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The Next Generation Of Petroleum Engineering Students: Challenges And Needs

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Abstract

The next generation of petroleum engineers will need to be prepared with knowledge in both the domains of petroleum engineering and technology, innovation, and digital knowledge due to the industry's rapid adoption of technology and digitization, as well as the necessity to address and work toward sustainability. As the sector develops quickly, they will also need to promote sustainability, meet the demand for higher efficiency, and be prepared for a career path that will constantly alter.

This paper presents some ideas and suggestions that could improve the performance of petroleum engineering education in the next few decades. This improvement in academic performance will assist petroleum engineering students in controlling the rapid development of technology used in the oil and gas industry. The paper showed the most important changes in the petroleum engineering industry for the time being and also the future trend. This future trend is driven by the oil and gas industry, which is focused on the improvement in exploration, drilling, and production technology and innovations. The paper suggested how to change the students' learning outcomes through the Accreditation Board for Engineering and Technology, to give the newly graduated students the required knowledge and skills needed in the work field to handle any task given to them without extra time and effort for any new training. The required competencies for petroleum engineering students, such as those in artificial intelligence (AI) algorithms, advanced robotics, the internet of things, three-dimensional visualization, and big data management, will provide them with a competitive advantage and assist oil and gas companies in increasing productivity at the oil fields or in oil and gas wells.

Introduction

The world is powered by petroleum engineers. "Petroleum engineers make the world run." This proud quotation, taken from the Society of Petroleum Engineers website, demonstrates how highly we value our profession while also emphasizing the value of the educational process in preparing the upcoming generation of engineers to meet the demands of the industry (Cunha, J.C. and Cunha, L.B, 2004).

As a recognized academic discipline, petroleum engineering is about to mark its first century. Clearly, there have been significant developments in educational approaches as well as industrial technologies, which are somewhat mirrored in modern curricula. In addition to knowing the basics of math, physics, and chemistry, a petroleum engineer must also have a solid understanding of geology, oil well drilling, formation evaluation, oil and gas production, reservoir rocks and fluid properties, fluid flow in porous media, reservoir engineering, and oil property evaluation (Cunha, J.C. and Cunha, L.B, 2004).

The education system for petroleum engineers has had to develop in tandem with the petroleum industries and its technology's rapid evolution. Companies in the oil industry once demanded that young graduates be capable engineers who could contribute right away and fit into the daily work environment, but today's companies have different expectations. They will continue to need engineers who are technically proficient and have a thorough grasp of the various industry technologies, but they are increasingly demanding more. The modern ideal petroleum engineering graduate possesses all the fundamental technical knowledge but is also a more complete engineer with a comprehensive perspective of the industry, a desire for lifelong learning, and the teamwork, communication, and computer skills necessary in today's global industry (Kazemi, H. et al., 2000) (Agbaraji, C.I., 2002), (Tamir Aggour, 2005).

Companies are gradually becoming aware that the petroleum industry and other sectors are experiencing a technical skills shortage. There is a need to re-evaluate the approach to teaching and manpower training for the petroleum sector in our various institutions taking into account the fact that the education sector stands as a resource key to generating employees for this sector. This is due to the growing experienced workforce, funding constraints on training, increased staff turnover, reduced field exposure, reduced interest from graduates, etc (Paul Ugoji. et al. 2017).

With an emphasis on the petroleum industry, this paper aims to emphasize the skills and job requirements of employers from a variety of industries. These needs serve as a guide for the implementation of an effective strategy that can deliver the desired output to the companies while concentrating on the main skill components that are present in our educational system. Because they will seem to fully understand topics important to employers like data analytics, big data, artificial intelligence, machine learning, robotics, nanotechnology, hydrogen fuel production, and carbon capture and storage, graduates from higher education institutions will be fully prepared to work immediately after graduation. Higher education institutions will be able to use this method to draw attention to their weaker study and interest areas. The improvement of their academic curricula can benefit from the involvement of the government and the commercial sector, particularly the oil and gas industry (Kamal, Medhat M., 2021).

The remaining essential competences, including multidisciplinary and intercultural competencies as well as health, safety, and environmental awareness, are mostly acquired at work. In order to develop the competences of the upcoming generation of petroleum engineers, university educators, company coaches, and managers must all modify their instructional approaches. They must behave more like supervisors than educators in order to be successful coaches (Kamal, Medhat M., 2021), (Tamir Aggour, 2005).

The most crucial upskilling for the next generation of petroleum engineers

As the industry has progressed and developed it has become apparent that training an engineer for competence in the first few years of his/her career is no longer sufficient. Educators must provide students with the tools necessary to perform in the modern rapidly changing global industry, see Figure 1. This means an ability to adapt to new technologies, a broad understanding of the

whole upstream industry system, and competent behavioral skills such as effective oral and written communication and teamwork skills (Tamir Aggour, 2005). Exploration and extraction of unconventional oil and gas, including heavy oil, oil shale, gas shale, and enhanced oil recovery, have begun in several countries. New trends in the oil and gas sector are improving the sector's effectiveness, safety, and intelligence. In order to achieve this, businesses look into effective and competitive ways to digitize, automate, and address challenging sub-surface engineering issues. For instance, artificial intelligence (AI) algorithms give oil and gas companies a competitive edge and let them boost oilfield or well productivity. Furthermore, processing times are accelerated and the demand for human labor is decreased by the gradual deployment of sophisticated robotics and data management techniques (Anirbid Sircar et al., 2021). Petroleum engineering students must learn the following modern skills in order to work in the oil and gas industry.

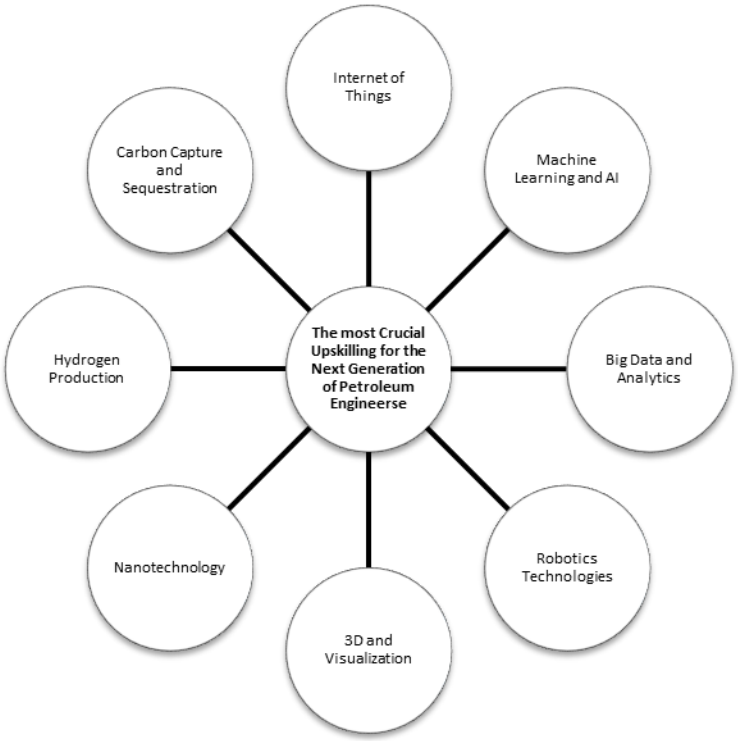

Figure 1: The most crucial upskilling for the next generation of petroleum engineers

1. Internet of Things

The Internet of Things is used by the oil and gas industry to boost production, optimize machines, guarantee worker safety, and keep an eye on outlying locations. Real-time data collection is made possible by sensors installed inside wells, blowout preventers, and choke valves. Oil and gas startups can quickly identify defective equipment using this data, assisting field engineers in foreseeing and responding to situations. Oil and gas facilities can save maintenance costs and obtain thorough visibility into their equipment or processes by using Internet of Things solutions. This will reduce overall operational costs and increase revenue. (R.G. Alakbarov and M.A. Hashimov, 2018)

2. Machine Learning and Artificial Intelligence

The upstream, middle, and downstream operations of the oil and gas sector increasingly use artificial intelligence and data science to tackle complicated challenges. Artificial intelligence assists managers in the oil and gas industry in discovering and putting into practice novel exploration and production concepts to increase revenue. (Anirbid Sircar et al., 2021)

The use of artificial intelligence is currently progressing quickly in the oil and gas industry as the concept permeates more and more phases of the industry, including intelligent drilling, intelligent development, intelligent pipeline, intelligent processing, and so forth. (Kumar, 2019)

Utilizing an optimization method, the best control was found to increase overall production of oil. The parametric analysis can be done by contrasting different machine learning methods to forecast seismic properties, wireline data, and permeability. (Teixeira and Secchi, 2019)

3. Big Data and Analytics

Data analysts in the industry can gain insights from production and reservoir performance data with the aid of big data platforms. Engineers trying to maximize production and guarantee the best depletion of the oil and gas reservoirs can also benefit from this. The oil and gas business gains more value from making choices to save operating costs and increase profit by utilizing big data analytics. Big Data's primary use is to give tools for processing and analysis of the huge amounts of data. Recently, a new generation of reservoir simulation has been developed that combines closed-loop reservoir management (CLRM) and integrated asset modeling with artificial intelligence and data mining technologies (IAM). The outcome will be a novel information-oriented method to reservoir modeling that will enhance the modeling by forecasting reservoir performance. (Mehdi Mohammad and Farshid Torabi, 2020)

4. Robotics Technologies

Robotic solutions are utilized in the upstream and downstream stages of the oil and gas production process, including drilling, production, and transportation. These solutions are mostly in the form of in-pipe inspection robots, tank inspection robots, wireless sensor networks, etc. With greater frequency and accuracy, the majority of robotics technologies are primarily focused on inspecting, maintaining, and repairing plant facilities. The automation of 3D jobs raises the bar for health, safety, and environmental norms while also increasing economic efficiency by lowering the number of workers needed for ongoing plant maintenance and manipulation, production cycle, and floor space requirements (Amit Shukla, Hamad Karki, 2016).

5. Three-Dimensional and Visualization.

The creation of realistic depictions of underground reservoirs and other oil and gas machinery is aided by Three-Dimensional (3D) modeling and excellent visuals. 3D modeling simulates the production and injection phases throughout the reservoir's lifecycle in conjunction with historical production data. This makes it easier to forecast risks that affect the reservoir's safety. Oil and gas engineers optimize production and operations planning based on the data. Furthermore, 3D modeling and visualization increase performance for the oil and gas fields while lowering costs and reducing risks. One crucial stage in the comprehension and application of reservoir simulations or models is their display. In particular, the absence of visualization can make huge, complex models like three-dimensional/three-phase reservoir models unusable. By fostering integration and interaction, visualization strengthens ties

between geoscientists and reservoir engineers. To increase our effectiveness, it is essential to translate the enormous volumes of simulation results into visuals that are simple to comprehend. (Austin, A.Z, 1993) (Tamir Aggour, 2005)

6. Nanotechnology

New scientific and technological sectors have emerged as a result of the utilization of nanoparticles in several applications. Nano-science and nanotechnology are these disciplines. While nanotechnology deals with the design, characterization, manufacture, and use of materials and devices based on Nano-scale, Nano- science describes the study of the phenomena and principles regulating the behavior of materials at the Nano-scale level. As seen by recent years, the use of nanotechnology in the oil and gas sector is expanding. Drilling and hydraulic fracturing fluids, oil well cementing, enhanced oil recovery, corrosion inhibition, well logging, formation fines control during production, heavy oil viscosity reduction, hydrocarbon detection, methane release from gas hydrates, and drag reduction in porous media were all areas where nanotechnology was applied in the oil and gas industry. (Muili Feyisitan Fakoya et. Al, 2017)

7. Hydrogen Fuel

In several kinds of transportation, hydrogen is being examined as a substitute fluid to lower greenhouse gas (GHG) emissions and enhance energy storage. Natural gas is the feedstock needed to create the two types of hydrogen, grey and blue hydrogen. Therefore, more natural gas production would be required in this area. As a byproduct of converting natural gas into hydrogen, carbon dioxide (CO2) is produced in concentrated streams. The separated CO2 can be compressed and injected into a depleted natural gas field and safely sequestered there if manufacturing is done close to one (Kamal, Medhat M., 2021).

8. Carbon Capture and Storage/Sequestration

Climate change is a very important problem. The students must be educated on how to make significant efforts to solve the problem of climate change. The SPE Gaia Sustainability Program offers fresh approaches to sustainability issues to the oil and gas sector and representatives of its stakeholders in order to raise awareness of climate change among our members.

More than 60% of global greenhouse gas emissions are attributed to Carbon Dioxide (CO2) emissions from power plants and stationary industrial sources. This CO2 can, however, be captured and stored, and when injected into depleting oil reservoirs, it can increase recovery via a "enhanced oil recovery" (EOR) process. Thus, CO2 capture and storage and EOR present opportunities for the oil industry to participate in activities that will significantly reduce emissions and, in the case of EOR, increase oil field recovery (Kamal, Medhat M., 2021).

Educational Challenges: Standard and Accreditation

Because of the certification standards established by the Accreditation Board for Engineering and Technology (ABET) and SPE, the majority of undergraduate petroleum engineering programs have similar curricula. Curricula modifications take place gradually. The petroleum engineering courses are unlikely to undergo any significant changes in the near future. Every year, new technology is included in the curricula. It's likely that economics, communication abilities, and a deeper comprehension of the petroleum sector will receive more attention. Additionally, petroleum engineering departments need to figure out how to keep their faculty stable throughout the significant fluctuations of the industry's boom and bust cycles. (Von Gonten, W.D, 2000)

For Baccalaureate Level Programs, all programs seeking accreditation from the Engineering Accreditation Commission of ABET must demonstrate that they satisfy a seven General Criteria for Baccalaureate Level Programs. In the Criterion 3, Student Outcomes, "The program must have documented student outcomes that support the program educational objectives. Attainment of these outcomes prepares graduates to enter the professional practice of engineering. Student outcomes are outcomes (1) through (7), plus any additional outcomes that may be articulated by the program." (ABET Accreditation Commissions Web Site, 2022)

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

In the outcome 7, ABET give a flexibility for applying a new knowledge with using appropriate learning strategies. However, the commission did not specify the strategy that will be used for how to applying the new knowledge.

The suggested appropriate strategy for updating the students' outcomes

The decision makers could make two plans, short and long, to sustain the academic development of the department to keep up with technological advancement in the oil and gas industry.

In the short term plan, the curriculum of the petroleum engineering would be upgraded by 10% to 20% (for the selected courses) to cover the advanced technology in the industry. The advanced technologies (topics) which will be targeted in this 10% to 20% of upgrading are as the following:

1. Application of Machine Learning and Artificial Intelligent (AI)
2. Application of Robotics Technologies
3. Application of Nanotechnology
4. Application Three-Dimensional and Visualization. (Industrial software packages)
5. Application of Internet Things
6. Application of Big Data & Analytics

In the long-term, the petroleum engineering programs would build a strong partnership (exchange the experience in research and reform and update the curriculums) between the similar departments in the locally, regionally, and globally Moreover, while maintaining the necessary emphasis on the basic industry technologies and fundamentals, petroleum engineering programs must be influenced by the changing needs and advancements of the industry. This requires a continuous interaction between industry and academia. The channels of

communication between the two parties must be established and be strong and significant to solidify and advance the cooperation.

To demonstrate all these operations, a strong and well-devised curriculum is useless without the proper faculty to deliver it. Educators are charged with much more than simply transferring knowledge. They must encourage independent thinking, make use of problem- solving exercises that require more than simple substitution into equations, and motivate students to be lifelong learners[8]. This should start at the earliest stages of undergraduate education, and students must be made aware of the relevance of fundamental subjects to their future coursework and professional careers. Educators must also actively help students develop essential skills for their future careers such as teamwork and communication skills. Petroleum engineering faculty should have the requisite inspirational and teaching abilities in addition to an extensive knowledge of the subject matter and experience as a practicing petroleum engineer.

Conclusions

Students studying petroleum engineering nowadays must be given access to and instruction in the most recent knowledge and abilities that the oil and gas business has to offer. In order for petroleum engineering education to keep up with the significant changes in technology used in the oil and gas sector over the coming few decades, the curricula must simultaneously introduce some new ideas and innovations.

It is challenging to anticipate that graduates of our universities, which rely on outdated and underdeveloped curricula, will possess the abilities required to exploit the new technology. It is obvious that achieving this aim would depend not only on university infrastructure but also on its scientific infrastructure and well-prepared faculty. In order to construct a sustainable cooperative approach and improve petroleum engineering curricula and laboratories, it is also necessary to work in partnership with national and international enterprises. This will help to train highly skilled students for the workforce.

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