

Powerful Interdisciplinary Adult Education for Industry: “Combining Andragogy and Project Based Learning”

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In this rapidly changing world of technology and economic conditions, it is essential that practicing professionals continue to grow in their skills and knowledge in order to stay competitive and relevant in the industrial workplace. This paper describes an approach to adult education that combines the best techniques of andragogy with project based learning taking advantage of the experience, maturity and wisdom of the adult learner. Well known project based learning (PBL) exercises such as the Skyscraper Project [1] and the “Deep Dive” video [2] have been adapted and expanded to include andragogic approaches and capitalize on the knowledge and depth of maturity in these mature learners.

Key words: inter-disciplinary, andragogy, project based learning, industry adult education, project management.

The Need for Adult Education.

A person’s initial period of education takes 15-20 years of life and prepares them to enter the work force. The working life of most adults continues for 30-40 years or more particularly as longevity is continually increasing. Investment in adult education is not only beneficial to the individual but is beneficial to society as well. It is important to create an awareness during the initial education period that self-directed learning and continuous personal development is critical to success and depends largely on the ability to learn independently. In fact the UNESCO International Commission Report on Education for the XXI century [4] proclaims that teaching people how to independently acquire knowledge, skills and abilities should be the main objective of traditional education. Beside technical skills, improving interpersonal skills in an interdisciplinary environment is critical to professional growth in industry.

Today’s engineering professional working in industry is challenged to

grow and remain current in their areas of expertise. Besides the challenging requirements of rapidly changing technology particularly in the information technology, their career growth is often into human resource management involving inter-disciplinary teams and require a high degree of interpersonal skills to manage and direct such teams. In fact an engineer in most countries and specifically in Russia are required to seek and enroll in continuing education [8, 9]. Nevertheless, in their years of industry experience, these professional have acquired vast experience themselves and by observation of others in their environment. This experience gives the learner a context for applying new knowledge and new techniques.

Universities, on the other hand, are superbly positioned to and do provide such ongoing, continuing education to these learners. Universities play a major role in providing exciting learning opportunities for professionals and are a key component of the economic and social development of a

region and country. An example of this role is the Institute of Additional Professional Education (IAPE) at Kazan National Research Technological University in Kazan, Tartarstan 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 petrochemical 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, IAPE has adopted many of the principles of andragogy in these 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.

Andragogy – What is it?

Although the early concepts on adult education go back to the early 1800s, the concepts and name “andragogy” was popularized by Malcom Knowles in order to distinguish adult education from pedagogy or child education [3]. Since that time, andragogy has continued to grow particularly in Europe. Knowles theory and later embodiments in Europe are based on several assumptions that differentiate the mature and experienced learners from student just entering their careers.

1. Mature learners must see the relevance of what their learning in their careers.
2. Mature learners have a solid basic in their experience to make the content relevant.
3. Mature learners must take responsibility for 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.

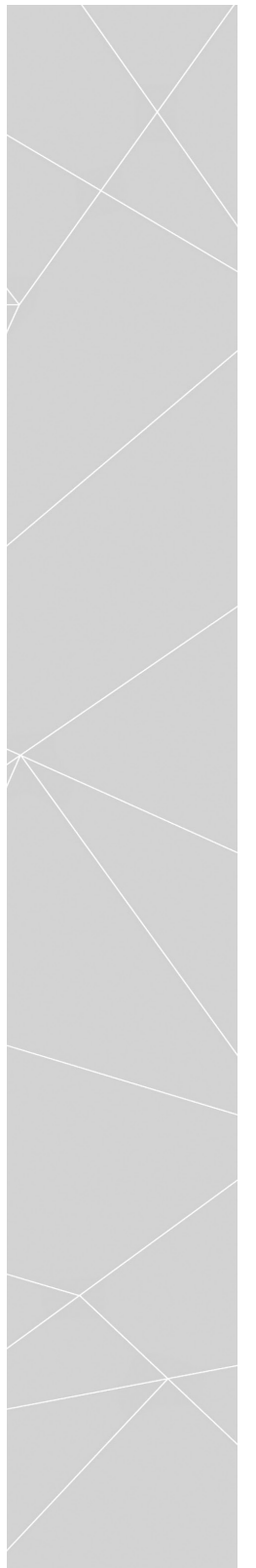
Based in these fundamental assumption, the principles of andragogy include

- 1) Active learning
- 2) Problem centric
- 3) Relevancy of Previous experience
- 4) Relevancy of the content to life
- 5) Emotional Connection
- 6) Self-Learning
- 7) Alignment
- 8) Fun

In adult learning situations, teaching should focus on training. Training activities should be less formal, and the role of the instructor shifts from a disseminator of information to a mentor and guide requiring a greater variety of methods. When traditional lectures and seminars are used, they must provide practical exercises, often experimental in nature, 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 Russia, the teacher acts as «the sage (the wise man) on the stage”. Andragogic approach involves a subject-subject teaching. The teacher becomes instead a «mentor beside» and facilitator. Typical techniques used in the andragogic approach are: case studies, critical incidents, lecturettes (short concentrated lectures), peer to peer round table discussions.

Learning – what is it?

Project-based learning (PBL) is a pedagogical concept developed in the 1970s and initially applied to early childhood education. Lately project based learning has resurfaced and is being recognized as a path to relating engineering training to real world experience. The value of project-based learning is in training the individual to life experiences, and in the process of mastering new ways of solving problems and generating new knowledge. PBL is one of the modern technologies that



universities in many parts of the world are adopting to develop engineering graduates capable of being the practical application oriented engineers needed in industry. This pedagogical approach is well established and has been reviewed extensively [5, 6, 7].

PBL is being implemented in a variety of different ways depending on the curriculum and the surrounding economic climate. Essential characteristic of projects within PBL are that the projects are central to the content being taught and not peripheral to the course, projects are focused on a driving question, the projects require transforming acquired knowledge, the projects are largely student controlled, and finally the projects are real world problems [5].

With the introduction of projects into the learning process, students investigate problems and propose solutions over an extended period of time to acquire a deeper understand of the techniques and approaches being taught. The learner is actively engaged in the project, feels responsibility for the results and recognizes the trust placed in him. The PBL approach is often described as "learning by doing". An additional benefit to PBL is that many of these projects are team based requiring the acquisition of and practice of interpersonal skills and increases an awareness of the complexity of interdisciplinary work.

There are many educational outcomes attributed to PBL and among them are the following:

- 1) An ability to navigate changing conditions and to adapt to the new conditions which is a common occurrence in production activities.
- 2) An ability to use modern computer technologies in the processing of the results.
- 3) A thorough understanding of the theory and possession of the practical skills in the technical area.
- 4) An ability to analyze literature in order to select the direction of the project.
- 5) An ability to analyze results, reaching the necessary conclusions and formulate proposals.

6) An ability to communicate conclusions and their basis in data and fact.

Integrating PBL with Andragogy. It is at once clear that the two approaches, andragogy and PBL, share many of the same principles and approaches. Projects provide a pathway to relevancy, projects are learner centric, properly designed projects require active participation, engage the learner emotionally and are usually fun (sometimes only in retrospect). 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 generating new knowledge [2]. At the same time, the combination can create supplemental benefits. When projects are used in adult education, particularly for participants from industry, the project provide an opportunity to create something of direct value to their company as a result of the educational experience. Moreover projects can be created that require interdisciplinary teams and the development of interpersonal skills alongside the exploration of technical knowledge. For all the reasons above, an initiative at KNRTU was created to integrate both approaches, andragogy and PBL, into adult engineering and professional education.

This approach represents a comprehensive system integrating andragogic and pedagogical techniques and methods of individual and team work (lectures, discussions, round tables, brainstorming, search methods, research methods, independent work and teamwork) that will allow students to actively participate in learning, analysis and finding solutions to problematic situations. This approach requires active engagement of each participant, which feels its responsibility, and trust. It ensures a high level of involvement of all participants in the educational process. This individual responsibility coupled with team based, project oriented responsibilities in a unique learning opportunity. This approach is even more challenging, as it is implemented

in a very traditional Russian structure of education.

This work is the combination of andragogic learning methods with project based learning applied to the development, testing, implementation of a sustainable training program of courses and seminars with capable coaching practices. The results will be more mature professionals using a set of organizational tools to improve productivity, innovation and organizational effectiveness. This toolkit includes the field of project management tools ranging from systems engineering, from lean philosophy with skills in the team based on human interaction techniques, personal conflict management skills and communication.

Initial Steps- A Progress Report. As mentioned above this initiative has started in the area of project management and

systems engineering. The tools in these two disciplines include the development of a clearly defined scope of activities, the establishment of a matrix of requirements with measurable results, brainstorm and quantitative analysis of alternatives, as a result 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 for to ensure that the product or project meets the expectations and requirements. Two projects that have been highly successful in training both early career students and mature students in these areas are the Skyscraper Project [1] and the video "Deep Dive" [2].

The Skyscraper Exercise was created by engineering educators from Massachusetts Institute of Technology and United States Naval Academy and it contains all the

Fig. 1. Enthusiastic mature learners with the Skyscraper project from Russian faculty and industry (Arkhangelsk, Russia, 2015-2016)



major components of the conceive, design, implement and operate (CDIO) 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 % 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. www.cdio.org/files/document/file/Skyscraper_Template_Full.pdf

The PBL outcomes 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, trading off technical performance within a defined and fixed budget and executing the design strictly according to the design documentation. This project was used with a group of twenty two professor with a wide range of disciplines and a second group of professionals from a wide range of industry including the Russian Post office, Gazprom Bank and a large Pulp and Paper company. To enhance this project and capitalize on the experience of mature learners, this project was extended to include group discussion on the issues experience during the project. The groups were asked to reflect on the activity, give examples in their own jobs where research and advance planning had avoided problems, to consider the impact of budget constraints on the solutions developed. The groups then reported back

to the whole group. From the reactions of the group and the engagement of the group in realizing common observations, this approach shall be expanded.

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 re-designed 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 common for the instructor to guide the students to conclusions based on his/her perceptions and experience. For mature 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 plant? What would not work? What was their experience with innovation, brainstorming? What were the problems? What creates a culture that encourages innovation? What destroys innovation?

These are just two examples where established tools and exercises in project based learning has been applied to project management and extended with andragogy techniques to appeal to the mature learner with good success. During this initiative, this approach will be expanded into other areas of knowledge.

Conclusions. The introduction of integrated andragogic/PBL techniques applied to project management has added interactivity, effectiveness, independence and involvement of students in the learning process while promoting the formation of key competences of future specialists. As the initiative continues, expansion of these techniques will serve adult learners in more areas of content and knowledge.

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