Cloud and Mobile Systems as a Means of Forming Professional Competencies in Economics and Engineering Students

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Abstract

The study is relevant since there is a contradiction between growing requirements for the informational and communicative competence of different students, including the use of cloud-based computer modeling systems, and the insufficient use of cloud technologies in teaching bachelors of economics and technology.

The study aims at determining cloud-based systems that are advisable to use as a means of forming the professional competencies of future specialists in economics and technology and developing guidelines for their use.

Based on the analysis of various programs, the authors have proved that the most appropriate is the use of specific software in the professional training of future specialists. Scattered software and cloud services need integration based on unified access that a Google account can provide. They also developed a method of using cloud technologies as a means of forming the informational and communicative competence of bachelors of economics and

technology. The use of cloud-based information and communication technologies ensures an increase in the level of professional competence of future specialists.

Keywords

Cloud Service, Cloud Technologies, Professional Competence, BPM System, Simulation Modeling, CAD, CAM, AutoCAD.

Introduction

The current informatization of society, as well as the rapid development of information technologies and computer systems, plays a major role in its genesis and applies to all spheres of human activity, including higher education. At the same time, two types of higher education (economic and engineering) greatly contribute to the sustainable development of modern society (Poddubnaya et al., 2021; Bukhteeva et al., 2019; Rabadanova et al., 2020).

Firstly, any economic theory is based on modeling (i.e. economic) that provides a logical, abstract model and helps economists identify and sort out complex cause-and-effect relationships between many interacting elements in the economy. Using such a model, economists can create different scenarios and rationally test them to assess the effect of political alternatives or the logical robustness of any argument. Some models are useful for visually representing the essence of economic arguments. Their visual appeal makes the explanation more clear.

Secondly, one of the modern social issues is the development of the basic industries, i.e. mechanical engineering (Dudin et al., 2018). Mechanical engineering companies require competitive specialists demonstrating high productivity and quality of work, therefore the effectiveness of their training in educational institutions becomes more important. The main elements of developing modern mechanical engineering are the transition to the information support of processes and the use of computer systems for engineering modeling.

A contradiction between growing requirements for the informational and communicative competence of future specialists, including the use of cloud-based computer modeling systems, and the insufficient use of cloud technologies in teaching bachelors of economics and technology determined the relevance of this research.

Literature Overview

According to scholars, the fundamental disciplines in teaching bachelors mathematics and natural sciences include information disciplines. They should develop skills necessary for working with graphic and text software (Bagiritima, Tesha, Kiman, 2019; Ismail et al., 2019); systematize and search for technical and scientific data using computer networks and software (Raju, A.B., Annigeri, S. 2014; Vieira et al., 2019); select the required standard software or create such programs (Gorissen et al., 2010; Okudan, 2004); formalize the solution of economic and general engineering issues (Barr et al., 2002; Nedaei et al., 2019); process graphic information through computer technology and use an automated workstation (Harfoushi et al., 2013; Jackson, 2008).

Some scholars (Loschilova et al., 2015; Dorozhkin et al., 2016) believe that it is impossible to study professionally oriented disciplines without the basic informational and communicative competencies of future specialists since complex computerized systems become the leading teaching aids at this stage, including visual and simulation modeling for economists, and design and documentation automation (specific CAD/CAM systems) for engineers. There are certain requirements for the informational and communicative competencies of future specialists (Table 1).

Table 1 Requirements for the informational and communicative competencies of future specialists

Source	**Requirements for informational and communicative competencies**
Munns (2017)	To use computerized systems and specific software to solve economic and engineering issues
Shamshina (2014)	To know and understand the basics of information technology and programming, to use applied software to perform economic and engineering calculations, process information and experimental research results
Kurennov et al. (2020)	To understand the principles of automated control systems managing technological equipment, including microprocessor-based systems, to select and use the optimal automation tools
Qarshiboev (2020)	The professional competence of a specialist is largely determined by their ability to learn about an object or the principles of its action from documents, to record information in a graphic form and use an image for communication; to make an appropriate decision in modern technogenic society using graphic means and methods, graphics software

A large amount of research is concerned with business process modeling.

At the empirical level of cognition, modeling can perform measuring, descriptive and exemplary functions, reflecting the form of an object, its structure, behavior, internal or external links (Bandara, Gable, Rosemann, 2005). The main role of modeling is to create conditions for studying phenomena or processes that are inaccessible for direct observation. In some cases, modeling is the only way to study objects by replacing complex and hard-to-reach objects with simpler and more accessible ones (Wyssusek, 2006).

Within the framework of productive human activity, modeling is the initial stage of research. A model becomes the basis for studying an object, its state or behavior under given conditions. While studying the behavior of a particular model, we obtain new knowledge about the object and can transfer the parameters of this model to similar phenomena or processes (Siau, 2004).

Considering the cognitive nature of the human activity, modeling is the final stage of any research. It consists in processing information about the object under study. These studies are mostly spontaneous and might include the following stages: 1) observing environmental phenomena; 2) highlighting typical phenomena, processes, objects, features and behavioral patterns; 3) measuring and recording the properties of phenomena and objects revealed during the study; 4) systematizing information about the outside world; 5) developing models for the presentation of theoretical and practical provisions regarding the essence of the studied phenomena and objects, their structure and behavior (Rosemann, 2006).

Modeling differs from productive human activity in its planned nature, organizational measures and scientifically grounded research methods. The process involves the following actions: 1) to determine the purpose of modeling based on the existing knowledge about a certain object; 2) to develop a model of the research object; 3) to justify the conditions in which the model will be studied and the principles of its study; 4) to prepare technical means for conducting such a study; 5) to observe the behavior of the model, measure and record its properties during the study; 6) to process statistical data; 7) to classify the data obtained and compare the model with its original; 8) to transfer features of the model to the research object and form theoretical and practical provisions regarding the essence of the object, its structure, behavior and predicted state; 9) to develop models for the presentation of theoretical and practical provisions regarding the essence of the studied phenomena and objects, their structure and behavior (Davies, 2006).

The concept of "business process modeling" can be interpreted as an effective means of finding ways to optimize the company's activities, predict and minimize the risks arising at their various stages. Forecasting allows assessing each process and the work of some enterprise as a whole (Recker, 2006).

Business process modeling considers a work schedule, the availability of sufficient resources and other important factors. It provides a manager with the necessary information about the internal and external environment and helps estimate the time required to perform certain actions. It is quite challenging to create a model, including an interconnected structural model of the process and a set of analytical models (Bandara et al., 2007).

The methodological principles of business process modeling are based on four categories: processes associated with project work; production processes; customer distribution and service; processes between business units (Ougaabal et al., 2020).

There are four types of modeling techniques used in business process analysis: visual models, mathematical models, empirical models and simulation models. However, we will discuss typical features of visual and simulation modeling.

According to scholars (Domingos et al., 2016), visual models are simple images of abstract economics or graphs with lines and curves that tell an economic story. They are mainly used in teaching and learning. Some visual models are schematic, i.e. they show the flow of income from one sector of the economy to another. In other words, they use a visual trick to present a general business concept. However, most visual models are visual extensions of mathematical models and contain the primary mathematical model in their structure. Models usually do not require the knowledge of mathematics but still represent complex relationships between economic variables. These models are relatively easy to understand.

Simulation modeling is an experimental method for studying a real system based on its model that combines features of an experimental approach and specific conditions for using computer technology (Vasilecas, Laureckas, Rima, 2014). The advantages of simulation are as follows (Bocciarelli et al., 2020):

1. The display of dynamic processes and behavioral aspects of the external environment.

2. The ability to determine patterns and dynamic trends in the development and functioning of a complex system in the conditions of incomplete and inaccurate information.
3. The description of the interaction and behavior of many active agents in social systems.
4. The implementation of the principles of object-oriented design and the use of high-tech solutions in the construction of computer models, etc.

The research hypothesis is as follows: the use of appropriate methods and forms of organizing the educational process with the help of cloud-based information and communication technologies will increase the professional competence of future specialists.

To prove the above-mentioned hypothesis, it is necessary to solve several issues:

1. To determine the role of cloud-based software in the professional training of future bachelors of economics and applied mechanics.
2. To analyze studies and publications in the chosen sphere.
3. To select a cloud-based BPM system as a means of teaching bachelors of economics.
4. To select cloud-based CAD/CAM systems as a means of teaching bachelors of applied mechanics.
5. To develop a methodology for using cloud-based BPM systems and CAD/CAM systems in the professional training of bachelors of economics and applied mechanics.

The article comprises the following sections: introduction, literature overview, methods, results, discussion and conclusion.

Materials and Methods

The objectives and tasks of this research conditioned the use of scientific methods, including theoretical ones: analysis, generalization and systematization of studies on the use of cloud and mobile BPM, CAD/CAM systems as a means of forming the professional competencies of future economists and mechanical engineers.

The selection criteria for choosing software for the subsequent analysis included their availability, functionality, multi-device access, integration with other cloud services and programs, and support for collaboration.

Based on information from the websites of software developers and other open sources on the Internet, we analyzed mobile applications and cloud services that can be used in the professional activities of modern economists and mechanical engineers:

- Cloud services and mobile applications that function as business process management (BPM) systems.
- Cloud services and mobile applications that perform simulation functions.
- Cloud services and mobile applications that function as computer-aided design (CAD) systems.
- Cloud services and mobile applications developed by Autodesk (the leader in the development of CAD/CAM systems).

Results

The results obtained demonstrate that there is a large number of companies developing control (including modeling), BPM and CAD systems. The trend towards professional mobility encourages developers to create cloud services and mobile applications that perform the functions of BPM and CAD/CAM systems or extend their capabilities.

BPM systems have comprehensive tools for business process modeling. In addition to modeling tools, BPM systems contain the capabilities of simulation, monitoring, analysis and runtime environment, while providing the user with a set of interfaces for interacting with the business process that is currently running.

BPM systems emerge as IT platforms that are created for business process management and modeling. These systems offer a user-friendly interface for novice users and a complete set of tools for creating, recording, testing, executing and monitoring business processes. The advantages of BPM systems are determined by their flexibility in design and maintenance, as well as by their ability to run tests to optimize business processes. Business process management encompasses many technology products and solutions aimed at creating a new category of information systems.

Commercial BPM systems are not suited for training future economists since such systems often require significant financial costs for their maintenance and upgrade (i.e. expensive licenses). High costs make commercial software unaffordable for training. In this case, an alternative is to use open-source information systems. However, it is

necessary to take into account the issues related to product updates and highly specialized human resources.

To analyze the effectiveness of BPM systems, we need to consider the following groups of criteria:

1. Process modeling (a visual representation of a workflow in the form of either information or a specific business process document).
2. Security management (controlled access to content through authentication, roles and directory management, access control settings and passwords).
3. Process interaction.
4. Form management (the ability to edit, validate and markup forms using business process management).
5. Work portal (the inspection of the work portal as part of a business process).
6. Monitoring and management (the type of monitoring available for workflow and auditing).
7. Process analysis (types of analytics applicable to business processes).
8. Product technology. This group of criteria defines the technical architecture of the product and the technological environment in which this product can operate successfully.

Such criteria cover product and application architecture, software usability and management, platform and database support, application support standards, communication protocol support and integration capabilities. If the best system is selected, this criterion is often considered less important in comparison with the other evaluation criteria. This understatement is misleading since product technology is usually one of the must-have selection criteria that determine the type of a server, client, protocol and database support, application scalability and other architectural capabilities.

After reviewing and analyzing the main components and functions of Bonita Soft, BizAgi and Intalio, we compiled a table with scores (from 0 to 10) and groups of criteria for comparison (Table 2).

Table 2 Groups of criteria for assessing the effectiveness of BPM systems

Groups of criteria	BizAgi	Intalio	Bonita Soft
Process modeling: business management, business rules, data modeling, dates, events, graphic designer, task distribution	8	8	10
Security management: role and timer management, user profiles	9	8	9
Process interaction: support for various import/export formats, version control	9	8	10
Form management: data binding, data validation, dynamic forms, forms, form elements, formatting types	9	9	9
Work portal: reports, search, the availability of target information, user account management	8	6	8
Monitoring and control: audit, instance management, resource organization, workflow monitoring, workflow statistics	9	7	8
Process analysis: optimization, data efficiency, trend analysis	7	7	8
Product technology: platform installation, product licensing, technical support	8	8	9
Average score	8.375	7.625	8.875

In addition, we will consider software developed, inter alia, for simulation modeling. The most popular programs (among different approaches to simulation modeling) with advanced graphic tools are ARIS, iThink, Anylogic and Arena.

To compare the above-mentioned simulation systems, we selected characteristics that reflect their capabilities for conducting research, building models and interacting with the user (Table 3).

Table 3 Comparative analysis of simulation systems

Features	**ARIS**	**iThink**	**AnyLogic**	**Arena**
Developer	IDS Scheer	Isee systems	XJ Technologies	Rockwell Software
Building a model	Graphic	Graphic	Graphic software	Graphic software
Adjustment	+	+	+	+
Animation	+	+	+	+
Data export and import	+	+	+	+
Web interface	+	-	-	-
User interface	-	-	+	-
Visibility of models	+	+	+	+
Extended possibilities of conducting experiments	+	+	+	+
Hierarchy	+	+	+	+
Specialized language	UML	-	Java	SIMAN
Creating graphs	+	+	+	+
Making reports	+	+	+	+

A comparative analysis of the capabilities of cloud services and mobile CAD applications intended for training future engineers is presented in Table 4.

Table 4 Cloud services and mobile CAD applications

No.	Software	Development company	Opportunities
1	DWG FastView-CAD Viewer	GstarsoftCo (China)	Works on tablets and mobile phones; compatible with 2D/3D DWG files; opens files created in AutoCAD; supports various formats. Users can create, view and edit drawings, work with files via cloud storage or e-mail. The application supports the export and import of drawings in other graphic formats. The system supports relative, polar and absolute coordinates for editable drawings, as well as cylindrical and spherical coordinates for 3D drawings.
2	3D CAD Models Engineering	CADENAS (Germany)	A service for downloading 3D CAD data from CADENAS. This application is suitable for engineers working in the construction, automotive and machine-building industries. The drawings created in the program can be opened in other CAD/CAM systems, including Autodesk Inventor, AutoCAD, SolidWorks, etc.
3	GrabCAD	Electronics Workbench (Germany)	Provides access to a free library of models and projects stored in GrabCAD Workbench. With the help of the application, users can view 3D models; read and respond to comments made by Workbench employees; develop Workbench projects and load files into them; search for models and designate them; receive notifications and project updates.
4	Sketch Box Free	Colabox.NET (Malaysia)	Created for the development of sketches and technical drawings. It is an alternative to vector CAD systems. The application supports interactive tools to work with the map that is based on Google Maps. It allows saving, duplicating, sharing and reusing projects. The basic geometric primitives are used in the creation of drawings: rectangles, lines, arcs, etc. It also provides a set of brushes for drawing by hand. It is possible to use a grid and quick sizing tools.
5	Ares Touch Beta	Graebert (Germany)	A component of the ARES cross-platform CAD system developed to create and edit DWG files on a tablet or smartphone. The application synchronizes with Google Drive and Dropbox. It contains tools for working with geometric primitives, coordinates and layers. Collaboration is realized through comments, in particular, voice comments.
6	AndCAD Demo	Talon Designs LLP (USA)	Is used as 2D CAD for Android and allows to edit and create drawings on a mobile device. Its features are as follows: working with layers and vector objects; rotations, scaling and other actions with such geometric objects as polygons, points, polylines, etc.
7	SchemataCAD viewer DWG/DXF	ELMER Software S.R.O. (Czech)	Is used as 2D CAD for Android and allows to edit and create drawings on a mobile device. Its features are as follows: working with layers and vector objects; rotations, scaling and other actions with such geometric objects as polygons, points, polylines, etc.
8	SketchUp Mobile Viewer	Trimble Navigation (USA)	Supports the shared viewing of 3D models and allows downloading models from e-mail, Trimble Connect or Google Drive.
9	eDrawings	SolidWorks (USA)	Works on tablets or mobile devices for quickly viewing and discussing 3D and 2D models. Models can be stored in network folders, website directories or cloud services. Users can create text notes, pan, rotate and scale models, store comment history, etc.

Discussion

Let us describe and analyze three open-source BPM systems: Bonita Soft, BizAgi and Intalio (Table 2).

Bonita Soft stands out for its ease-of-use and intuitive interface. Its modeling algorithm allows importing processes from other commercial information systems (Tibco, Lombardi) and integrating them with business rules. Bonita Open Solution is made up of three main elements:

- The Execution Engine (control center) is a console responsible for connecting and running system processes.
- Studio is a graphic designer of process applications.
- Form Builder is a tool for creating forms for end-users.
- User Experience is an application that manages all the aspects of BPM process deployment.

BizAgi BPM Software is a free business process modeling system to compile graphs and documents. The system also turns processes into executable files due to its transparent integration with BizAgi Xpress, JBossjBPM and Bonita Soft.

Intalio is a service-oriented system. It allows integrating the existing applications into end-to-end power supply units, automating any power supply units and reducing the cost of upgrading the system in the future. Intalio consists of three components: a) a business process designer built on Eclipse; b) the core that executes the models created by the designer; c) an application server that hosts business process services.

While considering the above-mentioned BPM systems, we decided it is more expedient to use Bonita Soft for teaching business process modeling.

Let us describe and analyze four systems of simulation modeling: ARIS, iThink, Anylogic and Arena (Table 3).

ARIS was developed by IDS Scheer (Germany). The IM ARIS system is a complex of tools for analyzing and modeling the company's activities. Using the system, it is possible to create one model through several modeling methods. Thus, ARIS can be used by specialists having different theoretical knowledge. ARIS supports four types of models that reflect different aspects of business processes: organizational, functional, informational and managerial models.
Models in ARIS are represented as graphs, whose elements are various "functions", "events", "structural units", "documents", etc. There are certain connections established between different objects ("implementation", "decision making", "reporting on results", etc.). Each object corresponds to a certain set of attributes that allow entering additional information about such an object. Attributes can be used in simulation or cost analysis. The result is a set of interrelated models that represent the source material for further analysis.

iThink utilizes the approach of system dynamics. For its implementation, it comprises four types of components: stations, streams, converters and connectors. To make discrete models, iThink uses three specific stations: queues, vaults and transporters that transfer items among stations. iThink-powered models consist of levels and hierarchies. The user forms a high-level description of the model using process modeling environments, each of which creates a model from one subsystem. After completing the description, the developer proceeds to the next level and enters the necessary components into each sub-model. Links are established among the sub-models, indicating the interaction of subsystems. After building a model with the required number of hierarchical levels, the developer switches to the simulation mode to determine the mathematical relationships of stations, streams and other structures. The iThink package offers a list of acceptable variables for defining mathematical relationships and conducts a sensitivity analysis of the model by running it multiple times with different input parameters. The initial data are the main types of distributions used for statistical analysis or charts. When the model created in iThink is launched, the animation moves the stations located at different levels in accordance with the logic of this model. Simulation results are displayed in the form of timing charts or scatter plots. Such tables and graphs can be viewed in special windows or right in the model window.

AnyLogic is intended for the development and study of simulation models. Its graphic environment supports the design, development and documentation of models, the execution of computer experiments, the optimization of parameters with due regard to a certain criterion. When working on a model, a person can use some elements of visual graphics (state charts, signals, events, ports, etc.), the synchronous and asynchronous schedule of events, and object libraries.

Arena allows creating dynamic computer models to adequately represent a variety of real-life systems. Arena has a user-friendly and object-oriented interface. During the process of simulation, the user builds a model in the graphic editor step-by-step. Then the system generates the corresponding code and animation starts automatically. The Arena interface includes all kinds of tools for working with data, including spreadsheets and databases. Simulation modeling helps test hypotheses about the causes of certain phenomena, consider processes at different periods, highlight variables that are crucial for the effective functioning of the modeled system, analyze the connections between them, and reveal "bottlenecks" in material, information and other streams. The Arena package comes with ready-made templates. Each template is a set of specialized modules that transform Arena into a problem-oriented modeling environment. By creating new templates or modifying the existing ones, the user can adjust Arena to meet their specific needs.

In general, Table 3 demonstrates that the above-mentioned simulation programs provide users with ample opportunities to build models of various complexity, generate reports in the required form, customize and expand built-in libraries.

If compared to the other systems, AnyLogic combines many simulation paradigms under one roof, which expands the user's possibilities for conducting research in various fields. The popularity of this product is confirmed by numerous commercial and scientific studies, a large number of publications and speeches given at various conferences concerned with the software developed by XJ Technologies.

Next, we need to dwell on CAD software intended for the formation of professional competencies of engineering students (Table 4).

The programs we analyzed are equipped with many features for viewing, sharing and editing drawings, cloud storage, commendation, etc. At the same time, they support most model and drawing formats introduced by Autodesk. The latter is the recognized world leader in the development and implementation of CAD/CAM systems.

One of the most popular Autodesk products is AutoCAD. In addition, these programs come in a large number of configurations, contain different libraries that extend their functions and support integration with various environments for modeling, project management, design, etc.

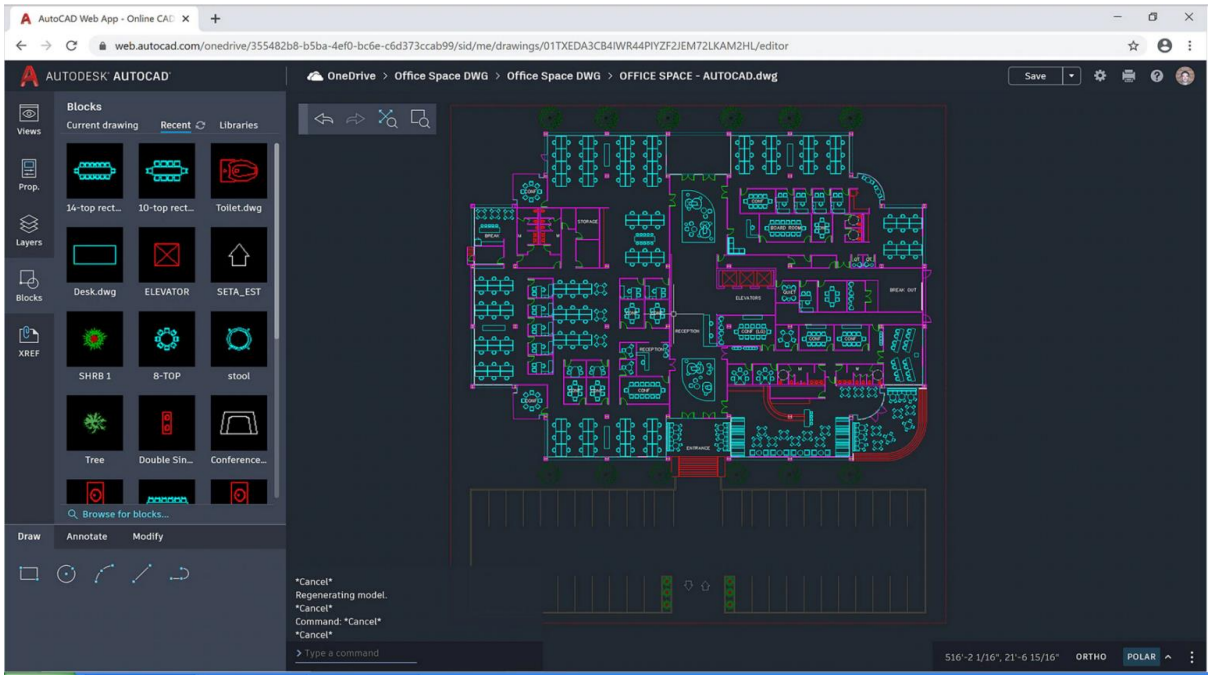

Figure 1 The working window of AutoCAD

For example, the company offers AutoCAD Mechanical for mechanical engineers.

Autodesk developers were among the first to understand the power of cloud technologies for modeling and computer-aided design tasks. Nowadays they offer a wide range of mobile applications and cloud services that can become a convenient and effective tool for training future specialists and solving various production and economic issues (Table 5).

Table 5 Cloud-based and mobile applications by Autodesk

No.	Autodesk product	Characteristics and main features
1	Autodesk A360	• 2D and 3D project collaboration. • Support for more than 50 file formats. • Viewing and uploading CAD systems models from e-mail. • Zooming and navigating through large 2D and 3D models. • Geometric point-by-point measurements in the drawing. • Services for collaborative work with drawings and models. • Updating and commenting on projects. • Monitoring design stages. • Maintaining documents on the work progress by uploading Photographs to the user account from a mobile device. • Sharing directly from a mobile device.
2	AutoCAD 360	• A free mobile application. • Contains a set of easy-to-use tools for creating, viewing, editing and sharing AutoCAD drawings via mobile devices. • Allows opening and downloading 2D DWG files from external storage or e-mail.
3	AutoCAD 360 Pro	Additional features are as follows: • Provides access to the output and editing of tooling designs. • Supports large files. • More editing and painting tools, including advanced tools. • Allows to edit and draw precise shapes using object snapping and a new keyboard feature (available only on iPad). • Allows to edit files that are stored in the external cloud. • Allows to rotate, select, move and scale objects. • Allows to edit and add comments to the drawing. • Allows to edit and view properties of objects. • Allows to carry out various measurements in real-time mode. • Allows to view DWG files. • Allows to synchronize amendments online and work offline. • Allows to use scaling and easily navigate through large drawings. • Allows to connect to such cloud systems as Dropbox, Google Drive and OneDrive. • Allows to share projects with other users directly from a mobile phone. • Allows to use GPS. • Allows to use a free web-based application to download pictures from browsers. • Allows sharing models in DWF or PDF formats via e-mail.
4	Fusion 360	• Allows to work jointly with 3D projects, markup, view, comment and collaborate in using CAD models. • A free program works together with Autodesk Fusion 360, 3D CAD, CAE and CAM tools for the development and design of cloud-based models. • Review and integration of 3D structures of various sizes. • Viewing projects of various formats. • Panning and rotating. • Allows to hide and view particular components in the drawing; examine and mark designs for convenient cooperation; share information with stakeholders; comment on constructions.
5	A360-View & Markup CAD files	• Designed for collaborative work with 2D, 3D and CAD models on tablets and mobile devices. The program supports over a hundred CAD file formats. Any file can be downloaded and opened regardless of the software used to create it. A360 provides an opportunity: • To view and download CAD models from local storage, e-mail, Box, Buzzsaw, Dropbox, OneDrive, etc. • To work on the same task simultaneously with colleagues and clients. • To make transitions between 2D and 3D CAD models of a larger size. • To measure the distance, area or angle between points in the drawing. • To comment on constructions and monitor changes. • To invite new members to join the project in the development process and work with them.

A wide range of tools allows the use of mobile applications, cloud services and computer-aided design programs in the educational process and helps parties work together on design projects. This complex of programs supports authorization through a Google account and enables integration with its cloud services. Since Google services are actively used in training specialists in economics and applied mechanics and teaching them general scientific disciplines (Sorby, 2009), it will be logical to use the above-mentioned programs to develop the informational and communicative competencies of future economists and mechanical engineers.

After analyzing these programs, evaluating their functions, integration possibilities and platform support, we concluded that it is most expedient to use the ARIS package in the professional training of future economists. It has a web-based version and its own cloud service for using the system. At the same time, AutoDesk products are more preferable for training mechanical engineers since they are widely used both in training and in professional activities of engineers due to a large number of libraries and configurations, a rich toolkit, integration with various design, simulation and project management environments (Planchard, 2007). AutoDesk was one of the first companies to develop cloud services and mobile applications which today can become an effective tool both for training future mechanical engineers (Evans et al., 2014) and for solving industrial engineering issues. AutoDesk products allow the systematic use of mobile applications, cloud services and computer-aided design programs in the educational process with the joint use of design projects (Carbonell-Carrera et al., 2019).

Let us consider the methodology of using cloud-based BPM, simulation and CAD/CAM systems in the professional training of bachelors of economics and applied mechanics.

The public need for highly qualified economists and mechanical engineers and the feasibility of forming their informational and communicative competencies in a progressive cloud-based information and communication environment determines the main objective of training, i.e. to ensure an increase in the informational and communicative competencies of bachelors of economics and applied mechanics through the use of cloud technologies. The analysis of the professional competencies of future economists and mechanical engineers has revealed the competencies associated with the use of information and communication technologies and divided them into three groups: fundamental, operational and organizational.

Each level is formed during the study of certain disciplines within the Bachelor's degree program in economics and applied mechanics and involves the use of appropriate cloud-based information and communication tools. Thus, the fundamental informational and communicative competencies are developed within the framework of such disciplines as "Information Technology and Programming". At this stage, the main cloud-based information and communication tools are Google Apps, including Google Drive, Google Docs, Google Sheets, Google Slides, Google Forms, YouTube and other sources used for educational purposes.

The operational component of informational and communicative competencies is formed during the study of the following disciplines: "Visual modeling in 2D and 3D systems", "Business process simulation", "Computer technologies in economics", "Design modeling in 2D and 3D systems" and "Computer technologies in mechanical engineering". The leading cloud-based information and communication tools emerge as professional tools, including Bonita Soft, ARIS (for economists), AutoCAD and cloud-based Autodesk A360 (for mechanical engineers).

The organizational component of informational and communicative competencies associated with the skills and abilities of project management is formed mainly during the preparation of a graduate qualification work. A cloud-based project management environment is added to the cloud-based information and communication tools used in this phase.

Special attention should be paid to Google communication services, including Gmail, Google Groups, Hangouts, etc. Their intensive use is expected throughout professional training. They are part of the learning communication environment and means of integrating various cloud-based information and communication tools, in particular, tools for general scientific and educational activities and tools for professional and practical activities.

Recommendations for the use of cloud-based tools in the process of teaching bachelors of economics and applied mechanics are summarized in Table 6.

Table 6 The use of cloud-based information and communication tools in teaching bachelors of economics and applied mechanics

Learning stages	Information and communication tools															
	Communication means						Means of general scientific and educational activities					Means of professional and practical activities				
	Gmail	Groups	G+	Hangouts	Keep	Calendar	Google Drive	Google Docs	Google Sheets	Google Slides	Google Forms	Bonita Soft	ARIS	AutoCAD	A360	Fusion 360
Information technology and programming	+	+	+	+	+	+	+	+	+	+	+	+	+	+		
Visual modeling in 2D and 3D systems	+	+	+	+	+	+	+					+				
Simulation modeling of business processes													+			
Computer technology in economics												+	+			
Engineering modeling in 2D and 3D systems	+	+	+	+	+	+	+							+	+	
Computer technology in mechanical engineering	+	+	+	+	+	+	+							+	+	
Implementation and presentation of graduate qualification work	+	+	+	+	+	+	+			+		+	+	+	+	+

Conclusion

In the course of the study, we reached the following conclusions.

Over recent years, cloud computing and web-based applications have become especially popular and relevant. However, most developers unreasonably neglect them. We believe that the majority of software products will be created in this direction.

Cloud-based and mobile open source BPM applications, CAD/CAM systems become the main tools forming the professional competencies of future economists and mechanical engineers, developing the ability to apply business process management (BPM) systems and computer modeling systems for business processes, computer-aided design (CAD), computer-aided manufacturing (CAM), computer-aided engineering (CAE) and specific systems for solving engineering issues in applied mechanics.

Google cloud services provide an opportunity to improve students' skills in using applied software for the computer modeling of business processes and performing engineering calculations, processing information and experimental research results. In addition, they perform an integrative function and combine scattered software, which allows the systematic use of cloud-based tools in the professional training of future economists and mechanical engineers.

It is advisable to use means of professional activity of future economists and mechanical engineers in teaching the basic disciplines and integrate Google services into the educational process. As a result, students have the opportunity to update the skills and knowledge they acquired while studying the fundamental disciplines. The tools used in their teaching will create an integrated system with a unified access method.

The study results have proved the hypothesis that an increase in the level of the professional competencies of bachelors of economics and applied mechanics is achieved through appropriate methods and forms of organizing their training with the use of cloud-based information and communication technologies.

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