Enhancing Petroleum-Engineering Education through Active Student Engagement, Hands-On Experience, and Technology Integration

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Abstract

The oil and gas industry is continuously changing; therefore, it is essential for petroleum engineering education to keep pace with these changes to keep attracting the brightest students. This is important because petroleum engineering schools need to prepare the future engineering leaders of the industry. The aim is to equip them with the essential skills and to make them agile and adaptive so they can use their technical background and experiences to attain new skills and tackle challenges whenever needed. Thus, the petroleum engineering (PETE) program at Texas A&M at Qatar (TAMUQ) has implemented different educational tools (integrative and cooperative capstone project, fourth-year comprehensive exam (CE), augmented reality and 3D visualization, field trips and laboratory simulators, engineering video games, programming and data analytics skills, 3D printing, research, soft skills enrichment program) to enhance the learning experience of petroleum engineering students and derive engineering education excellence. In this paper, the educational tools used and their role in achieving these goals are assessed and discussed. These tools are assessed through faculty observations, enrolment monitoring, and feedback from internship supervisors. The results show increased student enrolment in the program and improvement of students problem-solving, teamwork, communication, and thinking skills, as well as reinforcing theoretical concepts. In addition, the involved faculty members and internship supervisors believe that the educational tools improved students' learning experience, helped them in job interviews, and improved their employability.

Introduction

With the continuous change that the oil and gas industry is going through, it is crucial for petroleum engineering education also to change in order to enhance the learning experience of students and equip them with the necessary skills and knowledge that will allow them to keep pace with the ongoing change in the industry. This makes them agile and adaptive so they can use their technical background and experiences to attain new skills and tackle challenges whenever needed. To do so, it is important to implement different educational approaches. Active student engagement, hands-on experience, and technology utilization are some of the different ways that are used to achieve this goal.

Active student engagement is essential for an effective student learning experience as it promotes an interactive learning environment where students take responsibility for their learning instead of passively listening to lectures. In other words, Active student engagement promotes an

educational environment in which students learn by doing. Hernández-de-Menéndez et al. [1] showed that active student engagement helps achieve student learning outcomes and better conceptual understanding. Other studies concluded that active student engagement improves students' motivation to learn, as well as academic performance and achievement [1], [2].

Another educational method that has a great positive impact on the learning experience of students and is related to active student engagement is hands-on experience. This method allows students to put what they have learned theoretically into practice [3]. In addition, it helps students connect theoretical knowledge with real-world applications. Internship is an educational tool that offers such hands-on experience to students and, at the same time, improves their chances of getting employed after graduation [4]. Other advantages of hands-on experience based educational tools are promoting the development of different skills such as teamwork, communication, and adaptability, which are important for success in a professional work environment [5], [6]. Furthermore, they also help in improving creative thinking, critical thinking, and problem-solving skills [7].

The continuous change in the oil and gas industry also comes with rapid technological advancements that dictate the utilization of different technological tools, programming, and data analytics in engineering education. Such technology integration into engineering education is beneficial in enhancing students' learning and professional development [3]. Although such technological integration in some traditional teaching methods could be expensive and hard, it helps students understand fundamental engineering concepts [8]. Two benefits of using technology in engineering education are: (1) enabling students to virtually participate in field trips that they are not able to participate in physically, and (2) allowing students to virtually go into reservoir models to understand them better, which is impossible to do in real life [3]. Thus, it improves their critical thinking and problem-solving skills. On the other hand, the integration of programming and data analytics in petroleum engineering education is very important as they teach students how to analyze and interpret big data, which is exactly what petroleum engineers are doing daily to make well-informed decisions.

This comprehensive study explains how different educational tools that fall under the three main methods discussed above, namely, active student engagement, hands-on experience, and technology, are integrated into petroleum engineering education. The development and use of these tools are due to feedback from different industry partners that are represented by the program Industry Advisory Board (IAB) members. The nine used educational tools are:

1. integrative and cooperative capstone project,
2. fourth-year comprehensive exam (CE),
3. programming and data analytics skills,
4. soft skills enrichment program
5. virtual / augmented reality and 3D visualization,
6. field trips and laboratory simulators,
7. 3D printing,
8. undergraduate research, and
9. internship.

The details of how these tools have been used in the petroleum engineering (PETE) program at Texas A&M university at Qatar (TAMUQ) to improve students' learning experience and to achieve learning outcomes, are provided in the following subsections. These details include the observations of the faculty members as well as the feedback from industry partners (i.e. internship supervisors). Four of these nine educational tools (i.e. virtual / augmented reality and 3D visualization, field trips and laboratory simulators, 3D printing, and undergraduate research) and their benefits have been discussed in the authors' previous publications [3], [8], [9], [10], [11], however the results of these publications are provided again here to make this study a comprehensive reference for the reader.

An Integrative and Cooperative Capstone Project

Starting in 2017, the PETE program at TAMUQ set a mission to change the senior capstone design project in a way that enhances the learning experience of fourth-year students as well as exposes them to all aspects of development planning of oil and gas fields. Both onshore and offshore fields are considered, focusing on regional carbonate fields that are known to be the most challenging ones in the industry. As a result, students get the chance to practice all they have learned during their studies in the PETE program to complete a one-year-long and detailed enough field development project. Teams of three-to-four students work together in each capstone design project. In this project, multiple instructors and industry professionals are involved, but they only work as mentors, and the students are the ones who lead all the project work. The development plan includes reservoir modeling, performance analysis, simulation, production, drilling, economic analysis, risk assessment, uncertainty analysis, and reservoir optimization plan. It also incorporates realistic economic, environmental, and sustainability as well as other constraints associated with the reservoir and field following different industry standards such as the American Petroleum Institute (API) and the Society of Petroleum Engineers (SPE) standards. To reflect on this and show their awareness, the teams are required to develop a plan that demonstrates how they will consider public health, safety, and welfare, as well as global, cultural, social, environmental, and economic aspects in their field development plan.

The deliverables of this project are individual and team presentations as well as a final report. The individual presentation is delivered in front of the program faculty members, who provide their feedback to each student as well as each team to improve their presentations. While the final team presentation is the most rewarding experience for the students as it is delivered in front of a panel of oil and gas industry representatives with 7 to 35 years of experience. This panel discusses the projects with the teams and judges the quality of their work.

To support the senior capstone design project and enhance the learning of students, the PETE program has implemented a project-based learning approach in different related courses. This was done through a multiyear plan based on adding projects to drilling engineering, production engineering, reservoir engineering, formation evaluation, and economics courses that are connected to the capstone design project. In other words, all technical skills needed to complete the senior capstone design project successfully were divided into small projects and assigned to

their related courses. By doing so, students were able to directly apply what they had learned in each course to a realistic project. Thus, by the time they are assigned the senior capstone design project, they will be equipped with all the necessary technical skills.

Fourth-year Comprehensive Exam

As students conclude their academic journey, the last year of university is the most important one because they start to apply what they have learned in previous years to solve complex engineering problems. The senior capstone design project is a central part of the final year in many academic disciplines. Students will get the chance to demonstrate their ability and apply their knowledge and skills to situations in the real world through this project. However, to excel in senior capstone design, students must thoroughly understand every course they have taken in their academic program to be able to undertake the obstacles that their projects pose. That is because they are required to combine information from various courses and apply it to solve complicated challenges in those projects. Thus, the PETE program at TAMUQ developed a comprehensive exam (CE) for the senior (fourth year) students that they must pass to enroll in the capstone design projects. This exam covers the most critical subjects in the petroleum engineering field, which are significant for our students to succeed as petroleum engineers. This initiative helps make the senior design project experience more educational. It also allows students to revise and reinforce their academic knowledge, which is essential for succeeding in job interviews. Therefore, it enhances the quality of graduates from the PETE program at TAMUQ.

Programming and Data Analytics Skills

In recent years, the oil and gas industry has undergone a tremendous transformation toward automation and digitization. Sensors, meters, and other monitoring tools in this area generate a large amount of data. Because of this, data analytics skills are becoming more important. Engineers skilled in data analytics can do predictive maintenance to foresee and stop equipment problems, minimizing downtime and associated expenses. For example, inefficiencies in production can be found, and processes can be improved by analyzing production data. At the same time, the oil and gas industry is embracing the digital oilfield concept, where real-time data from various sources are collected, integrated, and analyzed to improve decision-making. Experts in this area who can apply data analytics techniques to gain meaningful insights from this vast amount of data are required. By identifying significant patterns, trends, and correlations, professionals in the sector can maximize the value of these data.

Companies are investing in cutting-edge technology like artificial intelligence (AI) and machine learning (ML) to fully utilize data analytics skills in the oil and gas business. These tools make it possible to automate data analysis procedures, create prediction models, and draw conclusions from big and complicated datasets. Professionals skilled in data analytics are better able to use these cutting-edge technologies and promote innovation in the sector.

Thus, for students to succeed in the future, programming and data analytics abilities are essential. Students gain logical reasoning and analytical thinking abilities by learning how to code. Additionally, they gain the ability to deconstruct complicated issues into more manageable chunks and create algorithms to solve them. By using this method, they become better at approaching problems methodically and forming creative solutions. As students may utilize their coding knowledge to bring their ideas to life and develop interactive projects, programming abilities can promote creativity. Instructing students in coding languages like Python can give them a strong basis for building their understanding of programming's core ideas.

To improve students' knowledge of programming and data analytics, two courses have been added to the curriculum. The first one is ENGR 102 Engineering Lab I - Computation. The design and creation of computer applications for engineers are covered in this course, along with the use of computation to improve problem-solving skills. PETE 219, Foundations of Petroleum Data Analytics, is the second course. In this course, the introduction to petroleum data analytics and calculations is covered. Besides these two courses, other courses in the PETE Program at TAMUQ are required to have programming and data analytics components as well. In those courses a couple of assignments related to programming and data analytics are added. By doing so, the PETE program ensured that the students not only learn about programming and data analytics in only two courses but also have the chance to reinforce and master what they have learned by applying them in other courses. This also allows them to extend the depth and breadth of their programming and data analytics skills.

Soft Skills Enrichment Program

Soft skills are as important in the job market as technical skills because they affect how one works or interacts with others, which also aids in furthering the career. These skills include work ethics, oral and written communication skills, teamwork skills, and problem-solving and critical thinking skills.

The PETE Program at TAMUQ worked internally with the Office of Advancement and the Writing Center at TAMUQ to prepare and implement an enrichment program that equips students with all necessary soft skills before graduation. The enrichment program includes report and scientific paper writing, presentations, and workshops. Workshops are delivered as components of courses or separately. The program extends from the sophomore year to the senior year. The reason for this is to introduce the skills in the sophomore year, reinforce them in the junior year, and master them in the senior year.

The oral and written communication skills enrichment program will be considered here as an example. In the sophomore year, students attend three workshops to develop new skills, two for technical writing and one for presentation skills. In their junior year, they attend seven workshops: two for resume writing and professional communication, two for technical writing, two for presentation skills, and one for presentation feedback. In addition, as a part of PETE 336 course (See Table A1 for details) in the fall semester, students do research on a technical topic of

their selection and present their findings before a panel of industry representatives in the spring semester as a part of PETE 337 course. This panel judges the quality of their presentations (slides and delivery) and provides feedback. The panel also selects the best three presenters to receive awards, which generates a competitive environment that encourages students to work hard and give their best. Next, during the senior year, students attend two team building workshops and one presentation skills workshop, then conduct more detailed research and prepare a research paper following the Society of Petroleum Engineers (SPE) paper format as a part of the PETE 436 course in the fall semester. After that, they present their work again before an industry panel of professionals in the spring semester as a part of the PETE 437 course. The panel provides feedback and selects the best three presenters to receive awards. Finally, students attend a mock interview that is conducted by experts from SLB company, which boosts their confidence and provides them with invaluable experience in real job interviews before graduation. Thus, the enrichment program helps the PETE students develop their technical writing, presentation, communication, and teamwork skills by the time of their graduation, which smooths their transition from students to industry professionals and distinguishes them from other fresh graduates. Table 1 shows the enrichment program that has been developed in collaboration with the Office of Advancement and the Writing Center at TAMUQ. The table shows the workshops, whether they are delivered within a course or not, the semester and the year they are delivered. The names and main objective(s) of the courses listed here are provided in Table A1 in the Appendix.

Table 1-The PETE soft skills enrichment program developed in collaboration with the Office of Advancement and the Writing Center at TAMUQ.

Year	**Sophomore (2nd Year)**		**Junior (3rd Year)**					**Senior (4th Year)**				
Semester	**Fall**	**Spring**	**Fall**	**Spring**				**Fall**		**Spring**		
Course	**PETE 225**	**PETE 311**	**PETE 310**	**-**	**PETE 325**	**PETE 336**	**PETE 337**	**PETE 404**	**PETE 436**	**PETE 402**	**PETE 437**	**-**
Workshop 1	LRB	TRW 1	TRW 2	RW&PC 1	TRW 3	PS 3	PF 1	TB 1	PS 4	TB 2	PF 2	SLB-MI
Workshop 2	-	PS 1	PS 2	RW&PC 2	-	-	-	-	-	-	-	-

LRB: Lab Report Writing, **TRW:** Technical Report Writing, **PS:** Presentation skills, **RW&PC:** Resume Writing and Professional Communication, **PF:** Presentation Feedback, **TB:** Team Building, **SLB-MI:** SLB Company Mock Interview

Virtual / Augmented Reality and 3D Visualization

Field trips help bridge formal and informal learning by connecting the students to real-world experiences. Field trips are one way of adding variety to instruction, thus optimizing teaching effectiveness while motivating student learning. Despite research confirming enhanced learning, it is not usually feasible to arrange field trips due to several logistical and safety reasons, especially for offshore rigs. The PETE program at TAMUQ developed two virtual reality field trips in 2017, one to an offshore rig and the other to a Middle Eastern petroleum reservoir outcrop analog. Since 2017, the PETE continuously used these two virtual field trips in education. Through these two field trips, the PETE program managed to bring real-world

petroleum facilities and structures to the classroom. The goal is to increase the students' interest, promote their curiosity, and enhance their learning experience by using these innovative teaching methods in courses. In addition, using these technologies improves teaching effectiveness by offering an active learning environment that provides hands-on experience. Therefore, virtual and augmented reality are becoming the industry standard for employee training. Figures 1 and 2 demonstrate the use of the CAVE (Cave Automatic Virtual Environment), and HMD (Head-Mounted Display) in an ongoing class session at TAMUQ.

Fig. 1-Students experiencing the VR application in TAMUQ CAVE (left) and HMD headsets (right) [3].

Fig. 2-Screenshots of the virtual field trip VR application [12].

Another utilization of technology to enhance education in the PETE program at TAMUQ is developing an interactive magazine with augmented reality to provide the students with a virtual journey to an offshore rig. This magazine was innovated during COVID-19, to ensure that

students can visualize and understand different component of an offshore rig, namely, drilling floor, derrick, Kelly bushing and rotary table, Kelly and Kelly hose, swivel, traveling block and crown block, drawworks, drilling pipe, drilling bits, and blowout preventer. In addition to all the previous components, the magazine included supporting text to answer "what, why, and how" these rig components are used. Figure 3 shows an example of the interface students see when accessing the 3D models in the developed magazine.

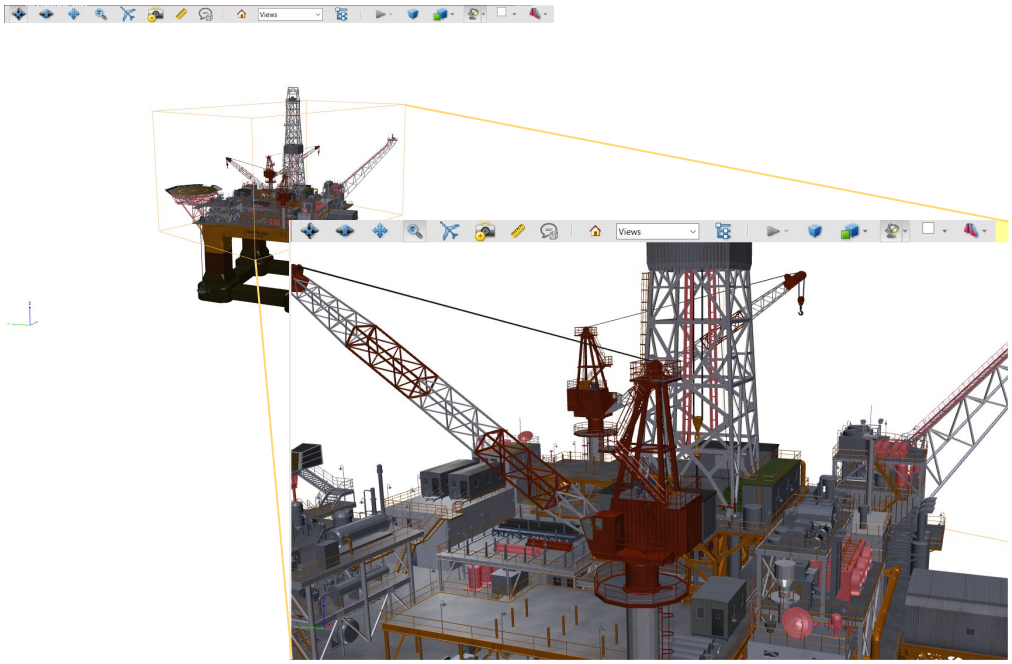


Fig. 3-The interface students see when accessing the interactive 3D magazine [10].

Field Trips and Laboratory Simulators

Engineering students must produce solutions that meet specific needs considering several factors. Accreditation bodies require this as part of preparing students for their professional practice. Therefore, practical experience is one of the key elements in engineering education. Based on that, engineering programs need to offer real field trips related to their areas. Field trips offer an experience that connects students to the real world. In petroleum engineering, a field trip to a drilling rig site provides students with information about drilling rig components, drilling fluids, drilling operations, and safety during the drilling process. In addition, the field trip allows the student to experience the real-life work environment in the oil and gas industry. Figure 4 depicts a group of PETE students during their field trip to an onshore rig. Field trips also help engineering students to relate what they learn in their courses with industry applications. In addition to real field trips, the use of a drilling training simulator or software simulator also augments the learning process. Figure 5 shows a drilling simulator in the PETE laboratory at TAMUQ that is being used to train students on the process and control while drilling a well. Both the field trips and the drilling simulator offer exceptional hands-on experience that boosts the motivation and curiosity of students, hence enhancing their learning.

Fig. 4-Petroleum Engineering student at TAMUQ field trip to a drilling rig.

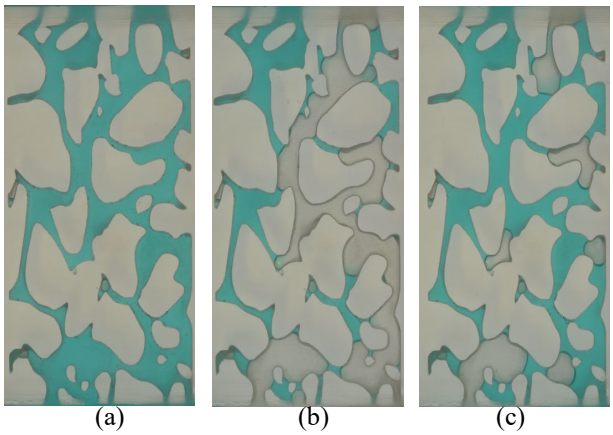
Fig. 5-A student being trained on how to use the Petroleum Engineering drilling simulator at TAMUQ.

3D Printing and Visual Learning

In 2019, the petroleum engineering program started featuring visual learning projects to enhance understanding of abstract concepts and field operations. That is because students in petroleum engineering majors are introduced to various topics during their undergraduate studies, such as subsurface flow, which are hard to understand. To address this issue, a distinct project has been introduced.

The aim of this project is to create macro-fabricated transparent models of porous media (macro-models) from realistic and synthetic rocks using 3D polymer printing. These macro-models serve as a pedagogical tool, enabling students to visualize drainage and imbibition processes directly,

thus providing an enhanced understanding of multiphase fluid flow within porous media. Seers and Alyafei [13] developed software to generate a macro-model of the project from micro-CT scan images in stereolithography (.stl) file format to be 3D printed. The software is also equipped with a tool that allows the generation of complete self-contained flow cells for the macro-models, which makes conducting flow experiments accessible and repeatable. The experimental procedure for the study of multiphase flow using 3D printed macro-models follows the same one used for equivalent etched/molded models of porous media and documented in the study of Idris et al. [14]. Those macro models enable a visual demonstration of drainage and imbibition, highlighting the effects of pore geometry over each process. For drainage, students directly observe the gas phase filling the pore spaces, draining the water out of the system, and eventually reaching the irreducible water saturation (S_{wir}). The imbibition and waterflooding to achieve the residual gas saturation (S_{gr}) can be readily observed using the 3D printed macro-model-based experiments, providing students with strong visual cues to otherwise abstract multiphase fluid processes occurring within hydrocarbon reservoirs. Figure 6 shows the top view of the printed 3D models with drainage and imbibition processes. In addition, in the same project, students are required to estimate several petrophysical properties such as porosity, grain size distribution, fluid saturation, contact angle, and displacement efficiency using open-access image processing software.



(a) (b) (c)

Fig. 6-3D printed macro-models showing (a) the model is fully saturated with water (blue), (b) the model after drainage with air to achieve the irreducible water saturation, and (c) the model after imbibition to achieve the residual gas saturation [8].

Undergraduate Research

Qatar National Research Fund (QNRF) has established and funded the Undergraduate Research Experience Program (UREP) for many years to develop research infrastructure in Qatar. In addition, TAMUQ has its own undergraduate research programs established for the same purpose. The PETE Program at TAMUQ is making full use of all these programs to allow as many students as possible to perform research before they graduate. This helps in enhancing both the quality of instruction and the way in which students learn by giving them an active learning environment and more opportunities for hands-on experience. Another benefit that

undergraduate research offers to students is the ability to present their work at international conferences or publish it in international journals. This also helps students develop their technical writing and communication skills. Figures 7 and 8 show results published by Abdulhussein et al. [15] (An undergraduate student at the time of conducting the research) at the 81st EAGE Conference & Exhibition.

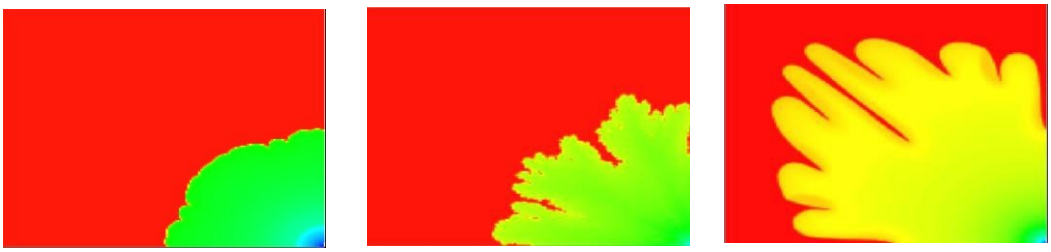


Fig. 7-Schematic showing simulated viscous fingering in water, oil, and mixed wet in a homogeneous rock system.

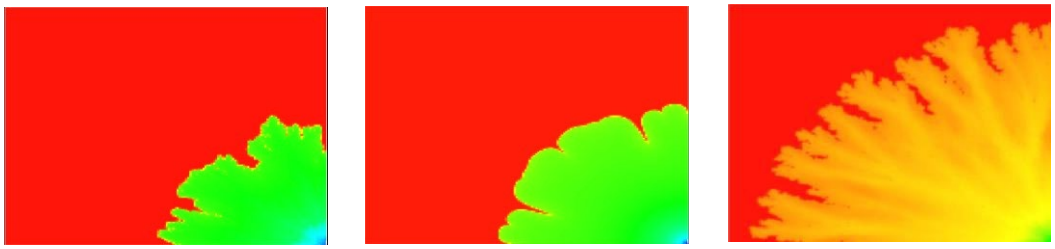


Fig. 8-Schematic showing simulated viscous fingering in water, oil, and mixed wet in a heterogeneous rock system.

Internship

Students in the PETE program at TAMUQ must complete an internship, which is considered a high-impact, hands-on experience, in a company that is working in the oil and gas industry to be able to graduate. This internship must be completed in the summer between the third and the fourth year of their study (when they complete their junior year), and it should not be less than six weeks of full-time employment (i.e. 30 working days) under the supervision of industry experts. This allows the students to gain a short work experience that not only introduces them to the work environment but also helps them integrate their academic work with real-world practices and enhance their employability. In addition, this opportunity helps them improve their analytical abilities, as well as their technical and communication skills.

Results and Discussions

The used educational tools are evaluated mainly by three methods, which are faculty observation, monitoring of enrollment in the program, and feedback from internship industry supervisors. For the faculty observation, the authors of this paper, who are faculty members in the PETE program at TAMUQ, kept track of the progress of four batches, namely the 2021,

2022, 2023, and 2024 batches. The students' progress in these batches is monitored starting from their sophomore year (2nd year) as it is the year in which they start to take the PETE major courses and get introduced to the educational tools discussed earlier. Different tools are used in the assessment, namely, exams, presentations, technical reports, surveys, and one-to-one meetings with students. The assessment results show improvement in students' critical thinking, problem-solving, teamwork, and communication skills. In addition, students reported that the utilized tools enhanced their learning experience, motivation, and engagement. Furthermore, the students reported that the educational tools helped them develop a deeper understanding of the content and improved their understanding of the work environment.

Another assessment tool that is used to evaluate the impact of the educational tools is the monitoring of student enrolment. Although enrolment of undergraduate students in many PETE programs worldwide is decreasing, and some had to close, the student enrolment in the PETE program at TAMUQ in the last six years clearly shows an inverse trend with a continuous increase (Figure 9). This is attributed to the implementation of the educational tools discussed herein. That is because the use of these educational tools and their positive impact on the graduates of the program are presented every year to high school students and their parents through multiple outreach and university events to attract them to join the program.

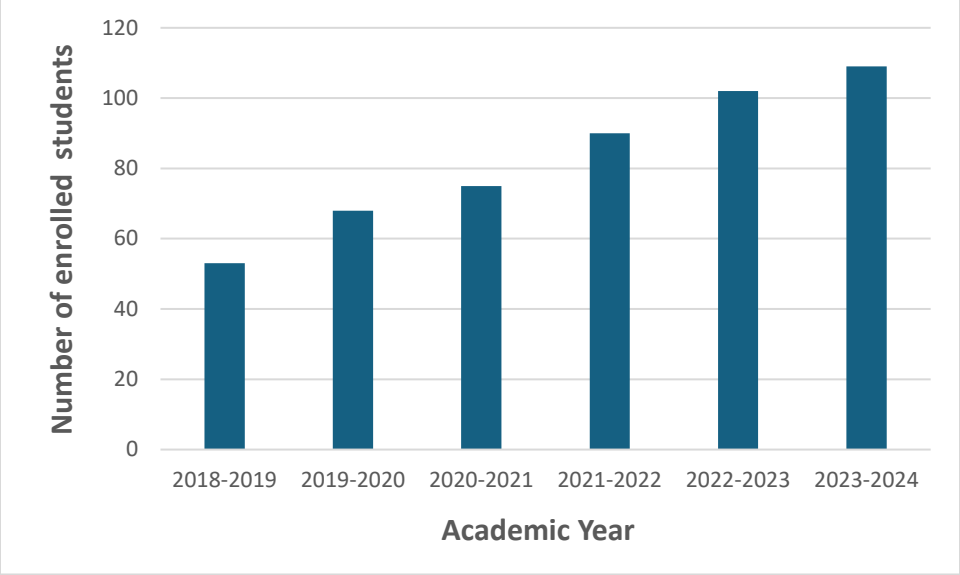


Fig. 9-Number of total undergraduate students enrolled in the PETE Program at TAMUQ every academic year starting from 2018-2019.

The third method of assessment is based on feedback from the internship supervisors, who also represents the employers of PETE program's graduates. 56 internship supervisors of junior PETE students from the 2021, 2022, 2023, and 2024 batches provided their feedback regarding the qualities of these students. More than 80% of the internship supervisors believe that the PETE students at TAMUQ have very good qualities that make them ready for the transition into the industry once they graduate. In addition, 95% of the supervisors indicated that the students were able to achieve the required results of their internship projects, which is due to their very good

analytical abilities, technical skills, and discipline. Besides, 92% of the supervisors believe the students have very good communication skills. Based on that, some of the junior students of the program were recommended by their internship supervisors for permanent job posts and received their job offers even before they graduated from the program.
As a result, it can be said the internship opportunity as well as the other used educational tools helped the PETE graduates in their job interviews and improved their employability.

Conclusion

The petroleum engineering education needs to follow the change that is going in the oil and gas industry to keep attracting the brightest minds and prepare them to be the future leaders of the industry. To do that, petroleum engineering schools should equip them with the necessary abilities and improve their agility and adaptability to enable them to utilize their technical knowledge and experiences to acquire new skills and take on problems as they arise. As a result, the PETE program at TAMUQ has implemented nine different educational tools to improve the learning experience and achieve excellence in petroleum engineering education. This comprehensive study explains how these educational tools that fall under three main methods, namely, active student engagement, hands-on experience, and technology integration, are integrated into petroleum engineering education to attain these goals. The used educational tools are (1) integrative and cooperative capstone project, (2) fourth-year comprehensive exam (CE), (3) programming and data analytics skills, (4) soft skills enrichment program, (5) virtual / augmented reality and 3D visualization, (6) field trips and laboratory simulators, (7) 3D printing, (8) undergraduate research, and (9) internship.

These tools are evaluated by faculty observation, monitoring of enrollment in the program, and feedback from internship industry supervisors. The results show that the educational tools improved the students' teamwork and communication skills, as well as allowed them to connect all that they have learned during their four years of undergraduate study and apply them to solve real-world problems. In addition, the results indicated that the educational tools enhanced the student's learning experience, motivation, and engagement, helped them develop a deeper understanding of the content, and improved their understanding of the work environment. Finally, the results show that the internship industry supervisors are very satisfied with the quality of the TAMUQ PETE students and their skills. Based on these results, it can be concluded that the utilized educational tools helped in attaining different course learning outcomes, in equipping the students with the required technical knowledge and experiences, and the necessary skills that increase their employability and put them on the right track to be the future leaders of the industry.

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Appendix

Table A1-Names and main objective(s) of the courses used to implement the soft skills enrichment program in the PETE program at TAMUQ.

Course code	Course name	Main course objective(s)
PETE 225	Introduction to Drilling Systems	write simple lab reports
PETE 311	Reservoir Petrophysics	write comprehensive lab reports
PETE 310	Reservoir Fluids	write comprehensive lab reports
PETE 325	Petroleum Production Systems	write comprehensive lab reports
PETE 336	Petroleum Technical Presentation I	do research, and present their work before the instructor
PETE 337	Junior Student Paper Contest	present their work from PETE 336 before a panel of industry professionals
PETE 404	Integrated Reservoir Modeling	work in teams to complete the first part of their senior design capstone project, present their work as a team before a panel of faculty members
PETE 436	Petroleum Technical Presentation II	do research, and present their work before the instructor
PETE 402	Integrated Asset Development	work in teams to complete the second part of their senior design capstone project, and present their work as a team before a panel of industry professionals
PETE 437	Senior Student Paper Contest	present their work from PETE 436 before a panel of industry professionals