

# Management of online platform development and support process

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## Abstract

The matter of building an optimal model of managing the online platform "Higher School Mathematics Teacher" is considered in this article. The existing researches on the management of online platform development and support process have been analyzed in this paper. The model developers described the process of building an online platform according to the Software Development Lifecycle rules. The researchers described an online course platform creation and functioning process that corresponds to a five-stage pedagogical ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) of online course preparation. The research describes the roles and objectives of online platform team members. These results allowed the authors of the article to model the organizational structure of online platform management. The method of survey among the team members of the online platform "Higher School Mathematics Teacher" and its participants was used to prove the efficiency of the offered model. The results allowed us to confirm the actuality of the research in the management of educational platforms, the convenience of teamwork in online platform management, and successful model implementation.

## Keywords

online platform management model, organizational structure of online platform management, teamwork

## 1. Introduction

Among the experts [1], who help newcomers to cope with the challenges of teaching online courses, the importance to determine creative strategies to manage large online classes is

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CTE 2020: 8th Workshop on Cloud Technologies in Education, December 18, 2020, Kryvyi Rih, Ukraine

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 CEUR Workshop Proceedings (CEUR-WS.org)

stated. These strategies include the use of a strong syllabus, clear instructions, well-organized learning materials, and prompt feedback. A great issue for online moderators must be that the nature of online education increases the importance of the right solution to these management issues, adding several additional obstacles. Among them – the selection of the right tools of communication and protocols, the solution to technological issues, management of students' expectations, and community building. And these are only some of the issues that can cause difficulties among online moderators. For instance, teachers who cannot organize weekly face-to-face meetings with students in the class, claim that the management of online course workload is much more difficult than the class course management. While organizing education on the online platform “Higher School Mathematics Teacher” [2], its objective, concept, and development principles that are described in the researches [3, 4], tutors also faced certain problems of managing the support process of the online course development.

## **2. Analysis of scientific researches**

While describing the stages of online course development Puzziferro and Shelton [5] emphasized that the teachers who are experts in their subject cannot be expected to become experts in educational design during the course development. According to the researchers, online course development requires a systematic process that analyzes the goals of course learning, provides the content, interactivity, and assessment. Considering the challenges of online learning, Gillett-Swan [6] described the obstacles that students face while completing the course tasks online. The scientist paid attention to the importance of a clear division of roles and tasks among the team members who organize an online education. Muriki [7] examined the readiness of tutors from Kenyan universities for online education and pointed out the necessity of constant team members' interaction that ensures the online educational process. The research results given by Alam [8] showed that students often feel anxiety while doing their first online course. The scientist recommends helping students feel more confident and secure by doing that at a controlled level.

According to the Gagné's theory 'Conditions of Learning' [9], there are several different types or levels of online education. The significance of these classifications is that each different type requires different types of instruction. Gagné identifies five major categories of learning: verbal information, intellectual skills, cognitive strategies, motor skills, and attitudes. The theory shows how to manage an online course. Merrill [10] in his research selected 5 principles of instructional design that allow increasing the online education efficiency. The scientist highlighted the use of Software Development Life Cycle (SDLC) as a basis for these principles.

Sacchanand and Jaroenpuntaruk [11] also showed the considerable efficiency of SDLC use with a combination of the waterfall, phased, and prototyping approaches while developing web-based applications for distance learning. Later Hughey in [12] pointed out the disadvantages of SDLC use for system development. He assumed that Agile methodologies use, in particular, Scrum methodology allows to improve significantly the whole development process. Considering all the existing researches on the management of online course development and support, the aim of the research has been formulated. It included the determination of the structure and sequence of online platform team development stages; it also offers and describes an optimal

model of managing the online platform “Higher School Mathematics Teacher” [2].

The objectives of the research were the following:

1. To determine the roles and objectives of online platform team members.
2. To describe the process of online platform development, assign the objectives and roles for online process participants at every stage.
3. To offer the stages of the online course platform creation and functioning, indicate team members’ roles and describe the necessary objectives.
4. To develop the organizational structure of online platform management.
5. To check the efficiency of the organizational structure of online platform management.

### **3. Method**

#### **3.1. Roles and objectives of online platform team members**

The first objective implied the analysis of the existing resources [1, 6, 7, 8] and experts’ recommendations [5, 13, 14]. A group of researchers [1, 6] described management problems that can be experienced while creating an online platform. They determined the requirements for the development technologies and its organization, formulated the conditions of interaction with participants, described team and systematic approach to online course development, defined team members’ roles and objectives. According to the researchers, the efficiency of online platform creation and functioning depends directly on the work clarity and synergy of all the team members. In order to ensure this task, it is necessary to determine the leading role of an online platform coordinator. The online platform coordinator carries out project management, ensures the coordination and functioning of staff work at all the stages of Software Development Life Cycle (SDLC) [15]. The main objectives of the online platform coordinator are:

- 1) compilation of requirements for the platform and problem statement;
- 2) selection of online platform development technologies and methodologies;
- 3) task implementation planning;
- 4) involvement in team creation and coordination of its daily activities;
- 5) creation of the course template.

In order to create an online platform, in particular design and its software, it is necessary to have a developer or a group of developers in the team. The developer provides software tools to create, manage, and assess the course and also is responsible for software modernization during its lifecycle.

The main objectives of online platform developers are:

- 1) selection of software tools for online platform development (front end technology, back end technology, system of data storage);
- 2) determination of system requirements for the online platform;
- 3) creation of the online platform design according to its usability;
- 4) online platform program implementation;

- 5) online platform software testing;
- 6) software modification according to modern tendencies of information technology development;
- 7) software modification according to the users' recommendations to improve its elements;
- 8) online platform workability and reliability maintenance;
- 9) security.

The course developer (teacher) or a group of developers are responsible for course content design and development and management of the learning process. At the same time, it is recommended [1, 5] to consider that the process of course creation should be done following ADDIE models (Analysis, Design, Development, Implementation, and Evaluation) [16], Bloom's taxonomy [17], the conditions of learning by Gagné [9], and Merrill's principles [10].

The main objectives of the course developer are:

- 1) course learning goals and problem statement;
- 2) creation of the learning program according to the aims and objectives;
- 3) development of structure, content, form, and methods of knowledge control;
- 4) determination of knowledge assessment criteria, description of requirements for task implementation;
- 5) learning process control;
- 6) communication with the course participants during private and group online consultations.

Considering the fact that teachers are not experts in educational design, there should be a content manager in the team for the technical support of content management while creating and using a course. They provide technical assistance in publishing course content on the platform and during all the time of its use.

The main objectives of the content manager are:

- 1) text content uploading on the platform;
- 2) ensuring high quality of the course content design;
- 3) creation, transformation, optimization, and posting of graphics, video, audio, animation content of the course;
- 4) posting of knowledge control elements, such as testing, surveys, and interactive tasks;
- 5) ensuring the right workability of the course elements during all the time of its use.

Moreover, an important factor of the educational platform functioning is the presence of its clients - participants. In order to ensure the search for and service of course participants, the presence of a client manager in the team is recommended.

The main objectives of the client manager are:

- 1) users' signing up for the course and providing access to it;
- 2) incoming calls and emails processing;
- 3) mailing management;
- 4) signing a contract for the course;

- 5) forming participants' group;
- 6) course scheduling;
- 7) course certificate issuance;
- 8) course advertising and promotion.

In order to check the course content correspondence to intellectual property law, it is necessary to introduce the role of a copyright specialist. They have legal control over the use of image, video, and audio information and other course elements. They analyze the course plagiarism and ensure legal support of online platform work.

### **3.2. The process of online platform development**

The process of developing an online platform “Higher School Mathematics Teacher” [2] was implemented according to the rules of the SDLC rules [15] that described the stages of this process. This method is successfully implemented while creating software for online education [11, 18, 19]. It includes such stages as Requirement Analysis, Designing, Developing, Testing, Deployment in the Market, and Maintenance. The use of the waterfall model methodology [15] during the platform development turned out to be inappropriate because this model does not consider possible requirement changes during the development cycle. Also, it was considered that the project implementation can take much more time than the development using iterative methodology [20]. Due to this fact we used a flexible development methodology Agile [3] in particular Scrum process [3].

Scrum-development process is designed for teams that usually include up to 10 people. This number of people corresponds approximately to the permanently functioning team of the online platform “Higher School Mathematics Teacher” [2]. The process itself allows providing a functioning product with new capabilities for the final user during strictly determined and short intervals (sprints).

Considering that the online platform after all the development stages will be continuously improved, we are planning to use this method during all its functioning. Based on the outlined methods, online platform lifecycle stages were offered. Following every stage, the participants' roles and the main objectives of the process were determined (table 1).

### **3.3. Creation and functioning process of the online course on the platform**

Every online course [2] has a template structure, determined at the stage of requirement analysis. Accordingly, the process of online course creation and functioning should also have a versatile lifecycle from its formation until the end of the learning process. The process of the online course creation and functioning should correspond to the pedagogical models.

ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) [16] is the most spread model of online course development that includes 5 design stages. Considering these stages we also use the system offered by Merrill [10]. The scientist highlighted 5 principles of instructional design: demonstration, application, task-centered, activation, integration. Moreover, he recommended Conditions of Learning, pointed out by Gagné [9]. The expert outlined nine instructional events and corresponding cognitive processes:

**Table 1**

The process of developing an online platform and participants' role in the waterfall development model

Development stage	Participants' roles	Description
Requirement Analysis	Online platform coordinator Online platform developer Online platform coordinator Online platform developer Course developer Course developer	Requirement analysis is the most important and fundamental stage. It is performed by the most experienced and advanced team members. The participants discuss the requirements for the online platform. This stage aims to determine detailed requirements for the system. Moreover, it is needed to make sure that all the participants have understood correctly the set the objectives and how exactly every requirement would be implemented
Designing	Online platform coordinator Online platform developer	The designing stage implies the selection and description of online platform software architecture, modularity, and determination of data storage structure, description of users' options, design creation and coordination according to its usability
Developing	Online platform developer	The factual development takes place at this stage and the online platform is created. The programming code is written according to the predetermined requirements. Data storage structure is created. The server and other online platform hardware are set up
Testing	Online platform developer	This stage includes fault determination (bugs, errors) of the online platform. They are determined, monitored, corrected and tested again as long as the platform achieves the quality standards determined at the stage of requirement analysis
Deployment in the Market and Maintenance	Online platform coordinator Online platform developer Course developer Content manager Client-manager	After testing and determining the online platform readiness, the deployment stage takes place. The platform is posted on the Internet. Team members, who upload the content, ensure feedback with users, and organize the learning process. In case of finding post-release bugs (errors) the information about them is given to the developers who carry out their corrections in reports

1. Gaining attention (reception),
2. Informing learners of the objective (expectancy),
3. Stimulating recall of prior learning (retrieval),
4. Presenting the stimulus (selective perception),

5. Providing learning guidance (semantic encoding),
6. Eliciting performance (responding),
7. Providing feedback (reinforcement),
8. Assessing performance (retrieval),
9. Enhancing retention and transfer (generalization).

Bloom's taxonomy was chosen to manage the assessment system. In the Bloom's taxonomy [17] the cognitive domain is broken into the six levels of objectives: remember (knowledge), understand (comprehension), apply (application), analyze (analysis), evaluate (evaluation), and create (synthesis). Considering the chosen models and their conditions of use, we were focused on the stages (table 2), where team members' roles and necessary objectives were indicated.

### **3.4. Organizational structure of online platform management**

After the distribution of roles and objectives among online platform team members we represented an organizational structure of its management (figure 1). The online platform consists of separate independent online courses. Every online course is created by a course developer and is posted by a content manager under the course developer's control. After the course posting a copyright specialist checks the content's correspondence to the intellectual property law. In case of detecting inconsistencies, the copyright specialist gives this information to the course developer who makes corrections in the course with the help of the content-manager. The platform coordinator ensures control over the course quality and posting terms, and also solves non-standard situations that can arise during the communication among team members.

While posting the course content managers use software tools that were created in the development process by online platform developers. In case of necessity, online platform developers consult content managers on technical issues of using a particular tool. If it is necessary to add or improve course posting tools, the developer modifies the programming part of the platform.

## **4. Results**

In order to carry out the analysis of the offered organizational structure model of managing an online platform and check its efficiency, we held a survey among the team members of the online platform "Higher School Mathematics Teacher" and the participants who had or have online courses on our platform.

We offered 13 questions for team members; every question was processed on a scale from 1 to 5. The rating of every task was defined by calculating the total number of points among all the respondents and its division into the number of respondents (table 3). Overall, 15 team members took part in this survey; the majority of them are teachers (online course developers).

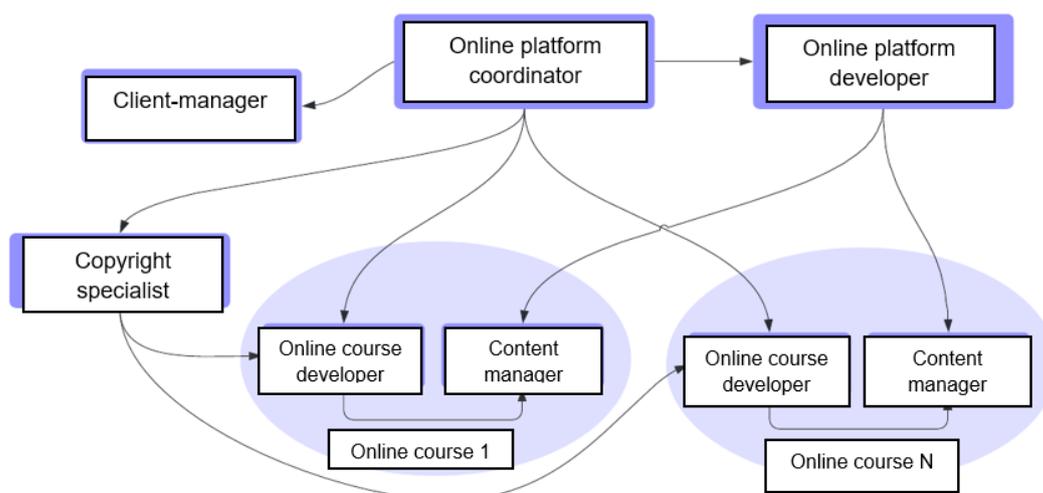
In general, all the survey questions were highly assessed, which confirms the research actuality in the management of educational online platforms. As it is seen in Table 3 the survey participants gave the highest rating to convenience of teamwork while developing an online platform and an online course on the platform, which can indicate the efficiency of this model. The need of having a copyright specialist in the team was highlighted as the least important

**Table 2**

Process of online course creation and use

Stage	Participants' roles	Description
Development of the course curriculum	Online platform coordinator Course developer	Creation of the course structure, problem statement, and results of its research, list of knowledge and skills that will be received as a result of its research. Description of types and criteria for the studied material assessment. Determination of communication method
Course material preparation	Course developer	Preparing text, graphic, video, audio course content. Preparing individual or group tasks to assess the studied material (tests, situational tasks, practical or laboratory tasks, etc.)
Course posting on the online platform	Course developer Content-manager	Converting the prepared course material into the type which corresponds to the requirements of platform usability and their deployment in the platform system. For instance, optimization of graphic files and their modification to "the best" format to increase the downloading speed via the Internet
Course testing	Course developer Content-manager	Checking the course completion and content conformity to the program. Checking "broken" links in the text. Checking the correctness of video opening, animated elements workability, tests, etc. Testing by simulating the entire course taken by a participant
Legal course verification	Copyright specialist	Checking the conformity of the used images, video and audio information, presentations, and other course elements to the intellectual property law. Plagiarism check
Course clients' search and registration	Client manager	Course advertisement and promotion on the Internet and social networking sites. Participants' registration and group forming, course schedule. Signing course agreements if necessary
Learning process	Course developer Client-manager	Learning process management. Carrying out communication with participants. Carrying out knowledge assessment. Preparation and issuance of course certificates
Course participants and control system assessment	Course developer	Developing tests and practical tasks. Checking practical course tasks using those ones that include checking course-mates' tasks and peer assessment, along with discussing it on the forum
Course modernization	Client-manager Course developer Content-manager	Carrying out surveys among the participants on course readiness, its design, and usability. Carrying out survey analysis. In case of detecting problems, modifying the course

requirement, the fact that proves that most course developers can monitor independently the observance of intellectual property law. Considering that several teachers have special skills to post independently online course materials on the platform the content manager's role does not have a high rating. The use of ADDIE model, Merrill's principles, Gagné's levels of learning, and Bloom's taxonomy in the online course have the highest rating, which proves that the platform



**Figure 1:** Organizational structure model of managing the online platform “Higher School Mathematics Teacher” [2].

teachers have a certain experience of online course creation and management. Participants of the online platform “Higher School Mathematics Teacher” were given 10 questions, each of which was assessed on a scale from 1 to 5 points. The average rating was calculated using the same method as the previous one. 127 respondents took part in this survey. The survey results are represented in table 4.

The survey participants gave the highest rating to the convenience and quality of the online platform “Higher School Mathematics Teacher”, which proves that the model we offered can be successfully put into practice. The participants gave the highest rating to the online platform structure quality and to the quality of representing the text content that is in our opinion very important in the whole area of educational software. The participants gave the lowest rating to the quality of visual design on mobile devices and the convenience of the interactivity system during the course. It stimulates us to work over the improvement of adaptive design for modern mobile devices, the functions of which constantly improve, as well as to search for methods to improve the online course interactivity.

## 5. Discussion

The actuality of developing a matter of educational online platform management is conditioned by a constant extension of demand for online education.

The authors’ idea about using a team model of online management is supported by the researches on the system of online course development process [5], and search for solving problems that students face during online education [6, 8, 21], and research on tutors’ preparation for online education and interaction between online platform team members [7, 22, 4]. The research analysis ensured the development of a model to implement an organizational

**Table 3**

Survey results among team members of the online platform “Higher School Mathematics Teacher”

Question number	Questions	Average rating
1	Convenience of teamwork during online platform development	5,00
2	Convenience of teamwork during online course development	5,00
3	Quality of organizational structure management	4,85
4	Necessity of a coordinator role	4,69
5	Necessity of a content manager role	4,62
6	Necessity of a client-manager role	4,77
7	Necessity of a copyright specialist role	4,38
8	Quality of lifecycle stages of online platform development	4,46
9	Convenience of Scrum methodology while working with the online platform	4,62
10	Necessity to use ADDIE model in the online course	4,38
11	Necessity to use Merrill’s principles in the online course	4,38
12	Necessity to use Gagné’s levels of learning in the online course	4,38
13	Necessity to use Bloom’s taxonomy in the online course	4,38
On average		4,61

structure of management during online platform creation. As a result of implementing the model developed by the team, an online platform named “Higher School Mathematics Teacher” was created and posted on the Internet; this platform is functioning and developing [2].

While developing the online platform “Higher School Mathematics Teacher” a team of 8-10 participants was engaged, and among them, the roles of a coordinator, platform developer, course developer, and content manager were defined. One participant could perform up to two roles depending on their technical skills. For instance, the platform coordinator created their separate online course and was a course developer, and the platform developer assumed an additional role of a content manager.

One coordinator of all the team members was responsible for the organization of the whole process. Two people were engaged in software development, they took part in the process at the stages of requirements analysis, designing, development, and testing. Three content managers who posted and tested the material together with the developers were determined at the online course posting stage. After posting every online course a copyright specialist carried out an analysis of the conformity of the used materials to the intellectual property law.

Teamwork provided successful development and functioning of the online platform “Higher School Mathematics Teacher”

**Table 4**

The results of the survey among the participants of the online platform “Higher School Mathematics Teacher”

Question number	Questions	Average rating
1	Quality of online platform structure	4,82
2	Quality of online course structure that was or is learned	4,65
3	Convenience of carrying out knowledge assessment	4,53
4	Convenience of communication with the teacher during the course	4,76
5	Convenience of interactivity system during the course	4,41
6	Convenience of navigation system	4,65
7	Quality of visual design on the computer	4,71
8	Quality of visual design on mobile devices	4,41
9	Quality of presenting graphic, video, audio information	4,59
10	Quality of presenting text content	4,88
	On average	4,64

## 6. Conclusions

The research on the matter of development and support management of the online platform “Higher School Mathematics Teacher” was carried out in the article. The actuality of the matter to develop the online course management has been proven, which is conditioned by the fact that online education quality depends on the quality of its development and support management, as well as some issues that tutors of the online platform “Higher School Mathematics Teacher” face.

The analysis of scientific researches and resources allowed us to determine the research direction. The role of teamwork in online platform management was explained in the research; the processes of online course development, as well as online course creation and functioning of the platform, are described. The authors of the research recommended determining the leading role of the platform coordinator and formulating their main objectives for the high quality of the online platform management. It is necessary to choose an online platform developer to represent software tools for creation, management, and assessment of the course process, and also for the modernization of the software in the team. The researchers recommended having course developers (teachers or a group of teachers) among team members to design and develop the course content, as well as to manage the learning process. Considering the fact that teachers are not experts in educational design, the authors of the article consider it necessary to have content managers in the team for technical support of content management while creating and using the course. Due to the need to satisfy the clients’ needs (educational platform participants), the authors of the course offered to involve a client manager in the process. The necessity to check the course content conformity to the intellectual property law required to introduce the role of a copyright specialist. The rules and models are determined by the researchers and in

accordance with them, it is necessary to develop an online platform and create online courses on it. The process of developing the online platform “Higher School Mathematics Teacher” [2] should be carried out according to SDLC rules. Online course creation and functioning should take place in accordance with ADDIE pedagogical model. The management of the assessment system is better to be held following Bloom’s taxonomy. The selection of these models allowed us to represent an online course creation and use process by stages with the description of objectives for every stage and team members’ roles at these stages. As a result of the research, the components and represented model of the organizational structure of online platform management are determined.

The survey responses which were given by the team members of the online platform “Higher School Mathematics Teacher” and online course participants prove the positive results of the model implementation. The analysis of the participants’ responses confirmed the importance of the educational platform management and convenience of teamwork in its implementation. The participants’ high rating of the online platform convenience and quality proved the successful implementation of the model.

The authors of the article consider the direction of further researches in the development of a structural-functional model to design an online course for teachers’ professional development.

## References

- [1] 11 Strategies for Managing Your Online Courses, A Magna Publication, Madison, Wisconsin, 2009. URL: <https://tinyurl.com/3zebws>.
- [2] Higher school mathematics teacher, 2020. URL: <http://www.formathematics.com>.
- [3] P. Abrahamsson, O. Salo, J. Ronkainen, J. Warsta, Agile software development methods: review and analysis, Technical Report, VTT, 2002.
- [4] K. Vlasenko, S. Volkov, I. Sitak, I. Lovianova, D. Bobyliev, Usability analysis of on-line educational courses on the platform "Higher school mathematics teacher", E3S Web of Conferences 166 (2020) 10012. doi:10.1051/e3sconf/202016610012.
- [5] M. Puzziferro, K. Shelton, A model for developing high-quality online courses: Integrating a systems approach with learning theory, Journal of Asynchronous Learning Networks 12 (2008) 119–36. URL: <https://olj.onlinelearningconsortium.org/index.php/olj/article/view/1688>. doi:10.24059/olj.v12i3-4.1688.
- [6] J. Gillett-Swan, The challenges of online learning: Supporting and engaging the isolated learner, Journal of Learning Design 10 (2017) 20–30. URL: <https://www.jld.edu.au/article/view/293>. doi:10.5204/jld.v9i3.293.
- [7] M. Muriki, Relevance of ODeL in TVET institutions during challenging times in Kenya (2020) 1–12. URL: <https://www.researchgate.net/publication/343788065>. doi:10.13140/RG.2.2.33142.01606.
- [8] A. Alam, Challenges and possibilities of online education during Covid-19, Preprints (2020) 2020060013. URL: <https://www.preprints.org/manuscript/202006.0013/v1/download>. doi:10.20944/preprints202006.0013.v1.
- [9] R. M. Gagné, The Conditions of Learning and Theory of Instruction, volume 68 of *Lecture Notes in Computer Science*, CBS College Publishing, New York, NY, 1985.

- [10] M. D. Merrill, First Principles of Instruction, volume III of *Instructional Design Theories and Models: Building a Common Knowledge Base*, Routledge Publishers, New York, NY, 2009.
- [11] C. Sacchanand, V. Jaroenpuntaruk, Development of a web-based self-training package for information retrieval using the distance education approach, *The Electronic Library* 24 (2006) 501–516. doi:10.1108/02640470610689197.
- [12] D. Hughey, Comparing Traditional Systems Analysis and Design with Agile Methodologies, University of Missouri, St. Louis, 2009.
- [13] K. Vlasenko, O. Chumak, V. Achkan, I. Lovianova, O. Kondratyeva, Personal e-learning environment of a mathematics teacher, *Universal Journal of Educational Research* 8 (2020) 3527–3535. URL: <http://www.hrpub.org/download/20200830/UJER12-19516378.pdf>. doi:10.13189/ujer.2020.080828.
- [14] K. Vlasenko, O. Chumak, I. Lovianova, D. Kovalenko, N. Volkova, Methodical requirements for training materials of on-line courses on the platform "Higher school mathematics teacher", *E3S Web of Conferences* 166 (2020) 10011. doi:10.1051/e3sconf/202016610011.
- [15] J. P. Dias, H. S. Ferreira, State of the Software Development Life-Cycle for the Internet-of-Things, 2018. URL: <https://arxiv.org/pdf/1811.04159.pdf>.
- [16] K. Shelton, G. Saltsman, Applying the ADDIE model to online instruction, in: L. A. Tomei (Ed.), *Adapting Information and Communication Technologies for Effective Education*, volume 2 of *Advances Series*, 2006. doi:10.4018/978-1-59904-922-9.ch004.
- [17] B. S. Bloom, M. D. Engelhart, E. J. Furst, W. H. Hill, D. R. Krathwohl, *Taxonomy of Educational Objectives – The Classification of Educational Goals*, Longmans, Green & Co. Ltd, London, WI, 1956.
- [18] V. Jakchaikul, Application of learning management system for online learning modules, *Applied Mechanics and Materials* 804 (2015) 347–350. doi:10.4028/www.scientific.net/amm.804.347.
- [19] A. N. binti Jaafar, S. binti Rohafauzi, N. I. binti Md Enzai, F. D. H. bin Mohd Fauzi, N. N. S. binti Nik Dzulkefli, M. T. bin Amron, Development of internship monitoring and supervising web-based system, in: 2017 IEEE 15th Student Conference on Research and Development (SCORED), 2017, pp. 193–197. doi:10.1109/SCORED.2017.8305395.
- [20] J. Gosling, G. Bollella, The Real-Time Specification for Java, *Computer* 36 (2000) 47–54. doi:10.1109/2.846318.
- [21] I. Lovianova, K. Vlasenko, I. Sitak, I. Akulenko, O. Kondratyeva, Model of the on-line course for training master students majoring in mathematics for teaching at university, *Universal Journal of Educational Research* 8 (2020) 3883–3894. URL: <http://www.hrpub.org/download/20200830/UJER12-19516378.pdf>. doi:10.13189/ujer.2020.080912.
- [22] K. Vlasenko, S. Volkov, D. Kovalenko, I. Sitak, O. Chumak, A. Kostikov, Web-based online course training higher school mathematics teachers, *CEUR Workshop Proceedings* 2643 (2020) 648–661.