Ubiquitous Personalized Learning Environment in Post-Industrial Society

Andrei Kojukhov, Ilya Levin
School of Education, Tel Aviv University, Israel
andreik1, ilia1{@post.tau.ac.il}

Abstract

The paper deals with the significant technological changes in engineering education in society when it moves into Post-Industrial age. We consider the following social trends and their influence on the engineering education: Virtualization, Personalization and Ubiquitous learning. The concept of Virtual Reality allows formulating the main features of the Post-Industrial engineering education and building the concept of ubiquitous personalized learning environment.

1. Introduction

We consider Computerization as a secondary phenomenon of our post-industrial society, wherein the primary phenomenon is Virtualization of the society [1], [2]. Nowadays in the computerization, pure computing steps aside and gives way to simulation. In our everyday life, the computerization has introduced the expanding plurality of examples of Virtual Reality (VR). Computer simulated activities have become a supplement and even a replacement of the real life. Presently, a lot of commonly accepted and respectful institutions of the modern society are transforming into their virtual forms, for example into virtual social groups and communities.

The past industrial technology is the technology that provided great achievements transforming the society on the basis of great inventions and the unprecedented success of science and scientific applications. The main revolutionary idea that formed the technology of the industrial society was the idea of formalization. Representation of both natural and technological processes and phenomena by means of formal notations allowed forming engineering educational institutions of the industrial society in their present form. Till now, these institutions are based on the formal well-structured curriculum, on deep studies in exact sciences as a main part of the curriculum, and on some kind of symmetry between science and technology. This symmetry is usually referred to as a "Technology = Applied Science" paradigm [11].

In contrast to the above, a role of formalization in technology of the post-industrial society decreases, so in the modern *high-tech technology* formalization is not the main fundamental idea already. Great volume of the scientific and engineering knowledge, upon being formalized, has become available to specialists and to public by means of the new information technology. The formal component of such knowledge has actually been moved to the so-called "virtual space". This formal component thus loses its central role in the curriculum. Technology of the post-industrial society may therefore be characterized by the increased role of a non-formal, creative component of the knowledge. Formalization is not fully sufficient anymore. As a result, the post-industrial education seems to become more and more non-formalized and creativity-oriented.

Needless to say that many modern education institutions undergo a deep crisis. In our opinion, the transition to the post-industrial epoch is the main root of that crisis. The boosting development of computerization and the communication technologies, diverse efforts and interests of the students contradict with the formal educational programs.

Obviously, struggling with the today trends of post-industrial technology is counter-productive; the technology will win anyway. The only way to improve education of students of various ages in the post-industrial epoch is to become allies of its technology and members in the coming Virtualized Society.

Recent technology innovations, such as packetized media in conjunction with revolutionary communication technologies in mobile/wireless networks (LTE, WiFi, WiMax etc.) and their capacity provide an individual with ubiquitous learning capabilities today. These capabilities allow the individual to be always connected to the learned content across various access networks, when at home or traveling.

We believe that the idea of creating a Ubiquitous Personalized Learning Environment (UPLE), that enables a student to study in the way he or she likes (in the way maximally suitable to the student's personality), may become an adequate answer to the challenge of the post-industrial engineering education. The Ubiquitous Personalized Learning Environment would allow presenting the formal content in the manner and at the level that suit a specific individual. The environment would be further tunable and adapted for changing the manner/raising the level of presentation in line with the progress of the student.

2. Engineering education in the industrial society

Fundamentals of technology of the Industrial Society were rooted in formalization. Actually, according to the idea of formalization, any science and technology phenomena might be formalized; every technological problem might be resolved by finding a relevant formula or model. Consequently, the world was perceived as quite perfectly organized, describable and understandable because it could be expressed by using relatively simple laws usually having the linear nature. The creativity component of the science and technology knowledge was considered less significant for the technology. In general, the success of Industrial Technology was based on the simplicity of linear models successfully describing the science and technology knowledge.

As a result, all components of Industrial Society education (curriculum, teaching, learning, and learning environment) have a trend to be formalized.

Based on the mentioned above, the main characteristics of the engineering education in the Industrial Society can be summarized as follows:

- *Science and Technology Symmetry.* The definition of technology as “Technology=Applied Science” dominates. The fundamental exact sciences are used as the background of all engineering studies.
- *Profession of Engineer.* In the industrial era, an engineer is a profession. Registered (licensed) engineers are permitted to offer their professional services directly to the public. The term *professional engineer* and the actual practice of professional engineering are legally defined and protected by a government body stating that only registered or licensed professional engineers are permitted to use the title and to practice professional engineering.
- *Content Delivery.* Content delivery is mostly done by a teacher. Engineering class actually the same as a traditional frontal class, without any principal difference. Practice laboratory based studies are widely applied for engineering education.
- *Learning Environment.* Traditional engineering learning environment is based on real equipment. It is touchable, mechanistic, laboratory based and applicable for practical engineering.

3. Engineering education in the post-industrial society

Post-industrial society gradually becomes a virtualized society [1]. In contrast with the engineering education in the industrial society, which is based on formalization as the main paradigm, engineering education in the post-industrial society is characterized by increasing the role of creative components of the education, while the formal components move to some commonly accessible “virtual space”.

In the post-industrial society, our world is considered as more and more unpredictable and non-linear [8, 9]. The new emerging models that describe typical processes in the nature and in the social life are usually perceived as complex, non-linear and dynamic [4]. Achieving exact solutions and/or formal proofs is often impossible by such models. In these conditions, the absolute scientific truth [10], the absolute result, the optimal solution become less important and somehow lose their main role.

The traditional science and technology education meets significant difficulties. The formalization loses its central role as a main educational activity. Innovative methods of teaching and learning require innovative and usually non-formal approaches. The Post-industrial education seems to become mostly informal, creativity-oriented education.

Science and Technology – No Symmetry. Technology is not equal to the applied science anymore. This traditional paradigm of the Industrial Society does not work in the epoch of Virtualization, individualization and personalization. The engineering curriculum is dynamic and adaptive. It does not obligatory include fundamental scientific subjects (Calculus, Linear Algebra, Probability Theory, Physics, Theoretic Mechanics etc.). Instead, it will include such human oriented subjects as esthetics, psychology, cognitive science, ecology etc.

Engineer as a profession. Engineer as a formal component of the industry has been vanished (or substituted by a computing engineer). Traditional engineer is more and more substituted by a mediator (multi-disciplinary marketing consultant) between a manufacturer and a customer [8].

Content Delivery. A teacher is no more than one of the resources for educational content. The Virtual Environment with extensive prevalence of personal mobile devices will gradually replace traditional classrooms with a teacher in the center. Traditional laboratory studies are being transformed to studies in the ubiquitous environment. One of the examples of such environment is the “iTunes U” from Apple. Based on this software multiple educational applications have been created such as an Open University and mobile learning.

Learning Environment. Engineering studies will be based on a simulated virtual environment [4, 5] that some of them are being proposed below.

The future learning environment and educational process will likely include the building/extending of learning environment by students themselves.

4. Students challenges in the post-industrial society

From the discussed above and based on some late analysis [7, 8], the main student challenge in Post-industrial society is the new non-formal way of thinking required when dealing with complex dynamic systems of real life. The following ideas are subject for study.

Many of the core ideas associated with new ways of thinking about complexity may be challenging for students to learn. Considerable research has reported a variety of difficulties students have with learning concepts relevant to understanding complex systems that are currently taught in existing courses. For example, many students even at the college level believe that chemical reactions stop at equilibrium, or that evolution is the result of trait use or disuse and that acquired traits are passed down from one generation to the next one (i.e., Lamarckian view) [4, 5].

It has been suggested that important concepts related to complex systems may be counter-intuitive or conflict with commonly held beliefs. Many people believe that there is a linear relationship between the size of an action and its corresponding effect: a small action has a small effect, while a large action has a correspondingly large effect. However, it is now commonly understood that in complex and dynamical systems, a small action may have interactions in the system that contribute to a significant and large-scale influence—the so-called "butterfly effect." The students tend to solve problems using statements that are reductive, assuming central control, describing a single source of causality, are predictable, and focused on objects, while the complex systems experts tend to solve the problems with statements that considered the overall system, described de-centralized control and multiple causal factors, noted probabilistic nature of solutions, and are process oriented.

Known researches suggest that there may be additional learning challenges imposed by counter-intuitive epistemological and ontological components of the knowledge. A critical issue, then, will be to identify suitable approaches for learning and teaching complex systems knowledge that address these challenges.

An understanding of the world as comprising interrelated complex system is critical for all making effective decisions about their lives, their communities, and the environment. There is a need to introduce elementary and middle school children to the rudiments of complex systems within the mathematics curriculum. Calls for school curricula to increase students exposure to complex systems are clearly warranted, given that we live in a world that increasingly governed by such systems: the World Wide Web, political parties, school and university systems, family structures etc. It is necessary to seriously consider Complex systems and conceptual challenges with their learning and teaching.

A number of authors [5,6] proposed such an infrastructure to investigate complex multi-agent dynamic models – NetLogo where the students are transformed into players in a large-scale micro-world. Like classic micro-worlds, participatory simulations create a scenario, mediated by a set of underlying rules that enables inquiry and experimentation. In addition, these activities allow students to “dive into” a Virtual Reality - learning environment and directly engage with the complex system at hand.

Using agent-based, embodied modeling tools, students model the micro-rules and observe the resultant aggregate dynamics. Students frame hypotheses, construct multi-agent models that incorporate these hypotheses, and test these by running their models and observing the outcomes.

5. Ubiquitous personalized learning environment

The proposed schematic model (see Figure 1) is based on the following main principles:

- The Ubiquitous Personalized Learning Environment (UPLE) constitutes a universal, self-tuning and completely person-oriented tool. On the one hand, the UPLE is a powerful computerized simulation tool and, on the other hand, it allows emancipating the individual students from their troubles and shames, which would be non-avoidable in a conventional learning environment. The UPLE may be considered as an educational tool that supports developing creativity of individuals.
- UPLE is based on Global Personalization features, such as individualization, customized adaptation, context mining, Global Presence/Location and Global Mobility.
- The teacher’s role is changed drastically. Teachers should be able to virtualize (computerize) the formal component of the curriculum. Further functions of the teacher

become more creative than in a conventional educational process.

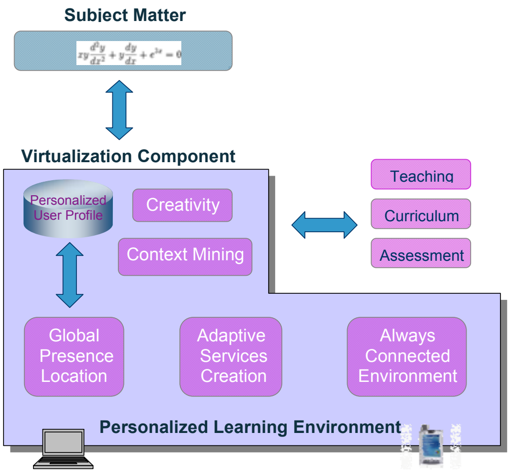

Figure 1. VR-based ubiquitous personalized learning environment

- Assessment of the student's achievement should not be made by a formal process, but by a new creativity-oriented education paradigm where the teacher would try to direct the students to develop their creative approach.

6. Conclusions

The highly technologically developed society becomes more and more virtualized in all aspects of social life in general and in Engineering Education specifically.

The global technological trends such as ubiquitous connection and personalization significantly affect all components of engineering education – learning, teaching, curriculum, and learning environment, but first of all - students themselves.

We have presented an opinion that, in order to preserve and improve the present level of education and help students overcome modern life challenges, it is useless to struggle with the main trends of the today's Post-Industrial society. It seems much more productive to become allies of the new technology and the new trends. The idea of creating a Ubiquitous Personalized Learning Environment (UPLE), that enables a student to study in the way he or she likes (in the way maximally suitable to the student's personality), may become an adequate answer to the challenge of the post-industrial engineering education.

Virtualization of the learning environment as a means to create a completely personalized and ubiquitous Virtual Reality based micro-world for each and every student is expected not only to fulfill the education function but also to emancipate both teachers and students by freeing them from formal activities so that creative activities become dominating.

7. References

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