2. *Боровских А. В.* Деятельностные принципы в педагогике и педагогическая логика : пособие для системы профессионального педагогического образования, переподготовки и повышения квалификации научно-педагогических кадров / А. В. Боровских, Н. Х. Розов. М. : МАКС Пресс, 2010. 80 с.

3. *Кирсанов А. А.* Методологические проблемы создания прогностической модели специалиста : монография / А. А. Кирсанов. Казань : КГТУ, 2000. 228 с.

4. *Невзоров М. Н.* Профессиональная педагогическая деятельность в условиях постиндустриальной культуры / М. Н. Невзоров // Педагогическое образование и наука. 2011. №11. С. 36 – 40.

5. *Новиков А. М.* Постиндустриальное образование / А. М. Новиков. М. : Эгвес, 2008. 136 с.

6. *Романова Е. С.* Психодиагностика : учебное пособие / Е. С. Романова. М. : КНОРУС, 2015. 336 с.

7. *Сергеев И. С.* Основы педагогической деятельности : учебное пособие / И.С. Сергеев. СПб. : Питер, 2004. 316 с.

8. *Сериков В. В.* Педагог и его деятельность: обновление функций / В.В. Сериков // Подготовка педагога новой формации в системе университетского образования: проблемы, практический опыт и перспективы : материалы Всерос. науч.-практ. конф. с международным участием. Тюмень : Изд-во Тюменского государственного университета, 2015. С. 25 – 33.

9. *Формирование* системного мышления в обучении : учебное пособие для вузов / Под ред. проф. З. А. Решетовой. М. : ЮНИТИ-ДАНА, 2002. 344 с.

10. *Щедровицкий Г. П.* «Естественное» и «искусственное» в социотехнических системах / Г. П. Щедровицкий // Щедровицкий Г. П. Избранные труды. М. : Шк. Культ. Полит., 1995. С. 437 – 448.

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ИНЖЕНЕРИЯ И ДИДАКТИКА: ИНТЕГРАТИВНЫЙ ПОДХОД

ENGINEERING AND DIDACTICS: BLENDED APPROACH

Аннотация. В данном исследовании детально изучается взаимосвязь инженерии и дидактики с целью осмысления конструкции дидактической инженерии как применения инженерной методологии к изучению преподавания и обучения. Ключевые термины (например, инженерия, дидактика, инженерное проектирование и инженерная дидактика) анализируются для проверки новой конструкции. Предметная область дидактической инженерии определяется как проектирование и построение ориентированных на результат обучающих продуктов путем применения научного метода и проектного мышления к анализу дидактических систем, процессов и ситуаций для создания эффективной учебной среды. Также обсуждается место дидактической инженерии в цепочке смежных понятий, а также влияние новой строительной переопределяющей дидактики.

Abstract. In this proposal, relationship between engineering and didactics is closely examined in order to conceptualize the construct of didactical engineering as an application of engineering methodology to studying of teaching and learning. Key terms (e.g., engineering, didactics, engineering design, and engineering didactics) are analyzed to validate the new construct. Subject domain of the didactical engineering is determined as design and construc-

tion of outcome-oriented teaching products via application of a scientific method and design thinking to the analysis of didactical systems, processes and situations for creating effective learning environments. The place of didactical engineering in the chain of related concepts as well as an impact of the new construct on redefining didactics is also discussed.

Ключевые слова: инженерная дидактика, дидактическая инженерия, проектное мышление, ориентированная на результат дидактика.

Keywords: engineering didactics, didactical engineering, design thinking, outcome-oriented didactics.

I. Introduction

Raising demands in digital age require interdisciplinary approaches to face challenges of intensive implementation of information and communication technologies (ICT) in higher education [13]. This paper examines potential benefits of interdisciplinary integration of engineering and didactics to address problems of designing effective learning environments. The blended construct of didactical engineering is considered as one of the innovative approaches to study and design effective teaching and learning [1, 4, 10, 11].

In order to unpack the meaning of didactical engineering, in Section II we provide definitions of key components of the new construct: engineering, didactics, and engineering didactics. Section III reviews prior research in didactical engineering and establishes its subject domain. Section IV describes relationship of didactical engineering to other related constructs such as teaching philosophy, learning theory, and teaching practice.

II. Engineering, didactics, and engineering didactics

According to Blocklye [2], “Engineering is, in its most general sense, turning an idea into a reality – creating and using tools to accomplish a task or fulfill a purpose” (p. 1). Analysis and design are the most important components of engineering. Moreover, “design is widely considered to be central or distinguishing activity of engineering” [5, p. 103]. On the other hand, design "not only reflects the activities of designers, architects and other professional engineers, but also economists, legislators, administrators, journalists, scientists, …" [7, p. 23]. Consequently, engineering as a human activity may be applicable to various professions and it involves analysis, design, construction, and quality control of objects and processes for practical purposes.

Historically, didactics was considered, primarily, as an art of teaching. In traditional textbooks, didactics is defined as a theory and practice of teaching and learning. More specifically, didactics addresses issues related to analysis of learning objectives, content and curriculum development, selection of instructional methods and techniques, and construction of assessment for the purpose of designing effective teaching and learning environments [11, 12]. Didactics is a discipline that extensively uses findings from research in the fields of learning theory and learning sciences [3].

Recently, term engineering/ design pedagogy is articulated among scholars [5, 8] to refer to a specific pedagogical model such as problem-based learning in engineering education. We propose to use a term engineering didactics, in a broader sense, as an application of didactical theory (e.g., theory of teaching and learning) to engineering education.

III. Didactical engineering

Didactics is an evolving field that expands its theory based on linking research and teaching [10]. To address challenges and complexities of learning and teaching in digital age with intensive use of information and communication technologies, scholars look for innovative solutions. One of the solutions is grounded on the application of engineering methodology in studying of teaching and learning. It is called didactical engineering.

The construct of didactical engineering is a relatively new in modern pedagogy. First attempts to implement an engineering approach into didactics took place in early 90-s [1, 4]. Douady [4] defined didactical engineering activity as a series of teacher-engineer's didactical actions to construct teaching products and implement learning projects with a group of students in order to achieve certain learning outcomes. Ruthven [10], on the other hand, emphasizes its replicability feature and believes that didactical engineering focuses on the "precise design" of the learning process, which later could be reproduced at another "point in time and space" under the same predetermined conditions. Interpretation of didactical engineering by Ruthven has much in common with the definition of pedagogical technology – outcome-oriented didactics [11].

Analysis and design of learning technologies are key objectives of didactical engineering. Therefore, didactical engineering aims at using scientific method in pedagogical design and fosters the development of instructors' analytic skills and design thinking [5, 9] in conducting macro and micro analysis of didactical systems, processes and situations. Accordingly, didactical engineering has it is own subject domain that is characterized by the following main parameters:

– study, design and construction of outcome-oriented teaching products (e.g., learning technologies);

– application of a scientific method and design thinking into the analysis of didactical systems, processes and situations in order to create effective learning environments.

Didactical engineering has a dual nature: it is both a product and a process of an educational design activity. It is a product of didactical analysis and design as well as a process of applying an engineered teaching product into the learning environment. Thus, as an instructional activity, didactical engineering can be defined as a series of steps in analyzing, designing, and constructing of teaching products and their use in the instructional process in order to achieve desired learning outcomes [12].

IV. Didactical engineering and related constructs

While introducing new construct, it is useful to define its place among similar construct. To this end, let us consider the relationship between the key categories of learning and teaching chain: teaching philosophy - learning theory - didactical engineering - teaching practice. Teaching philosophy is a belief system about effective learning and teaching, about the role of a teacher in student learning. The teaching philosophy may reflect different aspects of the phenomenon of learning: its ontology, epistemology, logic, and aesthetics. Teaching philosophy may be informed by learning theories; at the same time it could serve as

a tool for selecting a learning theory that best fit the teaching philosophy. Learning theory is a system of ideas that provides a holistic view of the nature and patterns of learning. The application of learning theory to design of outcome-oriented learning technologies is the essence of didactical engineering. Implementation of the teaching products designed by using the didactical engineering approach takes place in teaching practice. The teaching practice is a purposeful activity of the teacher and students to achieve the desired learning outcomes. Finally, technological innovations are constantly provoking a paradigm shift in teaching and learning that, in turn, influences the teaching philosophy.

The new construct also provokes rethinking of traditional definition of didactics which is limited to theory and practice of teaching and learning. In a digital era with emphasis on interdisciplinary approach, didactics encompasses scientific method and engineering methodology to design effective learning environments. Therefore, didactics could be reconsidered as science, engineering, and art of teaching and learning with emphasis on designing outcome-oriented learning technologies [11, 12].

References

1. Artigue, M. & Perrin-Glorian, M. (1991). Didactic engineering, research and development tool: Some theoretical problems linked to this duality. *For the Learning of Mathematics*, *Vol. 11*, 13-17.
2. Blockley, D. (2012). *Engineering: A Very Short Introduction.* Oxford, NY: Oxford University Press.
3. Bransford, J., Brown, A., Cocking, R., eds. (1999). *How People Learn: Brain, Mind, Experience, and School*. Washington, DC: National Academy Press.
4. Douady, R. (1997). Didactic engineering. *Learning and Teaching Mathematics: An International Perspective*/ Edited by T. Nunes & P. Bryant. – East Sussex: Psychology Press, 373-401.
5. Dym, C., Agogino, A., Eris, O., Frey, D., Leifer, L. (2005). Engineering design thinking, teaching, and learning. *Journal of Engineering Education, Vol. 94(1),* 103-120.
6. Jones, C. (2009). Interdisciplinary approach - advantages, disadvantages, and future benefits of interdisciplinary studies. *ESSAI, Vol. 6 (27).* dc.cod.edu/essai/vol7/issl/26.
7. Jones, J. (1970). *Design Methods*: *Seeds of Human Futures*. New York: *Wiley-Interscience*.
8. Mills, J., Treagust, D. (2003). Engineering education – is problem-based or project based learning the answer? *Australasian Journal of Engineering Education.* www.aaee.com.au/journal/2003/mills_treagust03.pdf
9. Rowe, P. (1987). *Design Thinking*. Cambridge, MA: MIT Press.
10. Ruthven, K. (2002). Linking researching with teaching: Towards synergy of scholarly and craft knowledge. *Handbook of International Research in Mathematics Education*. London: LEA, 581-598.
11. Tchoshanov, M. (2010). *Didaktika i Inzheneriya* (Didactics and Engineering). Moscow: Binom.
12. Tchoshanov, M. (2013). *Engineering of Learning: Conceptualizing e-Didactics*. Moscow: UNESCO IITE.
13. Youngblood, D. (2007). Interdisciplinary studies and the bridging disciplines: A matter of process. *Journal of Research Practice*, Vol. 3(2). www.eric.ed.gov/ERICWebPortal/contentdelivery/servlet/ERICServlet? accno=EJ800366.