

**Hristo Hristov**

PhD in Pedagogical Sciences: Methodology of Teaching Computer Science, Assistant Professor  
Department of Software Technologies  
Plovdiv University “Paisii Hilendarski”, Plovdiv, Bulgaria  
ORCID ID 0000-0003-2990-8015  
*hth@uni-plovdiv.bg*

**Emil Yonchev**

PhD Student in Computer Science, Department of Computer Informatics  
Plovdiv University “Paisii Hilendarski”, Plovdiv, Bulgaria  
ORCID ID 0000-0003-4917-4100  
*etj\_bg@abv.bg*

**Vladimir Tsvetkov**

PhD Student in Computer Science, Department of Computer Informatics  
Plovdiv University “Paisii Hilendarski”, Plovdiv, Bulgaria  
ORCID ID 0000-0003-3729-7461  
*vladimir@uni-plovdiv.bg*

## MODELLING OF PEDAGOGICAL PATTERNS THROUGH E-LEARNING OBJECTS

**Abstract.** Software platforms for e-learning support various options for presenting educational content. One of the ways to organize and structure it is via so-called pedagogical patterns. They are a method for describing and sharing knowledge and practical experience. Pedagogical patterns are used to describe pedagogical situations that occur repeatedly in the learning process. In the context of e-learning systems, there are various approaches to digitalization of pedagogical patterns. The purpose of the paper is to show how to build instances of pedagogical patterns using e-learning pedagogical objects, which can be easily and conveniently used as models in an adaptive e-learning environment. An e-learning pedagogical object is an abstract concept that can be presented in the concrete form of an e-learning object, an e-learning methodological object, an e-learning object for monitoring and diagnostics or an e-learning object with learning outcomes. These objects are building blocks for constructing instances of pedagogical patterns. This paper thoroughly discusses the issue of creating instances of pedagogical patterns of the four types of e-learning pedagogical objects. The instance of a pedagogical pattern is meant to serve to create subsections of educational topics. The instances of the patterns built of e-learning objects are learning units that are used depending on the context of a particular pedagogical situation.

The e-learning pedagogical objects and the pedagogical pattern instances are intended to be applied in an adaptive e-learning environment as teaching aids. Their theoretical models are applied in Moodle LMS in line with the tendency for software to assist and replace some of the teacher functions, while the teacher's role is raised to a higher organizational, pedagogical and methodological level.

Three instances of pedagogical patterns have been created through e-learning pedagogical objects: “Early Feedback”, “Feedback Sandwich” and “Consistent Metaphor” in LMS Moodle, which have been tested in the training course “Modeling of training courses in Moodle” during the autumn trimester of the academic year 2021/2022 at the Faculty of Mathematics and Informatics of Paisii Hilendarski University of Plovdiv, Bulgaria.

**Keywords:** e-learning object; pedagogical pattern; pedagogical pattern instance; adaptive e-learning environment.

### 1. INTRODUCTION

**Statement of the problem.** The increased use of adaptive e-learning environments in education raises the question of constructing the learning process through the composition of curricula and topics from small learning units. In the field of adaptive e-learning, it is accepted that such learning units are called learning objects or e-learning objects [1]-[4]. In this article

we expand the understanding of an e-learning object, through the concept of an e-learning pedagogical object. An e-learning pedagogical object is an abstraction of an object, which can be presented in its specific form as an e-learning object, an e-learning methodological object, an e-learning object for monitoring and diagnostics or an e-learning object with learning outcomes. These objects are building blocks for creating instances of pedagogical patterns. The specific situation for using a pedagogical pattern, together with the learning resources used, is called an instance of a pattern [5].

**The research goal.** The purpose of the paper is to show how to build instances of pedagogical patterns using e-learning pedagogical objects, which can be easily and conveniently used later as models in an adaptive e-learning environment. For the purposes of creating instances of pedagogical patterns from e-learning pedagogical objects and their application in an adaptive e-learning environment, a model of e-learning pedagogical objects, model instances of a pedagogical pattern and a concept for creating instances of e-learning pedagogical objects have been developed. Instances of the patterns built of e-learning objects are completed learning units which, depending on the context of a particular pedagogical situation, may be part of a learning topic. A characteristic of the instances of pedagogical patterns is that they represent a single step of the learning path that the learner takes in a certain course of study. From this point of view, the instances are considered as doorsteps of a training course, which the learner ascends.

## 2. THE THEORETICAL BACKGROUNDS

**The learning process in adaptive e-learning platforms.** Over the last decade, the question of the development and application of adaptive e-learning has been increasingly raised in educational practice. Adaptive e-learning software environments involve the use of web platforms, Internet technologies, cloud services, conferencing applications, etc. Adaptive learning is a new stage in the evolution of the learning process, where adaptation is achieved between actors (teachers and learners) and objects (software machine and technology) at the core of learning. The relationship between teacher and learner is improved. In adaptive e-learning environments, the role of the machine which assists and replaces some of the functions of the teacher is increasing. The role of the teacher has been raised to a higher organizational, pedagogical and methodological level. Apart from the content and methodological part of the training, the teacher is responsible for modelling the learning process in the respective technological environment. Thus, in adaptive e-learning environments there are interconnections between three parties involved in the learning process: teacher and learner, teacher and machine, machine and learner. In this sense, the classic definitions of the learning process in pedagogy as a relationship between teacher and learner need to be rethought and redefined for adaptive learning.

**Trends in adaptive e-learning platforms.** The adaptive e-learning system includes a comprehensive and systematic process of planning, design, development, evaluation of the learning material and its adaptation to the needs of the learner [6], [7]. According to [8], [9] [10] systems that automatically change their behaviour based on user actions and conclusions about their needs are referred to as having adaptivity, whereas those that adapt their behaviour based on changes in system parameters by the user are referred to as having adaptability. Issues related to the modelling of adaptivity and adaptability in adaptive e-learning environments are in the process of dynamic development. In scientific literature adaptivity and adaptability in adaptive e-learning systems are divided into several categories: adaptation of user interface, adaptation of learning process, adaptation of learning content, adaptivity of diagnosis and assessment of knowledge, interactive problem-oriented adaptations, adaptations with information filtering, group adaptations, on-demand adaptations, behavioral adaptations, etc.

[11]-[16]. A characteristic of these categories of adaptivity and adaptability is that the emphasis is on the development of technological tools for improving the possibilities for modelling adaptivity in training courses. In this study we place emphasis on the construction of the models of the study units which form or supplement the training course together with the standards and the means for presenting digital information. In this study such are the model of an e-learning pedagogical object, the model of an instance of a pedagogical pattern and interconnections between e-objects, forming an instance of a pattern.

In adaptive e-learning the learner's e-learning style, the ways of forming an "e-learning path" and the type of e-learning objects that make up e-learning content are essential [17], [18]. The structure of the e-learning objects created in an environment for adaptive e-learning needs to be such that they can be used repeatedly [19], [20]. E-learning objects in an e-learning course can be stored, categorized, indexed, retrieved, etc. There are high requirements for these objects in the adaptive training because through their models different educational and technological tasks are solved. The model and technology that the learning object is built on determine how it is designed, presented, transferred, etc. in and between different software platforms. There are even higher requirements for an e-learning pedagogical object than for e-learning objects. This is because through e-learning pedagogical objects, in addition to compiling learning content, solutions to methodological tasks are sought to increase the quality and effectiveness of education.

### 3. THE RESULTS AND DISCUSSION

#### 3.1. Model of an e-learning pedagogical object

An e-learning object has two main characteristics: subject-specific information content and technological content that achieves compatibility with software environments and portability between different platforms. We have tentatively accepted that the information content shall be called the core, whereas the technological content shall be called the envelope for compatibility and portability. By analogy, an e-learning pedagogical object also has an information core and a technological envelope (Fig 1. Model of an e-learning pedagogical object).

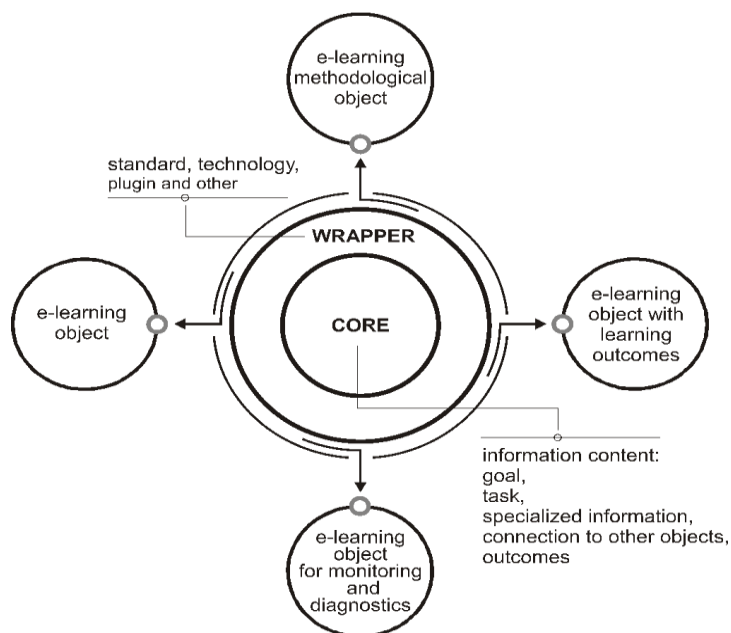


Fig 1. Model of an e-learning pedagogical object

Thus, the core of a monitoring and diagnostic object is the means for assessment of knowledge and quality of training; the core of a methodological object is the methods and means of learning, assignments to the learners, work instructions, etc. In the core of an e-object with learning outcomes various quantitative and qualitative learning outcomes are stored for an individual learner, group or course. Respectively, the core of an e-learning object is composed of thematic learning content. The technological envelope of these objects is developed through an electronic standard and specification for presenting a certain type of resource in electronic form. An alternative for building the envelope of an e-learning pedagogical object is to develop it through a tool of adaptive e-learning environment wherein the object is stored.

When creating e-learning pedagogical objects and building instances of them, we chose the option to develop them using the tools of LMS Moodle because of some advantages over alternative systems, which will be justified below.

### **3.2. Concept of a pedagogical pattern and an instance of a pedagogical pattern**

Pedagogical patterns are used to describe pedagogical situations that occur repeatedly in the learning process [21], [22]. According to Bergin, one of the pioneers in the field, a pedagogical pattern is a method for describing and sharing knowledge and practical experience [23]. The patterns are applicable both in sharing experience between specialists in one field and in teaching specific topics to students. Patterns are an abstract description of pedagogical situations or tasks [5]. They are represented by an abstract model composed of fields. According to different authors the fields vary in number and names with small differences. Most often these fields are: problem, context, results, solution, discussion, special resources, related patterns, contraindications, references [24]-[27]. The practical application of a pedagogical pattern in an e-learning environment presupposes the creation of its digital instance [28]. It is typical for an instance of a pedagogical pattern that it depends on the type of the pedagogical pattern and on the subject area of its application. If a pedagogical pattern is an abstract concept that can refer to different subject areas, its instance concerns a specific application in a particular subject area. In this study an instance of a pedagogical pattern is designed in such a way that its structure presupposes solution of a problem typical for the field when used in the learning process (*Figure. 2. Building an instance of a pedagogical pattern*). An instance of a pedagogical pattern is composed of e-learning pedagogical objects of a varying type and nature. For example, an instance contains a learning object with thematic learning material; a monitoring object with materials for monitoring the training and performing diagnostics on it, a methodological object with methods and means of training, etc. In the instance, i.e. the process of building an instance of a pattern of e-learning pedagogical objects, the definition of relationships between the different types of e-learning pedagogical objects that make up the instance is of the utmost importance. An instance of a pedagogical pattern contains pedagogical objects with different functions, such as a learning topic, a test for examination of knowledge, a teaching method, work instructions, etc. One of the tasks of an instance is to solve methodological problems characteristic of the subject of education through the interconnections between the different types of e-learning pedagogical objects and the technical possibilities of the environment for adaptive e-learning. The application of an instance of a pedagogical pattern presupposes, firstly, that it was created and, secondly, that it was integrated into an environment for adaptive e-learning. The first process is of a theoretical, pedagogical and methodological nature, i.e. it can be viewed as independent from technology, whereas the second process concerns the representation of e-learning pedagogical objects in a software system.

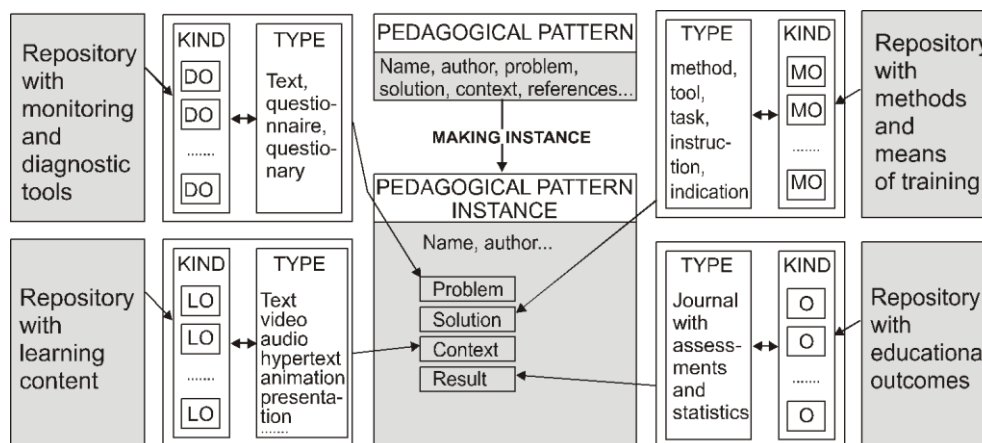


Fig. 2. Building an instance of a pedagogical pattern: LO - e-learning object content, MO - e-learning methodological object, DO - e-learning object for monitoring and diagnostics, O - e-learning object with learning outcomes

### 3.3. Relations between e-learning pedagogical objects in an instance of a pedagogical pattern

The realization of adaptive e-learning in a certain environment depends both on the tools of the environment and on the model of an instance of a pedagogical pattern, i.e. the interconnections between e-learning pedagogical objects. As can be seen in *Figures 2 and 3*, learning objects from a learning content repository correspond to the *context* field, methodological objects from a repository for methods and tools are connected to the *solution* field, monitoring and diagnostic objects from a repository for monitoring and diagnostic tools are connected to the *problem* field, electronic objects with learning outcomes from a repository with educational outcomes are associated with the *result* field. It should also be borne in mind that the fields of the instance problem, context, solution and result may include more than one e-learning pedagogical object, respectively the connections between them vary from zero to the number of electronic objects.

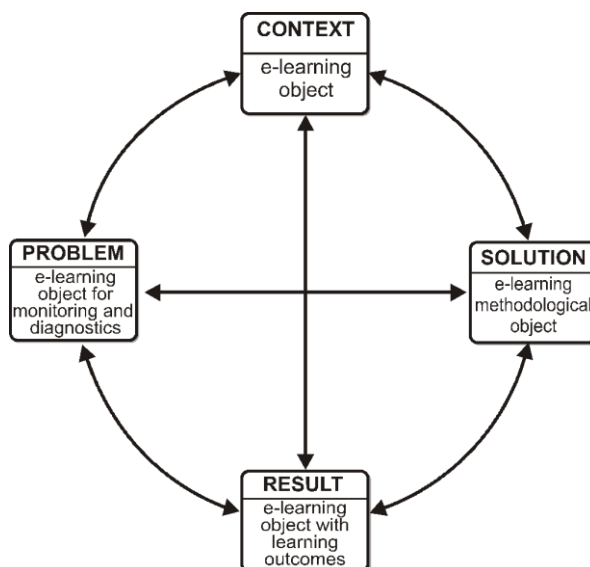


Fig. 3. Relations between e-learning pedagogical objects in an instance of a pedagogical pattern

### **3.4. Concept for building an instance of a pedagogical pattern through e-learning pedagogical objects**

A concept for creation of e-learning pedagogical objects and construction of an instance of a pedagogical pattern in an environment for adaptive e-learning was developed for educational purposes. When building an instance of electronic pedagogical sites, it is necessary to have repositories of different types of objects: training, methodological, monitoring and objects with learning outcomes. The concept of the creation of e-learning pedagogical objects and the construction of instances thereof are not bound to a specific technology. In practice, however, the creation of e-learning pedagogical objects and the creation of instances depends on the tools of the specific adaptive e-learning environment wherein they are developed or integrated. This implies that the learning environment should have a rich set of tools for modifying and modelling well-known electronic resources such as electronic text document, hypertext document, audio file, video file, photo, graphics, animation, presentation, etc.

When building instances of a pedagogical pattern, two main actions are important:

- 1) Storing e-learning pedagogical objects in the fields of the instance of the pedagogical pattern;
- 2) Determining the interconnections between the different types of e-learning pedagogical objects, which are already presented in the fields of the instance.

The process of instantiation in practice means presenting a certain number of the four main types of e-learning pedagogical objects in the fields of the instance of the pattern and to determine the relations between the already stored objects. Although, according to various authors, pedagogical patterns have between nine and fourteen fields, and respectively their instances are composed of most of these fields, we are interested in four of them. These are the *problem, context, solution and result* fields.

When building an instance of a pedagogical pattern, it is necessary to find a solution to the following tasks:

- 1) To identify the pedagogical pattern appropriate for the specific learning situation;
- 2) To design the fields of the instance of the pattern in a specific electronic learning environment;
- 3) To select and/or develop e-learning pedagogical objects intended for building an instance;
- 4) To determine the affiliation of the electronic pedagogical objects in the fields of the instance of the pedagogical pattern;
- 5) To make interrelations between the different types of e-learning pedagogical objects presented in the fields of the instance.

The construction of instances implies that the author of a certain learning course has developed e-learning pedagogical objects, which are stored in separate types of repositories. As can be seen in . 2, such repositories are: Repository with learning content, from which e-learning objects are selected; Repository with monitoring and diagnostic tools, from which electronic monitoring and diagnostic sites are selected; Repository with methods and means of training, from which methodological objects are selected; and Repository with results, which stores qualitative and quantitative assessments of the learning process of various types and nature.

### **3.5. Modelling of instances of pedagogical patterns in Moodle**

E-learning standards guarantee compatibility between different technological products and their components, the possibility of exchange and multiple use of e-resources [29]. From a technical point of view, the standards refer to the compatibility and portability of digital resources between different environments and platforms. They provide guidance for the design

and development of digital content, ensuring portability and compatibility. Although popular e-learning standards ensure the portability and compatibility of e-resources between different adaptive e-learning environments, their application leads to many difficulties and obstacles in building an e-learning course. In many cases the import of e-content from an external source into a specific adaptive learning environment through an e-learning standard limits the possibilities for modelling the adaptability of the course. The main organizations that develop and offer technical solutions to electronic standards are ARIADNE, Prometheus, Instructional Management System, Aviation Industry's CBT Committee, IEEE Learning Technology Standards Committee, ISO:Joint Technical Committee 1:SC36, Advanced Distributed Learning Initiative for creating a model for free exchange of learning objects (Shareable Courseware Object Reference Model – SCORM) [29]. After a number of experiments with different versions and products for application and compatibility of electronic standards by the above-mentioned organizations with adaptive e-learning environments Blackboard, ILIAS, Moodle, Claryline, Atutor, DisPeL and ADOPTA, we came to the conclusion that when importing and exporting digital resources, the use of an external electronic standard makes it significantly more difficult to prepare the course.

An alternative for importing e-resources in an adaptive e-learning environment is to use the integrated tools for e-content development on the e-platform itself. There is a wide range of e-learning systems in the digital learning space. Referring to comparative analysis of Blackboard, ILIAS, Moodle, Claroline, Atutor, DisPeL and ADOPTA environments from the source [30], on the basis of the possibility for adaptation to learning content, user needs and individualization of training, depending on user behaviour, on the results shown and adaptive testing and evaluation, it was concluded that the Moodle and DisPeL environments are the two systems that meet the most criteria. In the training course "Modelling of training courses in Moodle" held in the autumn trimester of the academic year 2021/2022 in FMI at Paisii Hilendarski University of Plovdiv, Bulgaria, the Moodle platform was selected for the construction of instances of pedagogical patterns of electronic pedagogical objects to the environment DisPeL, because it offers a richer tool kit for designing, creating and modelling electronic resources.

The elements that were used to create e-learning pedagogical objects and build instances of them in Moodle, together with specific tools for their modification, are file, folder, page, book, forum, dictionary, hyperlink, workshop, chat, test, assignment, survey, database, announcement, label, etc. The digital formats in which the e-learning pedagogical objects are stored are pdf, docx, rtf, djvu, ppt, midi, mp3, avi, mpeg and wmv. Three instances of pedagogical patterns were built through e-learning pedagogical objects: "Early Feedback", "Feedback Sandwich" and "Consistent Metaphor" in LMS Moodle, which were tested in the training course "Modelling of training courses in Moodle".

#### **4. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH**

In this paper, we have presented an extended interpretation of the term *learning object* in e-learning environments through a concept and modelling of an e-learning pedagogical objects. The discussed topics of digitalization of a pedagogical pattern, the concept of building an instance of a pedagogical pattern through e-learning pedagogical objects, relations between e-learning pedagogical objects in an instance of a pedagogical pattern and modelling of instances of pedagogical patterns in Moodle, show how the purpose of the paper is achieved. The presented research outcomes can be the basis for creating future e-learning courses and modules. This aspect of the current research has to be investigated separately, as an implementation of an instance of a pedagogical pattern application model. Such a model is unofficially implemented as a relation between several Moodle repositories for digital content.

Its formal description is a topic for another research paper and will be investigated in future research.

There are several prospects for future work. The first one is the formalization of the application model for implementing instances that can be achieved via the Moodle environment. An alternative view of this prospect is an approach to creating an instance of a pedagogical pattern in a Moodle-independent e-environment. After that, via a plug-in, this module can be integrated into Moodle. The third prospect is related to developing native software solutions. We have already planned the creation of such a plug-in module for integrating digital content into Moodle. Furthermore, we plan to conduct several experiments into the university courses *Web design* for gathering additional empirical data.

## ACKNOWLEDGEMENT

The work is funded by the MU21-FMI-004 and MU21-FMI-011 projects at the Research Fund of the University of Plovdiv "Paisii Hilendarski", Bulgaria.

## REFERENCES (TRANSLATED AND TRANSLITERATED)

- [1] M. Diego, G. Carlos, A. Jose, "Adaptive learning objects in the context of eco-connectivist communities using learning analytics," *Heliyon*, vol. 5, no. 11, pp. 1-14, Nov., 2019. Accessed: Jan., 1, 2022, doi: <https://doi.org/10.1016/j.heliyon.2019.e02722>. [Online]. Available:[https://www.cell.com/heliyon/pdf/S2405-8440\(19\)36382-0.pdf](https://www.cell.com/heliyon/pdf/S2405-8440(19)36382-0.pdf)
- [2] M. Sethi, S. Jain, S. Lomte, "Evaluation of Learning Strategy Specific Multi-Version Learning Objects," in *2017 Int. Conf. Transforming Eng.Educ. (ICTEE2017)*, Pune, India, 2017, pp.1-7, doi: <https://doi.org/10.1145/2345396.2345587>.
- [3] K. Sathiyamurthy, T.V. Geetha, M. Senthilvelan, "An approach towards dynamic assembling of learning objects," in *ICACCI'12: Proc. Int. Conf. Advances Comput., Communications and Inform.*, Chennai, India, 2012, pp. 1193-1198, doi: <https://doi.org/10.1145/2345396.2345587>.
- [4] N. Matar, "Multi-adaptive learning objects repository structure towards unified e-learning," *Int. Arab J.eTechnol.*, vol. 3, No. 3, pp. 129-137, 2014, ISSN: 1683-3198.
- [5] S. Hadzhikoleva, E. Hadzhikolev, T. Rachovski, "Pedagogical patterns and information technologies," *Announcements of Union of Scientists - Sliven Journal*, vol. 32, no. 1, pp. 63-69, 2017, ISSN: 1311-2864.
- [6] B. Khan, "A framework for web-based learning," *Techtrends tech trends*, vol.44, no.3, pp.51-53, Apr., 2000, doi: <https://doi.org/10.1007/BF02778228>.
- [7] A. Alsobhi, N. Khan, H. Rahanu, "Dyslexia adaptive e-learning system based on multi-layer architecture," in *2015 Sci. Inf. Conf. (SAI)*, London, UK, July, 2015, pp. 776-780, doi: 10.1109/sai.2015.7237231.
- [8] R. Oppermann, R. Rashev, Kinshuk, "Adaptability and adaptivity in learning systems," in *Knowl. Transfer*, vol. 2, A. Behrooz, Ed., pAce, London, UK, 1997, pp. 173-179.
- [9] C.-Y. Chou, K. R. Lai, P.-Y. Chao, C. H. Lan and T.-H. Chen, "Negotiation based adaptive learning sequences: Combining adaptivity and adaptability," *Comp.&Educ.*, vol. 88, pp. 215-226, Oct., 2015, doi: <https://doi.org/10.1016/j.compedu.2015.05.007>.
- [10] M. Bower, "A framework for adaptive learning design in a web-conferencing environment," *J. Int. Media in Educ.*, vol. 1, pp. 1-21, Feb., 2016, doi: <http://doi.org/10.5334/jime.406>.
- [11] E. Kovacheva, "Adaptive eLearning Systems" (in Bulgarian), Ph.D. dissertation, BIT Univ., Sofia, Bulgaria 2012.
- [12] D. Chin, "Empirical evaluation of user models and user-adapted systems," *User Modelling and User-Adapted Interaction*, vol.11, no.1, pp.181-194, Mar., 2001,doi: <https://doi.org/10.1023/A:1011127315884>.
- [13] P. Brusilovsky, P. Miller, "Course Delivery Systems for the Virtual University," in *Access to Knowledge: New Inf. Technol. and the Emergence of the Virtual University*, F. Tschangand T. Senta, Eds., Amsterdam: Elsevier Science and International Association of Universities: Issues in Higher Education, Jan., 2001, pp. 167-206.
- [14] P. De Bra, L. Aroyo, A. Cristea, "Adaptive Web-based Educational Hypermedia," in *Web Dynamics: Adapting to Change in Content, Size, Topology and Use*, M. Levene and A. Poulouvassilis, Eds., Berlin,



- Heidelberg, Germany, Springer Berlin Heidelberg, 2004, ch. 16, pp. 387-410, doi: [https://doi.org/10.1007/978-3-662-10874-1\\_16](https://doi.org/10.1007/978-3-662-10874-1_16).
- [15] P. Rosmalen, J. Boticario, "Using Learning Design to Support Design and Runtime Adaptation," in *Learning Design: A Handbook on Modelling and Delivering Networked Education and Training*, R. Koper, C. Tattersall, Eds., Berlin, Heidelberg, Germany, Springer Berlin Heidelberg, 2005, ch. 18, pp. 291-301, doi: [http://dx.doi.org/10.1007/3-540-27360-3\\_18](http://dx.doi.org/10.1007/3-540-27360-3_18).
- [16] A. Merceron, K. Yacef, "A Web-Based Tutoring Tool with Mining Facilities to Improve Learning and Teaching," in *Proc. 11th Int. Conf. Artificial Intell. Educ.*, vol. 97, pp. 201-208, July., 2003.
- [17] L. Bajenaru, I. Smeureanu, I. Marinescu, "Learning Styles in an Ontology-Based E-Learning System," in *Proc. 15th Int. Conf. Inform. Economy (IE 2016)*, Cluj-Napoca, Romania, June, 2016, pp. 153-158.
- [18] A. Kardan, S. Noorani, "Toward A Comprehensive E-Learning Style (CELS)," *ICVL 2009 - Proc. Of 4th Int. Conf. On Virtual Learn.*, Jassy, Romania, Oct./Nov., 2009, pp. 408-415.
- [19] A. Alanazi, M. Abbod, A. Ullah, "Intelligent e-learning repository system for sharing learning resources," *2014 Int. Conf. Web Open Access Learn. (ICWOAL)*, 2014, pp. 1-5, doi: [10.1109/ICWOAL.2014.7009209](https://doi.org/10.1109/ICWOAL.2014.7009209).
- [20] G. Costagliola, A. De Lucia, F. Ferrucci, C. Gravino, G. Scanniello, "Assessing the Usability of a Visual Tool for the Definition of e-Learning Processes," *J. Vis. Lang. Comput.*, vol. 19, No.6, pp.721-737, Dec. 2008, doi: <https://doi.org/10.1016/j.jvlc.2008.01.003>.
- [21] M. Fioravanti, E. Barbosa, "A Systematic Mapping on Pedagogical Patterns," *2016 IEEE Frontiers Educ. Conf. (FIE)*, 2016, pp. 1-9, doi: <https://doi.org/10.1109/FIE.2016.7757407>.
- [22] M. Fioravanti, E. Barbosa, "A Catalog of Pedagogical Patterns for Learning Applications," *2018 IEEE Frontiers Educ. Conf. (FIE)*, 2018, pp. 1-9, doi: <https://doi.org/10.1109/FIE.2018.8658904>.
- [23] J. Bergin et al., "Pedagogical Patterns: Advice for Educators," *CreateSpace Independent Publishing Platform*, 2012, ISBN-10: 1479171824, ISBN-13: 978-1479171828.
- [24] T. Iba, T. Miyake, "Learning Patterns: A pattern language for creative learning II," *Proc. 1st Asian Conf. Pattern Lang. Programs (AsianPLOP 2010)*, Mar., 2010, pp. 1-6, doi: <https://doi.org/10.1145/2371736.2371742>.
- [25] A. Seoane-Pardo, F. García-Peñalvo, "Pedagogical Patterns and Online Teaching," in *Online Tutor 2.0: Methodologies and Case Studies for Successful Learning*, F. García-Peñalvo, A. Seoane-Pardo, Eds., Hershey, PA, IGI Global., 2014, ch. 15, pp. 298-316, ISBN13: 9781466658325, <http://doi:10.4018/978-1-4666-5832-5.ch015>.
- [26] M. Fioravanti, E. Barbosa, "A Pedagogical Pattern Language for Mobile Learning Applications," *Proc. 24th Conf. Pattern Lang. Programs (PLOP 2017)*, Vancouver, BC, Canada., Oct. 2017, 1-22, ISBN: 978-1-941652-06-0.
- [27] S. Hadzhikoleva, E. Hadzhikolev, T. Rachovski, L. Iovkov, "Pedagogical Patterns and Software Tools for Pedagogical Patterns Management," *Scientific Researches of the Union of Scientists in Bulgaria - Plovdiv, Series B. Natural Sciences and the Humanities*, vol. 18, 2018, pp. 157-161, ISSN 1311-9192.
- [28] E. Hadzhikolev, S. Hadzhikoleva, E. Yonchev, T. Rachovski, "Formal Model of a Pedagogical Pattern Language," *Int. J. Scientific & Technol. Research*, vol. 8, no. 9, Sept., 2019, pp. 748-753, ISSN 2277-8616.
- [29] R. Nikolov, K. Stefanov, L. Vladinova, "Professional e-learning - technological standards, methodological challenges and applications," (in Bulgarian), *New Technol. Educ. Professional Training*, Sofia, May., 2003, Accessed: Jan., 12, 2022, [Online]. Available: <http://hdl.handle.net/10506/70>
- [30] A. Rahnev, T. Terzieva, E. Angelova and V. Arnaudova, "Adaptive e-learning systems," (in Bulgarian), *National Scientific Conf. Educ. and Science - Personal Social Develop.*, vol. 1, no. 1, Bulgaria, Smolyan, Oct., 2017, pp. 231-238, ISBN: 978-954-8767-65-1.

*Text of the article was accepted by Editorial Team 19.01.2022*

## ПЕДАГОГІЧНЕ МОДЕЛЮВАННЯ З ВИКОРИСТАННЯМ ОБ'ЄКТІВ ЕЛЕКТРОННОГО НАВЧАННЯ

### **Христо Христов**

кандидат педагогічних наук: методика викладання інформатики, доцент,  
кафедра програмних технологій,  
Пловдивський університет "Паїсій Хілендарський", м. Пловдив, Болгарія  
ORCID ID 0000-0003-2990-8015  
[hth@uni-plovdiv.bg](mailto:hth@uni-plovdiv.bg)

**Еміль Йончев**

аспірант з інформатики, кафедра комп'ютерної інформатики  
Пловдивський університет "Паїсій Хілендарський", м. Пловдив, Болгарія  
ORCID ID 0000-0003-4917-4100  
*etj\_bg@abv.bg*

**Володимир Цветков**

аспірант з інформатики, кафедра комп'ютерної інформатики  
Пловдивський університет "Паїсій Хілендарський", м. Пловдив, Болгарія  
ORCID ID 0000-0003-3729-7461  
*vladimir@uni-plovdiv.bg*

**Анотація.** Програмні платформи для електронного навчання підтримують різні варіанти подання навчального контенту. Одним із способів для його організації та структурування є так звані педагогічні моделі. Вони є методом для відображення і розповсюдження отриманих знань та практичного досвіду. Педагогічні моделі використовуються для опису педагогічних ситуацій, які неодноразово виникають під час навчання. У контексті систем електронного навчання існують різні підходи до цифровізації педагогічних моделей. Мета роботи – показати, як побудувати педагогічні моделі, використовуючи педагогічні об'єкти електронного навчання, які можна легко та зручно впровадити як моделі в адаптивному середовищі електронного навчання. Педагогічний об'єкт електронного навчання – це абстрактне поняття, яке може бути представлено в конкретній формі об'єкта електронного навчання, методичного об'єкта електронного навчання, об'єкта електронного навчання для моніторингу та діагностики чи об'єкта електронного навчання з результатами навчання. Ці об'єкти є базовими блоками для побудови педагогічних моделей. У даній роботі детально розглянуто питання створення педагогічних моделей з використанням чотирьох типів педагогічних об'єктів електронного навчання. Представлений приклад педагогічної моделі призначений для досягнення певних освітніх цілей. Приклади моделей, створених з використанням певних об'єктів електронного навчання, представляють навчальні блоки, які використовуються залежно від контексту певної педагогічної ситуації.

Педагогічні об'єкти електронного навчання та педагогічні моделі, призначені для їх застосування як засоби навчання в адаптивному середовищі електронного навчання, застосовуються в Moodle LMS відповідно до тенденції програмного забезпечення з метою допомоги викладачу або заміни деяких його функцій, а роль викладача піднімається на більш високий організаційний, педагогічний та методичний рівень.

За допомогою педагогічних об'єктів електронного навчання створено три приклади педагогічних моделей: «Ранній зворотний зв'язок», «Сендвіч - метод зворотного зв'язку» та «Послідовна метафора» в LMS Moodle, які були апробовані в навчальному курсі «Моделювання навчальних курсів у Moodle» під час осіннього триместру 2021/2022 навчального року на факультеті математики та інформатики Пловдивського університету "Паїсій Хілендарський", Болгарія.

**Ключові слова:** об'єкт електронного навчання; педагогічна модель; приклад педагогічної моделі; адаптивне середовище електронного навчання.

