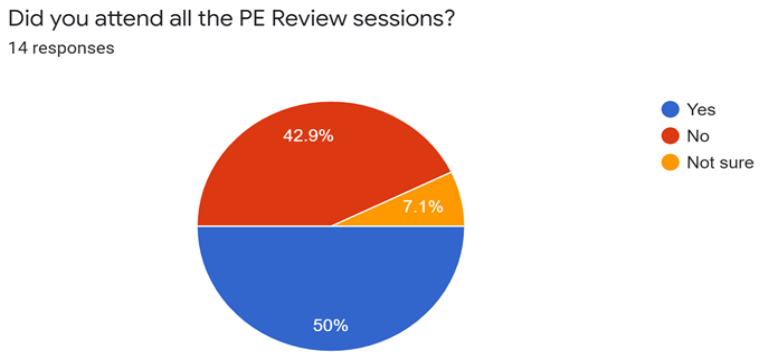


Fig. 24: PE Review sessions attended by participants

In figure 24, the pie chart displays that out of 14 responses, approximately half attended all the PE review sessions with a slightly smaller number at 42.9% revealing they did not attend every single session.

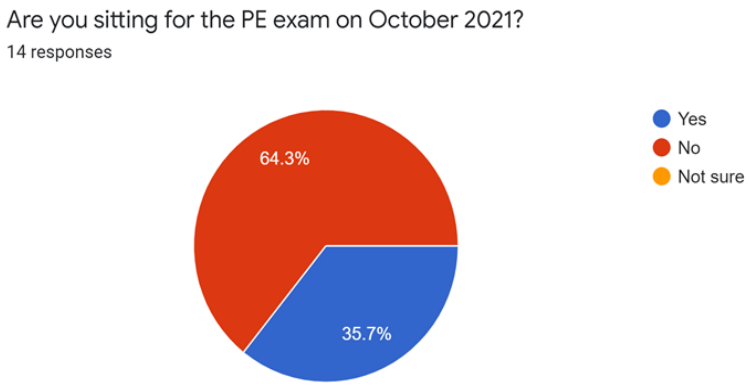


Fig. 25: Participants sitting for the PE Exam in October 2021

For the pie chart in figure 25, 64.3% of the 14 people that responded revealed they will be writing the PE exam in October 2021. 35.7% revealed they will not be doing so while no responses were recorded as unsure or uncertain.

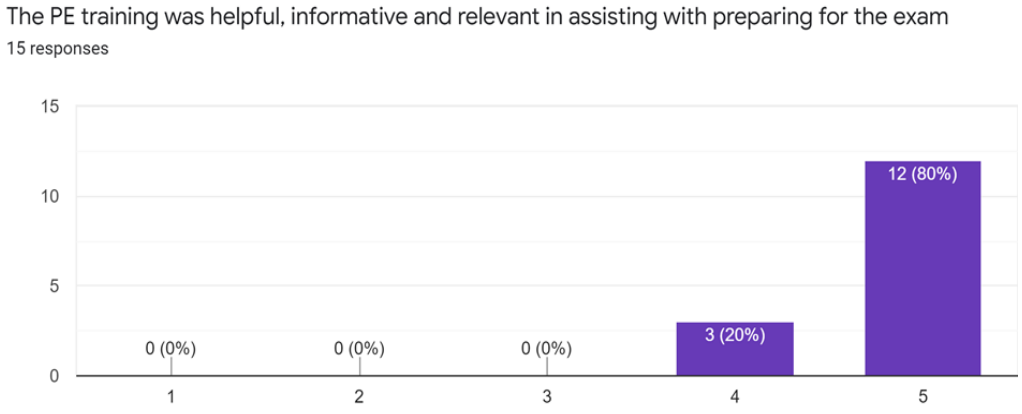


Fig. 26: Relevance of PE training in preparing for the exam

In figure 26 above, 80% of candidates strongly agreed that the PE training was relevant and helpful in preparing for the actual exam. The other 20% saw it as relevant and selected “Agree” for this question. Once again, an overwhelmingly positive response.

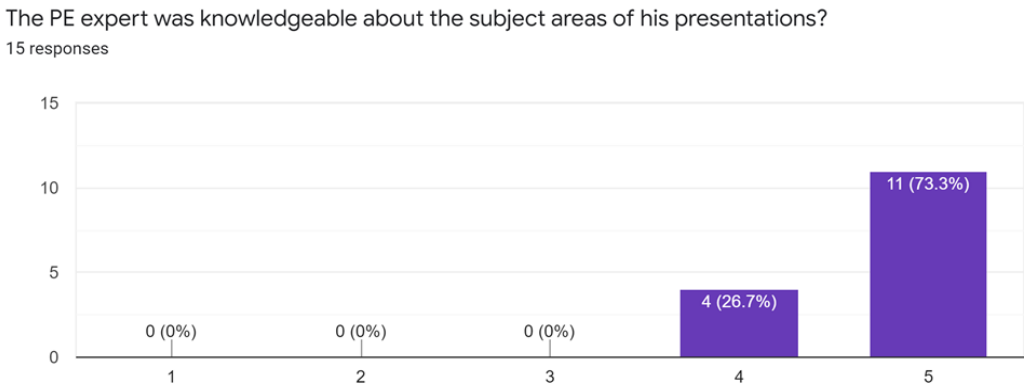


Fig. 27: Knowledge of PE expert on presentation subject areas

All the 15 candidates chose either a score of ``agree" or 'strongly agree" when responding to how knowledgeable the PE expert was during the training. 26.7% chose the former while 73.2% chose the latter in figure 27 above.

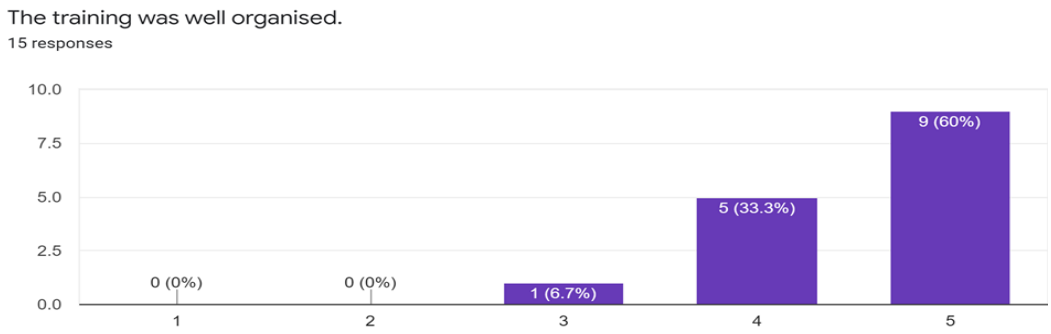


Fig. 28: Organization of the training

For figure 28, response of candidates to the organization of the training is recorded. Approximately 60% "strongly agree" that it was well organized, 33.3% "agree" it was well organized while 6.7% were neutral/undecided on this.

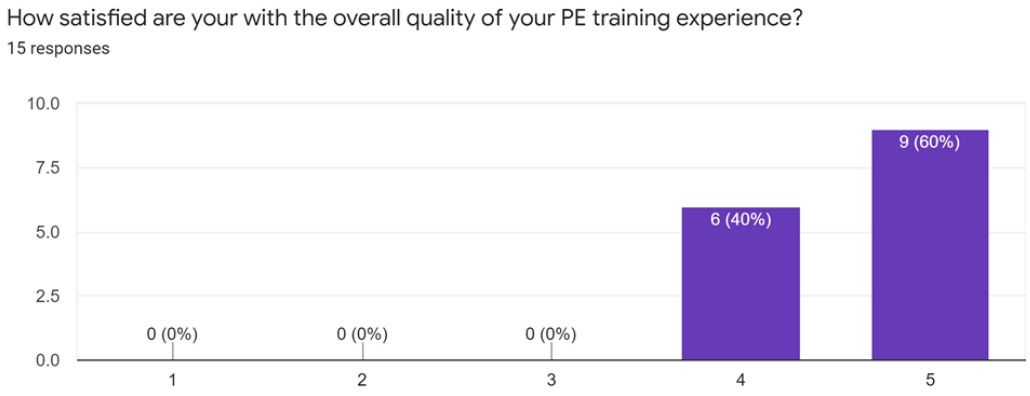


Fig. 29: Participant satisfaction with the overall quality of the PE training experience

In figure 29, 60% (9 people) were “strongly agreed” in terms of their satisfaction with the overall quality of the training while 40% (6 people) “agreed” to this. This is a testament to the efficiency of the instructors as well as the learning materials and resources provided during the training.

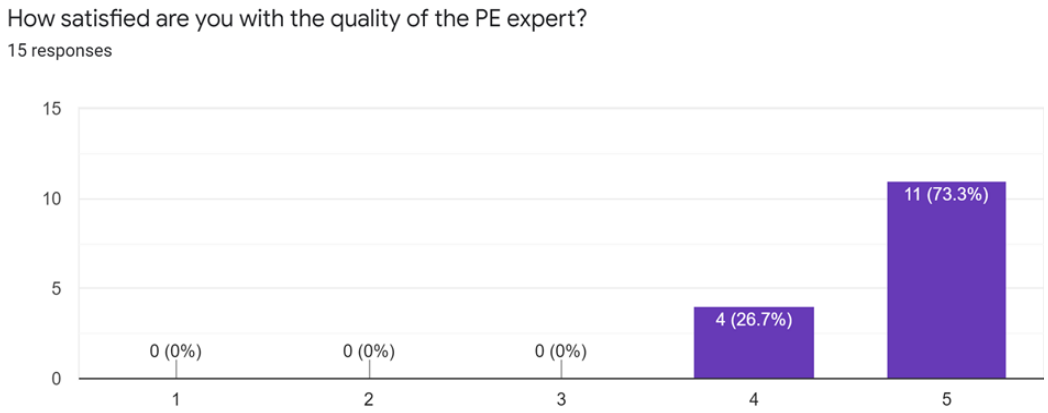


Fig. 30: Participant satisfaction with the quality of the PE expert

73.3% recorded the highest satisfaction (strongly agree) for the quality of the PE expert involved in the training while 26.7% recorded the next best rating of satisfaction in this metric in figure 30.

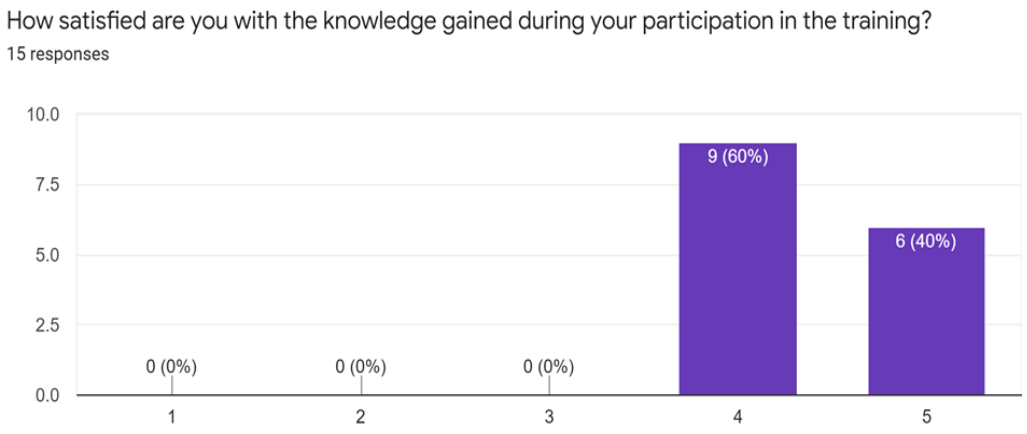


Fig. 31: Participant satisfaction with knowledge gained from participating in the training

In figure 31, 40% "strongly agreed" that they were satisfied with the knowledge acquired from their participation in the PE training. The majority, at 60%, agreed that they were satisfied with the knowledge gained during the training.

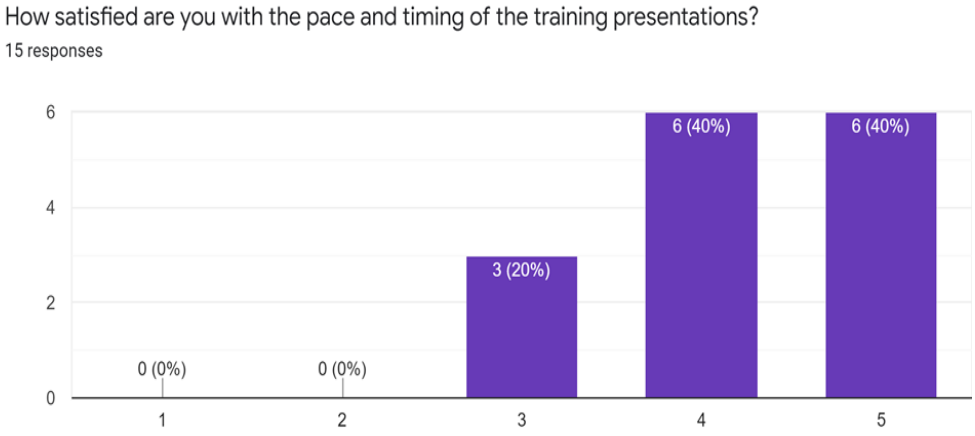


Fig. 32: Participant satisfaction with the pace and timing of the training presentations

In figure 32 above, 40% each selected "strongly agree" and "agree" with their satisfaction on the timing and pacing of the PE training presentations. 20% were neutral on the timing and pacing.

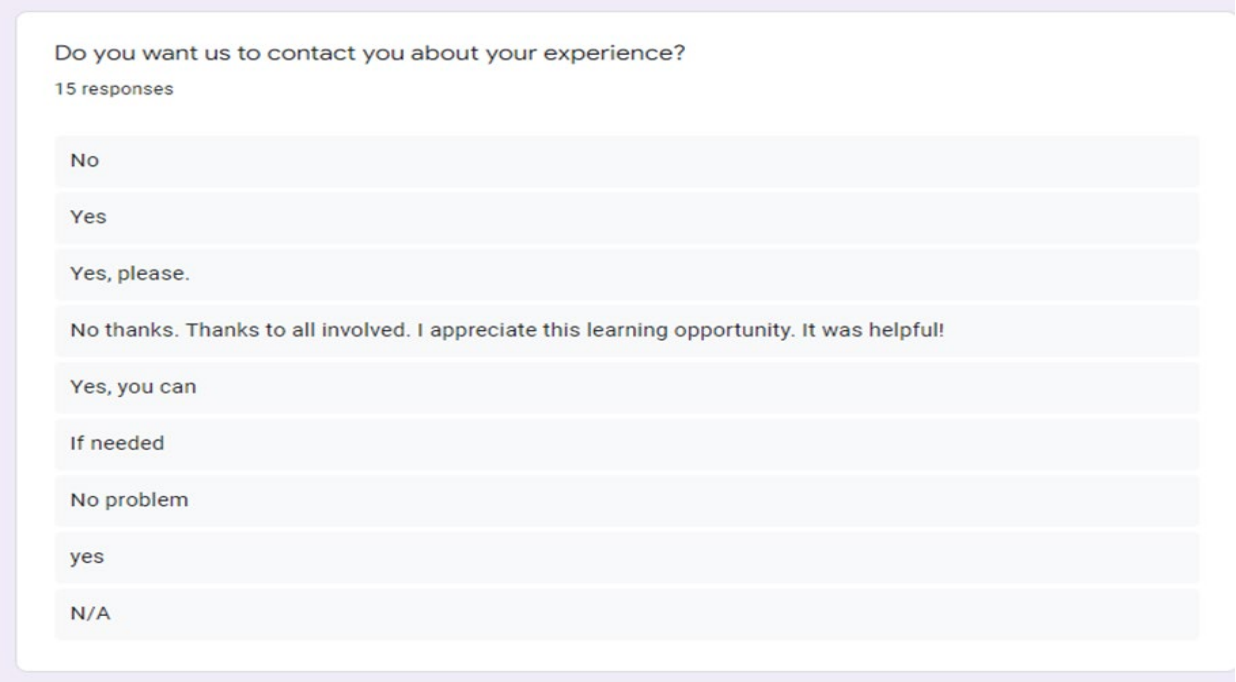


Fig. 33: Participants response to being contacted about their experience during the training

Figure 33 above shows the response of the candidates on whether they would like to be contacted and spoken to about their experience in the training. The responses show a wide variety from yes to no to one response being "if needed."

2.5: Data comparison from 2020 and 2021 Training Programs

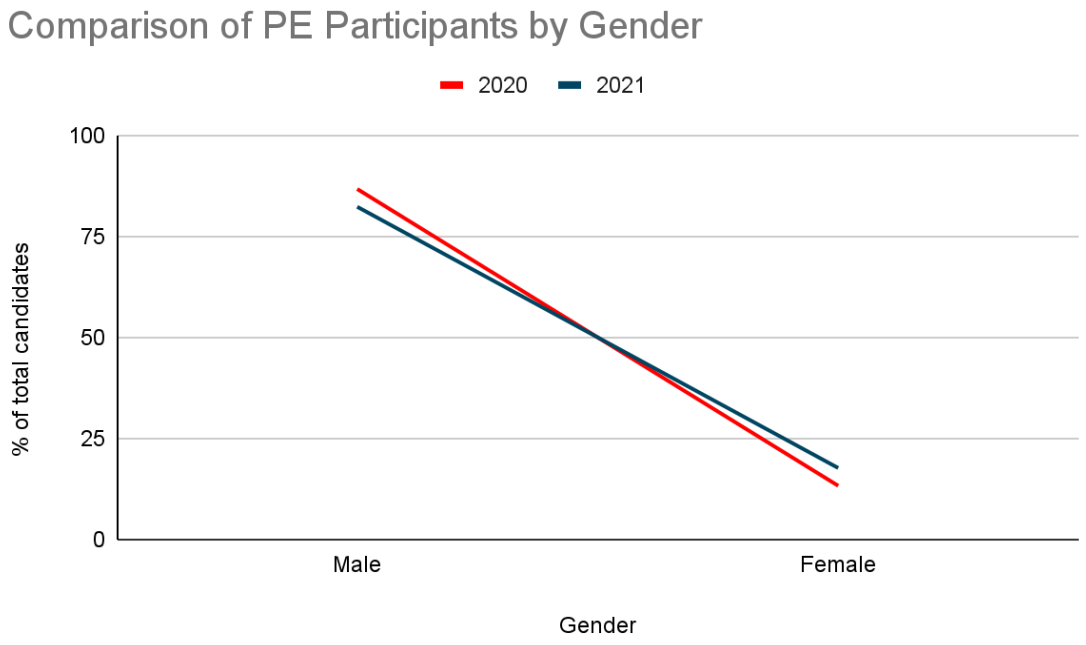


Fig 34: Comparison of participants by Gender from both 2020 & 2021

In figure 34 above, we see there was a slight decrease in percentage of male PE participants (by about 4.4% between 2020 and 2021 while the percentage of female candidates rose by 4.4% which indicates a slightly greater diversity of candidates in the training.

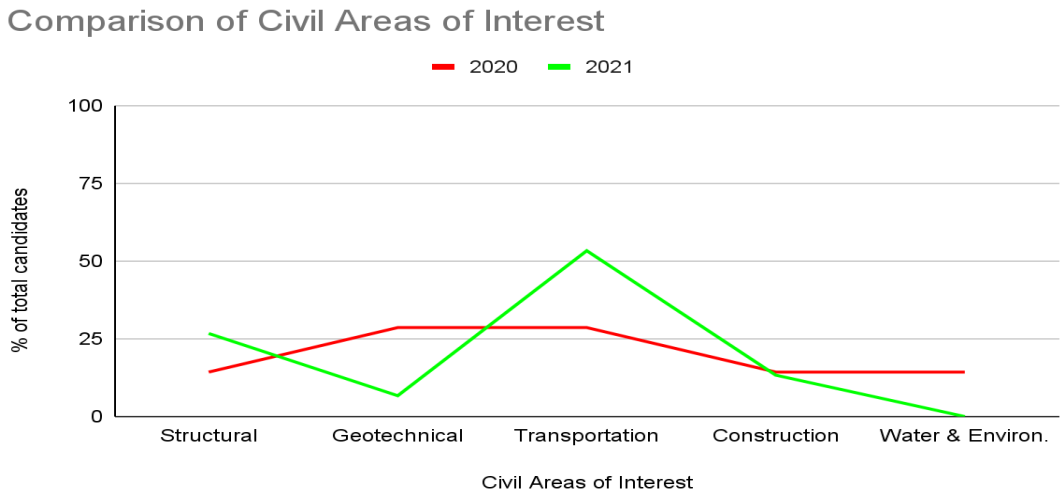


Fig 35: Comparison of Civil areas of interest from both 2020 & 2021

In figure 35, both Geotechnical and Transportation made up the largest portion of interest areas by participants in 2020 (both at 28.6%) while Transportation comprised the overwhelming majority of candidates in 2021. Transportation did experience the largest growth in candidates partaking in the PE training between 2020 and 2021; it grew by 24.7%. Structural candidates also grew by 12.4%, Geotechnical grew by 21.9%, candidates in the construction sector fell by 1% while Water and Environmental candidates fell by 14.3%; there were actually no candidates in this area that took part in the 2021 PE training.

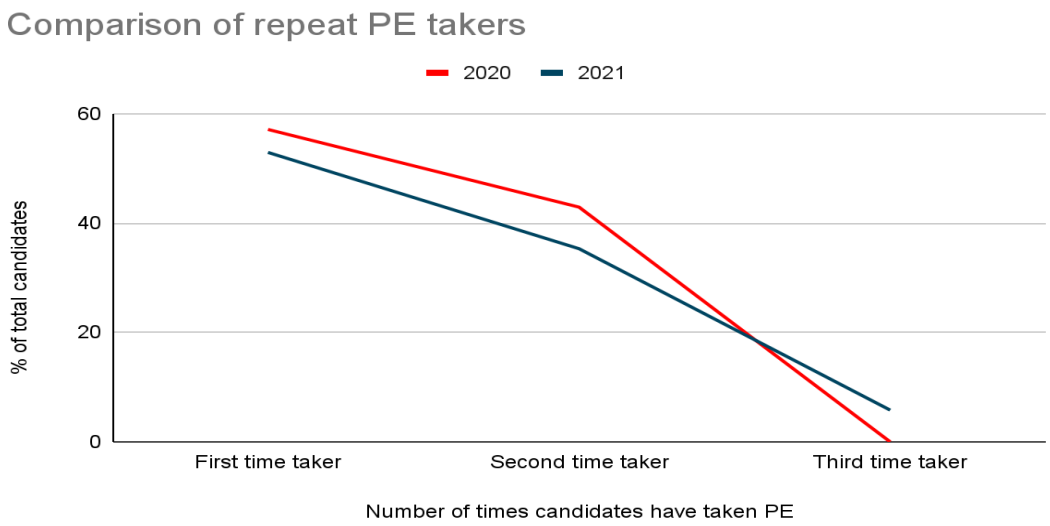


Fig. 36: Comparison of repeat PE takers from 2020 & 2021

In figure 36, the percentage of first-time takers of the PE fell by 4.2% in 2021 and the percentage of second time takers fell by 7.6%. However, seeing as there were no candidates taking the PE for a third time in 2020 third time PE takers grew by 5.8%.

Conclusions and Recommendations

Based on the data and line graphs given above, the PE training program between Morgan State University and CIAMTIS has been a very successful tool in its aim to provide more Transportation engineers the opportunity to become licensed and advance in their professional field. The overall diversity with respect to gender still needs to be improved upon but it is suggested a collaborative effort between organizations like the Society of Women Engineers (SWE) could help to address this issue.

Examining all the information and data given, structured PE exam training programs such as the one implemented in this paper can serve to equip candidates not only with the necessary knowledge and skills needed for the exam, but also the confidence and right mindset. Applying certain tips and strategies in conjunction with the necessary information to answer exam questions, taught by qualified teachers and PE instructors will ensure a higher pass rate for the exam and more engineers with PE license qualifications. This paper also supports the idea that a two stage training regimen such as the one carried out in this case study (with the initial review session followed by a more in-depth training session) will contribute to this as it raises the ability of students to greater retain information learned during the training.

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