Improving the content of technical and professional education through the inclusion of cloud solutions

Dilaram Baumuratova† & Meruert Serik‡

M. Auezov South Kazakhstan University, Shymkent, Republic of Kazakhstan†
L.N. Gumilyov Eurasian National University, Nur-Sultan, Republic of Kazakhstan‡

ABSTRACT: In this article, the authors present and discuss content improvement issues in technical and professional education in the Republic of Kazakhstan through the inclusion of distributed technologies, including cloud solutions. In *M. Utebayev* Higher College of New Technologies in Shymkent, Republic of Kazakhstan a special training course on cloud solutions was introduced to the educational content of technical specialties such as computer engineering and software, information systems and electricity supply. The special course's content covered the following topics: cloud technologies, developing private cloud storage, networks and network topology for implementing the developed private cloud storage, installing and using modern virtual machines, standardising and certifying cloud services, and legal aspects of using cloud resources. In their study, the authors investigated the use of instruments and procedures in cloud storage software, and undertook the development of a network compiler and its application in the educational process. They examined the setting up of a virtual machine and its application in the training process. Deploying remote disk space on the cloud and developing a database with applications was also part of their research.

Keywords: Networks, computer technology, distributed technology, cloud solutions, virtualisation, technical education

INTRODUCTION

To accelerate the pace of economic development in the Republic of Kazakhstan and improve the quality of life of the population through the use of digital technologies in the interim period of time, as well as to create conditions for the economic transition of the Republic of Kazakhstan to a fundamentally new development path, the creation of a digital economy of the future was approved and ensured through the Resolution of the Government of the Republic of Kazakhstan No. 827, On Approval of the State Programme *Digital Kazakhstan* [1].

One of the directions of the implementation of this programme is *human capital development*, and it refers to transformations, encompassing the creation of the so-called creative society to ensure the transition to a new reality - the knowledge economy. Therefore, in the system of higher and technical and professional education, new requirements have been set out for the training of future specialists in information and communication technologies. This entails educational content improvement in regard to cloud computing.

One of the main mechanisms in educational development in the Republic of Kazakhstan is the transformation of educational content from knowledge-based to competency-based, with a focus on outcomes. Therefore, to improve the training of college students, the system of technical and professional education requires curricular changes, and specifically introduction of new disciplines required in the rapidly changing world and the constantly increasing flow of information [2-5].

Based on the above, the authors have undertaken a study to improve the content of education in the system of technical and professional education by introducing cloud solutions into the educational process.

LITERATURE REVIEW

The theoretical and methodological basis of the study was determined by the fundamental ideas of Kazakh and international pedagogy and computer science. In their article, Serik et al present the conceptual structure of a training course on distributed data, settings and integration of local and open cloud servers [5]. They also discuss various applications in the educational process based on Microsoft (MS) SQL Server, Microsoft Azure SQL database, ASP.NET (Active Server Pages for .NET) MVC (Model-view-controller) 5 Framework [5]. Caminero et al consider the use of

developed laboratories in engineering education to provide students with the resources necessary for acquiring practical skills [2]. The distance learning form, where virtual remote laboratories are managed, is described. The system is based on the concepts of cloud computing and virtualisation [2]. In a conference paper, Songkram demonstrates studies on teaching-learning management for e-learning, i.e. on-line learning and learning about virtual teaching technology with the purpose of its application in the e-learning system [6]. The training results, include the following:

1) a learning management system (LMS) to be developed using the modular object-oriented dynamic learning environment (Moodle) software;
2) Web-based tools with cloud computing;
3) multimedia tutorials [6].

MATERIALS AND METHODS

A prerequisite for the study is the state programme of the Republic of Kazakhstan on digitalisation of society, including education, as well as the relevance of this problem in the world community. As mentioned above, the theoretical and methodological basis of the study was determined by Kazakh and international pedagogy, computer science and system-information approaches to the organisation of the pedagogical process in regard to distributed data, including cloud technology.

The study was carried out between 2016 and 2020, and covered technical and vocational colleges in Kazakhstan with technical specialties, such as computer engineering and software, information systems and electricity supply. During two years, an exploration of randomly chosen subjects was undertaken. The content improvement of college education in terms of cloud solutions was aimed at infrastructure and curricula, as well as the overall quality of training. In the special course that was introduced thereafter, students used many advanced cloud storages and processing functions, such as server configuration, technical components or a complete platform. They were acquainted with virtualisation and cloud storage methods, and also acquired knowledge of private cloud storage development by using local servers.

The use of cloud technologies relieves the necessity of organising special educational laboratories, as it provides the required resources and tools, so that students can use them in the classroom and beyond. Regardless of their geographic location, any student can work with complex technical projects. There is no need to install, license or update the programme, and there are no maintenance costs because all programmes and services are available through a Web browser. The use of cloud solutions in the educational process provides the following benefits: accessibility, interactivity, personalised learning and low additional infrastructure requirements. The practical part of the study was conducted at *M. Utebayev* Higher College of New Technologies, Shymkent, Republic of Kazakhstan. Students of specialties 1304000 - Computer Engineering and Software, 1305000 - Information Systems and 0902000 - Electricity Supply were engaged and included in the experimental group. Students of a polytechnic college of the same specialties also participated in the experiment. Pilot work began in the 2016-2017 academic year. Table 1 shows the number of students of the above specialties.

Table 1: The number of students participating in the experiment.

Academic year / Specialty	Computer Engineering and Software		Information Systems		Electricity Supply	
	Experimental group	Control group	Experimental group	Control group	Experimental group	Control group
2016-2017	73	70	24	-	19	23
2017-2018	72	69	67	-	20	22
2019-2020	51	86	42	50	22	25
Total	196	225	133	50	61	70

Preliminary surveys of college students confirmed their voluntary participation in the study. In the experimental groups, questions were asked that revealed positive motives justifying the students' interests. The Cisco Packet Tracer visual simulation tool is included in studies at technical and vocational institutions in information technology (IT) specialties.

Since 2015 in Kazakhstan, regional and national competitions on professional skills among college students have been organised, taking into account the requirements of the WorldSkills organisation, and national teams of the Republic of Kazakhstan have been formed to compete at the international level. WorldSkills is an international movement that promotes blue-collar occupations and improves training standards around the world. The WorldSkills competition allows the improvement of qualification standards in vocational education, in view of national and international requirements. At the WorldSkills competition in the network and system administration competency, one of the tasks for the contestants is to configure the network equipment, and this task is performed using Cisco Packet Tracer.

Therefore, the use of new teaching methods through the Cisco Packet Tracer application is relevant in education. Cisco Packet Tracer is an excellent network modelling and visualisation tool useful for educating both students and advanced users who do not have access to physical equipment. The simulator programme allows the virtual configuration of

various telecommunications equipment items, such as switches, routers, I-phones, gateways, servers, firewalls, and much more. Thanks to the simple and intuitive interface of Cisco Packet Tracer, it is possible to create and configure simple networks, even without deep knowledge of network technologies. Cisco Packet Tracer allows students to experiment with network behaviour and evaluate possible scenarios.

RESULTS AND DISCUSSION

The Conceptual Framework for Implementing Cloud Solutions into the College Educational Process

The purpose of this study was to improve the educational content in technical and professional education through the inclusion of cloud solutions. Therefore, the authors introduced a special course on cloud solutions into the college educational process. A programme had been developed to introduce a special course, as well as teaching aids and digital educational resources for the implementation of this programme. Figure 1 shows the general structure of the content of the developed special course on cloud solutions.

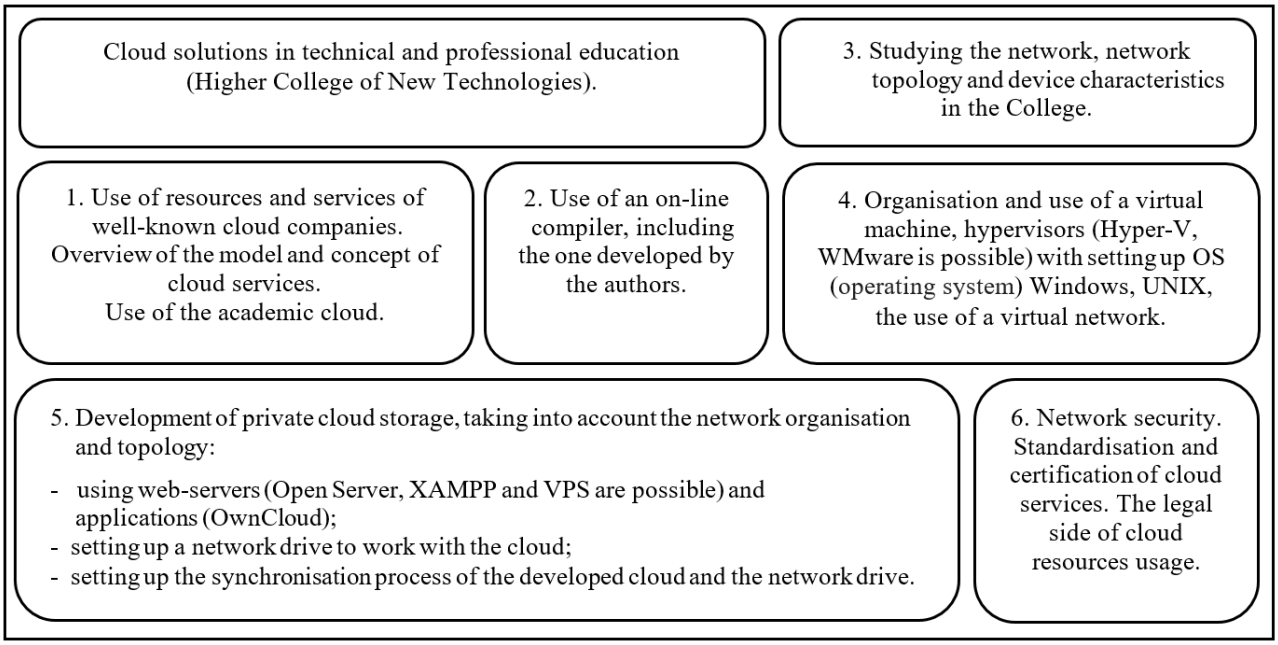


Figure 1: General structure of the content of the developed special course on cloud solutions. (Note: setting up MS Visual C ++ Runtime and patches. Source: download of Optifine for Minecraft 1.5.2 [7]; Installatron company [8]).

To monitor the development of students' competence in cloud technologies, testing was carried out at the beginning and at the end of the study. The average indicators of the ascertaining experiment were established at the initial stage of the study. In the next formative experiment, the results of the experimental group were recorded after studying the embedded subject on cloud technologies. In the control group, the experimental subject was not introduced; a special seminar and listening to reports were held. The average indicators of the ascertaining and formative experiments are shown in Table 2.

Table 2: Results of the ascertaining and formative experiments.

Levels and indicators of the competence development of students in cloud technologies at the beginning of the study	Low level		Middle level		High level	
	Experimental group	Control group	Experimental group	Control group	Experimental group	Control group
Ascertaining experiment						
Average indicators by level in percentages	35.2	48.4	49.1	38.5	15.7	13.1
Formative experiment						
Average indicators by level in percentages	9.2	37.5	74.4	51.3	22.4	17.2

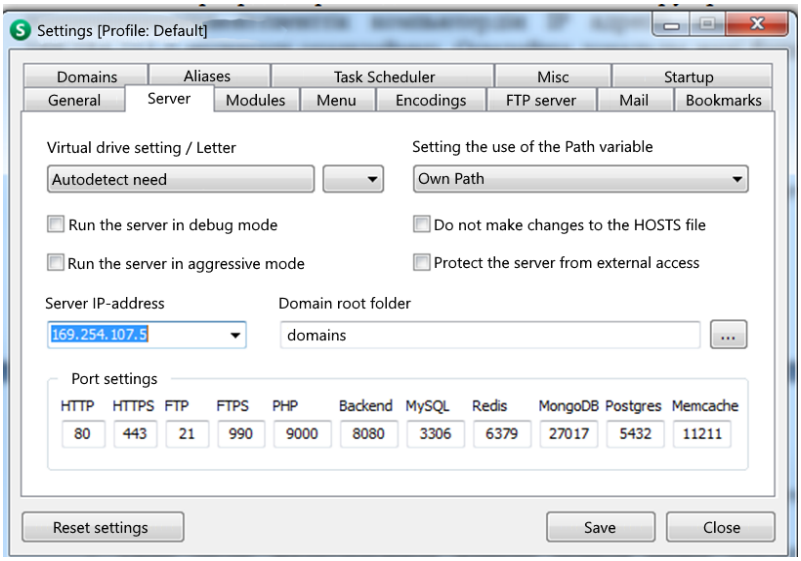
Implementation of Private Cloud Storage in the Educational Process

In the beginning, students were expected to get acquainted with the college network topology. Classes and servers had to be defined to be used directly when implementing a special course.

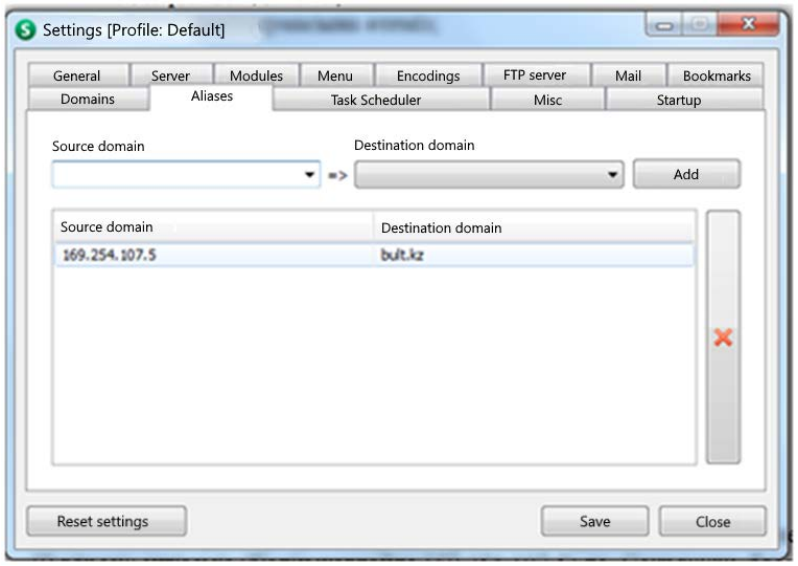
Excerpt 1. Open Server and setting up OwnCloud storage in it. The authors accessed the cloud domain created on Open Server through the local network. To do this, they used IP (Internet protocol) addresses, having performed such operations on all the computers on the network, as well as setting up Open Server to access the network (Figure 2).

```
#
# For example:
#
#      102.54.94.97     rhino.acme.com          # source server
#       38.25.63.10     x.acme.com              # x client host
# localhost name resolution is handled within DNS itself.
#       127.0.0.1       localhost
#       ::1             localhost
| 169.254.107.5 bult.kz
```

a)



b)



c)

Figure 2: Configuring the server and aliases tabs; a) notepad; b) server tab settings; and c) alias tab settings.

When performing this work, attention should be paid to access from the client computer to the local server. For this, on the client host's file, one should enter the IP address and the domain name - C:\Windows\System32\drivers\etc (one can create a code on Notepad). The actions are:

- the result is checked through the browser;
- OwnCloud users are registered in the local network, for document sharing the Lightweight Directory Access Protocol (LDAP) is used - applications - LDAP user and group backend [9];
- creating a network drive in OwnCloud when using the WebDAV application - setting the BasicAuthLevel key (to change 1 to 2) - connection of the Web client service;
- to enter as an administrator in OwnCloud on the Web site Bult.kz and enable WebDAV user backend;

- to create a network drive through My computer - connect a network drive;
- http://bult.kz/remote.php/webdav - setting up a network drive Y: \;
- to synchronise the cloud and the network drive.

Excerpt 2. Development of a network compiler and its application in the educational process. The next step of the study involved working with an on-line compiler. In the beginning, the site ideone.com was used to introduce students to this topic, where about 80 programming environments are offered. Secondly, the authors used the on-line programming environment that they developed. Students in this case studied the methods of developing on-line programming.

The content of the on-line compiler developed by the authors includes three programming languages: C, C ++ and Java.

Excerpt 3. Setting up a virtual machine and using it in the training process.

The next topic is the use of virtualisation technology. The Microsoft Hyper-V hypervisor was used in the college educational process. When setting up a virtual machine, students paid attention to the technical characteristics and resources of a personal computer, so as to competently distribute and use the resources of this computer, and skilfully use the provided virtual networks, etc. Particular attention was paid to managing a remote virtual machine by the IP address of the client computer. The advantage of a virtual machine is the usage of an isolated guest operating system, which allows it to work with other operating systems and programmes.

The deployment of remote disk space on the cloud and the development of a database in it to be used in the college educational process are based on the results of work implemented in university education [5]. Further, students, using the MS Azure portal, could develop various applications, including sites and publish them on the Internet, then maintain and optimise the sites. In working with this application, MS SQL Server Management Studio was used to work with databases and implement SQL queries. In this work, the authors implemented the principle of *cloud technology as an enhanced version of the client-server technology*. During the study in Shymkent, a special course on cloud solutions was introduced at *M. Utebayev* Higher College of New Technologies.

To implement a special course, a programme for introducing that course, teaching aids and digital educational resources were developed. The content of the offered special course and the study results can be used in the educational process of colleges, as well as a methodological guide for those who will be involved in the development of private cloud storage and its use in professional activities. The results could be implemented in other colleges of technical and professional education, including polytechnic colleges of the Republic of Kazakhstan. As the authors incorporated subjects on distributed data and cloud computing into the standard programme of the specialty of computer engineering and software at the polytechnic college, so in the future the results could be applied to other colleges at the state level.

CONCLUSIONS

One of the key issues in education is the implementation of distributed data technologies, including cloud technologies, in the educational process. Therefore, a special course on cloud solutions was introduced in a college within the system of technical and professional education. This created the prerequisite for the development of knowledge, skills and abilities of college students to be applied in their future professional activities and careers.

The implementation of the private cloud in the network carried out by the authors, enabled interactions between users located in various college buildings and their shared use of storage resources, Also, the developed private cloud on the Internet allows implementing the on-line model of storage in the educational process, where data can be stored both on numerous servers distributed on the network and on the college server.

Students can also deploy and use servers that are geographically remote from each other, up to locations on different continents, so they can choose remote servers located in Europe and the Pacific region, etc. Therefore, a connection is made between the subjects of education in the context of education globalisation. The following points are crucial in the development of private cloud storage: the use of various network topologies and routers; discovery of computers by IP addresses and their connection to the cloud storage; use of any devices connected to the Internet; and the use of a virtual machine as an educational resource and portal. It is also important to indicate that the use of this study results can affect the security of user data.

REFERENCES

1. Resolution of the Government of the Republic of Kazakhstan No. 827, On Approval of the State Programme *Digital Kazakhstan* (2017), 25 August, https://adilet.zan.kz/rus/docs/P1700000827
2. Caminero, A.C., Ros, S., Hernández, R., Robles-Gómez, A., Tobarra, L. and Granjo, P.J.T., VirTUal remoTe labORatories management system (TUTORES): using cloud computing to acquire university practical skills. *IEEE Trans. on Learning Technologies*, 9, **2**, 133-145 (2015).
3. Hu, H. and Zheng, J., Application of teaching quality assessment based on parallel genetic support vector algorithm in the cloud computing teaching system. *Inter. J. of Emerging Technologies in Learning*, 11, **08**, 16-21 (2016).

4. Serik, M., Nursaule, K., Sadvakassova, A. and Sarzhanova, G., Improvement of students' training in parallel and cloud computing. *Revista Espacios* (2017), 25 August 2021, http://www.revistaespacios.com/a17v38n60/a17v38n60p03.pdf.
5. Serik, M., Mukhambetova, M. and Yeskermessuly, A., Improving the content of a client-server technology training course: set up and collaborative implementation of local and cloud-based remote servers. *Inter. J. of Emerging Technologies in Learning*, 14, **21**, 191-204 (2019).
6. Songkram, N., The use of virtual learning environment and virtual technology for problem solving and team learning abilities in Thailand college classroom. *Proc. 10th Inter. Conf. on Society and Infor. Technologies*. Orlando: International Institute of Informatics and Systematics, 94-99 (2019).
7. Download optifine for minecraft 1.5.2. (2020), 25 August 2021, https://sites.google.com/view/ennmshcdlhjb/главная
8. Installatron Company (2020), 25 August 2021, https://installatron.com/updatefeed/owncloud_7_0_14.
9. OwnCloud (2020), 25 August 2021, https://owncloud.com.

BIOGRAPHIES

Dilaram Baumuratova is presently a PhD student in the Department of Computer Science at *M. Auezov* South Kazakhstan University, Shymkent, the Republic of Kazakhstan. Her research interests include educational technology, design technology and instruction methodology, Web programming, animation and multimedia technology, information and communication technology for education and computer education.

Meruert Serik holds a doctoral degree in pedagogy, and is presently a Professor, Head of the Department of Computer Science at *L.N. Gumilyov* Eurasian National University, Nur-Sultan, the Republic of Kazakhstan. In 2008 and 2014, she was the winner of the state educational grants *The Best Teacher of the University*. Professor Serik is the author of more than 100 scientific and methodical works. She was the scientific supervisor of the project: *Modelling and development of an information and didactic system in the context of the globalisation of education;* and a leading researcher of the project: *Implementation of the e-learning system in the organisation of secondary and technical vocational education*, to name a few.