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INTERDISCIPLINARY PETROLEUM ENGINEERING EDUCATION IN THE CONTEXT OF ANDRAGOGICAL AND DIDACTIC APPROACHES

INTERDYSCYPLINARNA INŻYNIERNA EDUKACJA NAFTOWO-GAZOWA
W KONTEKŚCIE PODEJŚCIA ANDRAGOGICZNEGO I DYDAKTYCZNEGO

МІЖДИСЦИПЛІНАРНА НАФТОГАЗОВА ІНЖЕНЕРНА ОСВІТА
У КОНТЕКСТІ АНДРАГОГІЧНОГО І ДИДАКТИЧНОГО ПІДХОДІВ

The world changes on a permanent basis and it is really quite obvious that the exclusive factor is change, thus, professionals are constantly adapting how to overcome the perils their spheres deal with. A human's primary cycle of education comprises 15–20 years of active life time and prepares them to enter the work force. The working life of most adults lasts for 30-40 years or more peculiarly as durability is constantly increasing. Financing adult training is not merely useful to a person but it is useful to the public too. It is necessary to create a comprehension during the basic training period that self-organized learning and life-long individually growth is key to achievement and connected with chiefly on the capability to learn personally. In essence, the UNESCO International Commission Report on Education for the XXI century (1996) admits that teaching people how to personally get, obtain knowledge, skills and abilities should be the major purpose of traditional education. In conjunction with technical skills, improving social competencies in an integrative or collaborative atmosphere is significant to career development in any field.

Apparently, engineering professional employment in industry is challenged to progress and keep current. In addition to the challenging demands of fast shifting technology distinctly in the petroleum sector, their professional development is frequently into personnel human resource management comprising interdisciplinary teams and need an appropriate level of interactive skills to cope with such teams and lead them. A petroleum specialist in most states worldwide and especially in Ukraine are demanded to pursue and join up the continuing education. Moreover, during engineers' periods of industry activity, these experts should obtain tremendous experience themselves owing to mutual communication and observation in their workplace. This expedience provides learners a setting for spreading new knowledge and new tools.

Higher education institutions are immensely established to supply corresponding continuing education to their learners. Universities have a key function in contributing to remarkable learning possibilities for specialists and are a main element of the economic and social progress of a region and country in whole. They are establishments where thousands of hours of further classes and education are provided to industry participants in topics including technological processes of chemical and machine building complex, organizational psychology, management and entrepreneurship, economics of petroleum industry, social communication and foreign languages in professional communication. While the technical knowledge unquestionably resides in the faculty and instructors of the Institute, the challenge is provide the content in a stimulating manner to engage the mature and experienced learner. To this end, higher educational establishments have adopted many of the principles of andragogy in their courses. To further increase the effectiveness of these courses, the techniques of project based learning is being added to create exciting environments and learning opportunities to their students.

Despite the fact that the early concepts on adult education go back to the early 1800s, the concepts and name "andragogy" was generalized by Malcom Knowles with aim of separating adult education from pedagogy (Knowles, 1980). Henceforth, andragogy has kept to expand peculiarly in Europe. Knowles' theory and later embodiment in Europe are dependent on several suppositions that distinguish the mature and experienced learners from trainees just entering their careers. They are: 1) mature learners need to see the pertinence of what their learning in their careers; 2) mature learners have a solid basis in their experience to make the content relevant; 3) mature learners must be in charge of their education; 4) mature learners are focused on the application of the content

to problems, not on the content for the sake of the content; 5) mature learners are internally motivated and driven to learn.

Actually, based in these fundamental assumption, the principles of andragogy include 1) active learning; 2) problem centred; 3) relevancy of prior experience 4) relevancy of the content to life; 5) emotional component; 6) self-learning; 7) alignment; 8) interest.

In adult learning situations, teaching should focus on training. Training activities should be less formal, and the function of the educator changes from a propagator of information to a mentor and guide demanding a greater diversity of methods. When traditional lectures and seminars are applied, they should give constructive and practical exercises, frequently experimental in origin, discussions, role plays, case studies, addressing specific industrial challenges. Effective use of group discussions and group work is common. The approach moves away from the theoretical knowledge and into practical application of the knowledge. In the tradition pedagogical paradigm widely used in Ukraine, the teacher acts as “the sage (the wise man) on the stage”. It should be stressed that andragogical approach involves a subject-subject teaching. The teacher becomes a “mentor beside” and facilitator. Among a number of common instruments used in the andragogical approach there are case studies, critical incidents, lecturettes (they are forms of short focused lectures), peer to peer round table discussions. All of these techniques provide access to the resources and solutions needed to support petroleum engineers at their career stages, furthermore, to prepare the effective specialists. Also, these pedagogical tools explore the questions that make them real experts of their field and provide some practical ideas to help learners to apply their professional skills and become more effective in their workplace. Undoubtedly, important practical life skills require lots of time and practice.

Undoubtedly, aforementioned literature highlights that the study of andragogy is still a major interest area in the adult education. Many research studies around the world have been applied and used the andragogy as a fundamental theory and practice to develop and enhance the adult learners' quality of lives. The educational community embraced the concept of andragogy when it was brought into the mainstream by Knowles (Taylor, 1986). Identifying several English language articles and studies since 1964 to the present as foundational to the theory of andragogy in its relationship to practice. The results indicated the continuing discovery and expansion of a much broader than Knowles' conception of andragogy, the number of documents referenced and analyzed in this article contributing to be written incorporating andragogy with a particular

discipline, to the international foundation for its research higher education institutions demonstrated the importance of increased attention to andragogy and its impact on the student experience.

Initially, Knowles (1970) indicated that he acquired the term in 1967 from Dusan Savicevic. However, after becoming acquainted with the term, Knowles infused it with much of his own meaning garnered from his already extensive experience in adult education. He then combined his expanding practice around the world, his university teaching of budding adult-educators, and quite broadly fleshed out his ideas on andragogy through the publication of *The Modern Practice of Adult Education: Andragogy vs. Pedagogy*. He originally saw pedagogy as being for children and andragogy being for adults. This American version of andragogy became popularized as a result during the time following 1970. The main structure of his andragogical expression took the form of a process design instead of a content design, with assumptions and processes. The assumptions about adult learners at that time were: They are self-directing, their experience is a learning resource, their learning needs are focused on their social roles, their time perspective is one of immediate application. The learning processes adults want to be actively and interactively involved in are: Establishing a climate conducive to learning, cooperative planning, diagnosing their needs, setting objectives, designing the sequence, conducting the activities, and evaluating learner progress.

Afterwards, Furter (1972) proposed that universities recognize a science for the training of man to be called andragogy. The purpose would be to focus not on children and adolescents, but on man throughout his life. In the same year, Knowles (1972) declared that there was a growing interest of many industrial corporations in the andragogical education process, with managers functioning as teachers (or facilitators of learning), and that andragogy offers great potential for improving both interpersonal relationships and task effectiveness. Knowles also suggested that andragogy applies to any form of adult learning and has been used extensively in the design of organizational training programs, especially for “soft skill” domains such as management development. An example he provided on this is for the design of personal computer training.

A series of doctoral dissertations over a number of years, focusing on the work of Malcolm S. Knowles, placed him squarely in the center of helping to expand and further develop the concept and philosophy of andragogy. In the first one, Henschke (2016) saw Knowles as a “field builder” in adult education with his ideas on andragogy becoming a central core of his contributions to the theory and practice of the adult education field. Knowles focused a full application of

his conception of andragogy toward the Human Resource Development (HRD) Movement. He worked vigorously in the corporate sector and thus saw the significance of testing and relating andragogy within it. He divided the listing of numerous learning theorists into the categories of mechanistic and organismic. His identifying andragogy as being in the organismic category helped cast, clarify and nudge the philosophy toward a more humane frame.

Knowles (1975) published his guidebook for learners and teachers on the topic of self-directed learning. This was the first time that he labelled pedagogy as “teacher-directed” learning and andragogy as “self-directed” learning. Previously, pedagogy was for children and andragogy was for adults. Now his perspective was that where new, unfamiliar content was involved with children and adults, pedagogy was appropriate; and, where adults or children had some background in the content, andragogy was appropriate. Andragogy was the underlying philosophy, and self-directed learning was the way andragogy was to be implemented.

It should be stressed that project-based learning is a pedagogical model established in the 1970s and firstly connected with early childhood education. This type of learning has been transformed recently and is apparently being accepted as a gateway to interacting petroleum engineering instruction to real world experience. The value of project-based learning is in training a person to life experiences in the process of mastering new practices of solving problems and generating new knowledge (Helle, Päivi and Erkki, 2006). Besides, project-based learning is one of the up-to-date techniques that universities in many countries are implementing to develop engineering graduates capable of being the practical application oriented engineers needed in industry. This pedagogical concept is competently set up and has been reconsidered thoroughly (Bell, 2010).

It is worth emphasizing that project-based learning is being used in a diversity of ways counting on an appropriate curriculum and the adjacent economic environment. Crucial features of projects within project-based learning are that the projects are main to the subjects being taught and not peripheral to the course, projects are concentrated on a strongly influential issue mainly learner controlled, and lastly the projects are true wide spread problems (Thomas, 2000).

With the advance of projects into the training process, learners explore issues and offer solutions over a long-termed period of time to accomplish a comprehension of the techniques and approaches being instructed. The learners are actively involved in the project, have obligation for the implications and realize the trust put in them. The project-based learning approach is often

characterized as “learning by doing”. An extra advantage to project-based learning is that many of these projects are team based demanding the accumulation and practice of interpersonal skills and raises an awareness of the complexity of interdisciplinary work.

All the same, the higher educational system is rich in its diversity. There are many educational implications referred to project-based learning and among them are the next: 1) a competence to cover changing conditions and to adapt to the new conditions which is typical in production activities; 2) an ability to use modern computer technologies in the processing of the results; 3) a complete understanding of the theory and possession of the practical competences and skills in the technical field; 4) a capacity to dissect literature so as to choose the direction of the project; 5) a capability to scrutinize results, arriving at valid conclusions and express considerations; 6) an aptitude to convey conclusions and their basis in data and fact.

It is evident that both approaches, andragogical and project-based learning, have many of the similar principles and approaches. Projects specify instructions to relevancy, projects are learner-centered, properly arranged projects demand active participation, engage the learner emotionally and are usually fun (occasionally only in retrospection). The value of project based education is a preparation for reality and its development in the process of mastering new ways of solving problems and obtaining new knowledge (ABC News, 1999). At the same time, the variety can give supplemental advantages. When projects are applied in adult education, in particular, for participants from the petroleum industry, projects deliver a possibility to create something of direct value to their company as an outcome of the educational experience. Afterwards, projects can be created that require interdisciplinary teams and the development of interpersonal skills alongside the exploration of technical knowledge. For the above-mentioned reasons, an initiative to integrate both approaches, andragogy and project-based learning, into adult engineering and professional education has become increasingly important.

Overall, this approach is a comprehensive system and describes andragogic and instructional techniques and methods of individual and team work (lectures, disputes, discussions, round tables, brainstorming, search methods, research methods, independent work and teamwork) that will grant learners to actively take part in training, analysis and providing explanations to controversial situations. This way necessitates active involvement of each participant, who has an obligation and trust. It ensures a high level of engagement of all participants in the learning process. This personal duty is united with team based,

project oriented duties in a unique learning possibility. This approach is even more challenging, as it is implemented in a very traditional Ukrainian structure of training. In addition, learners must add to their knowledge by consulting periodicals or reference books asking their educators – in short, doing a little private research work on a daily basis.

This work is the integrity of andragogical learning methods with project based learning used to the development, testing, implementation of a balanced training programme of courses and seminars with proficient instructing tools. The outcomes will be more mature professionals using a set of organizational methods to improve productivity, novelty and organizational effectiveness. This instrument set comprises the area of project management tools ranging from systems engineering, from academic philosophy with skills in the team based on human interaction techniques, personal conflict management skills and communication, and transferable skills.

As underlined above this commencement has begun in the field of project management and systems engineering. The mechanisms in these two courses involve the growth of a clearly defined scope of activities, the establishment of a matrix of demands with measurable results, brainstorm and quantitative analysis of choices, as an outcome of a project approach based on consensus, development tasks structure using Gantt charts, in-depth analysis of the solution of the problem, develop a test plan to guarantee that the product or project meets the expectations and needs. Two projects that have been highly successful in training both early career students and mature students in these areas are the Skyscraper Project (Sanger, Ziyatdinova and Ivanov, 2012) and the video “Deep Dive” (ABC News, 1999).

It is worth mentioning that the Skyscraper Exercise was created by engineering educators from Massachusetts Institute of Technology and United States Naval Academy and it contains all the major components of the conceive, design, implement and operate pedagogical approach in an exciting format. The three hour exercise is to design, build and test a model skyscraper based on an historical scenario using a variety of foam blocks and pencils as the fasteners. The structure is required to support a 0.5 liter bottle of water while being tilted on a 10 percent slope to simulate earthquake durability. Overall height and aesthetics are the principal evaluation factors. The exercise is available at with both instructor guidance as well as the challenge elements for the students (CDIO, 2019).

The project-based learning results combine performing basic course knowledge about structures, predicting and mitigating different risks by means of concurrent testing and research activities, maximizing team performance

through organization and delegation of tasks, allocating time and managing to a schedule, trading off technical performance within a defined and fixed budget and executing the design strictly according to the design documentation. To extend this project and capitalize on the experience of mature learners, this project can be enlarged to involve team discussion on the problems experienced during the project. The teams can be asked to reflect on the activity, give examples in their own jobs where research and thorough planning can be used to refrain from problems, to consider the impact of budget constraints on the solutions developed. The teams report back to the whole team. From the reactions of the team and the engagement of the team in realizing common observations, this approach will be widened.

The video “The Deep Dive” was first aired on ABC on July 13, 1999. In this video a process of development of new ideas is applied to the task of redesigning the shopping cart. The focus is on researching the problem, brainstorming solutions, generating prototypes of the solutions and testing it in the real world. For a classroom of young learners, it is typical for an educator to guide the students to conclusions based on their perceptions and experience. For adult learners, the situation is flipped. Once again in groups of five to six, the group is asked to give their observations asking questions such as: what would work in their workplace; what would not work; what their experience was with innovation; what the problems were; what creates a culture that encourages innovation; what destroys innovation.

These are just two examples where established tools and exercises in project-based learning have been used to project management and extended with andragogy tools to appeal to the mature learner with great progress. During this initiative, this approach can be expanded into different fields of knowledge. Regardless of the ups and downs in the world energy situation, societal needs in hydrocarbons are increasing steadily, driven in particular by the transport sector. Controlling and optimizing oil and gas production have therefore become strategic issues. To meet this growing demand and cope with the decline in reservoirs that are already producing, the professionals of tomorrow will need to find solutions to optimize production, increase the oil and gas recovery rate, and gain access to and exploit new resources. Petroleum professionals will be a driving force for innovating, rolling out large projects with complex organizations, optimizing drilling and ramping up production.

Future oil and gas facilities will be built in a wide range of environments: very large-scale projects, deep seabeds, reservoirs in extreme conditions, heavy and extra-heavy oils, etc. In all these projects, the environmental and societal

impacts must be controlled, as part of a rational economic framework. The Petroleum Engineering and Project Development program offers an overall vision of field development and training in the three fundamental areas of expertise in the sector: reservoir, drilling and production. Future petroleum engineers should become open-minded professionals for whom innovation will be a mission and the world their area of expression.

To help specialists succeed, higher educational institutions offer training in modules that cover the three key areas. During the training, learners will lead a major field development project using real data and working in teams. The professional educators will give petroleum specialists the tools to achieve their goals: case studies using real data from the field, work in multicultural project teams with industrial supervision, experience with industry specific software, and site visits in different countries. By covering the three key fields, such as reservoir, drilling and production, the petroleum engineering and project development program prepares future engineers for the petroleum engineering, project and technical management professions. They will find their natural place with an oil or gas operator or an oil supply service company. The learners will be capable to work in an international environment on cross-cutting and multicultural teams that require high technical and geographic mobility.

And in all, it can be inferred that the introduction of integrated andragogical and project-based learning techniques has increased interactivity, effectiveness, independence and involvement of trainees in the learning process while promoting the arrangement of key competences of future petroleum experts. As the initiative keeps, enlargement of these tools will serve adult learners in more areas of knowledge and capacity. Nonetheless, andragogical approach is the outcomes of efforts by multiple people from different nations around the globe.

ABSTRACT: Urgent issues of the development of interdisciplinary petroleum engineering education are considered. The organisational and didactic basics of future petroleum engineers' professional training in Ukrainian education system are revealed. Special attention is paid to the content formation and the usage of innovative pedagogical technologies, among them: case studies, lecturettes (short concentrated lectures), peer to peer round table discussions, critical incidents. The outcomes of petroleum engineers' training are represented: an ability to navigate changing conditions and to adapt to the new conditions which is a common occurrence in production activities; an ability to use modern computer technologies in the processing of the results; a thorough understanding of the theory and possession of the practical skills in the petroleum area; an ability to analyse literature in order to select the direction of the project; an ability to analyze results, reaching the necessary conclusions and formulate proposals; a capability to represent

conclusions in data and facts. The project-based learning results are outlined in details. They include exercising of basic disciplinary knowledge about structures, anticipating and mitigating risks through concurrent testing and research activities, maximizing team performance through organization and delegation of tasks, allocating time and managing to a schedule, exchanging technical performance and executing the design strictly according to the design documentation.

KEYWORDS: interdisciplinary petroleum engineering education, andragogy, project-based learning, personnel training, retraining, advanced training

АНОТАЦІЯ: Розглянуто актуальні питання розвитку міждисциплінарної нафтогазової інженерної освіти. Визначено організаційні і дидактичні умови професійної підготовки майбутніх інженерів нафтогазової галузі в системі педагогічної освіти України. Особливу увагу привернуто до формуванню змісту підготовки інженерів нафтогазової галузі, використанню інноваційних педагогічних технологій, серед яких кейсові завдання, короткі вступні лекції, дискусії, аналіз критичних випадків. Висвітлено результати аналізу якості підготовки інженерів-нафтовиків: здатність орієнтуватися в змінюваних умовах і пристосовуватися до нових умов; здатність застосовувати сучасні комп'ютерні технології для обробки результатів; досконале розуміння теорії і володіння практичними навичками в нафтогазовій галузі; здатність аналізувати літературу з метою визначення напрямку проекту; здатність аналізувати результати, досягаючи необхідних висновків, і формулювати пропозиції; спроможність подавати висновки у формі даних і фактів. Узагальнено одержані результати щодо використання проектно-організованого навчання, які включають: застосування фундаментальних дисциплінарних знань про структури; передбачення і зниження ризиків за допомогою спільних тестувань і дослідницької діяльності; максимізацію результатів командної роботи завдяки організації та делегуванню завдань; розподіл часу та управління розкладом; обмін технічними рішеннями; виконання проектування відповідно до проектної документації.

КЛЮЧОВІ СЛОВА: міждисциплінарна нафтогазова інженерна освіта, андрагогіка, проектно-організоване навчання, підготовка персоналу, перепідготовка, підвищення кваліфікації

Bibliography

- ABC News. (1999, July). *The Deep Dive*. Retrieved from: <https://www.youtube.com/watch?v=2Dtrkrz0U>.
- Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House*, 83(2), 39–43.
- CDIO. (2019). *Skyscraper: Project Based Learning*. Retrieved from: www.cdio.org/files/document/file/Skyscraper_Template_Full.pdf.
- Delors, J. (2019). *Chairman. Learning: the Treasure within, Report to UNESCO of the International Commission Report on Education for the XXI century*. Retrieved from: http://www.unesco.org/education/pdf/15_62.pdf.

- Furter, P. (1971). *Grandeur et misere de la pedagogie*. University of Neuchatel. (Cited In E. Faure (Ed.) (1972). *Learning to be: The world of education today and tomorrow* (p. 116). Paris: UNESCO Paris.
- Helle, L., Päivi, T., Erkki, O. (2006). Project-based learning in post-secondary education-theory, practice and rubber sling shots. *Higher Education*, 51(2), 287–314.
- Henschke, J.A. (2016). A history of andragogy and its documents as they pertain to adult basic and literacy education. *PAACE Journal of Lifelong Learning*, 25, 1–28.
- Knowles, M.S. (1970). *The modern practice of adult education: Andragogy vs. Pedagogy*. New York: Association Press.
- Knowles, M.S. (1972). The manager as educator. *Journal of Continuing Education and Training*, 2 (2), 97–105.
- Knowles, M.S. (1975). *Self-directed learning: A guide for learners and teachers*. NY: Association Press.
- Knowles, M.S. (1980). *The modern practice of adult education: From pedagogy to andragogy*. Wilton, Connecticut: Association Press.
- Sanger, P.A., Ziyatdinova, J., Ivanov, V.G. (2012). *An Experiment in Project-based Learning: ASEE Annual Conference, San Antonio, Texas*. Retrieved from: <https://peer.asee.org/2092>.
- Taylor, M. (1986). Learning for self-direction in the classroom: The pattern of a transition process. *Studies in Higher Education*, 11(1), 55–72.
- Thomas, J.W. (2000). *A Review of Research on Project-Based Learning*. Retrieved from: http://w.newtechnetwork.org/sites/default/files/news/pbl_research2.pdf.