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THE USE OF THE CLOUD-BASED OPEN LEARNING AND RESEARCH PLATFORM TO SUPPORT 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 cloud computing services implementation is the actual trend of modern ICT pedagogical systems development. 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 different types of software packages use to support learning and research processes within the cloud-based environment are proposed. The model of the cloud-based open learning and research collaborative environment with the use of the 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 educational systems of higher education are described. The research methods are the analysis of official international documents, publications on the research, observation, comparison, the analysis of the experience of the educational and scientific network packages use, 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 networks packages, and also cloud services for collecting, submitting and processing data as an actual and prospective trend for the development and modernization of the educational environment of higher education institutions and collaborative research.

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Key words: 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 research activities and also the research team working 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, the personification of learning and so on. The 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 require a holistic approach for 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 the cloud-based [4], [5], [6], [7], [8], [9], [10].

The 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], [21], [22], [23] 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 [24]. The adaptive cloud-based learning systems become the new stage of adaptive systems development that have 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 considered in [3].

The current issues include existing approaches and models for electronic educational resources delivery within the cloud-based setting [2, 14, 25], the methodology of CC-based learning and research university environment design, the information research and educational

networks and research infrastructures use [2, 26], the use of different types of services within the CC-based LRE such as educational robots, systems of language processing, databases, and others [27], [28] evaluation of current experience of cloud-based models and components use [3], [13]. The problem of creating the 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], [20], [22]. This brings the problems of the 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 within that 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 terminology body of the cloud-based environment investigation progresses, and the main principles of designing and developing the university cloud-based 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 by not exploring and managing the details of the underlying infrastructure to be able to use it for 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], [20], [22]. 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.

The cloud platforms fit most of all for the tasks of integration and aggregation of a considerable number of different services as this 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 [26], corporate network tools and services for learning and research [13], as well as various language tools to support the multi-language content [28] the use of intelligent educational agents and robots, databases [27], [28] and so on.

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

The unresolved issue remains the possibility to combine different cloud-based services for open learning and research within the united platform and test their integration to meet the current demand to support research collaboration in virtual teams smoothly and intuitively.

The purpose of the article is to consider, design and evaluate the 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 positive effect of better access to electronic educational

resources and more efficient use of ICT to support collaborative learning and research processes such as writing paper, knowledge/content exchange- 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 with the use of the cloud-based components based on AWS virtual desktop, IBM Box, WPadV4 and other tools. To measure the efficiency of the proposed approach the expert estimation and benchmarking studies of the research and experimental results were undertaken.

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 higher education institution [2], [3],[24].

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) [24].

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, 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 the learning and research as a whole. 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 the set of cloud-based tools to support different learning and research activities. Within the unite 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 the team or the 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 that 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 that 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 the cloud-based system that has the property to be adjusted automatically by its parameters to the different individual characteristics and educational needs of the learning process participants.

3.1. The V4 + Academic Research Consortium Aimes and Scope

In 2018 the V4 + Academic Research Consortium Integrating Databases, Robotics and Language Technologies 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, know-how to exchange was established. 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 [26].

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
- The building of the digital platforms of the future
- to overcome the languages barriers with the use of 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 solving 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 expertizes (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 prepare them also 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 change it.

3.2. Benchmarking studies for shared expertizes.

Because the V4+ academic research consortium is focused on the integration of partners expertizes, the benchmarking studies were focused on such IT fields, which represent research expertizes 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 project other phases.

The cloud services, cloud platforms and more generally the cloud-based university environment become in the focus of attention. The cloud platforms fit most of all for the tasks of integration and aggregation of a considerable number of different services such as the scientific and educational information networks [26], corporate network tools and services for learning and research [26], as well as various language tools to support the multi-language content [27], the use of intelligent educational agents and robots, databases [28] and so on. Thus the cloud-based open learning and research environment basic principles of 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. In the scientific and educational process in this period the cloud-based services for open education and open science support have been introduced [3].

In the course of this research work, the general model and the methodical system of certain cloud-based services use were elaborated [13], [14]. There were some cloud-based components created for this purpose. Among them, there was the research-educational cloud of the Institute that was 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, teachers on the use of cloud services in scientific and educational activities, intermediate and control testing were conducted [3].

The university cloud-based learning and research environment is a kind of open system. Thus, due to the wider involvement of facilities and services of scientific and educational networks, in particular, cloud-oriented into the process of scientific research it is possible to achieve positive changes in the implementation of this activity, improvement of its qualitative and quantitative indicators, the application of new forms and models of its organization, which positively influences the educational results of students [26].

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 to teaching and associated processes [27]. The breakthrough in their research was the formulation of the virtual knowledge, which is controlled and managed by its educational software and resulted also in the registered utility model of the personalized technical infrastructure.

The special attention while modeling and elaboration the open systems of learning and research are to be paid to the issues of the environment adaptively for peoples with disabilities. The experience of using ICT by visually impaired was considered by D.Mikulowski [29], [30]. 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, the 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 current. 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 teachers training [24].

Because 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 such an architecture to provide the processing, loading, distribution of these data. Given this the relevant and perspective point is to study the principles and approaches of designing the adaptive learning systems based on cloud platforms, as well as developing methods for their use within the open learning and research university environment [24].

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 supposed [31]. 60 Horizon 2020 Project Calls devoted to ICT were considered to reveal the state of the arts 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 the Call ICT-16-2018: Software Technologies. It was devoted to new challenges in the sphere of ICT and how it may influence the way software is developed. Among the issues of advanced software development there are such as: "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" [31]. 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 the 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).

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" [31].

Still, we may conclude that there are not so many Calls concerning to 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 Virtual Team

The main result of the V4+ACARDC project was the creation of the 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.

Computing the virtual knowledge and the knowledge tables is performed by the database application WPadV4 that is being developed by S.Svetsky [27], [28], [32]. 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 the teaching texts, material for lectures, and exercises.

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

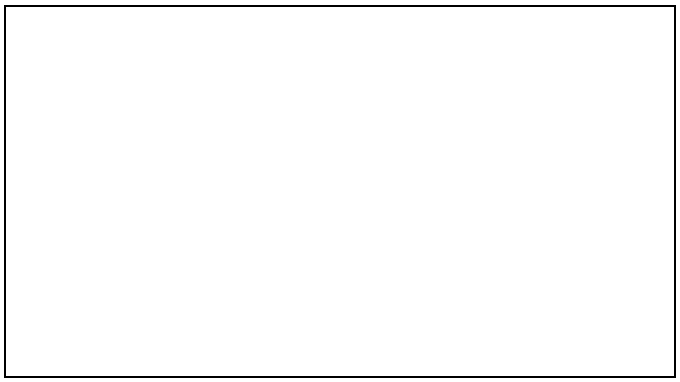


Fig. 1. Example of the content and meta-information in the database tables.

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

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

1. Educational packages 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.

The planned application software WPadV4 was developed/written by Stefan Svetsky. Then it was installed on the virtual desktops with Windows 10 and around 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. From the moment of realizing the importance of the virtual knowledge, the authors' research is more systematically focused on building the complex knowledge-based educational technology consisting of the educational software and online/off-line infrastructure that contains knowledge repositories, expert and language corpora, and educational packages. This additionally covers solving the transmission of the virtual knowledge and the files with the educational content 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 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 creating 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) have been created. The open learning and research environment is modeled and supported by means of this platform.

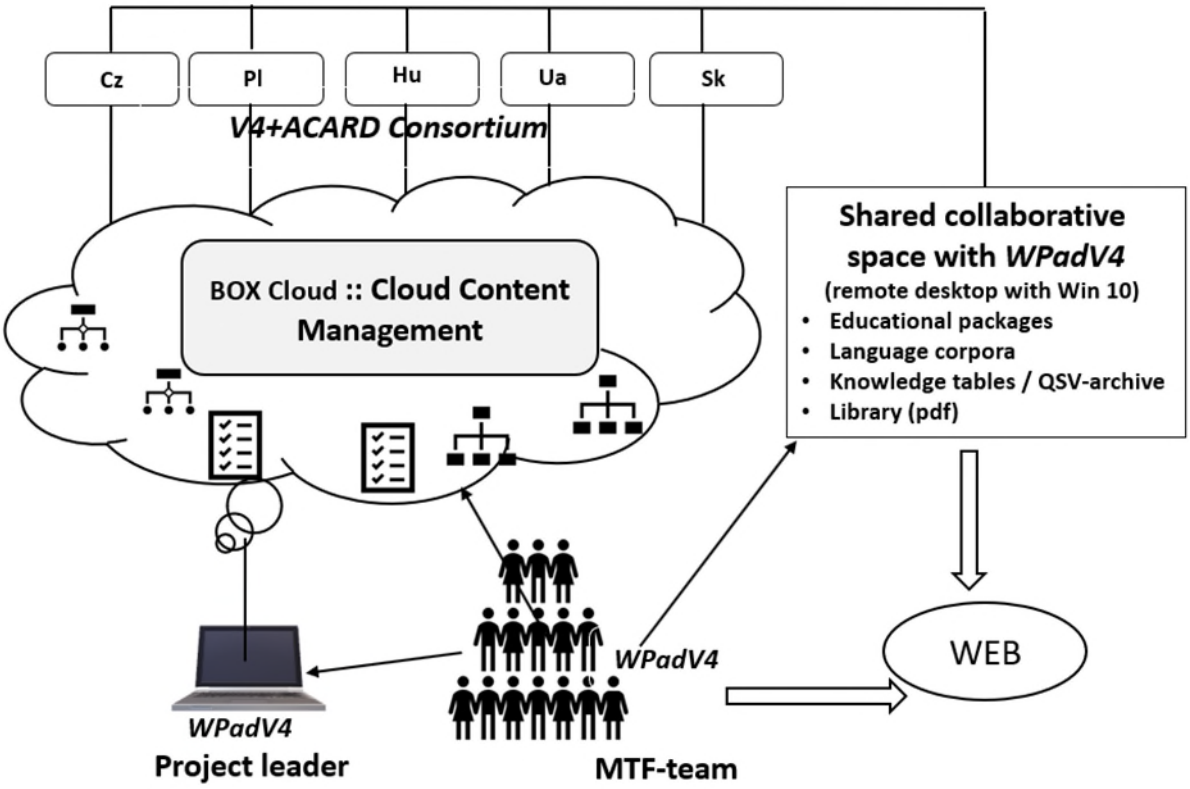


Fig. 2. The cloud-based learning and research platform to support collaboration within the V4+ACARDC project-team.

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 universities' 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, virtual V4+ library/ activities V4+ corpora/ V4+ science service.

Each of the partners has always an experience with 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 the project results dissemination and promotion.

A complex pilot IT support system was built up that consists of (see the Fig.2 above-mentioned):

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 collaboratively 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 solve the IT multilingual support in V4+languages, which is bridged by the English language – this support is challenged for writing the scientific papers and as well as the important starting point to design and produce collaboratively the V4+teaching texts to support building the courses of studies 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 storing 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. Deliverables as documents – as was above-mentioned, 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, there are in the library four thousand files, i.e. documents, covering four Gigabytes 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 the educational package creation that 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.

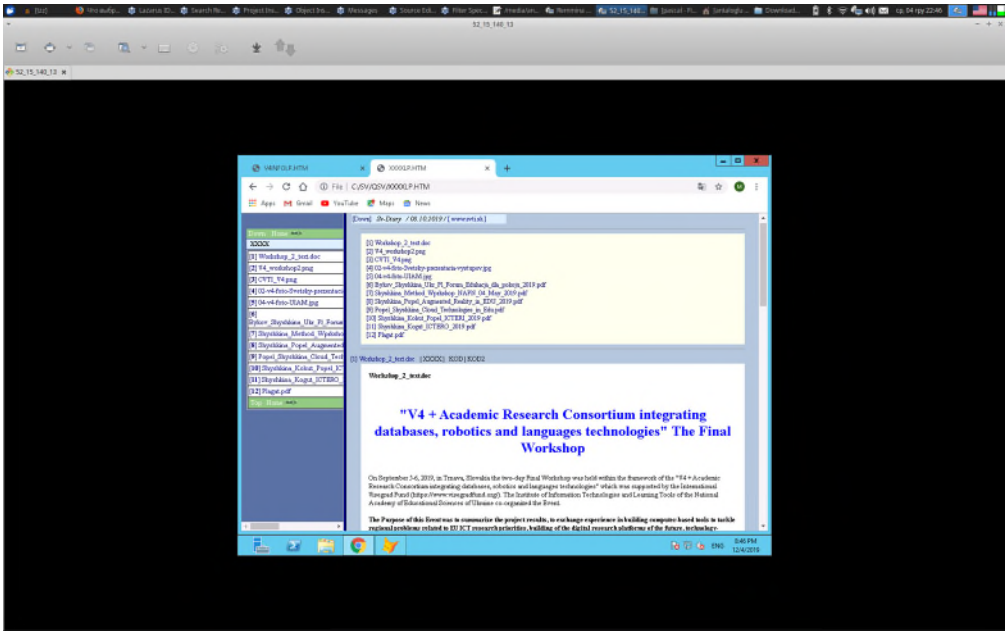


Fig.3. Printscreen from the virtual desktop with the WPadV4 installed.

3.4. The educational packages formation and implementation using WPadV4

A combination of the proposed utility model [32] 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, and it is not based on the common approach that software exists and it is solved if it is suitable for teaching or not.

One of the useful features of WPadV4 software may be the option of preparing an educational package from previously prepared materials. If the teacher has his tutor materials that are collected in pdf, html or txt files, he (she) can use them to prepare a complete educational package for his students with the help of WPadV4. To do this, a teacher should first generate a temporary table named XXXX based on his files. Then using this table, he will be able to generate an educational package that will be available to view in the student's web browser. So to create an educational package, the 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, the table XXXX will be generated and then the page representing this table will be opened in the browser.
3. To improve and modify the created package, a teacher should save the table with a different name.
4. Then he can arrange the table so that the order of the lesson is correct, complete the data in other columns such as lesson subjects, course author, etc.
5. Finally, a teacher can generate html package from the table by pressing ctrl f1 or choosing option Generate html from table from menu ZapisbBD. The finished educational package will be opened in the browser.
6. A Collection of html files generated from the table can now be placed in a place accessible to students.

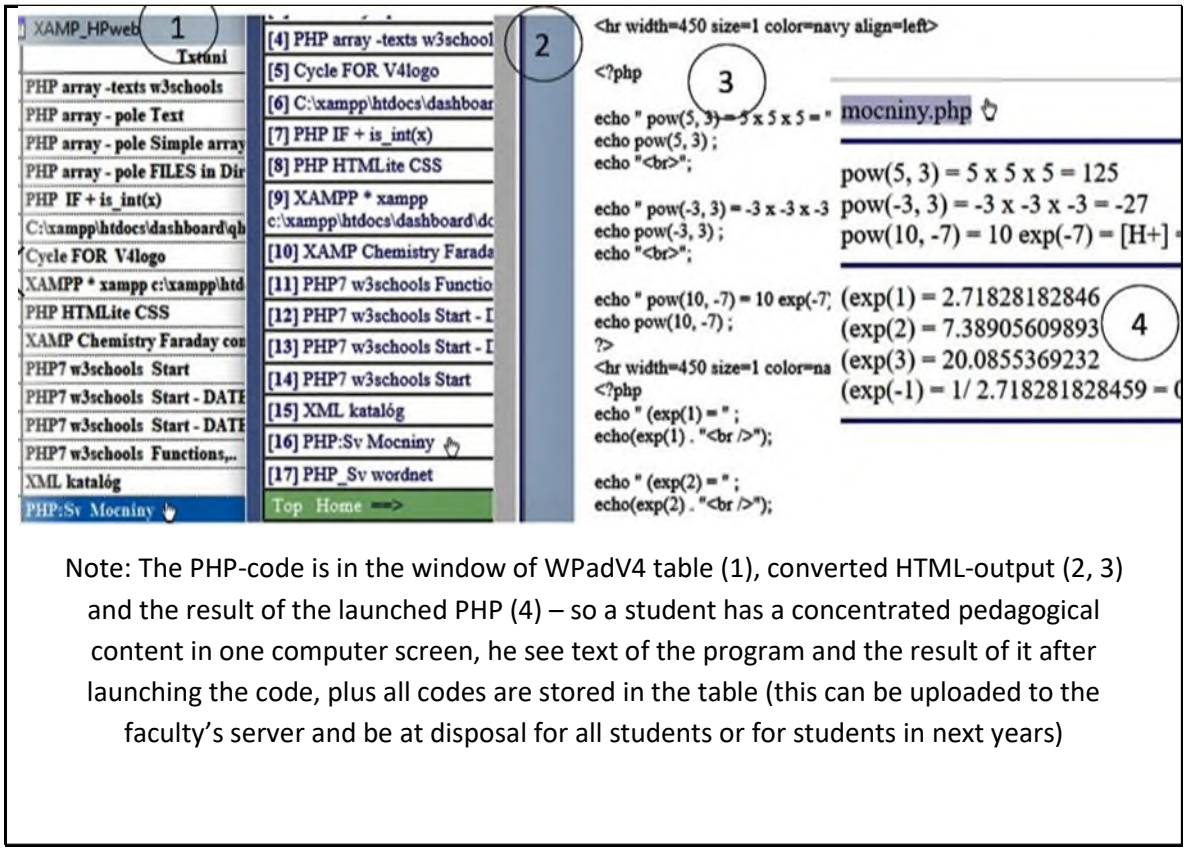
The possible result of such actions may be the educational package design that is presented in Fig.3. You may directly browse and use the documents from the right table as clicking by the rows of the left table containing the metadata. So the teacher may use the collection of learning materials organized into uniting 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 different disciplines study, for example, mathematical and computer science disciplines, to process the information with different languages maintained smoothly, etc.

It is good to describe one of the tested pilot situations when 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 open PHP-software firstly, 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. Bach 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, so they have not to be archived separately. Moreover, batch operation with tables is possible, so it also enables a 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, as illustrates the Fig.4.



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, he see text of the program and the result of it after launching the code, plus all codes are stored in the table (this can be uploaded to the faculty's server and be at disposal for all students or for students in next years)

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

Generally speaking, WPadV4 software can be successfully used by a visually impaired user using a keyboard. It works well with the 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 [30, 29].

Within the project, the 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.

4. CONCLUSIONS AND DISCUSSION

The cloud technologies are to provide the key features of the learning environment that are openness and flexibility. If the tasks of environment development are changed it is possible to modify adequately the tools 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, new challenges appeared or appearing in the future.

The IaaS or PaaS model is to provide the software access of what-ever kind deployed on the cloud servers of the provider by the user. The method of the learning components use within this kind of model was elaborated on the base of AWS (Amazon Web Services). This approach may be used to provide access to different kinds of learning services deployed in the cloud. For example, the learning component with the WPadV4 software was elaborated and researched.

The main result of the V4+ACARDC project was the creation of the 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. This is to create the cloud-based platform that 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 the document and so on were currently maintained and available at the platform. The adaptive content management was supported by research tool WPadV4 that was used to process available data in a sustainable model. So 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 ПІДТРИМУВАННЯ СПІВРОБІТНИЦТВА У ВІРТУАЛЬНИХ КОЛЕКТИВАХ

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Abstract. 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. 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 ПОДДЕРЖАНИЯ СОТРУДНИЧЕСТВА В ВИРТУАЛЬНЫХ КОЛЛЕКТИВАХ

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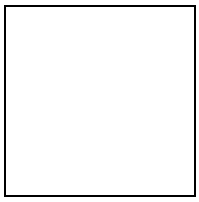
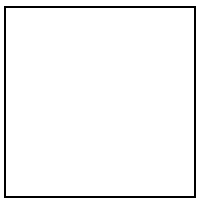
Аннотация. В статье освещаются перспективные пути обеспечения доступа к облачным учебным и исследовательским платформам и инструментам для поддержания сотрудничества. Рассмотрена концепция облачно ориентированной платформы открытого обучения и исследований. Отмечается, что внедрение сервисов облачных 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.





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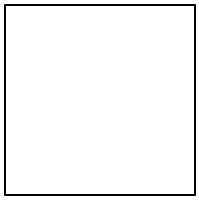

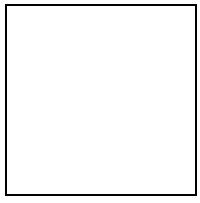

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