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THE USE OF THE CLOUD-BASED OPEN LEARNING AND RESEARCH PLATFORM FOR COLLABORATION IN VIRTUAL TEAMS

Abstract. The article highlights the promising ways of providing access to cloud-based platforms and tools to support collaborative learning and research processes. It is emphasized that the implementation of cloud computing services is a promising trend in the development of modern ICT pedagogical systems. The concept of cloud-based open learning and research platform is considered. The benchmarking studies of using ICT tools for learning and research within the pedagogical systems of higher education are fulfilled. The analysis and evaluation of the existing experience of using different types of software packages to support learning and research processes within the cloud-based environment are proposed. The issues of integration of knowledge-based services, language technologies and database network services within the open systems of learning and research are covered. A model of the cloud-based open learning and research collaborative environment involving the use of cloud-based components based on AWS virtual desktop, IBM Box, WPadV4 and other tools is substantiated. The reasonable ways of tools selection are considered and the prospects for their use within the cloud-based open learning and research platform in pedagogical systems of higher education are described. The research methods are the analysis of official international documents, publications on the subject of the research, observation, comparison, the analysis of the experience of using educational and scientific network packages, application of cloud technologies, benchmarking studies and experimental studies. Conclusions and recommendations encompass the application of cloud-based open learning and research technologies covering research platforms, scientific and educational network packages, and also cloud services for collecting, submitting and processing data as a promising trend in the development and modernization of the educational environment of higher education institutions and collaborative research.

Keywords: cloud computing; cloud-based learning environment; cloud services; open science; open data; openness; flexibility; collaboration; virtual teams.

1. INTRODUCTION

An open science paradigm seeks to capture all the elements needed for the functioning of the European Research Area (ERA): research data, research instruments, ICT services (communication, calculations, data and resources processing, and specific domain-oriented tools and program packages). The use of the digital infrastructure to support individual researchers and research teams has already demonstrated a great value. Managing shared resources for the community of scholars maximizes the benefits for society. It is expected that applying the principles and approaches of open science within the university learning and research environment will improve management, stimulate a higher level of participation, collaboration and social reciprocity [1], [2], [3].

In order for researchers to be able to focus on their work, newly developed electronic resources and specific domain services should provide the functions necessary to solve the problems of big data processing, adaptive learning and content management, collaboration support, personification of learning and so on. Modern environments meet the need to work smoothly and intuitively, without emphasizing the technical details of the ICT infrastructure deployment. Thus, the current demands of the research and education community seek a holistic approach to the development of the next generation of intelligent networks, which should work in concert with the components of a distributed application. The open science and research priorities such as open data, open methods, open research communication and evaluation are to be supported by the appropriate ICT platforms and tools, mostly cloud-based [4], [5], [6], [7], [8], [9], [10].

Open learning and research platforms are to be designed and tested to gain more adaptability, accessibility, flexibility, and openness [11], [12]. There is a need to consider and compare the most advisable methods of their design and delivery to support learning and research collaboration processes in virtual teams [13], [14], [15], [16], [17], [18].

The analysis of the recent research and publications. According to the recent research [3], [12], [18], [19], [20] the problems of formation of the cloud-based learning and research environment (LRE) in educational institutions to support collaborative learning and research processes in virtual teams, as well as other educational activities, are especially challenging.

The cloud computing approach gives new insights into the field of adaptive learning as artificial intelligence approaches and advanced network tools merge to create a new trend [21]. Adaptive cloud-based learning systems become a new stage in the development of adaptive systems, which have a great potential and significant prospects for use in educational institutions. So the special attention is to be devoted to adaptive cloud-based platforms to support learning and research collaborative processes.

The scientific and methodological issues of creation and development of the cloud-based learning and research environment in the context of Open Science Priorities as they are defined within ERA formation have been approaches and models for electronic educational resources delivery within the cloud-based setting [2, 14, 22], the methodology of CC-based learning and research university environment considered in [3].

The experience of using cloud service MS Teams in the learning process as a platform to support the students' teamwork was considered by O. Glazunova, O. Kuzminska, T. Voloshyna, T. Sayapina, V. Korolchuk, N. Dorosh [23], [24].

P. Szabo and J. Galanda report on the use of SageMathCloud and CoCalc cloud services to support collaborative learning [25]. The use of CoCalc to support students' teamwork is also considered by M. Popel [26], M. D. Ruiz and F. Torralbo [27] et al.

The current issues include existing design, the use of information research and educational networks and research infrastructures [2, 28], the use of different types of services

within the CC-based LRE such as educational robots, systems of language processing, databases, and others [29], [30], evaluation of current experience of using cloud-based models and components [3], [13]. The challenge of creating a hybrid university platform that would combine different types of services to support open learning and research activities and collaboration arises as essential and prevailing [19]. This brings the issues relating to cloud-based open learning and research environment design and development to the forefront.

Due to the introduction of the cloud computing technology (which enforces the emergence of adaptive information and communication networks), new forms of activity arise, which affect the content, methods and organizational forms of open education and science. Tools and services of cloud computing constitute the information and technological platform of the modern educational and research environment and become the network tools for its formation and development.

The unresolved aspects of the problem. The conceptual and terminological body of investigation, and the main principles of designing and developing university cloud-based learning and research environment such as the principles of open science, open education, as well as the specific principles inherent in cloud-oriented systems are considered in [3].

Cloud computing in several kinds of available models, such as IaaS, PaaS and SaaS, plays an important role in this attempt to facilitate collaborative research and joint data processing. Providing abstraction of resources and simple automation tools, modern cloud platforms simplify most routine tasks such as installation, maintenance, backup, security, and more [19]. Thus, cloud applications have become an important tool for modern researchers. Moreover, today, they are, as a rule, the best way to solve the problem of big data. The concept of open science deals with the problems of open data. So, the cloud computing platforms may serve as a reasonable framework to support open learning and research processes both in terms of maintaining and processing a large amount of data and also to make it available for the community of scientists for joint processing, retrieving and evaluation. This leads to the notion of smart data.

Cloud platforms are most of all suitable for the tasks of integration and aggregation of a considerable number of different services, which is necessary for the realization of open science aims. Among them, there is the need of integration into university learning and research environment of a large number of various information and technological support tools, such as the scientific and educational information networks [28], corporate network tools and services for learning and research [13], as well as various language tools to support the multi-language content [30], the use of intelligent educational agents and robots, databases [29], [30] and so on.

The academic writing support within virtual research teams becomes most crucial, as this kind of activity is needed at all stages of the research process, such as problem analysis, search for relevant literature sources and partners, search for research methods and tools, research data collecting, representation, processing, analysis, interpretation and discussion [18].

The unresolved issues are how to combine different cloud-based services for open learning and research within a united platform and test their integration to meet the current demand for smooth and intuitive support of research collaboration in virtual teams.

The purpose of the article is to consider, design and evaluate a cloud-based open learning and research platform to support collaboration in virtual teams. The main idea is in the hypothesis that design and development of learning and research environment due to the proposed approach will result in a positive effect of better access to electronic educational resources and more efficient use of ICT to support collaborative learning and research processes such as academic writing, knowledge/content exchange and research activities, design of edu-packages, computer-supported collaborative learning (CSCL) and so on.

2. THE RESEARCH METHODS

The research method involved analyzing the current research (including the benchmarking studies of the experience of the research project team participants as for the application of cloud-based tools and services for educational needs), examining existing models and approaches, technological solutions and psychological and pedagogical assumptions about better ways of introducing innovative technology into the pedagogical systems of higher education; modeling of the open learning and research collaborative environment involving cloud-based components based on AWS virtual desktop, IBM Box, WPadV4 and other tools. To measure the efficiency of the proposed approach, expert estimation and benchmarking studies of the research and experimental results were undertaken.

Valerii Bykov proposed the methodological approach for the investigation of the cloud-based learning and research university environment in the context of open science paradigm; Dariusz Mikulowski described and tested the approaches to adjusting open learning and research systems for people with disabilities; Oliver Moravcik investigated the technology-enhanced learning and a personalized knowledge-based approach to the integration of digital technology into teaching and associated processes; Stefan Svetsky developed the WPadV4 tool and proposed the model of the cloud-based open learning and research collaborative environment involving the use of AWS virtual desktop, IBM Box, WPadV4 and other tools; Mariya Shyshkina contributed to the analysis and evaluation of the experience of WPadV4 implementation within the cloud-based settings.

All authors contributed to the benchmarking studies of using ICT tools within the open systems of higher education, to revealing the prospects for their use within the cloud-based open learning and research platform.

3. THE RESEARCH RESULTS

The use of ICT affects the content, methods and organisational forms of learning and managing educational and research activities that require new approaches to learning environment arrangement [2], [3]. Therefore, the formation of modern cloud-based systems for supporting learning and research activities should be based on appropriate innovative models and methodology that can ensure a harmonious combination and embedding of various networking tools into the educational environment of a higher education institution [2], [3],[21].

The cloud-based learning and research environment (LRE) of a higher education institution is the environment in which the virtualized computer-technological (corporate or hybrid-based) infrastructure is purposefully built for the realization of computer-procedural functions (such as content-technological and information-communication functions) [21].

Essential features of the formation and development of the cloud-based learning and research environment of higher educational institutions are such properties as openness and flexibility [3].

At the same time, the cloud-based environment of an educational institution is a complex system that contains a significant number of subsystems, implements various functions that are formed at the level of the institution and its separate structural subdivisions. In this aspect, the cloud-based approach to the environment creation is to provide the basis for the integration of different types of services to support various kinds of learning and research activities as well as the integration and close relationship between learning and research. Special attention is required to the methods of designing and using environment components for different levels of its organization in the implementation of various types of cloud-based

tools [3], [13]. Therefore, a set of techniques may be needed to deploy and use the cloud-based environment or its components.

The cloud-based open learning and research network instruments are the ICT tools that provide the formation and current maintenance of network electronic information resources and cloud services of the open learning and research environment, the implementation of the technology of design and application of open cloud-based pedagogical systems. The most important network tools for open learning and research systems include cloud-based science and education information networks and infrastructures, in particular, the European Open Science Cloud (EOSC); cloud-based corporate information systems and services; network electronic educational resources and services for data collecting, processing, and presentation; educational and scientific laboratories of remote access; language technologies; educational robots and others.

The cloud-based learning and research platform is considered as a set of cloud-based tools to support different learning and research activities. Within a single platform a lot of different tools may be integrated providing more opportunities to realize open and adaptive learning and research.

The virtual project team is a team or community of participants (researchers) who undertake project activities (in particular, communications) according to the jointly determined aims. Sustainable information support of the project life cycle and information technological integration of the project management is provided using ICT-based tools.

The big data are the large amounts of data being structured or unstructured, which are collected and retrieved automatically.

The smart data are those collected in a segmented mode, available for human processing or for artificial intellectual agent processing, which are relevant for decision making.

Educational packages are understood as the structured collection of educational materials aimed at specific learning domains or learning tasks.

The adaptive cloud-based learning system is a cloud-based system that can be adjusted automatically by its parameters to different individual characteristics and educational needs of the learning process participants.

3.1. The V4 + Academic Research Consortium Aims and Scope

In 2018 the V4 + Academic Research Consortium Integrating Databases, Robotics and Language Technologies was established, which aimed to address regional issues related to EU ICT research priorities: Partner search for Horizon 2020, building up digital platforms of the future, language barriers, technology-enhanced learning, scientific-cultural heritage and know-how to exchange. The focus is on the networking of the V4 + partners to integrate their research expertise, perform partner search and benchmark these issues using the virtual technological platform. So, the processes of open learning and research are in the focus of this project. The partners of the project are six scientific and educational institutions from Slovakia, the Czech Republic, Poland, Hungary, and Ukraine. The important part of the project is to explore the use of the cloud-based platform to integrate and deploy different types of learning and research services, such as database tools, language technologies and educational robots [28].

Project reasoning. The aim of the V4+Consortium is to develop computer-technological instruments to tackle regional problems related to EU ICT research priorities. The research activity of the V4+Consortium is focused on several issues:

- ICT for partner search for Horizon 2020
- building digital platforms of the future

- overcoming language barriers using ICT
- Technology-enhanced learning
- ICT to support research and retrieval of scientific cultural heritage
- ICT know-how exchange.

This requires to start a pilot project for addressing these three blocks:(1) joining researchers into the V4+ Consortium for Partner Search, (2) coordination and sharing activities within the virtual technological platforms (networking), and (3) benchmarking with focus on their technological expertise (databases, robotics, soft computing, human language technologies, patents).

In this context, this pilot project could radically increase the competitiveness of the V4+ academic subjects and also prepare them for innovation activities in the context of Industry 4.0 (to assure compatibility of teaching with industry requirements), or for international cooperation in general. So, by creating a competitive research network- V4+ consortium we could contribute to changing it.

3.2. Benchmarking studies for shared expertise.

Because the V4+ academic research consortium is focused on the integration of shared expert activities, the benchmarking studies were focused on such IT fields, which represent research experience of the project partners. Thus, the content of the benchmarking studies was information exchange, analysis of state-of-the-art, and selection of research issues for other stages of project implementation.

Cloud services, cloud platforms and more generally the cloud-based university environment come to the focus of attention. Cloud platforms are most suitable for the tasks of integration and aggregation of a considerable number of different services such as the scientific and educational information networks [28], corporate network tools and services for learning and research [28], as well as various language tools to support the multi-language content [29], the use of intelligent educational agents and robots, databases [30] and so on. Thus, the basic principles of cloud-based open learning and research environment design and elaboration, as well as content and services modelling and implementation, are among the promising trends to be considered and discussed [3].

The cloud-based LRE was implemented at the Institute of Information Technologies and Learning Tools of NAES of Ukraine in the course of research projects and pedagogical experiments conducted during 2012-2017. During that period, cloud-based services for open education and open science support were introduced in the research and educational process [3].

In the course of this research work, a general model and a methodological system of using certain cloud-based services were elaborated [13], [14]. Some cloud-based components were created for this purpose. Among them, there was the research-educational cloud of the Institute developed by Office 365 service [3].

In the course of a series of pilot experimental studies (2012-2017), the mentioned cloud-based tools of ICT support of training and research processes were deployed; the cloud-based environment was created, and the methodological system and separate methods of using its components [13] were deployed, a series of training seminars, webinars and sessions were conducted for researchers, educators and teachers on the use of cloud services in scientific and educational activities, intermediate and control testing was conducted [3].

The university cloud-based learning and research environment is a kind of an open system. Thus, due to the wider involvement of facilities and services of scientific and educational networks, in particular, cloud-oriented, in the process of scientific research, it is

possible to achieve improvement of this activity organisation and results, which positively influences students' academic performance [28].

Within long-term research on technology-enhanced learning (2007–2014) and educational technology (2014–2019) S. Svetsky and O. Moravcik invented a personalized knowledge-based approach for the integration of digital technology into teaching and associated processes [29]. A breakthrough in their research was the formulation of the virtual knowledge, which is controlled and managed by the proposed educational software and the registration of the utility model of the personalized technical infrastructure.

A special attention in modeling and elaboration of the open learning and research systems is to be paid to adjustment of these systems for people with disabilities. The experience of using ICT by visually impaired people was considered by D. Mikulowsky [31], [32]. The use of different kinds of screen readers software was researched, for example, three types of software for Windows: namely, Narrator, which is built in the system, NVDA (open source) and JAWS. Generally speaking, a screen reader reads all the information that appears on the screen while the user is working with the operating system or with any other application. The unresolved issue was the integration of such tools into the open learning and research platform.

Despite numerous partial studies of specific issues in adaptive learning systems and cloud-based systems, the design and use of adaptive cloud-based systems remain relevant and topical. Adapting learning systems are still developing, gradually gaining momentum in developed countries of the world. The basis of the functioning of such systems is the competence approach, focusing on individual progress.

The analysis and assessment of the state of the art of using adaptive cloud-based systems in the Ukrainian educational space have shown that adaptability is largely not realized; the use of cloud-based services is not complex, conditioned by learning needs and subordinated to pedagogical goals of teacher training [21].

As these systems require computation of a very high order, analyzing enormous amounts of data in real-time, the scalability of the system can be considered from two points: how to effectively program these systems and how to prepare an architecture to provide the processing, loading and distribution of these data. Given this, it is important to study the principles and approaches of designing the adaptive learning systems based on cloud platforms, as well as develop methods for their use within the open learning and research university environment [21].

In the course of the project "V4+ Integrating Databases, Robotics and Language Technologies", the benchmarking studies of the ICT use to support learning and research processes were carried out [33]. 60 Horizon 2020 Project Calls devoted to ICT were considered to reveal the state of the art of the project scope related to the aims and the priorities of this European research program. Among the ICT Calls there were 45 Calls devoted to the different types and areas of ICT application (Technologies for digitizing European industry, European data infrastructure: HPC, Big Data and cloud technologies, 5G, Next-generation Internet (NGI), Cross-cutting activities), 13 Calls devoted to "Digitising and transforming European Industry and Services: digital innovation hubs and platforms", 2 Calls devoted to Cybersecurity.

Among them, there was Call ICT-16-2018: Software Technologies. It was devoted to new challenges in the sphere of ICT and how they may influence the way software is developed. Among the ideas devoted to advanced software development there is the following: "To enable the development of such complex structures of code and data, programming models must become more abstract and easier to use, following the principles of human thinking, rather than conventional algorithms" [33]. Still, this Call was not concerned directly with the issues of ICT for learning.

The Calls are addressing the education and learning issues, for example, ICT-25-2018-2020: Interactive Technologies. It was focused on new business and learning opportunities delivered by such interactive technologies as Augmented and Virtual reality.

The "ICT-28-2018: Future Hyper-connected Sociality" is devoted to the use of future social networks, media and platforms to enhance the communication, exchange, learning and knowledge acquisition. This Call was concerned with the social aspects of learning.

The Call "ICT-30-2019-2020: An empowering, inclusive Next Generation Internet" addresses, in particular, the personalized and inclusive digital learning issues, among them the use of various NGI (Next Generation Internet) technologies, such as machine learning, augmented and virtual reality and artificial intelligence.

The Call "ICT-29-2018: A multilingual Next Generation Internet" addresses the issues of technology-enabled multilingualism, language barriers, multilingual solutions and so on. "The actions will address technological challenges for language resources and interoperable tools and support coordination and networking by exploiting excellencies and synergies and activities carried out in the Member States and Associated Countries"[33].

So, we can see that the issues of adaptive content management, language technologies and other aspects of personalized learning are among the research priorities selected within the European Research and Technological Program Horizon2020. "... The projects shall create a sustainable ecosystem of multilingual applications and services tailored for the specific needs of the addressed sector" [33].

Still, we may conclude that there are not so many Calls concerning educational issues of using advanced ICT, in particular, adaptive learning and research platforms to support collaborative activities in multilingual context.

3.3. The Model of the Cloud-based Learning and Research Environment to Support Collaboration in a Virtual Team

The main result of the V4+ACARDC project was the creation of a complex system of IT support, consisting of technological network infrastructure, educational software WPadV4 and a didactics methodology on how to create educational packages and associated learning materials and multi-lingual support.

Computing of the virtual knowledge and the knowledge tables is performed by the database application WPadV4 that is being developed by S. Svetsky [29], [30], [34]. Because this educational software is based on the abstraction of the meta-information and content, it enables users to process any content in the default structure. So, the user can create knowledge tables for constructing teaching texts, material for lectures, and exercises.

From a human point of view, virtual knowledge consists of blocks of meta-information and content into which a user can insert their text or ASCII text in general. A teacher can insert any educational materials or content directly into the virtual knowledge tables in his/her natural language without the need of using any other machine languages. Fig. 1 illustrates virtual knowledge as one row of the free database table when the meta-information describing human knowledge was inserted into the table manually.

In this case, the meta-information identifies the content which is in the form of a manually written text.

WPadV4 tables can be focused on any kind of activities, e.g. such as:

1. Educational package design.
2. Information tables or Scientific-technical information tables.
3. Retrieval tables.
4. Navigation tables.
5. Personal tables for leisure, notes, organisational purpose, as personal calendar, etc.

6. Self-study tables.
7. eLearning tables.
8. Multilingual tables (dictionaries, phrases, ...).
9. File management tables, etc.

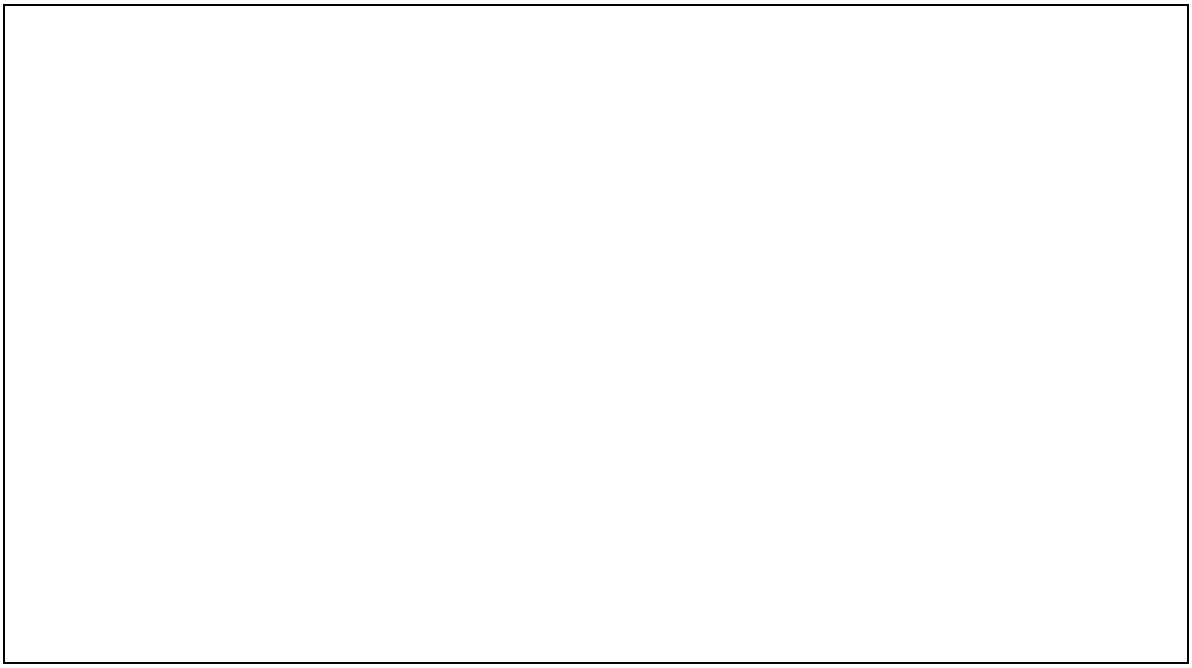


Fig. 1. Example of the content and meta-information in the database tables

The planned application software WPadV4 was developed/written by Stefan Svetsky. Then it was installed on the virtual desktops with Windows 10 for ten computers of partners and STU-MTF researchers. The WPadV4 beta-version represents a background solution for the Educational robot/Personal memory system. It also affects the Mobile application (including Text To Speech) for Android. Since the moment of realizing the importance of virtual knowledge, the authors' research has been more systematically focused on building a complex knowledge-based educational technology consisting of the educational software and online/off-line infrastructure, which contains knowledge repositories, expert and language corpora, and educational packages. This additionally covers the problem solving of the virtual knowledge and the files with the educational content transmission within the infrastructure. Modeling these elements within a community of researchers ("community of innovations") is explained in this paper by giving some examples from the design of using cloud service and a remote desktop. Fig. 2 illustrates the use of the cloud-based learning and research platform for modeling the knowledge-based educational technology that was built for this purpose.

In other words, a complex IT support for education and shared expertise has been created as CSA project (the coordination and support action) V4+ACARDC. So, the pilot V4+ regional network with a designed technological infrastructure (cloud computing, virtual machines, off-line WPadV4-content management), software application WPadV4 (including the android-test application), and a pilot educational methodology (e.g. edu-packages) has been created. The open learning and research environment is modeled and supported by means of this platform.

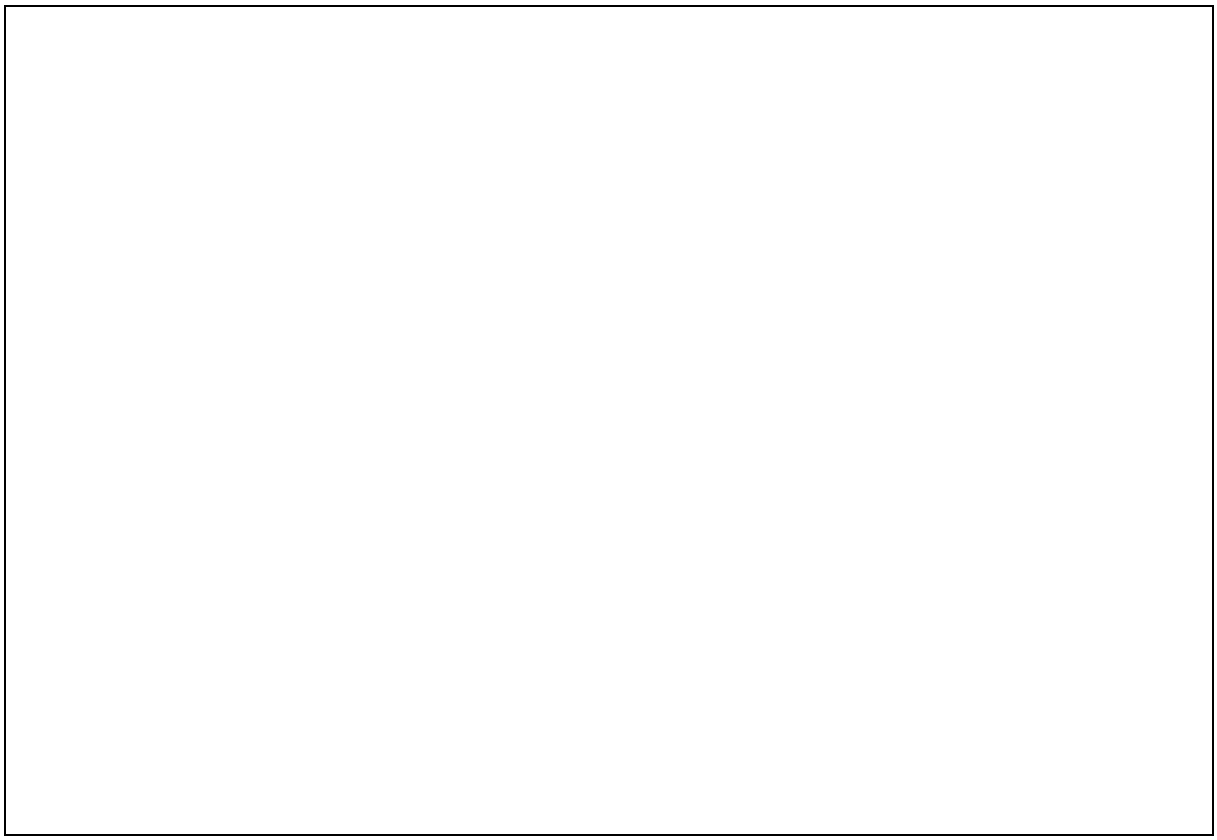


Fig. 2. The cloud-based learning and research platform to support collaboration within the V4+ACARDC project-team

3.3. The Main Deliverables of the Project

The research consortium and collaborative activities must function on a network infrastructure, so the shared virtual research networks were implemented and tested. In this context, global cloud services and university cloud or virtual environments have been benchmarked and selected within the project including WEB pages. As collaborative can be mentioned internet retrievals, testing educational packages and virtual V4+ library/ activities V4+ corpora/ V4+ science service.

Each of the partners had an experience of using virtual learning space. Actually, in collaboration with IBM Slovakia, partners use its cloud service IBM BOX. Each of the partners tested (1) global clouds, (2) their facilities/networks, i.e. clouds and virtual spaces, which were accessible by users via remote control, and (3) open WEB pages for dissemination and promotion of the project results.

A complex pilot IT support system was built up, which consists of (see Fig.2 above):

a) the shared technological IT infrastructure, which enables all V4+ partners to access and make shared activities from their personal or work computers or classrooms in collaborative way (cloud computing, virtual machines, and WEB-pages system);

b) a methodology of the design and semi-automatic production of educational packages, libraries, scientific service, retrieval system by using the all-in-one multipurpose software WPadV4 which was written within the project;

c) first steps regarding how to provide the IT multilingual support in V4+languages, which is bridged by the English language – this support is essential for writing scientific papers as well as designing and producing collaboratively the V4+teaching texts to support building academic courses in English.

Global deliverable 1: The BOX Cloud shared work-space – the shared work-space for all partners was built on the IBM BOX Cloud for storage and transfer of documents that networked researchers' computers. In other words, all events were documented in the shared BOX cloud project's content management area and supported by specific reports related to all work-packages. All documents created by the partners were retrieved in the BOX cloud work-space. All dissemination or promotion activities are archived in the BOX. For example, the library includes four thousand files, i.e. documents, covering four Gigabytes, which are structured according to the project management needs. This library is shared by all partners from their computers.

Global deliverable 2: Virtual machine with Windows 10 – this virtual machine is simply a shared computer with Windows 10 in the form of a remote desktop. This means that all partners have the same computer (with access via password). This was needed for developing and testing the WPadV4 software for the production of deliverables, e.g. educational packages. The following screenshot illustrates the shared desktop – you can see the desktop with icons and the result of creating an educational package, which was produced utilizing WPadV4 using the folder C:/SV/QSV/XXXXLP.htm that was situated on the remote computer. Thus, these are visible for all partners and can be used, inserted, etc. (Fig.3).

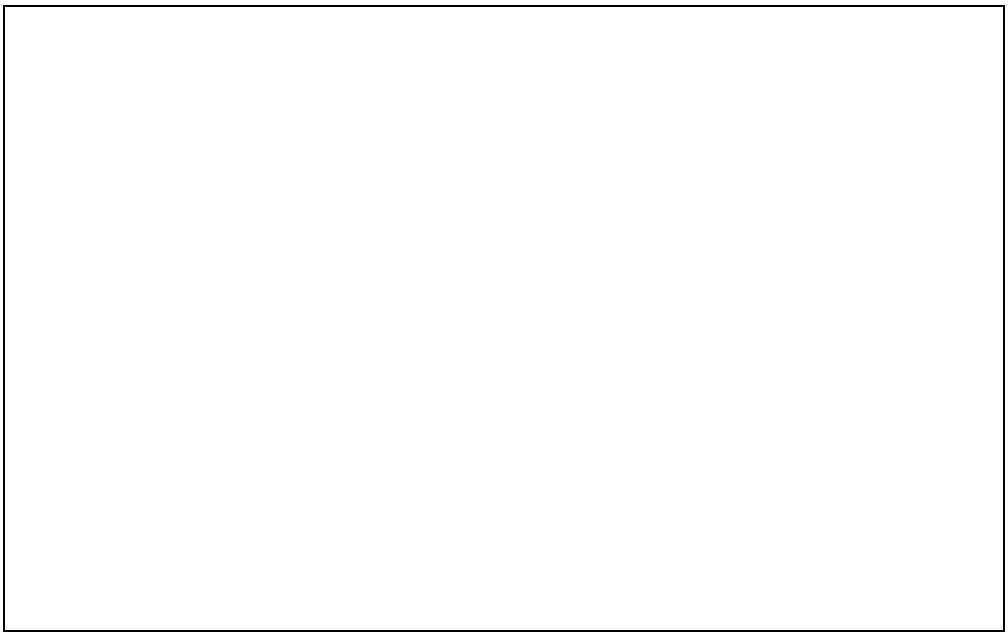


Fig.3. Print screen from the virtual desktop with the WPadV4 installed

3.4. Formation and implementation of the educational packages using WPadV4

A combination of the proposed utility model [34] as a system for conversion of unstructured data to semi-structured with the delivered software modification WPadV4 enables users to create a set of educational applications in manual, semi-automatic and automatic mode (knowledge management and information/file management). Thus, IT support is derived and designed tailor-made from teachers' needs.

One of the useful features of WPadV4 software may be the option of preparing an educational package from previously prepared materials. If a teacher has their learning materials that are collected in pdf, html or txt files, he or she can use them to prepare a complete educational package for students with the help of WPadV4. To do this, a teacher should first generate a temporary table named XXXX based on his/her files. Then, using this table, they will be able to generate an educational package which will be available to view in

the student's web browser. So, to create an educational package, a teacher should take the following steps:

1. Copy the files to the folder named XXXX.
2. Choose an option: "V4_BOX menu> 8.2 apps: EduPack (copy your file to c:\sv\XXXX folder) >Edupackage from all files files to XXXX table and HTML *png/jpg/txt" from the menu. After performing this step, table XXXX will be generated and then the page representing this table will open in the browser.
3. To improve and modify the created package, a teacher should save the table with a different name.
4. Then they can arrange the table so that the layout of the lesson is correct, complete the data in other columns such as lesson subjects, course author, etc.
5. Finally, a teacher can generate a html package from the table by pressing ctrl f1 or choosing option Generate html from the table from menu ZapisbBD. The finished educational package will open in the browser.
6. A Collection of html files generated from the table can now be placed in a place accessible to students.

The possible result of such actions may be the educational package design that is presented in Fig.3. You may directly browse and use the documents from the right table clicking the rows of the left table containing the metadata. So, the teacher may use the collection of learning materials organized into the integral block, namely the educational package. The advantage of this approach is the possibility to use data in any format that is compatible and available for collaborative retrieval and processing. This may be used to create educational packages for learning different disciplines, for example, mathematical and computer science disciplines, to process the information with different languages maintained smoothly, etc.

One of the tested pilot situations was designing PHP-programming language teaching.

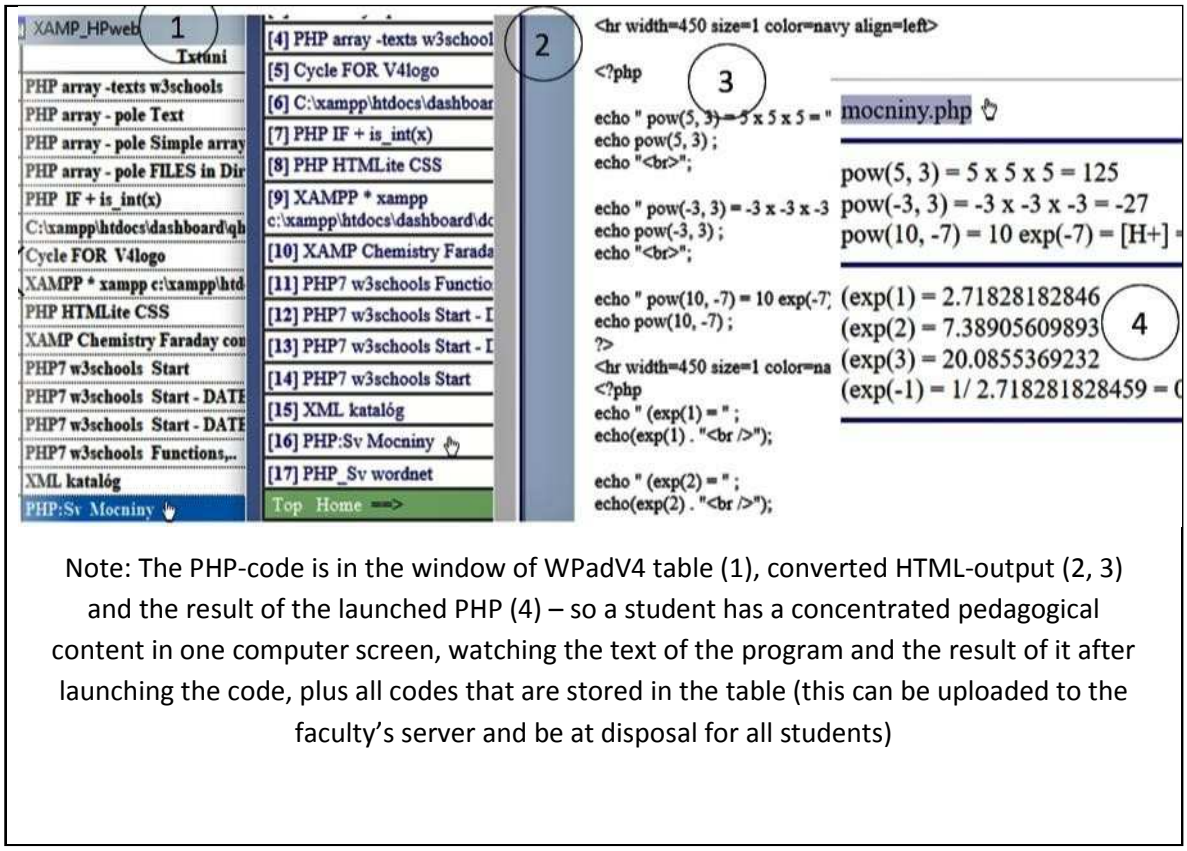
State-of-the-art: a teacher or student has source codes for learning PHP in any folder or library, which are written in a text editor. To practice these codes, they must first open PHP-software, insert one of the PHP-codes and launch it so that the result is visible in a browser (IE, Google Chrome, Firefox, Opera,...).

If it functions, the user decides if to store it to an archive. Batch operation with the PHP-sources codes is not possible.

In our case, all PHP-source codes are inserted manually or in an automatic way to rows of the WPadV4-table. After selecting a row with the PHP-code and clicking in the WPAdV4-menu (this launches the code), the default browser would be automatically open, and a student would see the result of the code. Because the codes are standing in the table, they do not have to be archived separately. Moreover, batch operation with tables is possible, so it also enables mass-production of the teaching materials. From a pedagogical point of view, the added value is in a concentration of the content in one screen, which is illustrated by Fig.4.

Generally speaking, WPadV4 software can be successfully used by a visually impaired user using a keyboard. It works well with different types of screen readers. It works best with a commercial JAWS screen reader, slightly worse with the built-in Narrator system reader and a free NVDA reader. However, a visually impaired user can work more or less comfortably with any screen reader [32, 31].

Within the project, educational packages for differential equations, programming languages, simulations and other areas of study were created and tested by the partners. This software was also used to get information resources of various kinds for research, for example, the list of scientific journals from the subject area, the library of the research papers of the partners along with the bibliographic notes, research report results and others.



Note: The PHP-code is in the window of WPadV4 table (1), converted HTML-output (2, 3) and the result of the launched PHP (4) – so a student has a concentrated pedagogical content in one computer screen, watching the text of the program and the result of it after launching the code, plus all codes that are stored in the table (this can be uploaded to the faculty's server and be at disposal for all students)

Fig.4. The example of using WPadV4 table to solve a computational task

4. CONCLUSIONS AND DISCUSSION

Cloud technologies are to provide the key features of the learning environment, which are openness and flexibility. If the tasks of environment development are changed it is possible to adequately modify the tool features and overall composition of the environment and also to modernize the methods of its use. So, the structure and the composition can be aligned with the planned development goals and new challenges that might appear in the future.

The IaaS or PaaS model is to provide the software access of whatever kind deployed on the cloud servers of the provider by the user. This opens a way for elaborating the methods of learning components deployment. For example, the learning component with the WPadV4 software was elaborated and tested on the basis of AWS (Amazon Web Services).

The main result of the V4+ACARDC project was the creation of a complex system of IT support consisting of the technological network infrastructure, educational software WPadV4 and a didactics methodology on how to create educational packages and associated learning materials and multi-lingual support. A cloud-based platform was used for sustainable information support of the project life cycle according to the jointly determined aims and information technological integration of the project management. The platform proved to be suitable to meet these needs and to perform smoothly and intuitively.

The principles and priorities of open science were met due to the use of the cloud-based learning and research platform to support collaboration processes. Among them, there were communication, information retrieval, research data, results and methods exchange, content management, as all the necessary materials such as guides, articles, learning materials, collections of documents and so on were currently maintained and available at the platform. The adaptive content management was supported by research tool WPadV4, which was used

to process available data in a sustainable model. Thus, all the data collected in the course of the research were findable, accessible, interoperable and reusable for all partners. This was to provide the openness and flexibility of the research collaboration processes.

The question of choosing and integrating services, exploring their various components, as well as supporting open education and science systems, combining intelligent technologies and network services presents a prospect for further research that needs careful study.

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ВИКОРИСТАННЯ ХМАРО ОРІЄНТОВАНОЇ ПЛАТФОРМИ ВІДКРИТОГО НАВЧАННЯ ТА ДОСЛІДЖЕНЬ ДЛЯ СПІВРОБІТНИЦТВА У ВІРТУАЛЬНИХ КОЛЕКТИВАХ

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Анотація. У статті висвітлюються перспективні шляхи забезпечення доступу до хмарних навчальних та дослідницьких платформ та інструментів для підтримування співробітництва. Розглянута концепція хмаро орієнованої платформи відкритого навчання та досліджень. Наголошується, що впровадження сервісів хмарних обчислень є актуальною тенденцією розвитку сучасних педагогічних систем. Виконано дослідження стану впровадження інструментів ІКТ для відкритого навчання та досліджень у педагогічних системах вищої освіти. Запропоновано аналіз та оцінку існуючого досвіду та освітніх досліджень різних типів програмних пакетів, що використовуються для підтримування навчання та співпраці в межах хмарного середовища. Висвітлені питання інтеграції хмаро орієнтованих сервісів у системах підтримування відкритих систем освіти та науки, поєднання інтелектуальних, мовних технологій та мережних сервісів. Обґрунтовано модель хмаро орієнтованого відкритого освітньо-наукового середовища для підтримування спільної діяльності. Розглянуто обґрунтовані способи відбору інструментів та описано перспективи їх використання в освітніх системах вищої освіти. Методи дослідження - це аналіз офіційних міжнародних документів, публікацій з проблеми дослідження, спостереження, порівняння, аналіз досвіду використання освітніх та наукових мережних пакетів, застосування хмарних технологій, тестування та експериментальні дослідження. Висновки та рекомендації висвітлюють застосування хмарних технологій відкритого навчання та досліджень, що охоплюють дослідницькі платформи, пакети наукових та освітніх мереж, а також хмарні сервіси збирання, подання та опрацювання даних як актуальної та перспективної тенденції розвитку та модернізації навчальної середовища закладів вищої освіти.

Ключові слова: хмарні обчислення; хмаро орієнтоване навчальне середовище; хмарні сервіси; відкрита наука; відкриті дані; відкритість; гнучкість; співпраця; віртуальні команди.

ИСПОЛЬЗОВАНИЕ ОБЛАЧНО ОРИЕНТИРОВАННОЙ ПЛАТФОРМЫ ОТКРЫТОГО ОБУЧЕНИЯ И ИССЛЕДОВАНИЙ ДЛЯ СОТРУДНИЧЕСТВА В ВИРТУАЛЬНЫХ КОЛЛЕКТИВАХ

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Аннотация. В статье освещаются перспективные пути обеспечения доступа к облачным учебным и исследовательским платформам и инструментам для поддержания сотрудничества. Рассмотрена концепция облачно ориентированной платформы открытого обучения и исследований. Отмечается, что внедрение сервисов облачных вычислений является актуальной тенденцией развития современных педагогических систем. Выполнены исследования состояния внедрения инструментов ИКТ для открытого обучения и исследований в педагогических системах высшего образования. Проведены анализ и оценка существующего опыта и образовательных исследований различных типов программных пакетов, используемых для поддержания обучения и сотрудничества в рамках облачной среды. Обоснована модель облачно ориентированной открытой образовательно-научной среды для поддержания совместной деятельности. Рассмотрены обоснованные способы отбора инструментов и описаны перспективы их использования в образовательных системах высшего образования. Методы исследования - это анализ официальных международных документов, публикаций по проблеме исследования, наблюдение, сравнение, анализ опыта использования образовательных и научных сетевых пакетов, применение облачных технологий, тестирования и экспериментальные исследования. Выводы и рекомендации освещают применения облачных технологий открытого обучения и исследований, охватывающих исследовательские платформы, пакеты научных и образовательных сетей, а также облачные сервисы сбора, представления и обработки данных как актуальной и перспективной тенденции развития и модернизации учебной среды высших учебных заведений.

Ключевые слова: облачные вычисления; облачно ориентированная среда; облачные сервисы; открытая наука; открытые данные; открытость; гибкость.