Lodz University
of Technology

Distance Learning
and Examining Systems
- Theory and Applications

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Distance Learning and Examining Systems

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(IT platform e – matura)

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e-matura

Distance Learningand Examining Systems
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Edited by: *Sławomir Wiak, Konrad Szumigaj*

Introductory remarks

The number of virtual learning environments is increasing recently. Many reports stress the virtual learning philosophy and technology is more effective than the classical learning methodology. E-learning technologies have played an important role in the development and even expansion of online education systems. Current e-learning platforms are distance learning systems without necessity of continuous contact with the teacher. E-learning system offers a huge number of tools such as course content, platform management, and systems, as in our case interactive courses.

One of the possible way of improving of the teaching methodology and technology lays in flexible learning, which means developing of the courses with the help of flexible learning methods and the support of ICT (Information and Communication Technology). Huge percentage of our population is convinced that ICT will play nowadays an increasingly important role in education, when classical teaching methods are being replaced by new ones.

E-learning technologies have played an important role in the development and expansion of online education systems. Moreover we would stress that many universities have been involved in creating and developing online tools. During the last decade the special attention is focused on integrating Internet technologies to be implemented into the teaching and learning process in higher education. Web-education technologies are now being widely applied for teaching and learning leading to huge number of users.

It has been seen a significant revolution in e-learning technologies (philosophy and systems) in commonly available higher education and training courses around the world. E-learning as a new emerging philosophy of life-long education could be realized by means of different ways. Essentially, it is about the transmission of learning content exploiting information technology (IT). Information and communication technologies (ICT) play important role in supporting of the development of distance learning strategy. As part of this strategy e-learning technology has been dynamically developed. We would stress that our civilization expects, as a profit of e-learning technology implementation, to find higher dependence on technologies. Universities are making a lot of progress in enhancing learning Information and Communication Technologies (ICT) infrastructures, teaching, a virtual learning environment, etc. Distance learning in special cases is becoming ever more important than traditional/classical one, moreover the number of institutions, where this system is successfully applied, is constantly growing.

We have seen high progress in developing web-based training, online learning, e-learning, distributed learning, internet-based learning and net-based learning having strong influence on the progress of our civilization. The number of Virtual Learning

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Environments (VLEs) is increasing during past decade. Moreover, these platforms are strongly recommended for distance learning for those who are not able to attend classical courses in class rooms, and as well for those who wish to invest themselves for their future professional carrier by use of sophisticated e-learning technology. Most professional organizations is involved in implementing e-learning systems and platforms in long-life learning strategy. While information technology revolutionized the delivery of education and training, e-learning have principally modernized flexible delivery around the world. E-learning system offers a huge number of tools such as course content, platform management, and systems, as in our case, interactive courses.

New teaching models and tools incorporating e-learning have been already successfully exploited by a huge group of Universities and professional institutions involved in education process. There are many reasons of changing the education system from traditional teaching to e-learning; one of them, even the most important, is knowledge based education thanks to e-learning methods.

It is worth to point out, thousands of e-learning projects have been in progress, while they differ in their outcomes and exploited technologies. Moreover, there is lack of a standardized way of planning, comparing and evaluating e-learning projects, their outcomes, and their effectiveness, as it stated and discussed in the literature. The proposed E-learning Indicators Methodology (ElIM) could give a chance in successful planning, and evaluating of different e-learning projects, strategies and platforms. E-Learning indicators are defined as the important concepts and factors that could be used in evaluating the e-learning level when planning e-learning strategy for an institution or University. Following the step rise of distance learning technology we would even assume that in the future distance-teaching universities would offer the complete university courses as traditional university in virtual form. Generally, universities are in progress in integrating process of selected online components into their campus courses, using different information technologies leading to advanced distance learning system to be developed.

Modern internet application must fulfill many exceptions of today's market. User expects that application will be intuitive, innovative, nice looking, fast, secure and work of any time of night or day. Those exceptions are very hard to achieve especially in systems where many users are trying to access to the server at the same time. To meet those expectations it is necessary to use the newest technologies in both software and hardware parts of the project. This platform must fulfill each expectation mention at the beginning, like as: security, intuitive application and high availability.

The general idea of distance learning and examining systems is to include both a test and open-ended questions. Students valued the application of the latest technologies that enables animations in given questions, as well as the instantaneous availability of results. Teachers received the results of all their students. The characteristics and features

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of the project facilitate in depth and precise statistical analysis of the answers given by students to improve the quality of education. Such projects are still under continuous development, to be even implemented for use on a large scale, but the overarching goal is more than to create a reliable system to conduct examinations at a distance.

Further, based on the results of a mathematical/statistical diagnosis, the system could help students and teachers to prepare for the examinations by implemented an e-tutoring module. Since teachers have access to a mathematical diagnosis of their students, they will be able to monitor the progress of students' knowledge and assign a variety of tasks for them to solve. The e-tutoring module will make it possible to test students' knowledge, in the same format as the final test, on this platform. In addition to completing tasks assigned by teachers, students can solve tasks in those areas that cause them the most problems, and they can monitor their progress and how much more they still have to learn.

One of the important contribution to information e-learning and e-examining systems are *E-matura and iMSi* platforms created at the Lodz University of Technology, Poland. Thousands of students from all over Poland could take the exams, even matriculation examination by use of E-matura platform in mathematics at the same time via the Internet. In our platforms (E-matura and iMSi) we use communication platform (Windows Communication Foundation). It is alternative to traditional Http request-response architecture and allows us to decrease the use of internet bandwidth. For application servers we use Internet Information Server with special module Application Request Routing which provide load balancing and redirecting futures.

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SŁAWOMIR WIAK
KONRAD SZUMIGAJ
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Sławomir Wiak
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An innovative interactive e-learning and examining platform - E-matura and iMSi (Survey)

1.1. Introduction

The number of virtual learning environments is increasing recently. Many reports stress that virtual learning philosophy and technology is more effective than classical learning methodology. E-learning technologies have played an important role in the development and even expansion of online education systems. Current e-learning platforms are distance learning systems without the necessity of continuous contact with the teacher. E-learning systems offer a huge number of tools, such as course content, platform management and systems, and in our case interactive courses.

One of possible ways of improving teaching methodology and technology lies in flexible learning, which means developing the courses with the help of flexible learning methods and the support of ICT (Information and Communication Technology). A huge percentage of our population is convinced that nowadays ICT will play an increasingly important role in education, when classical teaching methods are being replaced by new ones.

E-learning technologies have played an important role in the development and expansion of online education systems. Moreover, we would stress that many universities have been involved in creating and developing online tools. Let us point out that the new European initiative focused on Massive Open Online Courses (MOOC) has been promoted and supported by many Universities. During the last decade special attention is focused on integrating Internet technologies to be implemented into the teaching and learning process in higher education. Web-education technologies are now being widely applied for teaching and learning leading to a huge number of users.

There has been a significant revolution in e-learning technologies (philosophy and systems) in commonly available higher education and training courses around the world. E-learning as a new emerging philosophy of life-long education could be realized by means of different ways. Essentially, it is about the transmission of learning content exploiting information technology (IT)[1]. Information and Communication Technologies (ICT) play an important role in supporting the development of the distance learning strategy. As part of this strategy e-learning technology has been dynamically developed. We would stress that our civilization expects, as a profit of e-learning technology implementation, to find higher dependence on technologies. Universities are making a lot of progress in enhancing learning Information and Communication Technologies (ICT) infrastructures, teaching,

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1 Choy S., Benefits of e-Learning Benchmarks: Australian Case Studies. Electronic Journal of e-Learning, volume 5, issue 1, 11 − 20, (2007).

the virtual learning environment, etc. Distance learning in special cases is becoming ever more important than traditional/classical learning, moreover, the number of institutions where this system is successfully applied is constantly growing.

We have seen a high progress in developing web-based training, online learning, e-learning, distributed learning, Internet-based learning and net-based learning, which has a strong influence on the progress of our civilization. The number of Virtual Learning Environments (VLEs) has been increasing during the past decade[2]. Moreover, these platforms are strongly recommended for distance learning for those who are not able to attend classical courses in classrooms, and as well for those who wish to invest themselves for their future professional carrier by use of sophisticated e-learning technology. Highly professional organizations are involved in implementing e-learning systems and platforms in long-life learning strategy. While information technology revolutionized the delivery of education and training, e-learning has principally modernized flexible delivery around the world[3]. E-learning systems offer a huge number of tools, such as course content, platform management and systems, and in our case interactive courses.

New teaching models and tools incorporating e-learning have already been successfully exploited by a huge group of Universities and professional institutions involved in the education process. There are many reasons for changing the education system from traditional teaching toe-learning; one of them, even the most important, is knowledge based education thanks to e-learning methods.

It is worth pointing out that thousands of e-learning projects have been in progress, while they differ in their outcomes and exploited technologies. Moreover, there is no standardized way of planning, comparing and evaluating e-learning projects, their outcomes, and their effectiveness, as it is stated and discussed in literature[4]. The proposed E-learning Indicators Methodology (ElIM) could give a chance for successful planning and evaluating different e-learning projects, strategies and platforms. E-Learning indicators are defined (by authors) as the important concepts and factors that could be used in evaluating the e-learning level when planning the e-learning strategy for an institution or University. Following the step rise of distance learning technology we would even assume that in the future distance-teaching universities will offer complete university courses like traditional universities in virtual form. Generally, universities are in progress of integrating the process of selected online components into their campus courses using different information technologies leading to an advanced distance learning system to be developed[5].

It is also widely discussed and argued that e-learning technologies have been successfully exploited by Small and Medium Enterprises (SMEs). Moreover, it is expected that e-business technologies should offer better chances of remaining on the market.

Modern Internet applications must meet many expectations of today's market. The user expects that the application will be intuitive, innovative, nice looking, fast, secure and work at any time of night or day. Those expectations are very hard to meet especially

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[2] Koskela M., Kiltti P., Vilpola I. and Tervonen J., Suitability of a Virtual Learning Environment for Higher Education. Electronic Journal of e-Learning, volume 3, issue 1, 21 – 30, (2005).

[3] Plaisent M., Maguiraga L., Bernard P. and Larhrib S.,Evaluating e-labs' Experimentation. Electronic Journal of e-Learning, volume 2, issue 1, 195 – 202, (2004).

[4] Fetaji B. and Fetaji M., e-Learning Indicators: a Multi-Dimensional Model for Planning and Evaluating e-Learning Software Solutions. Electronic Journal of e-Learning, volume 7, issue 2, 1 – 28, (2009).

[5] Wiak S., Jeske D., Krasuski M., Stryjek R., An innovative interactive e-learning platform. World Transactions on Engineering and Technology Education, Vol.7, No.2, 2009.

in systems where many users are trying to access the server at the same time. To meet those expectations it is necessary to use the newest technologies in both software and hardware parts of the project. This platform must fulfill each expectation mentioned at the beginning, such as:

- Security – security is a very important aspect of modern Internet applications. In our platform we provide an encrypted connection between the client and the server to avoid any data leaks and wire-tapping. Beside the secure connection, every user is authenticated to the system and all the data saved on the user machine is encrypted to avoid data loss. To avoid very dangerous phishing attacks our system is identified by a certificate that assures the user that he is using our system and not a fake one.

- Intuitive – the application is designed in the newest Internet technology provided by the Microsoft Company, which is named Silverlight. It allows to design a very nice looking user interface with interactive elements and animations. The use of that technology allowed us to design exams that look closer to paper exams and because of that they are intuitive to use for everyone.

- High availability – multi-access systems which are exposed to use by many users at the same time must be designed to prevent timeouts and server service overloads. To meet those expectations it is necessary to minimize the number of bits transferred from the server to the client and route Internet traffic not to one but to many servers with a conjunction of load balancing algorithms (see Fig. 1). In our platforms (E-matura and iMSi) we use a communication platform which is named Windows Communication Foundation. It is alternative to the traditional Http request-response architecture and allows us to decrease the use of Internet bandwidth. For application servers we use the Internet Information Server with a special module - Application Request Routing, which provides load balancing and redirecting features.
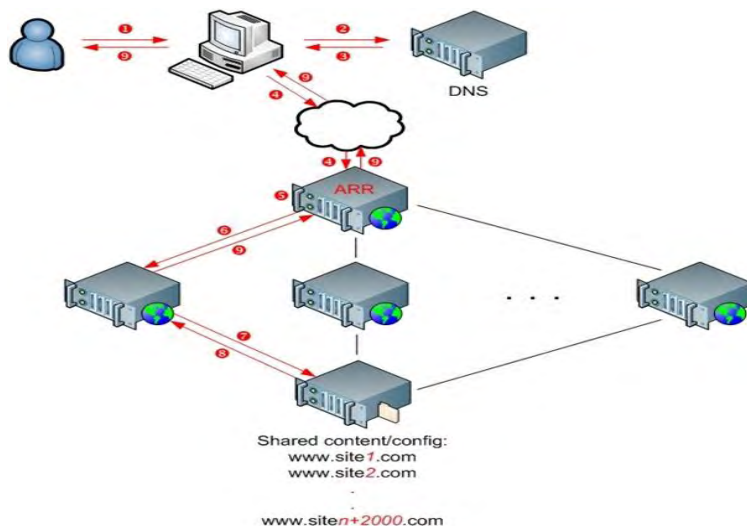
Figure 1. Load balancing.

Further, based on the results of a mathematical/statistical diagnosis, the system could help students and teachers to prepare for examinations by implementing an e-tutoring module.

Since teachers have access to a mathematical diagnosis of their students, they will be able to monitor the progress of students' knowledge and assign a variety of tasks for them to solve. The e-tutoring module will make it possible to test students' knowledge, in the same format as the final test, on this platform. In addition to completing tasks assigned by teachers, students can solve tasks in those areas that cause most problems to them, and they can monitor their progress and how much more they still have to learn.

Some of the most important contributions to information e-learning and e-examining systems are *E-matura and iMSi* platforms created at Lodz University of Technology, Poland. Thousands of students from all over Poland could take exams, even matriculation examinations using the E-matura platform in mathematics at the same time via the Internet. In our platforms (E-matura and iMSi) we use a communication platform which is named Windows Communication Foundation. It is alternative to the traditional Http request-response architecture and allows us to decrease the use of Internet bandwidth. For application servers we use the Internet Information Server with a special module - Application Request Routing, which provides load balancing and redirecting features.

1.2. User interfaces in modern education – selected tools

Nowadays, when advanced technologies accompany us in every aspect of our life, it is more difficult to interest students to listen to static lectures and lessons which have been conducted in this way for many years. To avoid the increasingly decreasing dependency on and frequency of lectures the authors invented a concept of a project called Board 2.0. The concept consists in the creation of a fully interactive board applied to communicate with students, through which they will be able, together with the teachers, to influence the course schedule. 2.0 Board Project uses the latest technologies available today, such as SmartGlass, rear projection and touch detection, using infrared cameras to create the board. [6]Thanks to this board the user will be able to work in a natural and intuitive way while leading a lecture or a presentation. Moreover, the project gives the possibility of placing images directly into the system using the touch screen surface so that the user does not have to wonder how to use the device.

The aim of Project Board is to create an interactive board which will display the image using back projection. Communication with the board will proceed with the MultiTouch interface and will enable to introduce new items directly through the screen plate. The figure below shows the principle of the board:[7]

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[6] Brave NUI World: Designing Natural User Interfaces for Touch and Gesture - Daniel Wigdor, Dennis Wixon (Morgan Kaufmann; 1 edition (April 27, 2011))

[7] Jeske D., Krasuski M., Stryjek R., Natural user interfaces in modern education, 2nd World Conference on Technology and Engineering Education, Ljubljana, Slovenia, 5-8 September 2011
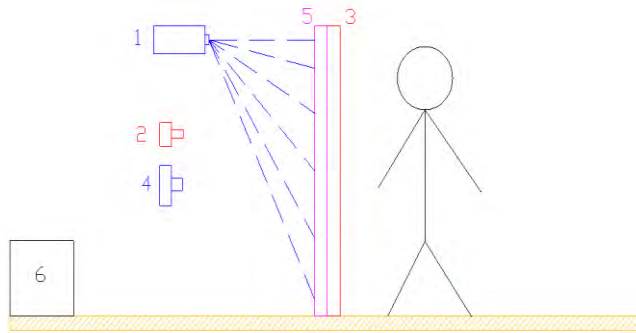
Figure 2. The concept of the Board.

Description of the project elements:
1. Graphic projector - a standard projector for rear projection, short focal length and a resolution of 1920x1080 pixels is used to display the image on the Smart Glass.
2. The camera working in the infrared band acts as a MultiTouch interface by reading shapes of items, which will be applied to glass projection.
3. Glass with embedded LEDs on the edges working in the infrared band. The glass provides adequate lighting for the infrared camera riding fingers applied to the glass. Fingers will scatter infrared light using the *Frustrated Total Internal Reflection* phenomenon. The operating principle can be seen in Figure 3, below.
4. A high resolution camera – a camera to collect color images of items which we want to digitize.
5. Control Unit - a computer which will control the operation of the whole device in real time.
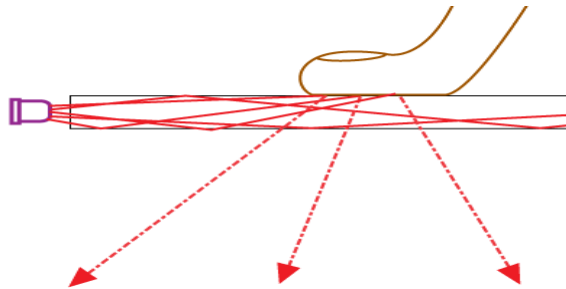
Figure 3. Frustrated Total Internal Reflection. [2]

6. Smart glass - glass on which back projection image will be shown. Smart Glass can change itself from fully transparent to milk glass under the influence of the applied voltage. The frequency of changes from transparent into milk glass is 100 Hz. Using this effect it will be possible to simultaneously display the image scattered on the glass when it is energized and opaque. There will also be downloading images in cycles in which the glass is completely permeable.

The principle of Smart Glass is illustrated in Figure 4 below[8]. The basic problem in building this device is to ensure proper synchronisation between the various components of the project. To ensure that the system works properly, the projector should display the image only in these cycles of Smart Glass in which the glass is opaque (in order not to dazzle the users).
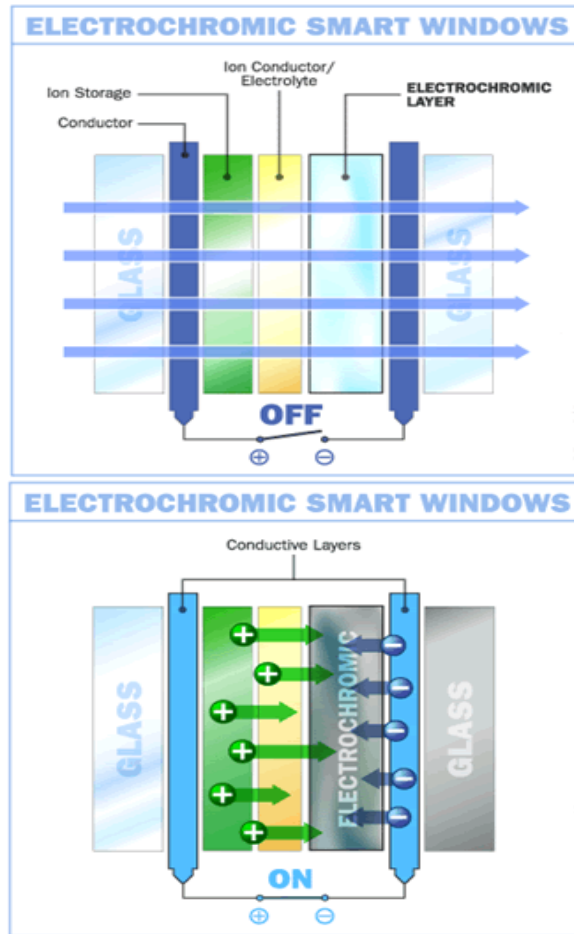
Figure 4. Electrochromatic smart windows. [4]

A similar assumption must also be made for the high-definition camera, which should take pictures only in cycles in which the glass is transparent to avoid photographing the image. Of course, all of this is possible because Smart Glass can change its state at a frequency of 100Hz, which is large enough. The picture displayed on the screen will appear completely smooth to the user and will not cause any eye strain while working.

Communication with the device using the MultiTouch interface will take place using the Frustrated Total Internal Reflection phenomenon. The diodes which emit infrared light will be installed on the edges of the acrylic glass in the way shown in Figure 5 below.

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[8] Smart Materials - http://www.matint.pl
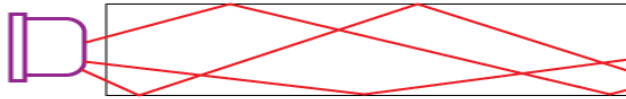
Figure 5. Light diffusion in acrylic glass. [2]

Infrared light LEDs are installed in such a way that they emit light which by internal reflection will fully pass through the glass while being invisible to the camera which acts in the infrared.

When applying a finger to the acrylic glass, a part of the light will be dispersed and directed down towards the camera, which operates in the infrared band, and the dispersed infrared light goes to the camera (as shown in Figure 3).

The camera, which operates in the infrared, will be able to read such a signal and, then, convert it into the user interface control commands. Figure 6 below shows the effect of light scattering by applying fingers to acrylic glass, which is read by the infrared camera.

Figure 6. Reading the hand position by the infrared camera. [2]

The construction of the Board 2.0 project will allow different work with a computer in the classroom through increased interaction and involving more users simultaneously. Classes can be conducted in a more natural way, where the teacher can keep introducing new facilities to the lecture, which may be achieved using the board. It should be emphasized that the user does not need to learn about the interface. The user can operate the system with his/her own hands and use items which need to be introduced to the digital world.

In addition to the scientific world, the project should also be a great solution in many commercial applications, for instance, as an interactive storefront, allowing certain visualization, for example, in advertisements which could be projected onto a specific user standing in front of the shop window. Advertisements could be chosen on the basis of physical characteristics of the person and, then, displayed on the screen. Another example of commercial application is a virtual dressing room where a potential customer could see his/her reflection concerning an outfit which he/she likes to try on without removing clothes.

The project is now at the conceptualization stage in which all the technical details are refined. On the other hand, the project is feasible already. All the components of the Board 2.0 project exist and can be purchased on the market, hence, its implementation should not cause any major problem. The control software system, however, will be made from scratch to ensure the quickest and most convenient device service for the users. During the first meeting of the board users it was noticed that they could easily figure out how to use it.

Building a user interface which will be able to effectively replace the mouse and the keyboard and at the same time be much more natural for the user who has no experience in working with a computer is not a simple issue, but it is possible to do. Thanks to the use of the latest hardware and software technology we are able to create a project that will not only give a new dimension to the human-computer interaction, but also offer an additional attraction to conducted presentations and lectures. Board 2.0 project allows the user to interfere with a touch with what is being displayed on the screen.

This new approach to using the computer during presentations and lectures will have a positive impact on the reception of the materials presented by the students.

1.3.   E-matura information system – challenges and opportunities

The *E-matura* system has been designed and built to cope with a heavy load which is generated by a huge amount of information and data generated by students who sit the examination simultaneously. Systems used for providing examinations at a distance must meet stringent requirements for security and high availability from both the programming and the organization. To meet this requirement in the *E-matura* project, a range of mechanisms and features that provide a high level of data security have been used. This paper presents the opportunities and challenges faced by the creators of *E-matura*.

One of the fundamental challenges faced in the designing stage of *E-matura* was ensuring high and uninterrupted availability of the examination. During the first attempt to run this examination, access to it was shared by over 10,000 students and the system, with this application, was composed of one application server and one database server. At that time it was an adequate configuration but it was not sufficient for the future because the number of high school graduates can reach hundreds of thousands.

In cases when thousands of users refer to one server at the same time, each connection to this server must be allocated a certain amount of memory and processor time. To ensure that the examination availability remains high, the so-called *Load Balancing* solution was used. This solution is based on building server clusters which can be distinguished in two main parts.

The first part is a computer, which is an access point to the examination. All connections are directed to this computer but they are not served directly but only transferred to computers in the cluster. On the basis of the load management algorithm that has been chosen, this server redirects the traffic to the least loaded server in the cluster.

This solution is scalable and allows unlimited server extensions. The only limitation is the Internet connection at which communication takes place. An additional feature which this server can meet is decoding the SSL - encrypted message and passing

it forward in the decrypted form, which reduces the load on the target servers, but with large numbers of connections it can overload the traffic balance server.

Due to the use of the above technique the scalability of the system is practically unlimited and enables the management of thousands of users in a dynamic way. The use of the cluster also ensures permanent availability of the application because a failure of any of the elements of the cluster does not affect the operation of the system because it can be swapped for another server in the cluster.
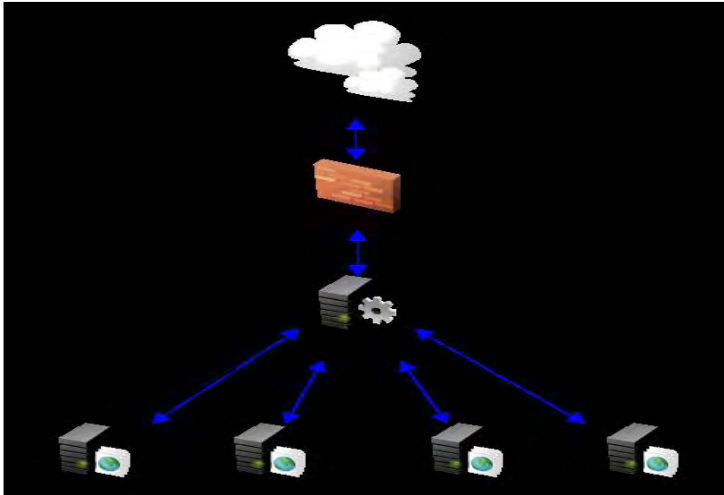
Figure 7. System architecture.

One very important role in designing the examination system is to ensure security during data transmission. To ensure secure communication between the client and the server, SSL technology was used, which helped to secure the system in the following two areas:

- Application server verification - each application available through the SSL protocol uniquely identifies the person/system for whom/which a certificate has been issued. Thanks to this solution, the user can check if he/she is acting with the original server,

- Transmitted data encryption - each SSL certificate contains a private and public key, and thanks to this, it is possible to achieve the asymmetric encryption of data transmitted between the client and the server[9].

The encryption of the connection and server identification through a certificate which is issued by a trusted certificate center does not provide complete system protection. The user of the system knows that he/she communicates with the original server and the data that he/she introduces does not fall into the hands of a third party.

However, the client himself/herself must be properly verified to decide which resources he or she needs to have access to. His/her authentication and authorization need to be conducted in order for there to be proper user verification. The authentication involves checking if the person is who he/she claims to be, so his/her login name and

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[9] Schaefer, K., Cochran, J., Forsyth, S., Baugh, R., Everest, M. and Glendenning, D., Professional IIS 7. Wrox (2008).

password are checked. The next step contains the authorization process that includes checking to which resources/functionalities the user has access rights.

In the *E-matura* system, the authentication for access to the system is built on giving a login name and password, which is checked while logging into the system. If the user gives proper data, he/she is given a specially generated number, the so-called token, which is assigned to the current login session. This token is used as authorization in all methods of net service, which is the only communication layer between the client and the server. Because the token is used, the login name and password do not need to be sent at each query to the net service. This improves security by reducing transition of sensitive user data to the minimum.

Having a token lifetime counter provides an additional security layer. Each token has been allocated a life span which is incremented at each reference to the server. If the time allocated to the token for referring to the system is used up, the token's validity is barred and subsequent access attempts will return an error and redirect the user to the login page. Because of this solution a token captured at a victim's computer cannot be used at any other computer in a different session.

Because *E-matura* is not an open system, it was possible to add an additional security layer. The registration process begins from the recruiter who contacts the unit representative who wants to have an account in the system. This is via personal or telephone contact. Later, the interested person receives a paper form - an application for participation in the programme. By using the traditional verification method at this stage, all persons who want access to the account just to penetrate it have been eliminated[10]. After the verification of the sent data, the interested person receives information which is required to log into the system. This information is sent to the person by e-mail. The person who receives such an account is then authorized to set up such accounts for the users within his/her unit.

Conducting examinations for the secondary school certificate is not just an encounter with technological challenges. It is also required to fulfil many formal requirements connected with the storage of personal data in paper form, which must be signed by every examination participant. Without proper authorization, tens of thousands of students' questionnaires with personal data would need to be supplied to the central registry and manually entered into the system. It would take an enormous amount of time and generate many errors. To avoid such a situation, an automatic management system has been developed.

The teacher, who is responsible for entering information about students, enters all this information into the system using an administrative module which is prepared especially for him or her. Next, he/she prints a student card for each student, which must be signed. The key element for this system is the barcode on each card. This solution means that every card has been allocated a unique barcode, so that each student can be clearly identified. The cards are scanned by a barcode reader by the central registry and students' data are marked in the system as verified data.

These data have a paper equivalent with participants' signatures. This solution drastically reduces the amount of work related to the registration of students. Additionally, the number of potential mistakes is also reduced because data is verified while it is entered into the system. Therefore, there are no errors that could be associated with this process.

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[10] Hirt, A., Pro SQL Server 2008 Failover Clustering. Apress (2009).

Each examination for the secondary school certificate must meet the requirements of the Central Examination Board. An immense challenge was to analyze and edit questions in such a way that they could be displayed in an electronic form and checked automatically on the server. With the help of a friendly institution, which specializes in mathematics and hires people with considerable examination experience, it was possible to achieve mathematics at a basic level, with 95% coverage, which is a very good result according to numerous specialists. Thus, it was possible to overcome barriers with innovative solutions. Such barriers include people for whom paper and pencil are the only option for taking the examination for the secondary school certificate. Because of good coverage in terms of the content questions of the paper examination for the secondary school certificate and a positive response from students and teachers, an increasing number of people are inclined to attend to an electronic form of examination.

The *E-matura* system is designed and built to cope with heavy loads which are generated by the huge number of students who sit the examination simultaneously.[11] The aim is to prepare the system for the future in order to replace the traditional, trial examination for the secondary school certificate with this electronic system. The objective is to apply this system not only to mathematics but also to other examination subjects. The examination for the secondary school certificate, which is conducted electronically, has very high prevalence in comparison to the traditional one, mainly because the costs are lower.

Furthermore, there is no need to employ a large number of examiners to check the students' examination results, because the system automatically checks the whole examination and displays the results. There are also no printing costs, which has a very positive impact on the environment. In addition, security is increased because there is no possibility of someone seeing questions before the examination, which was the case when sending and distributing paper-based examinations to carry out traditional examinations for the secondary school certificate.

E-matura is connected not only with savings but also with the possibility of a better analysis of the examination process. Traditional examinations do not provide much feedback, except for student results from each task. The *E-matura* system collects a vast amount of information during the examination such as: the number of attempts at each task and the total time spent on each question or every change of answer. Collecting such data provides the examiners with many options because they would be able to see all the questions that caused students the most problems. Based on this knowledge, examination questions can be better adapted.

The examination for the secondary school certificate, being one of the most important examinations in the life of every student, should be conducted in such a way as to make it difficult to cheat. In the case of conducting the examination in the traditional way, where each student gets the same examination paper, the prevention of cheating is based only on students being watched by examination supervisors. In the case of the examination for secondary school certificate performed using the *E-matura* system, options for preventing cheating are improved.

Nevertheless, examinations carried out with the use of the *E-matura* system have many similarities with the traditional examination for the secondary school certificate.

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[11] Jeske D., Krasuski M., Stryjek R., The E-matura project yesterday, today and tomorrow - challenges and opportunities, 3rd WIETE Annual Conference on Engineering and Technology Education, Pattaya, Thailand, 6-10 February 2012.

The examination is also administered in schools, where students take an examination at the same hour. Order in the class is also maintained by examination supervisors, but instead of using examination papers, students sit in front of computers and answer examination questions on the computer screen. Students have to log in using their unique login name and password before joining the examination.

What is more, after logging into the system, students enter login names of the students sitting close to them. Therefore, the system knows from whom this student could potentially try to copy the results. In addition, not only is it possible to analyze the similarities between students' answers, it is also possible to have the questions and the sequence of answers in a different order.

Cheating is, therefore, more difficult because although the numbers of questions might be the same, the content could be different. It means that even if a student could see the answer of his/her colleague to the question of the same number, he or she will not gain anything because the question might be about a different matter. The only way cheating would be possible is if the other student dictated all the content of the question. However, the chance of being caught by the supervisors is high. Generally, students are afraid to take such a risk, hence, this system and the solutions applied discourage them from cheating.

The final protection against cheating would be to place cameras in every examination room to transmit and record vision during the examination. These pictures would be helpful in resolving doubts concerning whether students were cheating or not, and would also oblige and motivate a better examination.

E-matura is an evolutionary project, which is constantly being upgraded with new functionalities to overcome any new requirements and challenges. This system offers great opportunities in many respects, and has a considerable advantage over traditional examinations. One such advantage is gaining results immediately after the examination so students do not have to be under stress awaiting the results for a long time. What is even more important is that the analysis of a huge amount of data collected during every examination for the secondary school certificate conducted with the aid of the *E-matura* system makes it possible to design better examination questions, which are better tailored to the knowledge delivered.

The *E-matura* system still faces many problems and challenges but this approach to the examination provides many opportunities that should not be missed. This is why the system is being constantly adapted and improved. Additional examination questions from other subjects are being added to this system, hence, it is envisaged that examinations for the secondary school certificate in Poland may soon be conducted only using the *E-matura* system.

1.3.1. Secure and highly available exam system "E-matura" case study

E-matura is a modern examination system created at Lodz University of Technology. The system is designed to handle thousands of students in real time manner and provide maximum security for data safety. This complex and highly available system has many possible weaknesses which had to be taken care of. The diagram below (Fig. 8) shows

us all the steps in the communication process between client and server where something can go wrong and the system could be exposed to a hackers' attack[12]
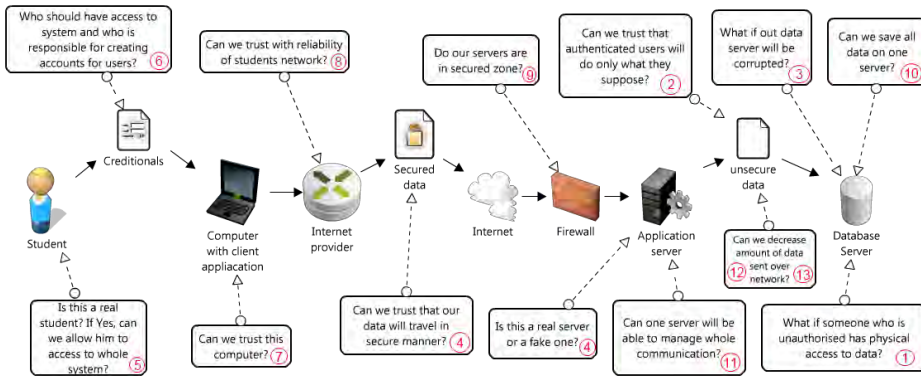

Figure 8. Communication process between client and server.

An IT system which stores and processes personal data of its users must ensure very tight security of data safety. This problem also appears in the E-matura project because the system has to store detailed information about the users (Name, Surname, Personal ID) for students and teachers who participate in the project. Storing this data is required to be able to identify each user of the project by the financial institution funding this project. Moreover, in E-matura classified data is stored, such as examination questions and survey questions which are asked during the exam.

In the E-matura project we use SQL Server 2008 R2 Microsoft database, which provides several possibilities to protect data against unauthorized access. Taking into account two basic features, such as the rate of application performance and the security of classified data security, we decided to encrypt data at line level using the AES algorithm. Only table columns that store sensitive data have been encrypted not to slow down the whole database action unnecessarily. By using encryption, even people with physical access to data will not be able to use it without a proper decryption key.

When building a web project whose users will be persons who are very determined to pass the exam, there must be taken into account some other factors affecting safety. A known problem which often occurs in these types of systems are SQL injection attacks. These attacks are very common in systems where business logic used to retrieve data from the database is located on the application. An example of a malfunction can be the creation of a mechanism to login whose query about the user's existence is built on the application and then run as dynamic SQL on the database. In this case, an unauthorized person can affect the appearance of the built query by typing an additional SQL command. In this way, the system will check if the password is correct and then execute the hacker's command.

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1.   [12] Jeske D., Krasuski M., Stryjek R., Secure and high available exam system "E-Matura" case study, *2nd World Conference on Technology and Engineering Education,* Ljubljana, Slovenia, 5-8 September 2011

To avoid this problem and prevent access to data directly from the application, all communication between the web application and the database is done through stored procedures. In this way the user cannot get to the tables and data, because the stored procedure which gives him such access is not available.

Another aspect in the construction of a Web-based service whose aim is to collect exam and personal data is protection against losing such data. To meet all the requirements, we built an infrastructure in which every night a backup of the entire database is made on a separate server which is located on a different subnet and connected directly to the database server. This server is not visible to application servers, so data security is increased. To provide even greater data security and a possibility of restoring data from a specified period, e.g. reaching the database of a user who could have deleted data, we use log shipping, which allows us to perform transaction log backups with a frequency of every 15 minutes. Fifteen-minute intervals between transaction log backups provide us with sufficient granularity of backups, while the database server loads low. The following diagram (Fig. 9) shows the server infrastructure which has been built in the E-matura project.

This diagram shows the infrastructure of the E-matura project. To ensure greater security, most systems are duplicated and divided into separated subnets. Users who connect to the E-matura are unable to connect to database servers, because these servers are connected to a separate subnet to which only application servers have got access. Creations of such separations required using separated NICs in application servers to handle traffic from the Internet and separated network cards to communicate with the database. Thanks to this approach, an unauthorized person who would like to have access to the data will have to deal with several servers on the way, and thus such a person will have more time for the burglary. This situation will give us more time for emergency reaction.
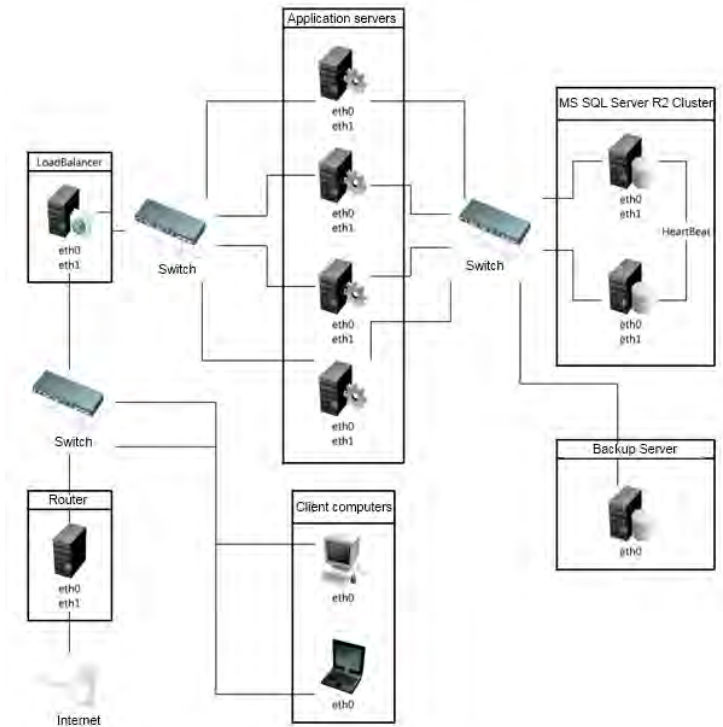
Fig. 9. Database server logic separation.

The client application communicates with the server part via a network service based on Windows Communication Foundation technology. This technology using open standards such as HTTP and SOAP provides the functionality to client applications. In order to ensure secure communication between the client and the server, SSL which allows the security of the system in two dimensions has been used.

- Verification of Application Server
- Encryption of transmitted data

Verification of the server is based on a system of certificates on the basis of which it is possible to check an entity identified by a given certificate. The certificate is issued by a special certification center at the request of an applicant. Each certificate is assigned to a particular Internet domain and is linked with a company or an individual user. Such a certificate can be issued only by an authorized center, so it cannot be issued by a fraudster or a third person having no such rights. Each center is further verified by the parent center for further verification and preservation of the so-called certification path consisting of a chain-level review of each issue of the certificate. Each certificate contains information about parent certification organizations, so certificates can always be verified by the end user.

Each certificate includes a pair of keys: private and public, which enables asymmetric encryption of data transferred between client and server. During the communication between the application server and the application installed on the end user's computer, keys are

used to encrypt and decrypt transmitted information. By using this solution, the data sent between the client and the server cannot be overheard by a third party.

Encryption of the connection and server identification through a certificate issued by a trusted certification center does not provide total protection. The user of the system knows that he communicates with the original server and the data he enters will not get into the hands of third parties, but the same client must be verified to determine whether and to what resources he/she should have access. In order to properly identify the user, authentication and authorization need to be done. Authentication involves checking whether the person is who he claims to be. By the authorization process it is checked to which resources/functionality the user is authorized to access. In the E-matura system authentication is based on the username and password which is checked when the user logs into the system. If the user gives correct data, as a result of this operation he receives a specially-called token-generated number that is assigned to the current logon session. This token is used to authenticate all Web service methods that provide a unique communication layer between the client and the server. By using a token, username and password are not sent with each request to the web service, which increases safety by reducing to a minimum the transmission of confidential data to the user. Additional protection is the lifetime of the token counter. Each token has its set time of life that is incremented with every appeal to the site. If the amount of time is exceeded, the validity of the token is barred and any subsequent appeal to the site returns an error and redirects the user to the login page. With this approach, a token captured on a victim cannot be used at another computer or the same computer in another session.

Because the E-matura is not an open system in which every user who knows the server address can have access to the system, an additional layer of security was able to be introduced. The registration process begins with a personal or telephone contact with a representative of the recruiter who wants to obtain his/her own account in the system. Then the concerned person receives a registration paper which is a participation request in the program. By using the traditional method of verification at this stage, all those who would like to get into the system account for its penetration will be eliminated. After verifying the data, the interested person receives on his/her e-mail address the information which is needed to log into the system. A person receiving such an account has the authority to set up accounts for users within his/her unit.

In addition to the verification of the persons participating in the exam, it should be remembered that the account that the user receives can be stolen or disseminated by this user. In order to provide additional protection against such an eventuality, a special verification system which can connect computers to the system has been created.

The person responsible for students' accounts must also perform a registration procedure for his/her computer that will be used during the exam. All the computers which will participate in the exam must be verified before the exam and their number cannot be greater than the number of the users in a given unit (precisely speaking, this number may be slightly higher than the number of the registered computers because there must be a computer backup in case of failure of the main unit.) With this approach, only verified and recorded CPUs (central units) will have access to the exam.

Safety does not only mean data confidentiality and verification of the participants. For complete safety a continuity of conducting the examination in all conditions should be ensured. The E-matura is designed to work despite unexpected interruptions in the Internet access and in the power supply on both the client and server-side applications. After starting the exam, the system retrieves all the questions to the client and stores them

locally in an encrypted form. While putting each response, the system first saves it locally in an encrypted form and then tries to send the reply to the server. If the answer cannot be sent immediately, it goes to the response pending queue. The queue is periodically checked and in case of contact with the server, all the replies are sent. If the failure continues, the system shuts down without giving the exam result, however, all the responses are stored on a local disk in a secure form and can be sent as soon as the fault is removed.

The last element in ensuring security is already a standard at this point but you cannot forget about it while describing a comprehensive solution to secure the information system. This refers to the firewall separating servers that are within our internal network from the so-called external world or the global Internet. The firewall allows to lock the computer ports on which our services do not operate in order to increase safety and not to leave loopholes for malicious software that could get through such ports to our internal network.

In systems for students examination, in addition to providing high security data, database availability should also be ensured while writing the exam. The aim of the E-matura project is to make the exam fully accessible to all candidates during the designated hour. With these assumptions, we handle a huge amount of visitors who begin an exam at exactly the same time. To ensure high availability of the database, a cluster database based on Microsoft operating systems Windows 2008 R2 was built. The infrastructure of database servers is identical and consists of the following elements:

IBM HS22 Blade Server
2x Xeon Processor E5640
32 GB RAM

Both servers use a shared disk array attached via a SAN. The cluster is configured as Active-Passive, allowing only one server running at one time, while the second one takes over the role immediately after the occurrence of any problem without losing the least amount of data. All the data (including transaction log files) is stored on a shared matrix, thus the server which currently operates in an Active has access to them. The diagram below shows how to connect the servers in the cluster.
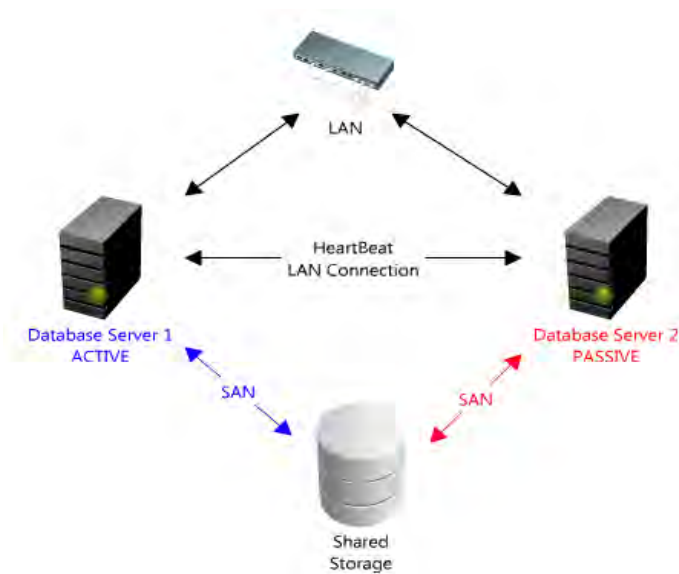
Fig. 10. Servers in the cluster architecture.

The classic application running in the online environment is activated on a single web server which handles all the traffic generated by this and other applications that are installed on the computer. This solution works in most cases because the average number of people who use the web server at the time are not able to overload the server resources. Such a situation, where several tens of thousands of people refer to a single server at the same time, is unacceptable. It is because a certain amount of memory and CPU time must be allocated to any connection to the server. To meet the requirement of high availability of the exam, a solution based on the so-called Load Balancing was applied.

The solution is to build a cluster of servers in which we can distinguish two main parts. The first one is a computer constituting the AP to the exam. All the connections are directed to this computer, but they are not directly supported but only transmitted to the computers in the cluster. Based on the selected load management algorithm, this server redirects traffic to the least loaded server in the cluster. This solution is highly scalable and allows for virtually unlimited expansion of the cluster - the only limitation is the Internet bandwidth at which the communication takes place. An additional feature that may satisfy this server is decoding an encrypted SSL message and passing it along as a decrypted message. This causes a reduction of the burden on the target servers, however, with a large number of connections it may cause an overload of the server balancing traffic.

Sometimes the data which is retrieved from the database server to the application server duplicates to each customer. For example, examination questions for a group of examinees are the same, so you can optimize access to the database by buffering the data on the server side applications. The data is collected only once during the first query to the application and then stored in an associative array where there is a key that uniquely identifies the buffering data. For each data retrieval operation this board is checked and when it appears that the data is already buffered, the database query can be replaced by fast data downloading from the buffer. It is worth remembering that stored data cannot

occupy too much space in the computer's memory because it can cause its slowing down or immobilizing.

The last step of the application performance optimization is to minimize the amount and size of information exchanged. In order to ensure adequate volume of exchanged data, all the data sent between the client and the server is encoded in a binary form. Unlike the classic implementation of the SOAP protocol, in which data is sent in plain text, this is a solution that helps to reduce the message size up to 40%.

Ensuring full security and high availability of data in the E-matura was not an easy task due to the nature of this project, which requires simultaneous access to data by all the users participating in the exam. By constructing this solution we have tried to ensure maximum scalability. If a need to support a greater number of users occurred, the solution could be adding just one more server without rebuilding the entire application.

1.3.2. E-tutoring as part of the e-examination - the use of data warehousing and data mining to assist in the learning and teaching process [5]

The character and features of the E-matura system enables deep and precise statistical analysis of answers given by students to improve the quality of education. The project is under continuous development. The system is ready for use on a large scale, but the goal is not just to create a reliable system to conduct examinations at a distance. Basing on the results of the mathematical diagnosis, the system would help students and teachers in preparing for the exam by an e-tutoring module.

In the e-examination area we diagnose the following problems:

- Test results don't give enough information to students to prepare efficiently for the exam.
- It is necessary to save the results in every part of the programme and present the learning progress over time – to students and teachers.
- The possibility of assigning additional tasks to students by the teacher.
- The system provides additional tasks for students in necessary areas for revising by them to achieve better final goals.

E-matura provides a computer-aided analysis of graduate characteristics. The E-matura system is built to collect, in addition to the response, as much information as possible, which can be analyzed after processing in order to inference. The system collects information to answer questions such as:

- Which questions were the hardest?
- How much time does a student need to solve a task?
- How many times does a student come back to this question?
- How much time does a student need to solve the whole exam?

The system collects very detailed information in the database, which is associated into each student and each question. If the student answered a given question several times changing the answer, the system recorded all his/her steps. The time of giving every answer and how many times the student went back to the question were also registered. During each test the system records over 600 000 responses of several thousand students. All the information regarding the questions and the provided answers is embedded in the context of the user, class and school.[13]

Currently, we are designing an e-tutoring module which will support the process of education for teachers and students. This module will be an integral part of the E-matura system.

The current plan is to provide students with additional tasks concerning the subjects which, according to the system, need revising. On the basis of the diagnosed weakest areas of the student or class, also the teacher will be able to assign tasks to a particular student or the entire class. The system will show who has done their homework and will check the correctness of their answers. The teacher will not have to check homework. Tasks will be drawn from a pool of tasks from previous exams or will be generated automatically by the system in the tasks for which it is possible. We are currently working on allowing teachers to add their own questions to the system.

The teacher will be able to use the system to prepare students for the exam forms. Teachers will be able to monitor the progress of each student individually or at a class level. The system will present an overall assessment of students' knowledge, as well as by individual parts of the program. What is more, the E-tutoring module will provide access to historical data for each student and class. It is possible to process aggregated data (current and historical) from the E-matura system in the popular Microsoft Excel spreadsheets. It is convenient for the user to apply familiar tools.

Question		Time spent to solve question [min]					Points for question				
Category	nr	avg	min	max	stddev.	median	avg	min	max	stddev	median
Open questions	1	14,7	0,1	322,0	19,54	10,1	0,6	0	2	0,90	0
	2	6,9	0	274,0	10,06	4,1	0,7	0	2	0,82	0
	3	6,1	0	182,2	5,38	5,6	1,0	0	2	1,00	0
	4	6,6	0	33,6	4,92	5,4	1,2	0	3	0,76	1
	5	2,5	0	167,6	4,05	1,9	0,1	0	2	0,48	0
	6	6,6	0	53,8	4,64	5,5	3,4	0	5	1,26	4
	7	7,3	0	117,4	5,64	6,2	1,9	0	4	1,25	2
	8	5,0	0	176,2	7,13	4,1	0,3	0	2	0,74	0
	9	7,3	0	60,7	5,11	6,4	0,1	0	2	0,26	0

Figure 11. A sample report with the examination results for open questions.

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[13] S. Wiak, D. Jeske, M. Krasuski, R. Stryjek, *Komputerowe wspomaganie diagnozy matematycznej uczniów przy użyciu Business Intelligence w systemie informatycznym e-matura*, System informatyczny zdalnego testowania wiedzy na przykładzie projektu e-matura z matematyki, Wydawnictwo Naukowe PWN

Question		Time spent to solve question [min]					Points for question				
Category	nr	avg	min	max	stddev.	median	avg	min	max	stddev	median
Closed questions	10	1,6	0	16,4	1,45	1,3	0,9	0	1	0,33	1
	11	1,0	0	18,1	1,05	0,8	1,0	0	1	0,19	1
	12	1,3	0	16,8	1,35	1,0	0,8	0	1	0,39	1
	13	2,2	0	22,5	2,29	1,5	0,4	0	1	0,48	0
	14	2,1	0	52,0	2,53	1,4	0,3	0	1	0,46	0
	15	1,9	0	53,7	2,41	1,2	0,6	0	1	0,50	1
	16	2,3	0	17,7	2,26	1,7	0,7	0	1	0,46	1
	17	1,7	0	46,7	2,33	0,9	0,6	0	1	0,48	1
	18	1,9	0	18,7	2,06	1,3	0,7	0	1	0,45	1

Figure 12. A sample report with examination results for closed questions.

The teacher will get answers to the following questions:
- Which questions were the hardest?

If the student answered any given question several times changing the answer (responses), the system recorded all his/her steps. The time of giving every answer and how many times the student went back to the question were also registered. Thus, the results for the student, school or country can be analyzed.
- Which parts of the programme should be repeated by the students?

The teacher will receive detailed information on areas requiring additional revision.
- The student's result against the class, school, country.

The teacher will see the results for the whole class with a comparison to the average result from the school, country and city. It will be possible to compare students' results with the results of other students attending the same type of school. The teacher will also be able to analyze the results quantitatively based on statistical analysis.

A set of selected parameters to analyze[14]:
- ease of the task/test - the ratio of the number of points obtained by students in relation to the maximum number of points possible to get for a task or test,
- difficulty of the task - the ratio of the number of students who have not solved the task properly in relation to the number of students,
- arithmetic mean of the results - the average score obtained by the test group of students, for example, a class,
- median - the result of the middle set of exam results of a particular population, example, a class,
- mode - the most common value among a group,
- area of typical results – the results interval on a scale located between the sum and the arithmetical difference of the arithmetical mean and standard deviation,
- standard deviation - a measure of variability or diversity, allowing to determine the range of typical results,
- variance - a measure of how far a set of numbers are spread out from each other[15],
- stanine scores.

Students will be able to solve the tasks assigned by the teacher and immediately after solving the task they will receive the result and identify the correct answers.

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[14] „Wyniki szkół ze sprawdzianów i egzaminów 2002-07 oraz matury 2007" – www.cke.edu.pl (in Polish).

[15] Wiak S., Jeske D., Krasuski M., Stryjek R., *E-tutoring as part of the e-examination - the use of data warehousing and data mining to assist in the learning and teaching process*. 3rd WIETE Annual Conference on Engineering and Technology Education, Pattaya, Thailand, 6-10 February 2012

The teacher will be able to add a theory to each task. The theory will appear when the answer is be wrong or at the user's request.

Students will be able to take a trial exam in a convenient time. Immediately after the exam the student will see the results and hints what he has done wrong in each of the tasks so that he will not make the same mistakes in the future. In case of difficulty in solving the tasks, the student will be able to mark all the tasks to which he wants to come back after the exam. Each student will be able to monitor his/her progress of knowledge in a convenient form, such as graphs. What is more, the system will diagnose in which parts of the program greater emphasis should be placed and the student will be able to choose only the tasks from that part. If a required number of correctly solved tasks is achieved, the system will mark this part of programme as completed.

We implemented techniques that are hidden under the name of Business Intelligence (BI). Business Intelligence tools are divided into groups:

- OLAP (On-Line Analytical Processing) - for multidimensional analysis,
- Data Management - allows storage of data - data warehouses,
- Exploration - data analysis algorithms.

Business Intelligence is directly linked to the data warehouse concept, through which data is stored in a uniform without affecting the OLTP transactional system. OLTP systems (On-Line Transaction Processing) are designed for efficient processing of transactions during the current activities of the project. The purpose of OLTP systems is to store data while ensuring concurrency and set the number of transactions (number of transactions per unit of time, usually per second). For large data sets OLTP servers have a limited capacity for in-depth analysis of current data especially historical.

OLAP systems (OnLine Analytical Processing) are used for multidimensional data analysis in enterprises, including:

- Trend analysis,
- Financial condition and profitability of the company,
- Human resource management and inventory,
- Predicting customer response.[16]

Data analysis is also related to the concept of exploration/extraction of data - data mining techniques – "move beyond simple data analysis to identify hidden trends, problems, or relationships in the data. After insights are extracted from patterns, clusters, and trends, people can better identify the root cause of problems and predict future outcomes".

Microsoft SQL Server 2008 R2 is a database which collects data during the exam. We plan to build our Business Intelligence solution using Microsoft SQL Server. We do not exclude using other software produced by other companies such as IBM or Oracle.

The E-matura will be a tool not only for e-examination. With the latest technology, it will enable support for the education of teachers and students in an e-tutoring module.

Teachers have access to the results of mathematical diagnosis of their students. They will be able to monitor the progress of their students and assign them tasks to solve. The e-tutoring module will make it possible to test students' knowledge in the same form as in the final test - on our platform.

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[16] Jerzy Surma, Business intelligence – systemy wspomagania decyzji biznesowych, Wydawnictwo Naukowe PWN, 2009

In addition to completing tasks assigned by teachers, students can solve the tasks of the areas that cause problems. They can continuously monitor how much they have to learn.

1.3.3. Computer aided business intelligence implemented in the E-matura platform

How do particular aspects of a sale look to you? Which regions have the best sales? When is it worthwhile to introduce a new product with the greatest chance of success? Managers look for answers to these and similar questions from Business Intelligence (BI) systems. However, data warehouses can also be used to improve the quality of education.

Why is BI so popular? Because it is a data acquisition and analysis system that supports business decisions[17]. Conclusions are based on historical data and can, for example, determine the financial standing of a company, and enable projection ahead. At present, BI systems origins date from the 1970s. By then Companies had started to aggregate transaction data, which could be used for business decision support by seeking trends and relationships between the data[18].

Managers often analyse business processes, such as sales, based on dimensions of time, region, branch or product. This type of analysis can be done using data cubes. Data processing, based on analytical cubes, enables answers to be derived to questions such as: *How do sales look in a given region? o*r: *In which regions were the best sales made over the past quarter?*
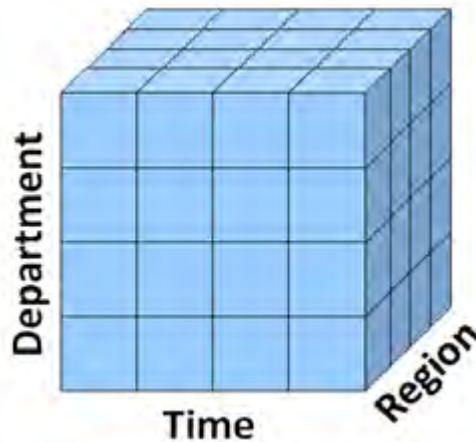
Figure 13. The analytical cube.

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[17] Garnter Reasearch, Business Intelligence Tools: Perspective (2003).
[18] Surma, J., *Business Intelligence Systemy Wspomagania Decyzji Biznesowych.* Warszawa: Wydawnictwo Naukowe PWN (2009) (in Polish)

Why not, then, in education, search for answers to such questions as: What types of school produced the best results? Which batches of teaching material gave the worst results? or: How does the size of a town influence the results? It is possible to derive answers to these questions based on the analytical cubes shown in Figure 13 and Figure 14.
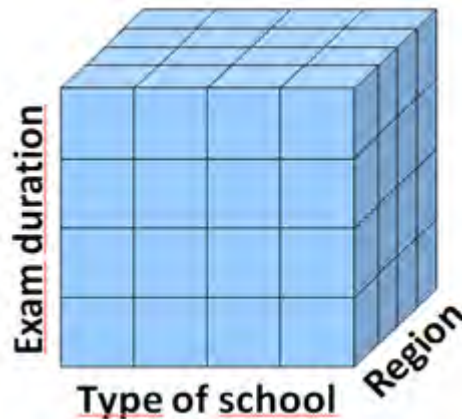
Figure 14. Example of an analytical cube in non-business usage.

The goal is not just to create a reliable system to conduct examinations at a distance, but also to produce a system for computer-aided analysis of graduate attributes.

The examination used both multiple choice and open question tests. Students taking the examination valued the new technologies, animations in the questions and the speed of achieving results. Teachers involved in the examination received the results of their students. The nature of the project enables a precise, comprehensible, statistical analysis of the students' answers to be derived, hence the improvement of the quality of education.

Teachers, examiners and authorities are trying to improve the learning process. Without additional information the process is limited - many of the factors contributing to the learning results are not examined. Analysis only at the level of a particular school or of the whole country does not show all the factors. Hence, *E-matura* offers not only a modern examination, but also great opportunities to study the process of teaching and learning.

A sample analysis enabled by *E-matura* includes:

1. Which questions were the most difficult?
2. How does the sequence of questions and answers affect the results?
3. How does the city, region or type of school affect the results?
4. How do factors not directly related to examination factors affect the examination results? For example, whether the students received tutoring, had a computer with Internet access, etc.[19]

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[19] S. Wiak, R. Stryjek, *Mechanizmy bazodanowe wspomagające wnioskowanie i raportowanie w systemach zdalnego egzaminowania na przykładzie systemu informatycznego e-matura*, Metody i narzędzia ewaluacji wyników zdalnego testowania wiedzy, Politechnika Łódzka, 2013

A computer-aided analysis of mathematics graduates can be divided into groups of end users:

1.   Students - the result against the class, school, city and country. In which parts of the programme should greater emphasis be placed?
2.   Teachers - which parts of the programme should be revised with students? How do the results of one teacher's students relate to the background of the school and country?
3.   Authorities - which types of school recorded the weakest results? How does the size of the city or the region affect the result of the examination? How do other factors affect the results?

End users use different interfaces. For teachers and students, the results of the analysis are presented in the system; for the authorities they can be presented in an easy-to-use spreadsheet file.

Today's systems for conducting examinations focus primarily on the so-called test questions known as closed questions, which consist of the question itself and a set of possible answers. Due to the availability of modern technology, such as Silverlight, the *E-matura* system could go a step further, that is, include open-ended questions. This technology allows a construction of questions that include elements such as:

- Interactive animations;
- Checkboxes;
- Interactive areas where the user can drag the selected items;
- Interactive areas where the user can highlight a range of numerical values.[20]

These few examples show that the possibilities of modern examination go beyond the traditional forms of examination. Furthermore, using animation and appropriate graphics, an examination becomes more user-friendly to people who often become stressed during tests. This is especially important to young people who prefer this form of examination. For them it is much more interesting to undertake this type of testing rather than traditional examination methods. Figure 15 shows a picture that highlights a range of numerical values.

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[20] 18 D. Jeske, M. Krasuski, R. Stryjek, S. Wiak, *Nowoczesne systemy do egzaminowania na odległość z wykorzystaniem najnowszych technologii na przykładzie systemu informatycznego e-matura*, System informatyczny zdalnego testowania wiedzy na przykładzie projektu e-matura z matematyki, Wydawnictwo Naukowe PWN
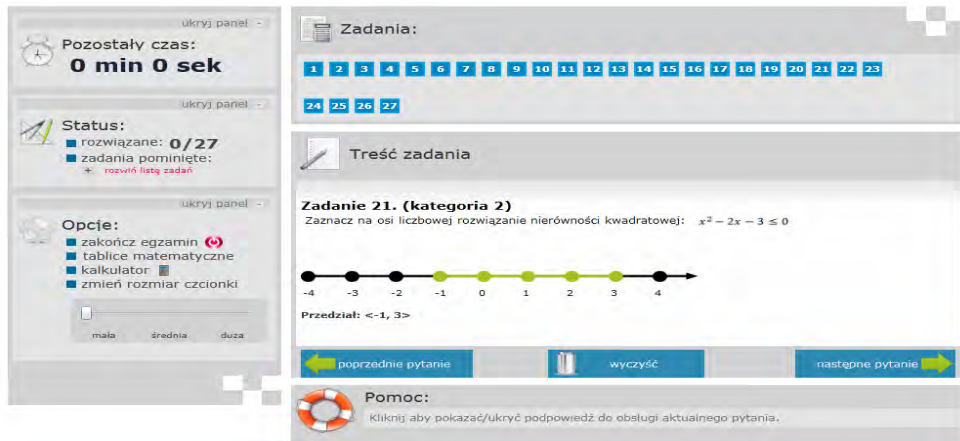
Figure 15. Highlighting a range of numerical values.

When used in the education process, a rich interface also makes learning enjoyable as demonstrated in another project undertaken by the authors, called IMSI e-platform. The use of a modern interface gives new opportunities in e-learning. The authors have provided many features to improve the efficiency of learning. Students can use features, such as the *virtual board*. Teachers can draw something that will appear in the student's application. Moreover, they can write notes quickly and easily. There are two ways of adding student notes to the lecture:

- Notes can be added directly to the lecture file - students are able to highlight some part of the text and add a text note;
- In the student application, there is a special tab with notes. The notes tab includes virtual sheets of paper where students can draw or write thoughts.

    Other features, which improve effectiveness, are:

- Audio/video streaming - students are able to see and hear the teacher during the lecture,
- Chat, which enables asking questions directly to the teacher.
    The use of these features is possible through a modern interface.
- Which questions were the hardest?
    During each examination hundreds of thousands of responses have been collected. If students answered any given question several times changing the reply, the system recorded all their steps. The time of giving every answer and how many times they went back to the question were also registered. Based on this, one can analyze the results of the questions for student, school or country.

    How does the sequence of questions and answers affect the results?

- Three sets of questions were implemented - from the simplest to the most difficult, from the most difficult to the simplest and randomly. Therefore, it is possible to analyse how the problem of initial questions affects the examination. For research

purposes, two answer versions were created: first for 70% of the questions the correct answer is hitting on B or C (however, 30% is A or B), and in the second version, this order is completely random (Figure 16).

	Points B C answers superiority distrubution		Uniform answer distribution	
	Points	Points percentage	Points	Points percentage
⊞From easier to harder	23,27	51,26	23,30	51,33
⊞From harder to easier	22,41	49,35	23,99	52,84
⊞Random	22,91	50,46	23,25	51,23
Summary	22,88	50,39	23,55	51,89

Figure 16. A report on how initial questions and correct answers order affect the examination results.

How do the city, region and type of school affect the results?

Because of the capacity to connect the correctness of the answers to given questions with the region, city or type of school, it is possible to draw conclusions concerning the improvement of the quality of the education process. Figure 17 shows a report on how the size of the city affects examination results.

	Points		
Population	Average points	Standard deviation	Number of schools
⊞>500 000	19,71	6,23	56
⊞10 000 - 50 000	22,95	5,69	73
⊞100 000 - 500 000	23,88	6,72	32
⊞50 000 - 100 000	24,77	5,98	24
⊞<10 000	25,97	5,48	72
Total average	23,90	5,82	257

Figure 17. Report on how the size of the city affects examination results.

One can analyze how the size of the city affected the results. Unfortunately, not enough data has been gathered to draw strong conclusions, but in the future a statistical selection of schools will enable conclusions to be drawn.

- How do factors not directly related to the examination affect examination results? For example, those who received tutoring had a computer with Internet access.

After the examination, students respond to a questionnaire. They respond to questions, such as whether they had received tutoring, who the authority is, how much time per day they spent at the computer using the Internet, if both parents work,

and whether parents helped with learning. Answers to these questions are combined with the students' results and the partial results of the questions. Further, it is possible to analyze this data at the level of school, city, region or nation. The responses allow for an examination of correlations between the results of students and the factors contained in the questions that are included in the survey.

- One student's result against the class, school, or country. In which parts of the programme should greater emphasis be placed?

The *E-matura* is available also for students to check their knowledge before the examination. Currently, only the individual result is displayed. Students can test their knowledge in a test similar to the matriculation test. Researchers are currently working on displaying a full analysis of a student's knowledge: what areas need additional study, and the topics within these areas that should be revised in particular.

The current plan is to provide students with additional tasks concerning the topics diagnosed by the system as needing to be revised. Tasks will be drawn from a pool of tasks from previous years or will be generated automatically by the system, in tasks for which it is possible to do so.

- Which parts of the programme should be revised by students?

The teacher will see the results for the whole class, including a comparison of the average result from the school, city and country. It will be possible to refer students' results to the results of other students attending the same type of school. Moreover, each student will receive detailed information on areas requiring additional revision.

It should be mentioned that 600,000 answers were collected during the examinations. If students answered a given question several times, changing their reply, the system recorded all the steps. The time taken to produce each answer was also registered. Furthermore, by determining the correctness of answers to a given question by region, city, and type of school, it was possible to draw conclusions concerning the quality of the education process. Three sets of questions were implemented for the examination, from the simplest to the most difficult or from the most difficult to the simplest, to be accessed randomly. Further, it was also possible to analyze how the choice of the initial question affected the examination.

		A15			f_x	lubuskie	

Province		Avarage	Maximum	Minimum	Average standard deviation	Number of schools
⊞ dolnośląskie		25,44	41	8	5,60	10
⊞ kujawsko-pomorskie		21,60	42	7	6,62	16
⊟ lubelskie		24,22	43	7	6,66	15
	BIAŁA PODLASKA	22,00	30	15	5,75	1
	BIŁGORAJ	20,00	25	12	6,27	1
	JÓZEFÓW	30,00	38	26	3,65	1
	KRASNYSTAW	19,00	29	14	6,78	1
	LUBLIN	25,00	42	7	8,72	6
	PUŁAWY	25,00	28	21	3,61	1
	WISZNICE	16,00	37	9	10,08	1
	ZAMOSC	32,00	43	16	10,93	2
	ŻÓŁKIEWKA	29,00	34	26	4,16	1
⊞ lubuskie		21,50	34	13	4,55	3
⊞ łódzkie		26,94	45	6	5,82	43
⊞ małopolskie		22,60	39	9	6,20	6
⊞ mazowieckie		26,18	41	7	4,54	22
⊞ opolskie		27,33	39	15	5,27	3
⊞ podkarpackie		21,75	39	10	5,19	26
⊞ podlaskie		23,00	43	9	4,45	6
⊞ pomorskie		23,00	40	0	7,14	16
⊞ śląskie		22,07	42	6	6,68	20
⊞ świętokrzyskie		28,00	43	13	5,30	7
⊞ warmińsko-mazurskie		22,20	36	13	5,43	5
⊞ wielkopolskie		22,56	42	6	5,67	21
⊞ zachodniopomorskie		23,33	40	14	5,75	4

Figure 18. Report on how region and city affected examination results.

The data warehouse in Microsoft SQL Server Analysis enabled processing based on analytical cubes and in-depth analyses were carried out.

It is possible to process aggregated data in the popular spreadsheet Microsoft Excel by using Microsoft SQL Server Analysis Services. In addition, it is convenient for the user to apply familiar tools. When examining the reports, it is possible to find information on the types of school and which part of the programme caused problems and, additionally, how a specific region affected the results. Figure 18 shows a report on how region and city affected examination results. By applying *Drill down* and *Drill up* functions, it is possible to go from the whole to the detail and vice versa. It is possible to conduct data analysis with differing levels of accuracy. A report concerning this matter is shown in Figure 19.

	F3			f_x	

	A	B	C	D
1		**Points**		
2	**Population**	**Average points**	**Standard deviation**	**Number of schools**
3	⊟ >500 000	19,71	6,23	56
4	GDAŃSK	17,00	7,50	5
5	GDYNIA	27,00	6,98	3
6	ŁÓDŹ	19,00	6,71	34
7	POZNAŃ	11,00	2,14	2
8	WARSZAWA	20,00	6,93	11
9	Wrocław	25,00	6,63	1
10	⊞ 10 000 - 50 000	22,95	5,69	73
11	⊞ 100 000 - 500 000	23,88	6,72	32
12	⊞ 50 000 - 100 000	24,77	5,98	24
13	⊞ <10 000	25,97	5,48	72
14	**Total average**	23,90	5,82	257

Figure 19. A report showing the drill down technique.

Basing on the results, one can easily analyse how the size of a city influences the results. The researchers have not gathered enough data to draw strong conclusions, but in the future a statistical selection of schools can help to draw conclusions. Work is continuing on the development of a system able to provide aggregated data for each group of users. Computer-aided diagnosis of mathematical graduates can be divided into groups of end users to achieve the following[21]:

- <u>Students:</u> Results are compared with the class, school, country, including an investigation into the parts of the programme on which greater emphasis should be placed. The *E-matura* system is also available for students to check their knowledge before the examination;
- <u>Teachers:</u> They will see results for the whole class, with a comparison to the average result from the school, country and city. They learn which parts of the programme should be revised with students, and how the results achieved by their students relate to the background of the school and country. Also, they will be able to compare students' results with the results of other students attending the same type of school;
- <u>Authorities</u>: They will be able to ascertain the type of schools that recorded the weakest results, how examination results were affected by the size of the city or the region and how other factors affect the results.

It should be emphasised that end users may use different interfaces. For teachers and students, the result of the analysis will be presented in the system, for the authorities it is easier to use a spreadsheet file. The classic examination system running in the on-line environment is activated on a single Web server, which handles all the traffic generated by this and other applications that are installed on the computer. This solution works in most cases because the average numbers of people who use the Web server at any one time are not able to overload server resources. In a situation where tens of thousands of people are referred to a single server at the same time, overload is always a potential problem. It is because any connection to the server requires a certain allocation of memory and CPU time.

To meet the requirement of high availability of the examination, the solution based on the so-called *load balancing* was applied. The solution is to build a cluster of servers in which one can distinguish two main parts. The first part is a computer constituting the access point (AP) to the examination. All connections are directed to this computer, but they are not directly supported, but only transmitted to computers in a cluster. Based on the selected load management algorithm, this server redirects traffic to the least loaded server in the cluster. This solution is highly scalable and allows for a virtually unlimited expansion of the cluster. The only limitation is the Internet bandwidth at which the communication takes place. An additional feature that may satisfy this server is decoding an encrypted secure sockets layer (SSL) message and passing it along as a decrypted message. This causes a reduction of the burden on the target servers; however, with a large number of connections, it may cause an overload of the server balancing traffic.

In this project, when using IMSI e-platforms, one confronts similar problems, which needed to ensure high availability of the system for the final users. On the e-learning platform, the solution architecture consists of client computers connected to the central server and teacher computers which also connect to the central server. The teacher's

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[21] Jeske D., Krasuski M., Stryjek R Computer-aided business intelligence for non-business solutions, *Global Journal of Engineering Education,* Volume 13, Number 3, 2011

computer has a very important role in this case, because from this computer the audio-video signal and synchronisation signal are transmitted to the server and then are sent to the connected students' computers. Thanks to such infrastructure, the teacher's computer is not overloaded with appeals from users' computers. Experience gained from the above IMSI e-platforms was used in the design of the *E-matura* project.

As mentioned earlier, after the examination students also complete a survey questionnaire. They answer several questions covering such issues as whether they had been attending tutorials, who was the authority, how much time per day they spent at the computer using the Internet, whether both parents work and whether parents help them with their learning. Answers to these questions are combined with the students' results and the partial results of the questions. Further, it is possible to analyze this data at the school level, city, region or nationwide. The responses allow examiners to look for a correlation between the students' results and factors contained in the questions included in the survey.

Business Intelligence is a technology that can be used for more than business purposes. In using the *E-matura* platform it is possible to analyze trends to improve education and diagnose problematic issues that require additional attention. The use of Business Intelligence can support the education process at every level. Students can check their knowledge, teachers can find out what needs revision, and the authorities can examine how different factors affect students' knowledge to prevent problems.

Anyone can analyse the results based on aggregated data analysis cubes in an easy-to-use spreadsheet. The collected data can be used to analyse different levels of detail. Information is collected at the level of student responses to individual questions, but it is also possible to analyze the results at national level. Surveys completed after the examination allow for correlations between various factors and examination results to be sought.

In conclusion, *E-matura* is a modern system for conducting examinations at a distance, but it is also a computer-aided mathematical tool for analysis of graduates' outcomes. The collected data can be analysed at different levels of detail. It allows for the collection of information at the level of student responses to individual questions, and there is no problem with comparing the results with those at national level, for example. Survey questionnaires completed after the examination allow examiners to look for correlations between various factors and examination results.

1.4. An innovative interactive iMSi e-learning platform[22] [23]

Let us repeat that: "e-learning philosophy is becoming more and more popular and useful thanks to developing an electronic learning environment, digitized lesson materials, software for learning, video streaming, advanced graphics facilities, functionality, interactive assessment, etc. It should be clarified that there is no system or platform covering the wide range of interest of both universities or commercial institutions.

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[22] Wiak S., Jeske D., Krasuski M., Stryjek R., An innovative interactive e-learning platform, World Transactions on Engineering and Technology Education, Vol.7, No.2, 2009
[23] Wiak S., Jeske D., Krasuski M., Stryjek R., iMSi – Modern e-learning platform, World Transactions on Engineering and Technology Education, Vol.7, No.2, 2009

Thus, we could conclude there are dedicated knowledge platforms on the market, also in higher education institutions. It is known that e-learning has a strong influence on our lives, and that it is largely based on digital information and communication technologies".

Our e-learning platform solves the problem of distance learning. Nowadays many people have limited access to knowledge depending on the level of local education, commuting to university, the geographical and political situation where they live or their specific disability. It is clear which problems could be solved by our project:

- Handicapped people have limited access to knowledge. They have problems with getting to university or school. What is more, most of the pre-existing e-learning platforms do not provide enough accessibility for them.
- Other groups of people have problems with commuting to school. They sometimes do not have enough time and money for expensive transport. Sometimes there are temporary situations in people's lives when they are not able to study in a traditional way. For example, women with small children have problems with continuing their education by attending classes. Many companies have problems with courses for employees working in different locations due to the cost of accommodation and transport, and also with the time needed to get to their educational establishment.
- Also people from some developing countries have limited access to an appropriate level of knowledge. Often there are not enough specialists.
- Selected groups of people want to attend university courses at famous foreign universities without the necessity to go abroad.

Our solution may be used to solve the problems mentioned in the "Problem definition" section. We could imagine many scenarios where our platform could be successfully applied and appear very useful:

- It is a good idea for people without any opportunities to use their valuable knowledge. Qualified handicapped teachers can provide lectures from home using our solution.
- With our application handicapped people have unlimited access to knowledge irrespective of their problems with getting to university or school.
- Students who have problems with commuting to school and are not able to study in a traditional way can study using the iMSi platform.
- Companies which carry out training sessions for employees can reduce the cost of accommodation and transport. Also, they can reduce the time needed to get to their educational establishment.
- People from some developing countries will have access from any place they wish.
- Students could continue their university courses at foreign universities without the necessity to be there personally.
- Thanks to our platform someone would be able to learn at home attending online courses in any case they need. Moreover, they could take part in a lecture in real-time, as well as have exams, ask questions to the teacher, etc. What is more, they could chat with each other.

Current e-learning platforms are distance learning systems without[24] continuous contact with the teacher. The iMSi system offers more to students than just downloading lecture files and leaving them alone. Thanks to iMSi every student can take active part in a lecture in real-time. What is more, students may participate in an off-line lecture which can be downloaded from the system. Students can receive live audio and video streaming from lectures no matter where it takes place. It is possible to communicate with each other and take active part in discussions during the lecture. Students can feel like they are actually in the classroom in person, no matter where they are.

People could be in the same place at the same time and learn as if they were sitting side by side irrespective of where they are. iMSi has a lot of good features which we could analyze in terms of a few aspects. The most important are:

- Innovation; The biggest innovation in our application is its user-friendly interface. For example, the magnifier to zoom into some part of a document and the live video streaming feature are just two of the unique aspects of our application (Figure 20).
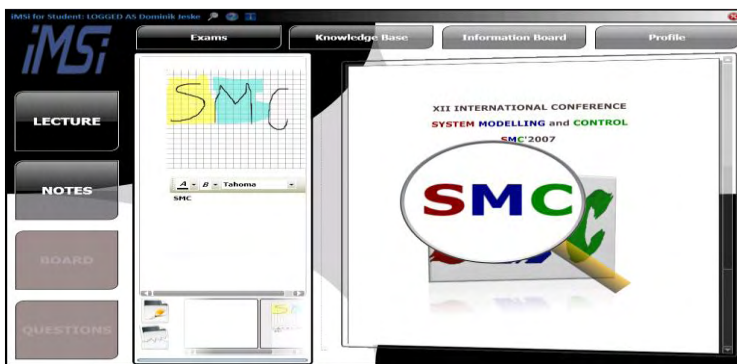
Figure 20. iMSi platform – general view of the board.

- Impact; iMSi project has huge implications for handicapped people. It enables them to learn from home using these features (Figure 21):
  - o iMSi platform is user-friendly for people with poor eyesight. To copy from the platform board we have provided:
    – over-sized GUI elements,
    – a magnifier to zoom into lectures in 3D mode
    – automated voice which reads notes and lectures
    – a virtual keyboard

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[24] Karlsudd P. and Tågerud Y., Bridging the Gap - Taking the Distance out of e-Learning. Electronic Journal of e-Learning, volume 6, issue 1, 43 – 52, (2008).
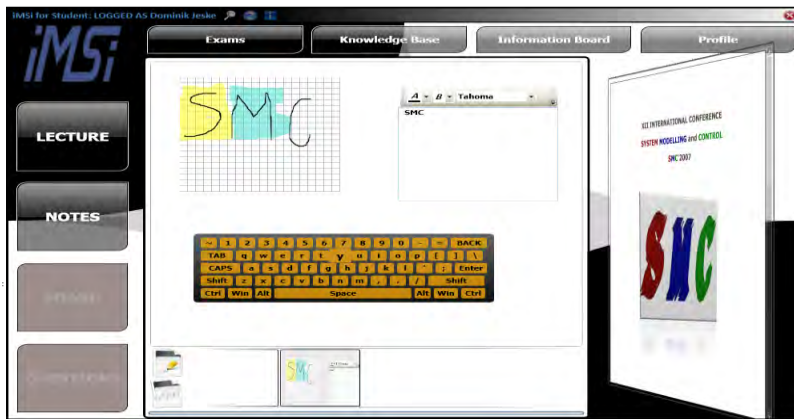
Figure 21. iMSi platform – virtual keyboard.

o People without the ability to use their hands can enjoy the lecture using the best accessibility feature – "voice control", which allows them to use the application with no need for a mouse or keyboard. Students can also use voice recognition to write down notes.

• Effectiveness; We have provided many features to improve the efficiency of learning. One could exploit features such as the "virtual board." Teachers could draw something which will appear in the student's application. What is more, you can quickly and easily write down notes. There are two ways of adding students' notes to the lecture (Figure 22):

  o You can add notes directly to the lecture file – students are able to highlight some part of the text and add a text note
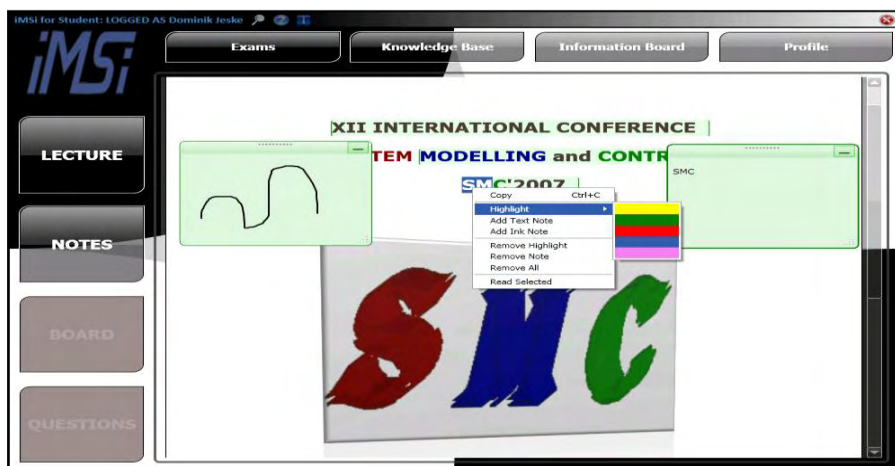
Figure 22. iMSi platform – virtual keyboard.

  o In the student application there is a special tab with notes. The notes tab includes virtual sheets of paper where students can draw or write thoughts (Figure 23).
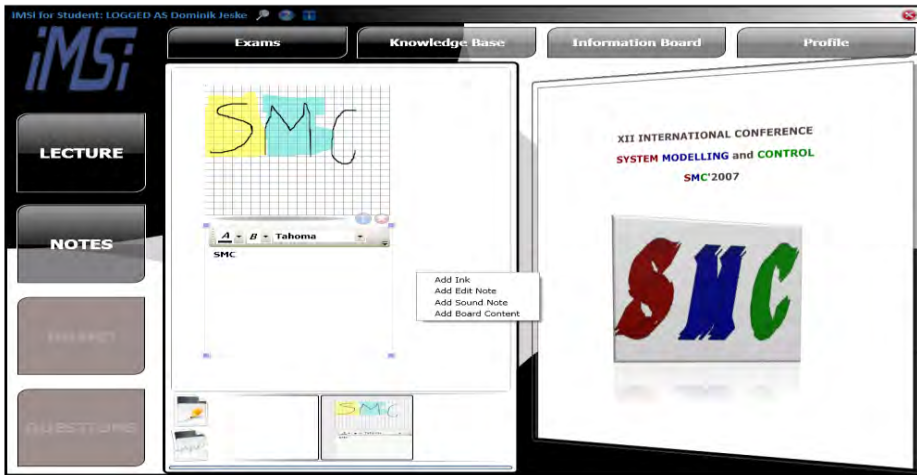
Figure 23. iMSi platform – virtual sheet.

The architecture of our solution is divided into 3-layers (Figure 24):

- Server application with connection to the database. It is a self-hosted application which provides WCF services to other layers. It is also an administrative application in which we can manage lectures, exams and people. It is also the place where teachers store files for students, which they can download.
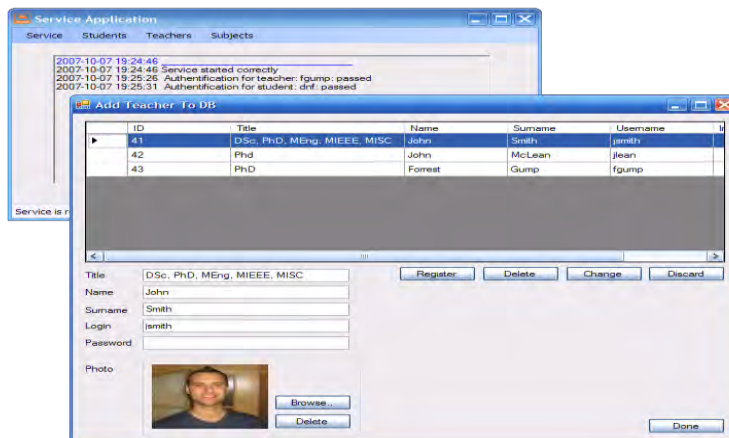
Figure 24. iMSi platform – service/teacher board.

- Student application - this is dedicated to students. It uses services supplied by the server. It provides a user-friendly interface for students (WPF). In this layer students can listen to a lecture making notes and all other necessary things needed to learn (Figure 25).

Figure 25. iMSi platform – student application.

- Teacher application – this is dedicated to teachers. It also uses the services supplied by the server and provides the opportunity to run lessons, prepare exams and upload files for students (Figure 26).

Figure 26. iMSi platform – teacher application.

Other features which improve communication between teachers and students are:
- Audio/video streaming – students are able to see and hear the teacher during the lecture (Figure 27).
- *Chat*, which enables the asking of questions directly to the teacher (Figure 8).
- Access to a recording of the lecture with optional subtitles.
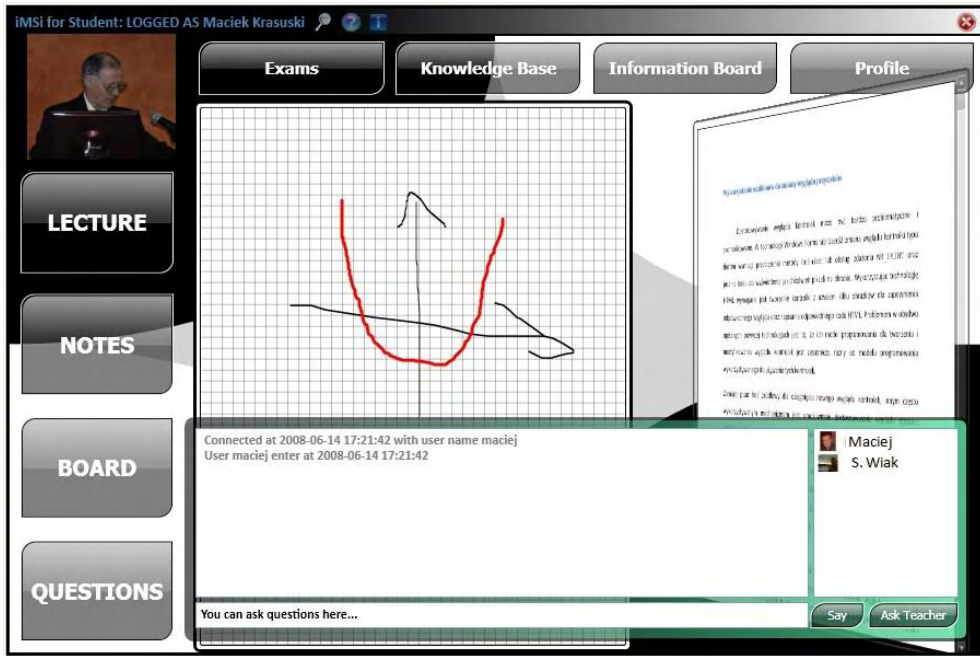
Figure 27 : iMSi platform – interaction with Teacher.

Designing iMSi platform the following hardware, technologies and software platforms have been implemented to realize our project.

Software:
- .NET - logic of application
- WPF – presentation layer of student and teacher applications
- WCF – used for communication
- Direct Show and Media Format – used to capture, code and transmit video/audio stream
- Sapi– speech API – use for voice synthesizer and voice recognition (recognition only in Windows Vista)
- SQL Server – database server
- XPS – format of documents used by our application

Hardware:
- Digital camera – used to capture the lecture,
- Tablet (optional – can be used with "notes" and "board"),
- Microphone – used to capture the lecture, voice control and to record notes.

This demand-oriented e-learning iMSi platform of distributed architecture provides a number of advantages for the user, namely: it offers support in didactic issues, integrates all required activities along the structure of a learning module, supports communication and collaboration activities within the team, etc. We describe selected results of the iMSi

platform, invented and created by the authors. It is structured in the board described above: virtual keyboard, student sheet, teacher board, etc. In each board we try to identify innovations in the product, as well as processes. Analyzing the project requests, we summarize that the project gives great possibilities in creating teaching objects which are more illustrative thanks to using visualizations and animations, which improves students' motivation. In general, the project expects an improvement of quality by using advanced ICT.

1.5. References

Final Remark

This chapter is composed on the basis of a set of published papers (listed below) of the authors.

1. Wiak S., Jeske D., Krasuski M., Stryjek R., An innovative interactive e-learning platform. *World Transactions on Engineering and Technology Education,* Vol.7, No.2, 2009.
2. Jeske D., Krasuski M., Stryjek R., Natural user interfaces in modern education, *2nd World Conference on Technology and Engineering Education,* Ljubljana, Slovenia, 5-8 September 2011
3. Jeske D., Krasuski M., Stryjek R., The *E-matura* project yesterday, today and tomorrow - challenges and opportunities, *3rd WIETE Annual Conference on Engineering and Technology Education*, Pattaya, Thailand, 6-10 February 2012.
4. Jeske D., Krasuski M., Stryjek R., Secure and high available exam system "E-Matura" case study, *2nd World Conference on Technology and Engineering Education,* Ljubljana, Slovenia, 5-8 September 2011
5. Wiak S., Jeske D., Krasuski M., Stryjek R., E-tutoring as part of the e-examination - the use of data warehousing and data mining to assist in the learning and teaching process. *3rd WIETE Annual Conference on Engineering and Technology Education,* Pattaya, Thailand, 6-10 February 2012.
6. Jeske D., Krasuski M., Stryjek R Computer-aided business intelligence for non-business solutions, *Global Journal of Engineering Education,* Volume 13, Number 3, 2011
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Sławomir Wiak
Przemysław Kosiorowski

Smart chatterbots as a teaching aid in the process of distance learning

2.1.   Introduction

The desire to create artificial intelligence is as old as the science of computers. Artificial intelligence can be understood and defined in many different ways. One theory says that if a computer speaks in a way that it cannot be distinguished from human speech, it means that the computer has possessed artificial intelligence. Currently there are a number of computer programs which strive to achieve this goal. Some of their authors were actually guided by the vision of creating artificial intelligence, while others simply tried to program a new type of interface without aspiring to fully mimic human beings. Regardless of the motives, we can often meet with this type of applications, colloquially called Chatterbots or Chatbots.

In modern science chatterbots appear on all websites of large and small businesses, ranging from the simplest, used in consulting firms (Ergo Hestia), courier companies (parcel machines), through more complex, used in e-stores (Shopabots) [5], or in computer games, as well as remote teaching at a distance (e-learning). It is a kind of software that will increasingly facilitate the process of distance learning and in the future strive to replace traditional teachers with virtual ones. Unfortunately, these programs still cannot draw conclusions and their answers are not always correct.

The subject matter is very interesting in terms of possible applications but also due to the reduction of barriers between man and computer. For over 40 years software developers have been trying to create applications that will be able to pass the Turing test: unfortunately, so far none have succeeded. It is therefore considered that the selection of research topics proposed in the project is interesting and gives large opportunities of software development in the field of human – computer communication.

2.1.1.   Basic concepts

In electronic literature we can find several definitions of Botics. It is a new field which matures and develops before our eyes. The term cannot be found in dictionaries or encyclopedias, although its derivatives, such as „bot" or „chatterbot" can already be found.

Botics [10] can be described as a branch of science which uses the knowledge about behavior, modeling and simulating digital characters.

Its end product may be:
- efficient Human - Computer Interaction using appropriate Natural Language Processing (NLP).
- characters for computer games imitating real characters by using scripts, descriptions and rules of behavior or ready-made solutions, i.e. Motivation System.

From the point of view of botics, important trends in the development of agent software are the following categories:
- Virtual Assistants: Chatterbots, Desktop Agents, Virtual Humans, Pets, World.
- Develop an Agent: Communication Languages, Onthology
- AI Games: Build your robot, Simulation Games (e.g. bots for Computer Role Playing Games), Logic.

2.1.2. The history of Chatterbots

Chatterbots are dedicated programs whose task is to fake a conversation between the user and the computer, the so-called Chatterbot. This software uses data gained by the Chatterbot during the conversation with the user and the information contained in the database.

The first Chatterbot which was built in the world was software developed by Joseph Weizenbaum at the Massachusetts Institute of Technology in 1966. The author called it Eliza [9]. This software was able to answer a question creating a new sentence by transforming the basic sentence:

Man: *I'm sad.*
Eliza: Have *you come to me because you feel sad?*
Man: *I'm fine, thank you.*
Eliza: *How long have you been feeling great, thank me?*

Another example of software which was founded in 1995 and was valued on the market for a long time was "ALICE" [5] by Richard Wallace. It was an open source software which allowed other developers to expand and modify it. ALICE was created by using the AIML programming language (Artificial Intelligence Mark-up Language)**,** which by its design resembles HTML.

A chatterbot consists of three major fields, namely:

a) the input text field (a field in which we enter data)
b) the output text box (where the Chatterbot shows us the answer)
c) the button that sends the data to the text analyzer

The most important element, the heart, is in our opinion the text analyzer, whose task is to understand what the user has written. For this purpose, two search engines have been built in: a *matrix search engine* [6] and *a special search engine* [6]. The special search engine is designed to compare the text entered by the user with the phrases that

are in the database. On the other hand, the task of matrix search engines is comparing the words in the database with the text entered by the user. Each of the above search engines uses databases stored in files. Each file contains data specific to both search engines.

A text analyzer [7] built in this way must be equipped with a module which searches for answers. To this end, two stages of seeking answers have been created and named accordingly: the first stage and the second stage of searching.

During the first search the special search engine is used. If the result is positive, it will return the answer, and if it is not, we move on to the second search.

The second search is done by the matrix search engine. By analogy: if the result is positive, it will return the answer, if not, a file-of-one-word is activated.

The file-of-one-word is a database that stores single words.

Of course, every search of the database according to the methods of searching for the correct answer has some efficacy rate, which is: for the special search engine - 96%, which means that we can talk about a specific answer; for the matrix search engine - 66%, so almost one third less than for the special search engine. For the file-of-one-word the accuracy is the lowest - 15%. You can improve accuracy by adding a large number of records into the database. Unfortunately, this method cannot guarantee an accuracy of 100%. How to improve it? Of course, creating other search engines that will use communication grammar ,artificial intelligence algorithms, etc.

Another important concept in Chatterbots is its reaction to a question.

Example:
U: *Hello, how are you?*
B: *Hi.*

If we keep asking the same question, our bot will respond in the same way. To avoid this, we must attribute a few answers to the same question; the answers will be changed in a random way, or using a tag system**.**
An example with a different response:

U: *Hello, how are you?*
B: *You said the same thing twice.*
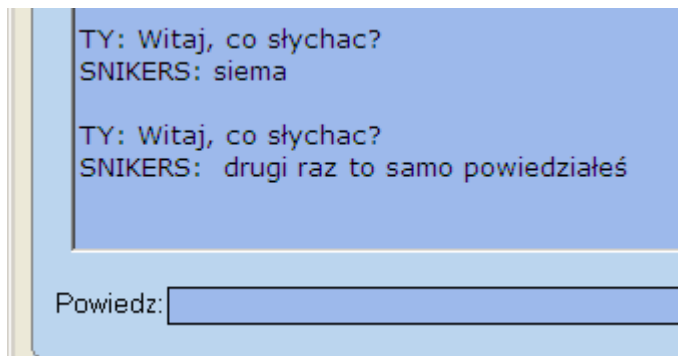
Figure 1. Chatterbot's answer to the same question.

Of course, sometimes the user may ask a question to which there will be no answer in the database. Then a masked response can be given by displaying information on the screen that the text is incomprehensible:

U: Do you have software update?
B: I'm sorry, I did not understand ....

or

B: I'm sorry ... my keyboard got blocked J

The introduction of auto talks to our bot can increase its genuineness, a belief that the bot is not software but a man. This mechanism can write to the user, and if sufficient time has elapsed, encourage him/her to continue the conversation.
For example:

B: This silence is annoying, say something!
B: I might think you're not there. Speak up!
B: Pity you don't want to talk to me. Goodbye.
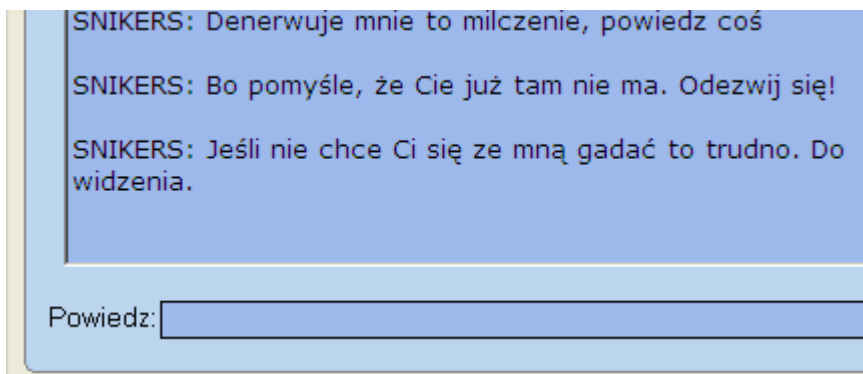
Figure 2. Chatterbot's answer with no response from the user.

To increase the accuracy of making the right decisions a learning module has been added to chatterbots. A bot can learn information that is contained in the conversation with the user.
An example of such a conversation:

U: How many fingers have you got in your hand?
B: Why don't you answer this difficult question yourself?
B: I'd like to hear the answer from you first.
U: You have five fingers in one hand.
B: I'll make a note of that in my memory, is this the answer indeed?
U: Yes.
B: I am very grateful to you for teaching me.
U: How many fingers have you got in your hand?
B: You have five fingers in one hand.

Recent bots have an implemented module which can memorize names and they can add these names to the conversation creating a realistic conversation. In the following example we assume that the user's name is Tom:

Tom: *Hi bot.*
Bot: *Hi, what's your name?*
Tom: *Tom.*
Bot: *Hi Tom, I am pleased with our meeting.*

Our bot has learned that the user has a name. There are three ways in which we will display names during the conversation. The authors propose to adopt the following terms:

- Draw – this method involves drawing whether or not to add the user's name to the answer.
- Tag – this method involves the insertion of a tag (/T) to our database. The tag is replaced with a name and displayed.
- Mixing – a combination of both of the above methods.

Recent bots are equipped with „mathematical engines" which enable them to perform such operations as: addition, subtraction, multiplication and division. In addition, they also have built-in organizers and modules for forecasting the weather.

2.1.3. A review and comparison of Chatterbots

Currently, there are quite a lot of various types of programs called chatterbots. You can easily find these types of applications on the Internet, and even try them out, because many of them provide a public interface in the form of a website. In order to study the solutions used in these programs, the authors of this study have tested their effects, taking into account both the accuracy and reliability of the responses, as well as the degree of similarity to human behavior.

Snikers, 4.0. [1]

Figure 2. Chatterbot Snikers 4.0.

Dianhuts, [2]

Figure 3. Chatterbot Dianthus.

Fido Interactive. [3]

Figure 4. Chatterbot Fido – fidointeractive.

For the above chatterbots we have conducted a test whose results are shown in Table No.1.

	Snikers	Dianthus	Fido
Teaching the bot new vocabulary and phrases	Yes	No	Yes
voice synthesizer	Yes	No	Yes
Ordering opening new files	Yes	No	No
Giving the bot its own "character".	Yes	No	No
Setting up a bot on a web page	Yes	No	Yes
Conducting mathematical calculations	Yes	No	In preparation
Setting up a bot on a personalized web page	Yes	No	Yes
Cost-free database update.	Yes	No	Yes
Presenting weather information for a particular city	No	returns link	returns link
In total:	**9/10**	**1/10**	**6/10**
Percent:	**90%**	**10%**	**60%**

Table 1 The results of a comparison of Polish chatterbots

After this study it is clear that Chatterbot Snikers has very useful functions and as the only one is very well developed technically. The author of the program decided to implement solutions such as a voice synthesizer and a simple mathematical module. Thanks to it, we can solve simple mathematical operations.

Other presented programs do not have such solutions. Their reaction is definitely simple and is based on the processing of information entered by the user.

2.1.4.   The use of Chatterbots in the process of distance learning

In the process of distance learning a number of tools and artificial intelligence methods are used, such as: genetic algorithms, fuzzy systems, neural networks, expert systems or chatterbots and bots.

The intelligent systems mentioned above are now being used to support the educational process. They can be used as a tool to support the work of the teacher as well as a means of self-education.

The distance learning system uses the tools and methods presented in Figure 5.
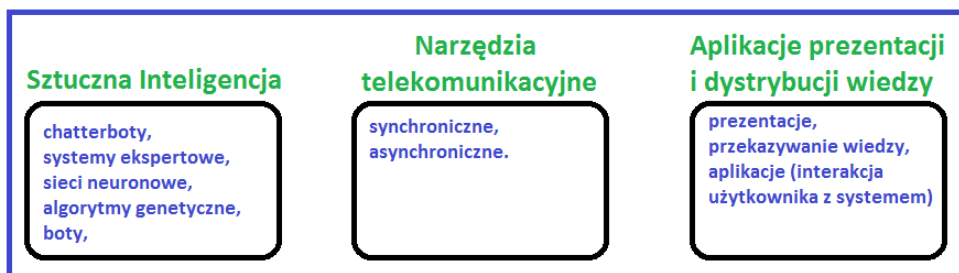
Figure 5. Tools and methods used in distance education.

To program a chatterbot which will be used in the process of distance learning, you can use the AIML (Artificial Intelligence Markup Language). In its structure it resembles the XML, which is based on tags. A popular tool used to programme a Chatterbot is Gaibot AIML Editor by Springwald Software.

It has a transparent graphical user interface, a built-in AIML interpreter and an empty knowledge base, which is formed during the creation of the chatterbot. In Figure 1 we present Graphic View, used for creating a Chatterbot's knowledge base.

The principle of the AIML-based software by Springwald Software is based on three major functional blocks which are interconnected: user interface, AIML interpreter and AIML Knowledge Base. It operates in the following way: the user asks the Chatterbot a question, this starts an interaction between the interface and the knowledge base, which in turn activates the interpreter. The task of the interpreter is to find the string of marks entered by the user with the string stored in the knowledge base. If the string is found, a response which is in the database is automatically generated. If the string is not found, a random sentence is generated or a message is returned that the sentence has not been understood.
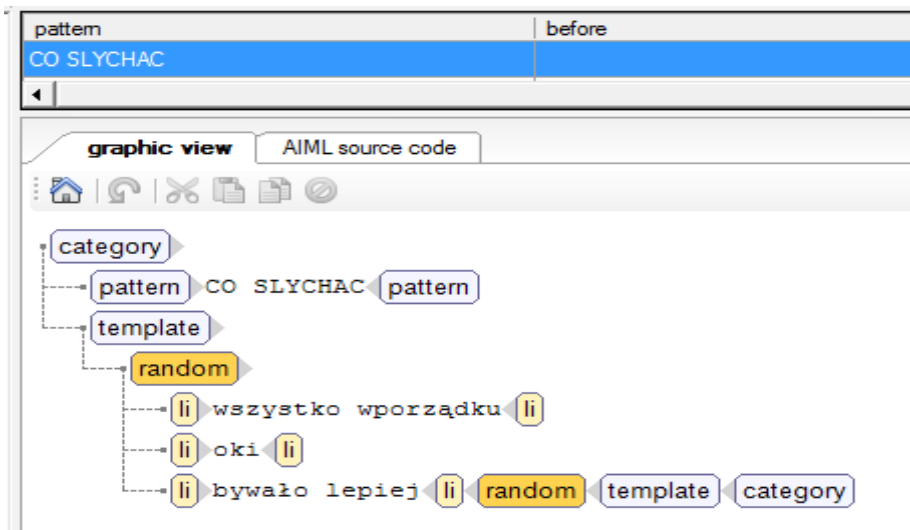
Figure 6. Graphic View - Gaibot AIML Editor [4].

In order to create a simple chatterbot supporting the teaching process, we need to know some basic commands to implement software.

One of the most important tags in AIML is <category> .

<Category> - a tag used for classification of knowledge, it tells to which statement made by the user the given category refers, an AIML document may consist of any number of such objects (categories), and each of them should consist of one pattern and response (template).

Another tag is <pattern> - here we have simple patterns of what the user can write, this is a simple regular expression and it can contain special characters "*" or "_", which generalize and simplify, for example, HELLO * To such a pattern the program will match all statements like "hello whatever" where "whatever" is any string of marks. However, the bot does not match the expression „hello", because "*" and "_" cannot mean a blank sign – the statement would have to be, for example, „hello bot".

<Template> - is a regular expression with which the chatterbot responds.

The last in the group of basic markers is <random> - (random posts) - this is a very interesting marker which enables greater humanization of the bot, placing it in the <template> tag causes a random selection of responses by the programme, defined as a list due to the following tags: <li> .

Software developers are trying to improve the package using newer and newer functions that generate pseudo random responses if the string of marks entered by the user is not in the chatterbot's knowledge base.

Below we present a flowchart of a chatterbot based on AIML by Springwald Software [4].
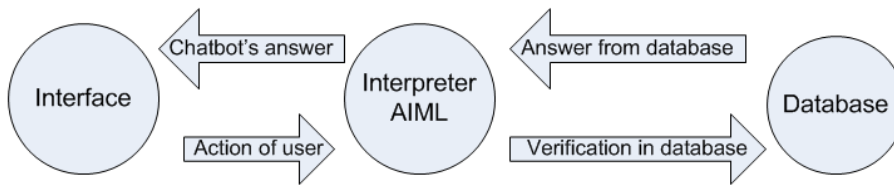
Figure 7 A flowchart of a chatterbot.

Another way to create a Chatterbot is the use of decision trees that appear in CLIPS software (C Language Integrated Production System) developed by Software Technology Branch (STB), NASA / Lyndon B. Johnson Space Center.

Creating a Chatterbot with the use of the _CLIPS_ [3] language is based on creating facts (groups of facts) and rules. To enter facts, use the command „assert".

CLIPS> (assert (Adam likes computer science))
<Fact-0>

By means of the above-mentioned command it was possible to define a fact that consists of three words, in other words, atoms. This atom is subject to division into smaller lexical units.

Atoms can be divided into:

Numerical – they contain floating-point numbers,
Literal – they contain any characters that are enclosed in quotation marks,
Symbolic – they begin with letters but later can contain numbers, hyphens or even underscores.

Each fact in the list has its number, thanks to which it is easier to manage them. To view the facts that have been entered, run the command "facts". The following command will return the facts defined as follows:

CLIPS> (facts)
f-0 (initial-fact)
f-1 (Adam likes computer science)
f-2 (Peter likes computer science)
For a total of 3 facts.

After defining the facts, you must define the rules. A rule are terms on the left side of the equation called **LHS** (left hand side), the fulfillment of which will run commands on the right hand side of the equation, called **RHS** (right hand side).
In order to define the rule, use the command defrule name_rule

CLIPS> (defrule they like computer science (Adam likes computer science) (Peter likes computer science) => (assert (the boys like computer science)))

A chatterbot which will support distance learning can be created on the basis of decision trees using the CLIPS language. An example segment of such a tree is shown below.
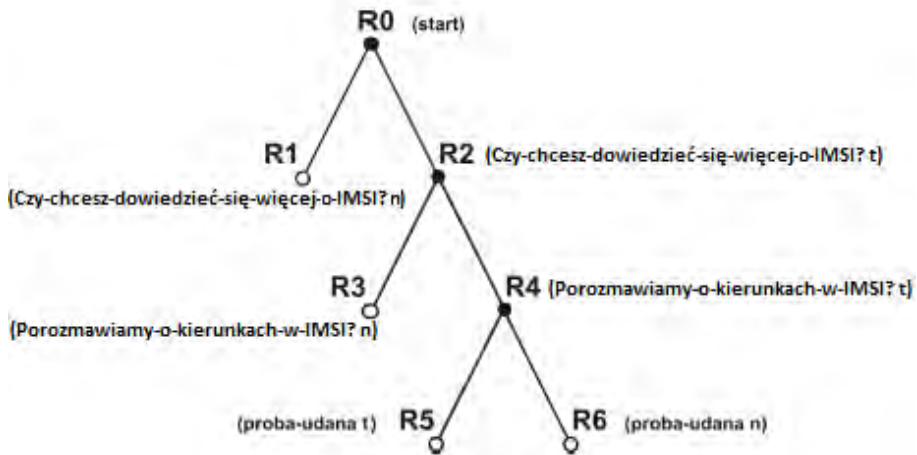
Figure 8. A decision tree based on the CLIPS language.

A disadvantage of software obtained through the CLIPS program is its directivity, in other words, we can get a chatterbot whose task will be to carry on the conversation and direct the user to specific questions. Such a chatterbot can be used as a tutoring assistant, which helps students in the process of e-learning. Unfortunately, lack of a knowledge base and concluding algorithms does not put it at the forefront of software tools for programming Chatterbots. Another disadvantage is that it is complicated to create the program code, which is shown below, and the instability of action for versions working under the Windows operating system.

```
(Defrule R0
? X <- (initial-fact)
=>
(Retract? X)
(Printout t crlf)
(Printout t " INFORMATION SYSTEM" crlf)
(Printout t "Please respond to the questions: y (yes) or n (no)." crlf)
(Printout t crlf)
(Printout t "Do you want to learn more about IMSI?" crlf)
(Assert (do-you-want-to-learn-more-about-imsi?(read))))
(Defrule R1
? X <- ( do-you-want-to-learn-more-about-imsi n)
=>
(Retract? X)
(Printout t crlf)
(Printout t "It's a pity :-(." crlf)
(Assert (end)))
(Defrule R2
```

```
? X <- ( do-you-want-to-learn-more-about-imsi? y)
=>
(Retract? X)
(Printout t crlf)
(Printout t "Shall we talk about trends in IMSI?" crlf)
(Assert (shall-we-talk-about-trends-in-IMSI? (read))))
(Defrule R3
? X <- (shall-we-talk-about-trends-in-IMSI? n)
=>
(Retract? X)
(Printout t crlf)
(Printout t "I am very sorry." crlf)
(Assert (end)))
(Defrule R4
? X <- (shall-we-talk-about-trends-in-IMSI? y)
=>
(Retract? X)
(Printout t crlf)
```

Figure 9 Chatterbot's code in Clips.

Summing up the above algorithms, we come to the conclusion that the solutions that they use are not entirely correct and have large errors that appear while using Chatterbots. In an effort to reduce errors in the above algorithms, it is essential to prepare a special database and algorithms based on the rules of psycholinguistics [1], semantic relationships [2], natural language and communication grammar.

Using artificial intelligence solutions we can create a platform for distance learning where at one end of the computer there will be a student and at the other a Chatterbot as a virtual teacher. Thanks to its behavior, conversation and debate the student will think that he/she is participating in a lesson with a teacher, not a chatterbot. With such solutions we can reduce the cost of hiring a teacher and increase its existence on the platform. As a result, our kids will be cared for all the time and more willing to take advantage of it.

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The design and implementation
of remote forms of education

3.1.   Introduction

The dynamically developing world, new information technologies and equipment have affected the way of transmitting knowledge. More and more often traditionally conducted lessons with chalk and blackboard are enriched through the use of modern technology. Teachers try to spice up lessons through films or slideshows.

Education is evolving, which results in the way of teaching with the use of electronic media which are an alternative for traditional class teaching. This modern form of education based on distance learning and the use of available technologies is called e-learning.

This study aims to highlight issues related to e-learning. It makes the reader more familiar with the definition of e-learning, its history and the forms that it takes. It describes the advantages and disadvantages of this modern form of education and the barriers to its implementation, and explains the concept of a platform and its different types. It describes selected commercial and non-commercial platforms.

At the end of the study we present selected functions of remote educational platforms based on commercial and non-commercial platforms which are available on the market, and which nowadays are a place of acquiring knowledge. Their attractive form of communication and the use of modern technology facilitates the acquisition of knowledge. Discussion forums and chat rooms allow efficient communication between the participants of the course and the lecturer. The Wiki tool enables the course users to co-create the page and the Dictionary lets them create a list of concepts on-line, thanks to which teaching and learning is much simpler. Training designed for these platforms may not only be an excellent alternative to the traditional way of teaching, but also a combination of both forms.

3.2.   E-Learning

3.2.1.   The concept of e-learning

There is a variety of interpretations of the term of e-learning, due to which there is no one universally applicable definition. The already mentioned term of e-learning comes from the English language and is a combination of two words: *electronic* and *learning*. According to Elliott Masie, an American authority on distance learning, the prefix "e"

in the word e-learning should mean "at least learning to be effective, engaging, educationally sound and enhacing" [1]. Masie defines e-learning as "the use of technology to manage, design and create, deliver, select, support and expand each kind of teaching" [2]. Another expert, Lance Dublin, believes that e-learning is "the use of technology for the creation, distribution and delivery of data, information, training and knowledge in order to improve the efficiency of work and the activities of an organization" [3] .

Figure 1. Information and Communiacation Technologies used in e-learning.
(Source: http://www.youtube.com/watch?v=b3dTU1lqYDE)

From both definitions Marek Hyla concluded (2007), that e-learning is "any action that supports the training process, using information and communication technologies" [4].

Thus understood, the term e-learning includes:

- typical e-learning courses delivered via a computer network or CDs,
- Internet lectures,
- web conferences,
- video conferences,
- distribution of content (e.g. via e-mail)
- mailing lists (used for exchange of information),
- instant messaging (used for exchange of information).

We can therefore assume that e-learning is a modern form of education involving distance learning and using available technologies.

Polish counterparts of the term are: e-learning, e-education, electronic education, computer distance learning, distance learning, on-line learning and computer-assisted learning. Despite the wealth of Polish counterparts, by far the most common and widely used term is the English term e-learning.

3.3.   The history of e-learning

E-learning was established as a form of distance learning (d-learning). The idea of distance education dates back to the eighteenth century, when in 1700 the first ad with an offer of a correspondence course [5] appeared in the press in the United States. Shortly thereafter, in 1776, the University of Krakow in Poland introduced correspondence courses to educate craftsmen. In 1886, also in Poland, the Flying University was established, which was recognized as one of the forms of distance education, due to lack of location in a particular academic center.

A breakthrough in the development of distance learning came in the 1920s, when the "educational radio" began its activity. In the 30s of the twentieth century the invention was widely used to transfer the contents of teaching in primary schools in sparsely populated areas of Australia [6]. Further development of electronic media brought another breakthrough in distance education. Along with the popularization of television broadcasting, educational courses using visual media came into view. The forerunner in this field was the University of Iowa, whose initiative was educational television launched in 1945. Three years later there were already five centers transmitting educational content using the television signal in the U.S. In Poland Television University took advantage of this technology and in the years 1966-1971 it offered programs designed to prepare candidates for higher education. In 1965 the University of Illinois developed the first computer system for distance learning, the so-called PLATO system. Starting with this event we can talk about e-learning. The next step in the development of distance learning was the introduction of computer education programs that emerged as a result of the collaboration of the IBM software company with the University of Stanford in the 1990s. Along with further development of information and communication technology (especially the Internet), there has been an increasing interest in distance learning with the use of multimedia. Since 2000 more and more universities and institutions have included this form of training in their offer.

3.4.   Forms of education in e-learning

Changes taking place in the modern world and the development of information technology affect the previously existing methods and forms of education. The traditional model of education is based on the so-called "just in case" training. It consists in equipping the participant with a body of knowledge that will be used by him, not necessarily fully, in the future. As a modern form of education e-learning is based on the model of the so-called 3J.

Forms of education based on the 3J model are characterized by:

*   adaptation to the needs of the trainee (just for me)
*   organization when they are needed (just in time),
*   sufficient learning (just enough) [7] .

The offered knowledge is suited to the user and limited to the necessary minimum and transmitted when it is actually needed. Additionally, the 3J model allows customizing the training material to the participant, allowing efficient acquisition of knowledge. This personalized approach enables the acquisition of knowledge in accordance with specific educational and perceptual needs of the trainee.

3.5. Forms of e-learning

Taking into account the time of transmission of information, we can distinguish the following types of training:

- asynchronous learning,
- synchronous learning,
- self-studying,
- blended learning

3.5.1. Asynchronous Learning

Asynchronous learning is the most common method of distance learning [8]. This is the kind of teaching during which there is no direct contact between the teacher and the student. The educational process takes place at any time chosen by the student. The participant is to do exercises and tests whose delivery time is limited by the trainer. The user receives the training material in the form of multimedia, presentations, texts and educational data contained on CDs. Contact with the lecturer is done by e-mail, discussion forums, chat rooms, etc. Asynchronous training is designed for people characterised by responsibility, independence and high motivation, largely because successful completion of the course depends on the students themselves.

3.5.2. Synchronous Learning

Synchronous learning is as popular a form of distance training as asynchronous learning [9]. In this educational model teaching is conducted in real time. The lecturer and the trainees communicate with each other at a specified time using computer networks and advanced technologies. Using the educational platform it is possible to lecture and train "live" via webcams and audio streams. In addition, contact between the trainee and the lecturer is done using the same tools as in the case of asynchronous learning, that is: e-mails, chats, forums. An advantage of synchronous learning is the opportunity to interact with the teacher and other students in real time. Synchronous training allows both individual work and group work and enables to control students' work. Synchronous learning is closer to the traditional model of teaching than asynchronous learning.

In the synchronous model we can distinguish two forms:

- one to many - training is provided for students located in different places
- one to one – the teacher teaches a group of people who are in a different place than the lecturer

3.5.3. Self-study

Self-education is characterized by complete lack of contact between the teacher and the student [10]. It is a method of distance training which uses tools similar to those in asynchronous learning. The difference is that in this method it is the student himself who decides about the pace and time of learning. Teaching materials are developed in such a way as to meet educational goals without intervention from the part of the lecturer.

3.5.4. Blended learning

Blended learning supports traditional teaching [11]. This educational model is a combination of traditional classroom training and distance learning. First the student acquires specific knowledge and skills during face-to-face training where he/she has direct contact with the lecturer to deepen them later on the platform under the supervision of the teacher. Additional materials posted on the platform allow the expansion of knowledge, and in the case of students with problems, revising the material and filling the gaps in knowledge. Blended learning combines the advantages of electronic training (saving time, unlimited access to teaching materials) with direct contact with the teacher, who knows the participants personally and therefore can choose appropriate exercises and materials for each of them. Blended learning is considered to be very efficient and it is becoming more and more popular.

3.6. Advantages and disadvantages of e-learning

Distance education is often compared to the traditional model of education. Participants of e-learning courses recognize both advantages and disadvantages in this form of teaching.

Irrefutable advantages of e-learning are:

- a reduction in training costs (eliminating fees associated with: hiring the lecture hall, the lecturers' salaries, commuting, accommodation, meals and delegations)
- learning to work systematically,

- getting motivated to learn through an attractive form of communication (modern, interactive materials),
- individualization of the learning process,
- acquisition of knowledge at the student's own pace of work,
- continuous monitoring of the learning progress,
- shortening the waiting time for test results
- saving time,
- continuous access to knowledge,
- the comfort of studying at any time and place,
- an opportunity to study regardless of the location of the student and the lecturer
- a wider range of choices thanks to a greater accessibility to courses and trainings,
- a possibility of expert consultations,
- quick access to training resources
- a possibility of multiple revisions of the training material,
- accelerating the implementation of new technologies,
- improving one's computer skills,
- adjustable rate of learning,
- an opportunity to return to the previous materials and exercises.

Undoubtedly, another advantage of e-learning worth mentioning is the increasing efficiency of memorising things. People usually remember [12] :

- o   10% of what they read,
- o   20% of what they heard,
- o   30% of what they saw,
- o   50% of what they heard and saw,
- o   90% of what they said and did.
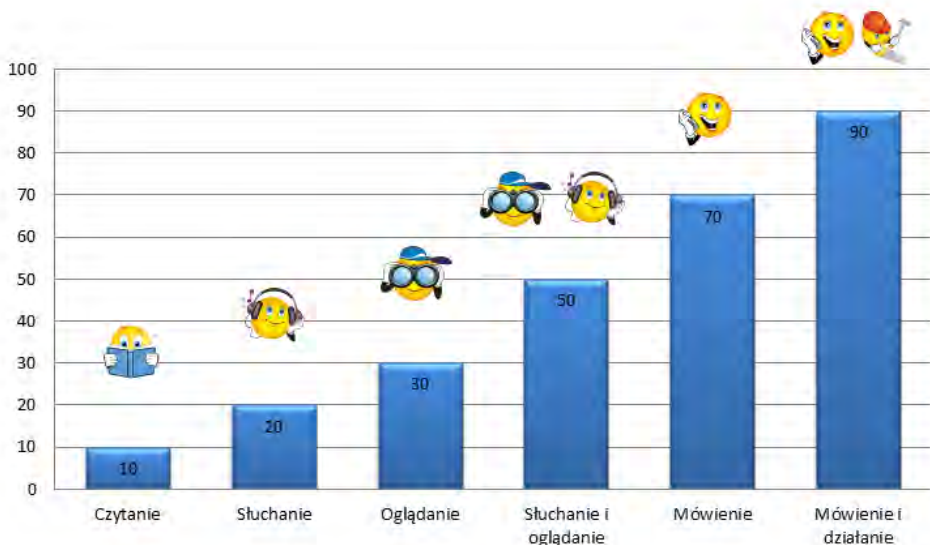
Figure 2. The degree of retention of information.
(Source: elaboration based on W. Scholz, Communication in the Bussiness Organization)

In addition to the unquestionable advantages, e-learning also has its drawbacks. The major disadvantages include:

- lack of personal contact between the lecturer and the student
- the necessity to be computer literate
- the neccesity to have strong motivation
- the neccesity to have computer hardware
- a risk that the sudent will not work by himself/herself,
- a feeling of isolation, alienation, saparation from the rest of the group
- time-consuming preparation of the courses
- the fact that the teacher has limited opportunities to motivate the students
- a decrease in motivation in case of problems with operating the platform
- problems with systematic work
- the fact that the training and courses are paid
- high cost of implementation
- high cost of buying professional platforms

3.7.   Barriers to e-learning implementation

E-learning is a modern form of teaching and learning and it is increasingly in line with the practice of training at colleges and companies engaged in the education process. Despite its obvious advantages, its implementation is still a big concern. Depending on the viewpoint barriers to the implementation of e-learning mechanisms can be divided into two groups. The first group are barriers faced by the training providers (companies, universities), other problems are faced by the recipients of the courses [13].

3.7.1.   Barriers from the perspective of the training organizer

From the point of view of the company or institution implementing e-learning solutions the barriers can be divided into two categories: technological and methodological.

E-learning requires modern technological solutions, which involves the purchase of appropriate hardware and software [14] . This, in turn, is associated with an increase in funding. The technological barrier is connected with organization, namely the selection of an appropriate staff member responsible for the process of implementing the elements of distance learning, e.g. choosing the course creators and deciding on the way of introducing distance learning to the organization. Another technical obstacle can be web overloading due to a large number of students participating in the training, which can have a significant impact on the work of the people who do not participate in remote learning.

Another barrier that companies wishing to implement e-learning courses may face is the methodological barrier. Despite the development of e-learning, the market still lacks experts prepared to implement and conduct such trainings. The courses are frequently

uninteresting, poorly prepared and even contain factual errors. The experts' task is to design, create, maintain, and implement innovative solutions for e-learning platforms.

3.7.2. Barriers from the perspective of the trainee

From the perspective of the participant the biggest concern is the transmission of knowledge, namely lack of direct contact with the teacher [15]. During a traditional face-to-face training the student can immediately ask the teacher for an additional explanation of incomprehensible issues, in the case of e-learning the training participants are not able to obtain an immediate response to their awakening doubts. Elderly people or those having problems with operating the computer may also fear contact with modern technology. Lack of trust in innovative solutions in the field of education and lack of belief in their efficiency if compared to traditional forms of education are a significant barrier inhibiting the development of e-learning [16].

An important element is also lack of personal contact with other participants, which can lead to a sense of alienation. The nature of traditional training was team building, during which it was possible to expand social circles and exchange experiences.

Another barrier faced by the trainee is lack of proper equipment, software or, if the training process requires Internet access, lack of an appropriate Internet connection. The e-learning platform itself can also cause problems if its service is not very intuitive and user-friendly.

An important barrier is also the participant's motivation and self-discipline. If there is not sufficient motivation on the part of the student, efforts put in the preparation and implementation of even the best e-learning course can prove to be futile.

3.8. E-learning platforms

The dynamic development of e-learning has caused the need for dedicated tools that support the process of distance education. One of such solutions is the e-learning platform. The platform is often called "an Internet substitute for school (understood as an institution or building)" [17] or "packaging, which can hold almost any content" [18]. Thus, the term ”platform” means a system designed to create, maintain and administer online learning.

There are three classes of platforms [19] :

- LMS - Learning Management System
- LCMS - Learning Content Management System
- VCS - Virtual Classroom System (a system managing Remote Communication and Synchronous Collaboration)
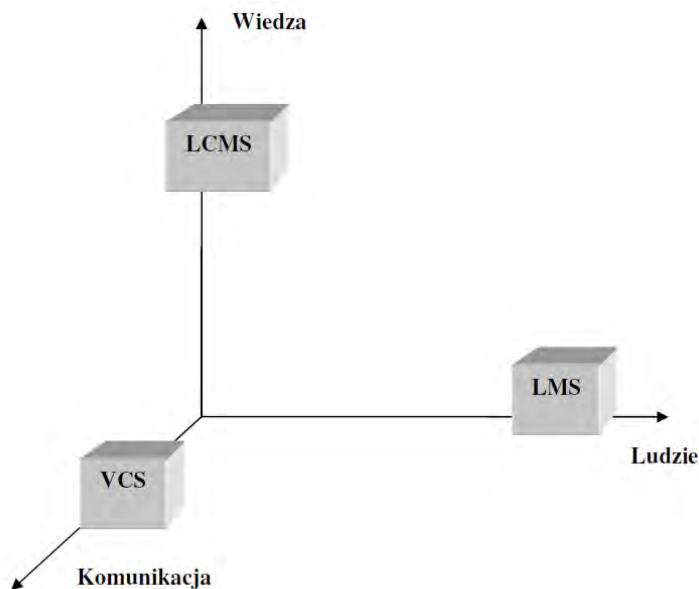
Figure 3. Information systems in the management of e-learning.
(Source: http://www.elearningonline.pl/wp-content/upload/konf_kielce06.pdf)

Zbigniew Zielinski explains the functionality of the various systems in three dimensions: people, knowledge and communication.

- people-oriented systems - LMS – "systems that manage training and people in the learning process and systems for managing competences, skills and testing" [20]
- knowledge-oriented systems - LCMS - "systems that manage the training content and authoring tools" [21]
- communication-oriented systems - VCS - "systems for presentations at a distance and remote communication and collaboration" [22] .

Individual systems bring large benefits, but only their integration creates a fully efficient and functional system for distance learning.

E-learning platforms can also be divided into:

- commercial
- non-commercial

The difference between them lies in the fact that you need to purchase a commercial platform, while the non-profit ones are distributed under the GPL (General Public License) as an open source. Commercial systems also have technical support, which is not always the case with commercial systems. In terms of functionality and tools both platforms show no large differences, because non-commercial platforms are often modeled on commercial ones [23] .

3.9. Non-commercial platforms

3.9.1. Moodle
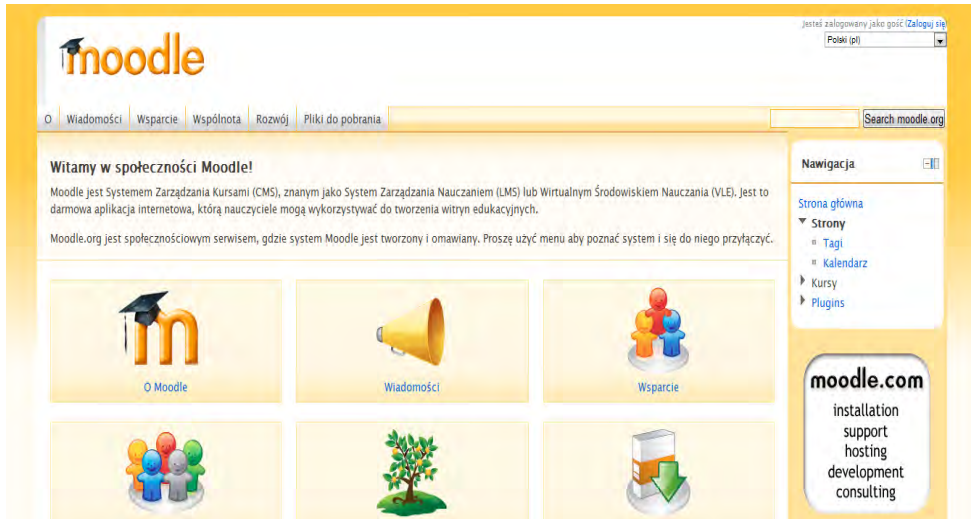
Figure 4. Moodle home page.
(Source: http://moodle.org/)

Moodle is an IT environment supporting the process of remote teaching and learning [24]. The word Moodle is the abbreviation of Modular Object-Oriented Dynamic Learning Environment. The creator and originator of this e-learning platform is Martin Dougiamas.

The system was created in 1999 and is constantly being modified and supplemented with new tools and solutions both by professional software developers and ordinary users of the platform [25].

The platform was based on the PHP language, allows the use of free databases (MySQL) and can be installed on any operating system (MS Windows, Linux). Currently there are 7,135,184 registered courses in 235 countries [26].

The Moodle e-learning platform is a system which enables the creation of courses by using a web browser. Moodle is an LMS (Learning Management System) - it organizes the teaching process (enrolls on courses, monitors the students' progress, reports the users' activities) and an LCMS (Learning Content Management System) - manages the content of the courses (creates, locates and manages the content of trainings, allows the construction of a new course by using the components of other courses, manages the courses).

Some of the features of Moodle:

- simplicity of operation,
- simple creation of individual courses

- transparent interface
- modular structure of the system,
- choice of graphic design of the course
- customizable look through the selection of appropriate blocks
- forums, chats, e-mail,
- calendar
- possibility to add external courses (SCORM format)
- three ways of access: registration, guest, anonymous,
- developed assessment tools: quizzes, tasks
- Wiki - enables the users to work together on a web page to add, modify or extend the content contained thereon

3.9.2. Claroline

Figure 5. Claroline home page.
(Source: http://www.claroline.net/)

Claroline is a web platform which supports the process of online learning. It was built at the University of Louvain in Belgium [27]. The platform allows hundreds of institutions from 93 countries to create and administer courses [28]. The platform was based on the PHP language and is compatible with the following operating systems: Linux, Mac and Windows. On this platform e-learning courses are composed of sections that make up the so-called educational trails, which in turn determine the chronological order of passing through the stages of training. The platform allows the creation of modules that contain documents, exercises or training materials imported in the SCORM format. Each section provides a list of tools that allow the creation of a wealth of educational materials and conducting classes in an interesting way.

Some of the features of the platform include:

- quick installation,
- intuitive management,
- publication of documents in any available format (text, PDF, HTML, video)
- administration of public and private forums,
- formation of student groups,
- creation of online training,
- user activity statistics,
- compatibility with any browser,
- calendar with the possibility of marking important events and information from the teachers,
- message management,
- creating your own html pages,
- possibility to upload pre-test papers to teachers,
- using Wiki to develop common documents by the users of the course,
- simplicity of management of different sections of the course
- easy enrollment
- defining the registration of the users,
- the possibility to track progress
- coordinating group work

3.10. Commercial Platform

3.10.1. Blackboard
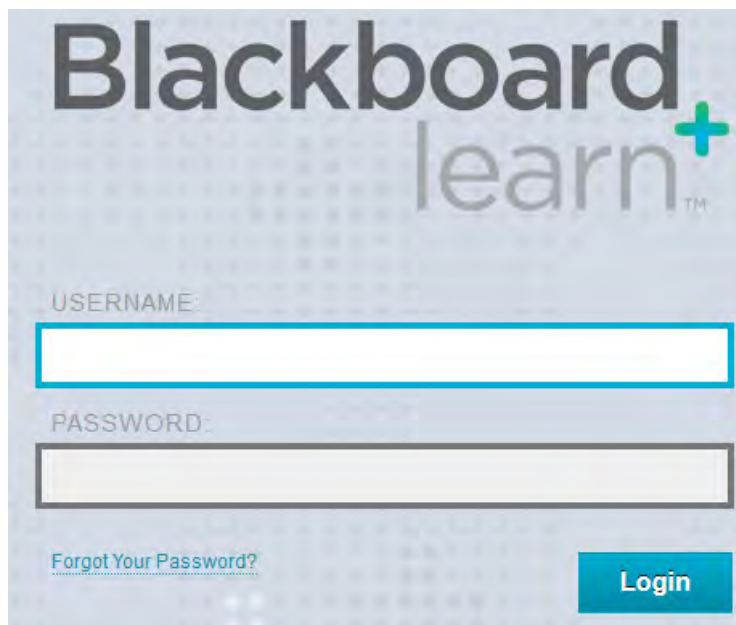
Figure 6. Blackboard home page
(Source: https://blendedschools.blackboard.com/webapps/login/?action=relogin)

The Blackboard platform is a system for creating courses and training materials. The owner of the software package is Blackboard Inc., a company founded by Michael Chasen and Matthew Pittinsky in 1997.

The platform includes [29] :

- Blackboard Learn - a set of tools supporting effective teaching and learning
- Blackboard Collaborate - a package forming virtual classrooms, offices and meeting places, it gives each participant the opportunity to freely express themselves
- Blackboard Connect - a tool for effective communication; creates and sends messages quickly and reliably
- Blackboard Transact - a tool for secure and non-cash purchases on or off-campus (students' village) using ID cards or badges
- Blackboard Analytics - a tool for data processing in order to make them easier to use
- Blackboard Mobile - greater mobility of the courses, through Blackboard mobile students can benefit from courses on their phones

Blackboard Package - features [30] :

- integration with the Windows MSN Toolbar - allows access to the training content from the browser,
- Wimba Pronto communicator - provides effective communication between the participants and the organizers of the course,
- address book, which facilitates communication between the participants and the lecturer,
- tools to create attractive educational content,
- integration with open source tools,
- calendar which allows planning activities and tasks,
- technology which allows individualization of the teaching process,
- tools for monitoring the users' activities (how long and what the user is viewing on the platform),
- discussion groups, blogs, working groups,
- a wide array of questions,
- space for group activities, which enables mutual learning and interaction between the participants,
- possibility to integrate the platform with Facebook.

3.10.2.   Oracle iLearning
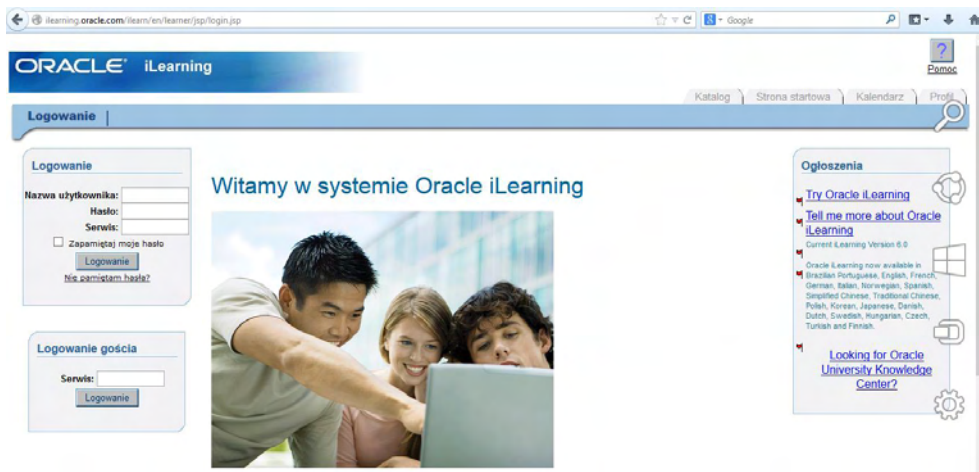
Figure 7. Oracle Learning home page.
(Source: http://learning.oracle.com/ilearn/jsp/login.jsp)

Oracle iLearning is a multi-functional e-learning platform, supporting the learning process [31]. Oracle iLearning is an LMS - Learning Management System. Oracle iLearning is a component of the E-Business Suite package offered by the Oracle company. The platform provides software which enables proper functioning of courses as well as

managing the training materials and the process of education. The Oracle platform is offered as a licensed product that provides ready-made courses or allows creating one's own courses [32].

In the case of independent products, Oracle provides technical support as well as necessary operational and maintenance work.

Functions offered by Oracle iLearning [33] :

- measuring the effectiveness of educational processes
- integration with the E-Business Suite,
- consolidation of training activities,
- providing an optimum combination of online and face-to-face training,
- instant creation and delivery of educational materials,
- monitoring the training process,
- administration of the courses,
- e-mail, forums, adverts, chat,
- creating reports,
- management via web browser,
- secure access to the content,
- editing the training materials
- creating tests (with granted points or not, with the possibility of assigning a time limit),
- bank of ready text tasks
- the possibility to view the current workload of the lecturers and their tasks,
- managing the users,
- training evaluation questionaires,
- clear user interface

3.11. A tool for testing and evaluation (HOTPOTATOES)

HotPotatoes is a free software enabling the creation of interactive educational materials [34]. Exercises prepared in this way can be made available to users connected to the Internet and with web browsers. The program creates exercises for the HTML page with the use of HTML and JavaScript.

The program can be installed on Mac OS, Windows, Linux and on any computer with the Java virtual machine. The tool can be downloaded from:

http://hotpot.uvic.ca/index.php # downloads

or:

http://www.enauczanie.com/authoring/hotpotatoes

which contains the installation package together with the Polish version.

Figure 8. The Hot Potatoes program.
(Source: http:WWW.elearningonline.pl/wp-content/upload/konf_wsh08_2.pdf)

HotPotatoes consists of 6 modules [35] :

- JCloze,
- JMatch
- JQuiz
- JCross
- JMix
- The Masher

Table 2.1. The functionality of each tool of the HotPotatoes program

Module	Function
JCloze	Creates gaps in the text to be completed.
JMatch	Creates exercises in which you must match the elements to each other
	Creates quizes with questions
	Questions with short answers
JQuiz	Multiple-choice questions
	Hybrid questions (a combination of the first two types)
	Questions with more than one answer
JCross	Creates crossword puzzles
JMix	Requires the user to arrange words or sentences from scattered elements.
The Masher	Allows the connection of separate resources created by HotPotatoes into a coherent whole and exporting them to the e-learning platform.

3.12. Conclusion

E-learning is a teaching process which uses the latest technology. The essence of e-learning is the opportunity to acquire knowledge using information technology and electronic media (including the Internet) practically without leaving home. Learning does not have to be confined to the classroom.

E-learning ceases to be perceived as a novelty, and is becaming a trend in education. Modern technologies increasingly support the educational process.

This paper describes a new form of distance learning technology, which is e-learning. We have explained this new model of learning by showing the history of its development, its advantages and disadvantages, as well as the barriers that hinder its implementation. In this paper we have presented commercial and non-commercial learning platforms, which are regarded as electronic substitutes for school.

On this basis it appears that an e-learning course extends the traditional forms of teaching by making them more efficient and effective.

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The application for computing the Principal Component Analysis method as an example of a distance learning education method

4.1. Introduction

Nowadays the distance between the teacher and student is not a factor any more. In this paper we presented the benefits of distance learning and stand alone specialized applications to show the future of education.

We use and combine different technologies such as client server model and our own models of computations of statistical method to show the advantage of using distance learning as an future of education.

In the simplest case, we use principal component analysis (PCA) as an example of a distance learning education method. We combine the benefits of distance learning and stand alone specialized application to show the future of education. Our application allows to calculate the principal component analysis and performers the analysis of the sum of squares product matrix, variance-covariance and correlation.

In this paper two different kinds of assumptions were analyzed: principal components analysis method as an stand alone specialized applications to and the advantage of using distance learning. Such broad perspective allows demonstration of the application as an example of distance learning.

4.2. Distance Education

Distance education, distance learning, dlearning, or D-Learning is a mode of delivering education and instruction, often on an individual basis, to students who are not physically present in a traditional setting such as a classroom. Distance learning provides access to learning when the source of information and the learners are separated by time and distance, or both.

Distance learning can expand access to education and training for both general populace and businesses since its flexible scheduling structure lessens the effects of the many time-constraints imposed by personal responsibilities and commitments. Devolving some activities off-site alleviates institutional capacity constraints arising from the traditional demand on institutional buildings and infrastructure. Furthermore, there is the potential for increased access to more experts in the field and to other students from diverse geographical, social, cultural, economic, and experiential backgrounds. As the population

at large becomes more involved in lifelong learning beyond the normal schooling age, institutions can benefit financially, and adult learning business courses may be particularly lucrative. Distance education programs can act as a catalyst for institutional innovation and are at least as effective as face-to-face learning programs, especially if the instructor is knowledgeable and skilled.

Distance education can also provide a broader method of communication within the realm of education. With the many tools and programs that technological advancements have to offer, communication appears to increase in distance education amongst students and their professors, as well as students and their classmates. The distance educational increase in communication, particularly communication amongst students and their classmates, is an improvement that has been made to provide distance education students with as many of the opportunities as possible as they would receive in in-person education. The improvement being made in distance education is growing in tandem with the constant technological advancements. Present-day online communication allows students to associate with accredited schools and programs throughout the world that are out of reach for in-person learning. By having the opportunity to be involved in global institutions via distance education, a diverse array of thought is presented to students through communication with their classmates. This is beneficial because students have the opportunity to combine new opinions with their own, and develop a solid foundation for learning. It has been shown through research that as learners become aware of the variations in interpretation and construction of meaning among a range of people construct an individual meaning, which can help students become knowledable of a wide array of viewpoints in education. To increase the likelihood that students will build effective ties with one another during the course, instructors should use similar assignments for students across different locations to overcome the influence of co-location on relationship building.

The high cost of education effects students in higher education, to which distance education may be an alternative in order to provide some relief. Distance education has been a more cost-effective form of learning, and can sometimes save students a significant amount of money as opposed to traditional education. Distance education may be able to help to save students a considerable amount financially by removing the cost of transportation. In addition, distance education may be able to save students from the economic burden of high-priced course textbooks. Many textbooks are now available as electronic textbooks, known as e-textbooks, which can offer digital textbooks for a reduced price in comparison to traditional textbooks. Also, the increasing improvements in technology have resulted in many school libraries having a partnership with digital publishers that offer course materials for free, which can help students significantly with educational costs.

Within the class, students are able to learn in ways that traditional classrooms would not be able to provide. It is able to promote good learning experiences and therefore, allow students to obtain higher satisfaction with their online learning. For example, students can review their lessons more than once according to their need. Students can then manipulate the coursework to fit their learning by focusing more on their weaker topics while breezing through concepts that they already have or can easily grasp. When course design and the learning environment are at their optimal conditions, distance education can lead students to higher satisfaction with their learning experiences. Studies have shown that high satisfaction correlates to increased learning. Students who are enrolled in distance education with high satisfaction in their online coursework are then motivated intrinsically to learn, which often means that their performance in class will improve.

For those in a healthcare or mental health distance learning program, online-based interactions have the potential to foster deeper reflections and discussions of client issues as well as a quicker response to client issues, since supervision happens on a regular basis and is not limited to a weekly supervision meeting. This also may contribute to the students feeling a greater sense of support, since they have ongoing and regular access to their instructors and other students.

Distance learning may enable students who are unable to attend a traditional school setting, due to disability or illness such as decreased mobility and immune system suppression, to get a good education. Distance education may provide equal access regardless of socioeconomic status or income, area of residence, gender, race, age, or cost per student. Applying universal design strategies to distance learning courses as they are being developed (rather than instituting accommodations for specific students on an as-needed basis) can increase the accessibility of such courses to students with a range of abilities, disabilities, learning styles, and native languages. Distance education graduates, who would have never have been associated with the school under a traditional system, may donate money to the school.

Distance Learning may also offer a final opportunity for adolescents that are no longer permitted in the General Education population due to behavior disorders. Instead of these students having no other academic opportunities, they may continue their education from their homes and earn their diplomas, offering them another chance to be an integral part of society.

4.3. Client–server model [18][19]

The client–server model, or client–server architecture, is an approach to computer network programming in which computers in a network assume one of two roles: The server selectively shares its resources, and the client initiates contact with a server in order to use those resources.

The *client–server* characteristic describes the relationship of cooperating programs in an application. The server component provides a function or service to one or many clients, which initiate requests for such services.

Servers are classified by the services they provide. A web server serves web pages; a file server serves computer files. A shared resource may be any of the server computer's software and electronic components, from programs and data to processors and storage devices. The sharing of resources of a server constitute a *service*.

Whether a computer is a client, a server, or both, is determined by the nature of the application that requires the service functions. For example, a single computer can run web server and file server software at the same time to serve different data to clients making different kinds of requests. Client software can also communicate with server software within the same computer. Communication between servers, such as to synchronize data, is sometimes called *inter-server* or *server-to-server* communication.
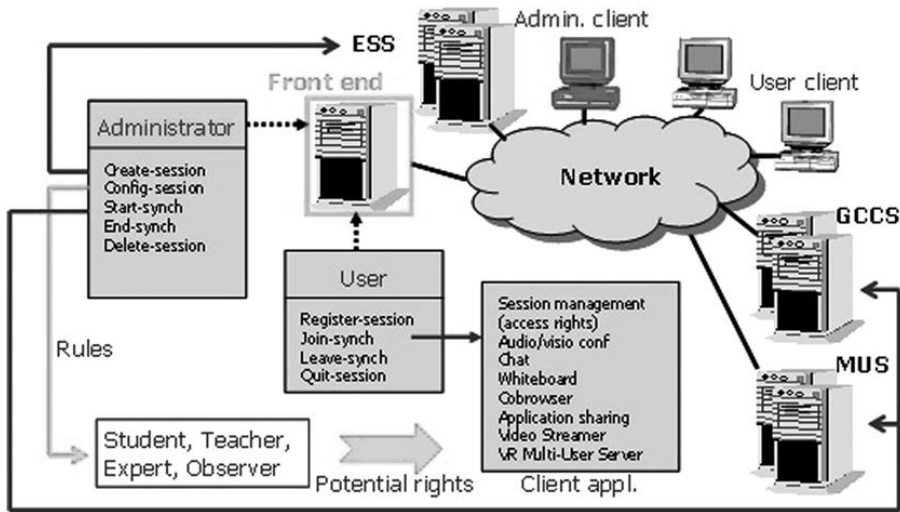
Figure 1. Client–server model.
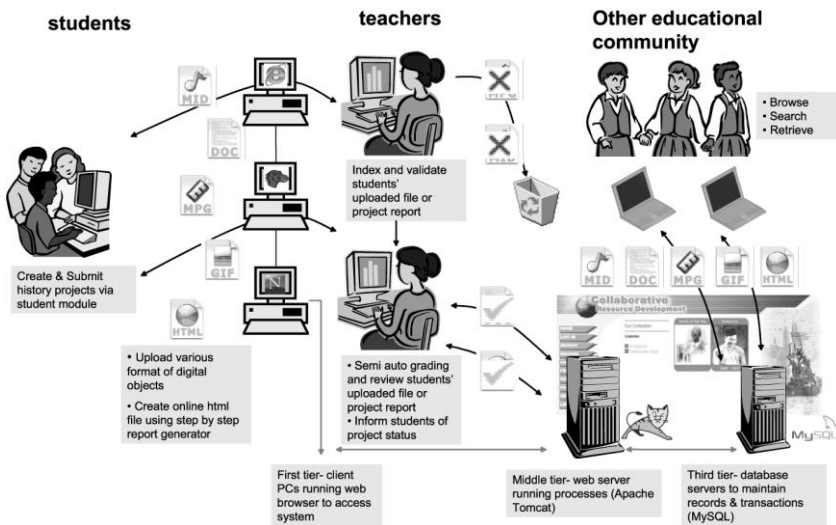
Figure 2. Client–server model for education use.

We use the client–server model as an technology for distance learning and examination system. This technology is very well suited to the above-mentioned approach to distance learning because it contains solutions implemented to carry out the process of distance learning.

4.4. Principal Components Analysis [3][4][7][10]

Principal component analysis (PCA) is a mathematical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly variables called principal components. The number of principal components is less than or equal to the number of original variables. The transformation is defined as one in which the first principal component has the largest possible variance and each succeeding component in turn has the highest variance possible under the constraint that it be orthogonal to the preceding components. Principal components are guaranteed to be independent only if the data set is jointly normally distributed. PCA is sensitive to the relative scaling of the original variables.

Principal component analysis is one of the statistical methods of factor analysis. Data set consisting of N observations, each of which includes the K variables can be interpreted as a cloud of N points in K-dimensional space. The purpose of PCA is the rotation of the coordinate system to maximize the variance in the first place the first coordinate, then the variance of the second coordinate, etc.

The transformed coordinate values are called the charges generated factors (principal components). In this way a new space is constructed of observation, which explains the most variation of the initial factors.

PCA is often used to reduce the size of a set of statistics, through the rejection of the last factors. You can also search for the substantive interpretation of the factors depending on the type of data, allowing you to better understand the nature of the data, although it can be difficult with more variables studied. The signal processing such as PCA is used to compress the signal.

PCA can be based either on the correlation matrix or covariance matrix formed from the set of input. The algorithm in both versions is otherwise identical, but different results are obtained.

If you use the covariance matrix in the set of input variables with the largest variance have the greatest impact on the outcome, which may be indicated if the variables represent a comparable size, such as changes in exchange rates of different shares. Using the correlation matrix corresponds to the initial normalization of the input set so that each input variable has the same variance, which may be indicated if the values of the variables are re not comparable.

4.4.1. The algorithm of use [3][4][7][10]

The input data is given a matrix containing further observations on which the main components will be determined. They are also returned as one array

PCA algorithm consists of the following steps:

- Determination of average for the lines

This is the first step required to form a covariance matrix of the input matrix. Mathematically, this step can be written as [4]:

$$u[m] = \frac{1}{N} \sum_{n=1}^{N} X[m,n] \qquad (1)$$

Another position vector U mean so keep the average corresponding rows. Calculated mean values are therefore the following characteristics for all observations.

- Calculation of the deviation matrix

This step is subtracted from the input matrix averages calculated in Section I. Since each element of the matrix we subtract the average for the line on which it is located [4]:

$$a[i,j] = a[i,j] - u[i] \quad (2)$$

The matrix obtained in this way will further denoted as X'.

- Determination of the covariance matrix. In general, the covariance matrix is calculated from the formula [4]:

$$C = E[B \otimes B] = [B \cdot B^*] = \frac{1}{N} B \cdot B^* \quad (3)$$

where E is the expected value and B is the matrix of deviations. If the values are real matrix B used in the model Hermitian conjugation is identical with the normal transposition.

- Calculation of the eigenvalues of the covariance matrix

The calculation of eigenvectors of the matrix V, which satisfies [4]:

$$V^{-1} CV = D \qquad (4)$$

where D is the diagonal matrix of eigenvalues of C.

The main goal of the paper is that we have a an application for these methods which can distinguish several groups of characteristics for which to apply the method of Principal Components Analysis and to check the speed of its behave and have the calculation of the method behave. In the paper we show the implementation of the method itself and verify the method by using the correlation analysis, the variance/covariance, and the sum of squares of the product matrix analysis.

4.4.2. Results of computations

In this part we show the results of computation obtained from our application.
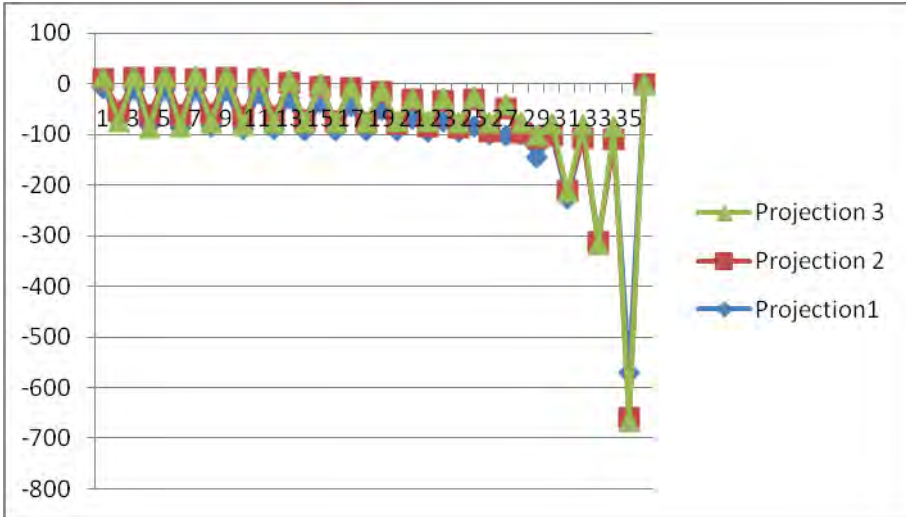
Figure 3. Analysis of sums-of-squares-cross-products.
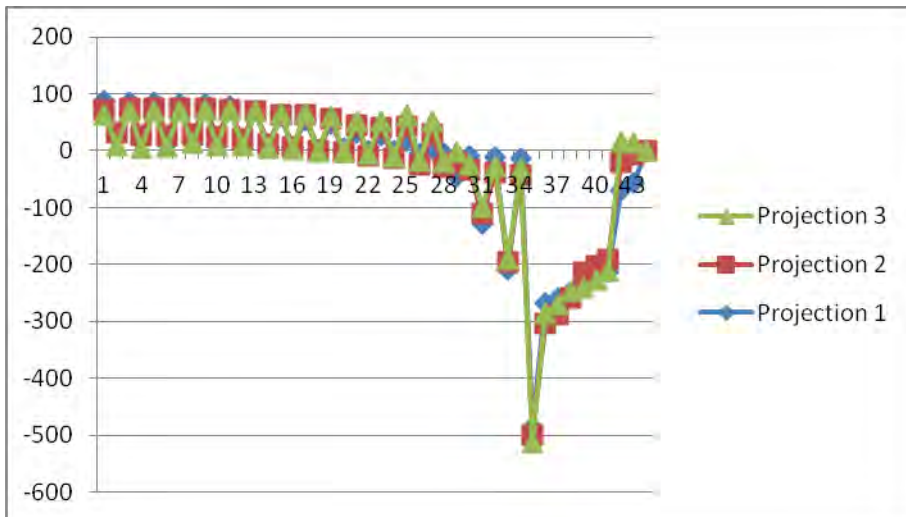
Figure 4. Analysis of variances-covariance.
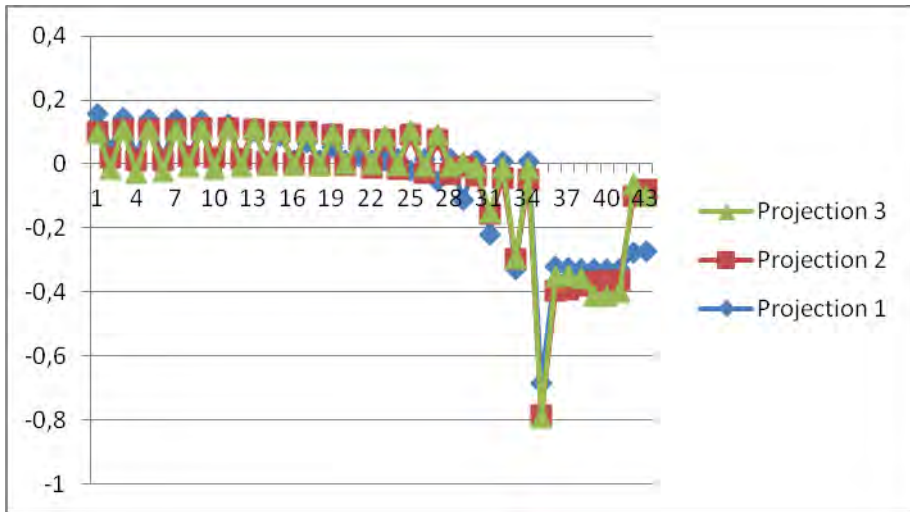
Figure 5. Analysis of correlations.

The graphs show the analysis of the sum of squares product matrix, variance-covariance and correlation for the PCA method.

The diagrams are based on the eigenvalues, which came from the output matrix. The method PCA has been implemented and is based on three different methods and we show three projections of row and column points from the output matrix, which shows also principal component, received from the PCA method. The analysis was conducted by implementing the PCA method mathematically in three different ways: as the sums of squares cross products from the output matrix [Figure 3], as a variance-covariance [Figure 4] and as a correlation [Figure 5] based on the equations presented above.

4.5.   Description of the application obtained results

Our application allows to perform several analyzes such as the sum of squares product matrix, variance-covariance and correlation.

These analyzes are calculated based on the input matrix which are loaded into the application from files saved in the appropriate format. When you select the appropriate options regarding the calculations performed, the application shows appropriate graphs of the results of calculations which were performed. We can also perform some calculations of the PCA method concerning on transforming the image using the PCA method.

Below we present our application. The application is divided into two parts first one is responsible for conducting calculations for different analysis. The second one is responsible for calculating the method Principal Component Analysis using various images.
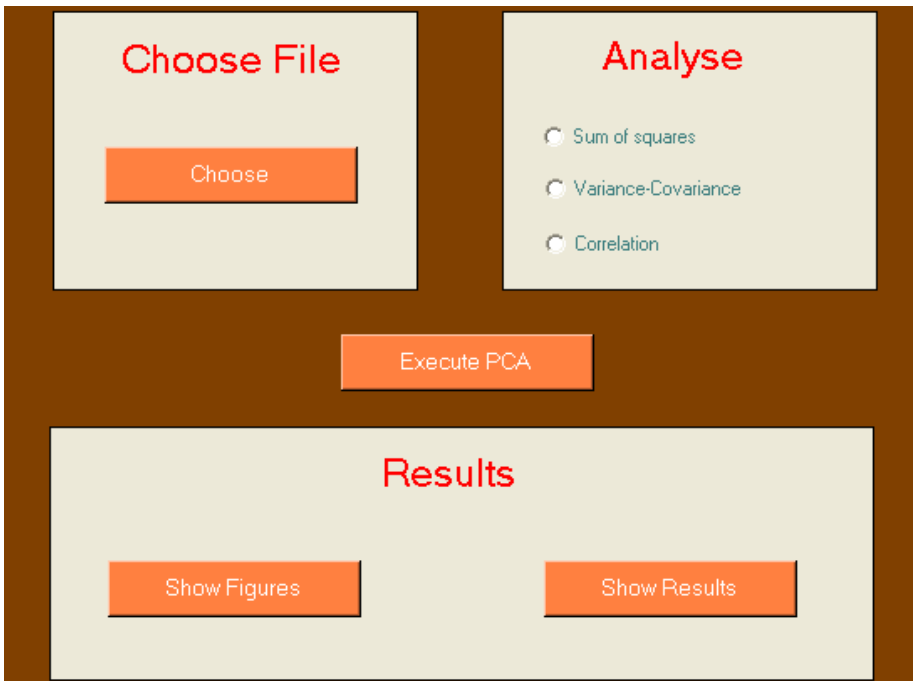
Figure 6. Appearance of the application for the selection of specific analyzes.
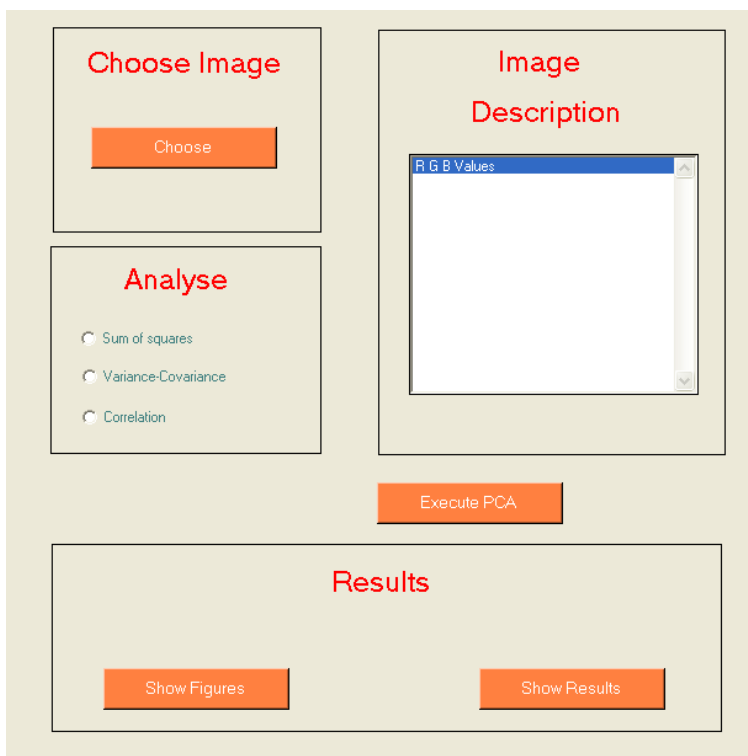
Figure 7. Appearance of the application for the selection of images.

On figures 6 and 7 we show appearance of the application for the selection of specific analyzes and for the selection of images.

Below we present the results of analysis conducted by our application:

Analysis of correlation matrix of 8 columns to 35 rows.

```
No. of rows: 35, no. of columns: 8.
Input file: macierztestowa.txt.
Analysis of correlations chosen.

Means of column vectors:
 112.8 109.4 101.3 104.3 103.0 99.8 101.8 106.3

Standard deviations of columns:
 137.5 132.2 125.8 119.8 114.9 109.6 46.9 39.4

Eigenvalues:
 7.10944
 0.77824
 0.10486
 0.00339
 0.00282
 0.00009
 0.00004
 0.00112


Eigenvectors:
 -0.3621 -0.2512 0.4129
 -0.3632 -0.2385 0.4072
 -0.3685 -0.1864 0.2262
 -0.3690 -0.1416 -0.3878
 -0.3689 -0.1319 -0.4222
 -0.3703 -0.1153 -0.3622
 -0.3134 0.6082 0.3452
 -0.3058 0.6517 -0.1830

Projections of row-points on first 3 prin. comps.:
 0.4651 -0.1700 -0.0043
 0.1319 -0.0773 -0.1056
 0.4312 -0.1081 -0.0031
 0.0775 -0.0468 -0.1188
 0.4261 -0.1016 -0.0016
 0.0426 -0.0020 -0.1089
 0.4222 -0.0987 -0.0064
 0.0336 0.0338 -0.0923
 0.4059 -0.0723 -0.0050
 0.0027 0.0537 -0.1010
 0.3687 -0.0341 0.0051
 0.0147 0.0345 -0.0687
 0.3134 0.0100 0.0078
```

```
0.0251 -0.0035 -0.0306
0.2607 0.0411 0.0058
0.0352 -0.0276 -0.0156
0.2035 0.0941 -0.0005
0.0323 -0.0419 0.0026
0.1610 0.1146 0.0095
0.0408 -0.0562 0.0112
0.0754 0.1540 0.0086
0.0383 -0.0711 0.0266
0.0314 0.2001 0.0272
0.0451 -0.0944 0.0394
-0.0581 0.3313 0.0430
0.0421 -0.1230 0.0605
-0.1509 0.3749 0.0487
0.0443 -0.1392 0.0725
-0.3316 0.3069 0.0347
0.0339 -0.1475 0.0820
-0.6611 0.1890 0.0118
0.0217 -0.1498 0.0883
-0.9921 0.0994 -0.0014
0.0191 -0.1650 0.1006
-2.0516 -0.3076 -0.0222

Projections of column-points on first 3 prin. comps.:
 -0.9655 -0.2216 0.1337
 -0.9685 -0.2104 0.1319
 -0.9825 -0.1644 0.0733
 -0.9840 -0.1249 -0.1256
 -0.9836 -0.1163 -0.1367
 -0.9874 -0.1017 -0.1173
 -0.8357 0.5365 0.1118
 -0.8152 0.5749 -0.0593
```

Analysis of the product of the sum of the squares of the matrix 8 columns to 35 rows.

```
No. of rows: 35, no. of columns: 8.
Input file: macierztestowa.txt.
Analysis of sums-of-squares-cross-products matrix chosen.

Eigenvalues:
 6092430.50000
 278946.09375
 50124.44531
 3092.99561
 866.85339
 477.95206
 71.07127
 21.89593

Eigenvectors:
 -0.4216 -0.2266 0.4457
 -0.4071 -0.2042 0.4150
```

```
 -0.3844 -0.1838 0.1647
 -0.3781 -0.0747 -0.4504
 -0.3673 -0.0434 -0.4596
 -0.3534 -0.0246 -0.3862
 -0.2322 0.6247 0.1908
 -0.2281 0.6891 0.0489

Projections of row-points on first 3 prin. comps.:
 -25.3261 50.6015 8.0658
 -217.7430 54.5072 -62.8652
 -33.3312 66.5445 9.7250
 -245.1250 61.2734 -75.3718
 -35.1797 68.1044 10.0200
 -257.9880 70.7346 -67.2548
 -37.1589 68.2907 9.8549
 -256.0666 80.6028 -59.2407
 -41.8112 74.8288 11.0566
 -271.9007 82.6748 -57.8502
 -57.3979 83.3321 12.8985
 -269.8225 75.3635 -40.2691
 -83.5009 91.5928 13.2878
 -273.5280 61.0499 -17.8970
 -110.8664 95.8988 12.4710
 -273.5753 52.4658 -7.2626
 -134.8222 109.1553 2.1625
 -279.6288 46.0879 3.5951
 -158.4685 110.6141 6.4799
 -277.9785 41.2449 10.1838
 -205.3778 114.2777 4.9825
 -284.5442 33.8085 23.9485
 -224.3102 123.4232 13.1924
 -286.4606 25.6441 33.2668
 -253.1567 155.2577 20.2573
 -296.8521 13.2519 50.5774
 -304.0928 159.1691 21.5615
 -300.2141 6.6491 60.6750
 -438.2159 118.5419 12.3119
 -309.3297 1.3921 67.1284
 -681.6714 45.9227 -1.8947
 -318.2372 -1.5980 71.3836
 -919.8234 -18.0682 -12.0645
 -324.3114 -8.4439 80.8551
 -1712.8124 -266.4850 -23.2871

Projections of column-points on first 3 prin. comps.:
 -1040.6874 -119.6775 99.7794
 -1004.8785 -107.8525 92.9062
 -948.8572 -97.0726 36.8713
 -933.3696 -39.4648 -100.8467
 -906.5889 -22.9457 -102.8895
 -872.2477 -12.9679 -86.4716
 -573.1556 329.9561 42.7085
 -562.9260 363.9303 10.9542
```

Analysis of variance-covariance matrix of 8 columns of 35 rows.

```
No. of rows: 35, no. of columns: 8.
Input file: macierztestowa.txt.
Analysis of variances-covariances chosen.

Means of column vectors:
 112.8 109.4 101.3 104.3 103.0 99.8 101.8 106.3

Eigenvalues:
 3225670.25000
 75401.42188
 40226.28516
 1793.09338
 493.52155
 242.73045
 48.29231
 21.78342

Eigenvectors:
 -0.4481 -0.3844 0.2757
 -0.4312 -0.3367 0.2789
 -0.4131 -0.1274 0.1616
 -0.3908 0.2167 -0.3915
 -0.3740 0.2393 -0.3942
 -0.3575 0.2370 -0.2965
 -0.1160 0.5253 0.5643
 -0.0938 0.5351 0.3242

Projections of row-points on first 3 prin. comps.:
 260.7556 -46.1780 -25.6454
 71.4771 20.8059 -66.8636
 255.8253 -32.4648 -15.8884
 45.6391 36.8748 -71.7333
 254.2922 -30.9569 -14.6187
 34.8140 42.8257 -58.7369
 252.4005 -30.7321 -14.8761
 38.5861 47.0941 -46.9379
 249.0383 -25.1587 -10.2798
 23.4545 49.9685 -43.8643
 235.2596 -16.1347 -2.4841
 24.3305 35.3705 -31.4692
 211.1037 -5.3444 4.5589
 18.3048 13.2745 -17.7883
 184.9821 2.7255 8.5559
 16.8227 0.7006 -12.7131
 163.6747 23.3737 9.3065
 9.8287 -9.0474 -5.5622
 140.7385 26.1117 16.2645
 10.6519 -16.7362 -2.4199
 95.2688 37.0343 21.4737
 3.0602 -29.6561 5.6213
 78.4074 43.7593 35.2268
```

```
-0.1685 -41.3768 9.3648
55.9333 71.6222 59.7957
-12.3805 -59.7134 18.4333
6.5760 82.0761 68.1078
-16.7302 -70.3631 23.6533
-132.8113 72.4942 53.9140
-26.6254 -75.9022 28.6270
-385.5717 54.5707 30.6849
-35.9018 -78.8490 32.2524
-631.5075 41.3189 14.8342
-43.0064 -88.4656 37.7632
-1456.5222 -44.9222 -36.5574

Projections of column-points on first 3 prin. comps.:
 -804.7524 -105.5451 55.2868
 -774.4109 -92.4520 55.9449
 -741.9607 -34.9879 32.4087
 -701.8286 59.4949 -78.5245
 -671.7762 65.7183 -79.0599
 -642.0027 65.0688 -59.4752
 -208.4086 144.2447 113.1702
 -168.4517 146.9401 65.0245
```

Below we present some graphs which are generated by using our application they are related to analyzes conducted above.
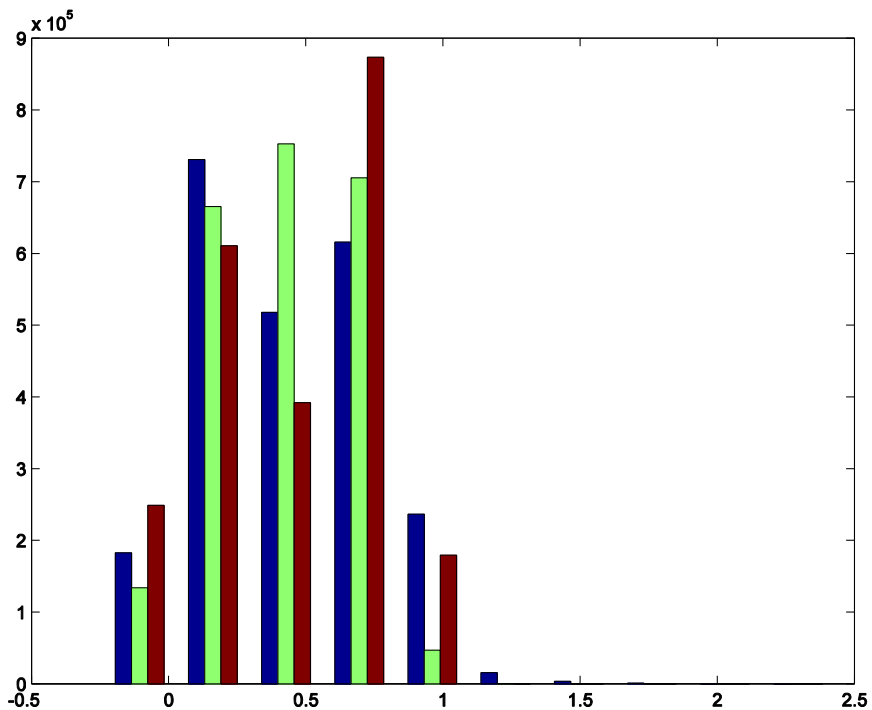
Figure 8. Histogram of image calculated using PCA method from our application.

On figures 8 and 9 we show the results of using PCA method and specific analyzes from our application this results were calculated and obtained by using the implemented algorithm of Principal Component Analysis method in our application. The both histograms show distribution of the main principal components of the method PCA obtained from selected different images.
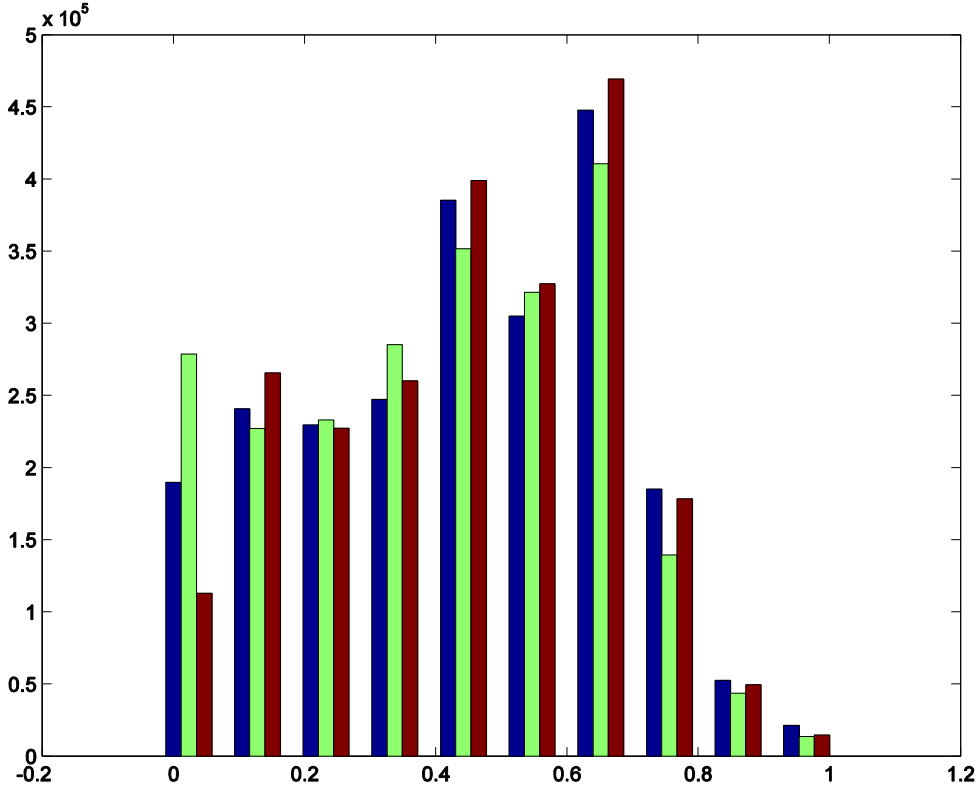
Figure 9. Histogram of image calculated using specific analyzes from our application.

4.6.   Summary

In this paper two different kinds of assumptions were analyzed: principal components analysis method as an stand alone specialized applications to and the advantage of using distance learning. Such broad perspective allows demonstration of the application as an example of distance learning.

Obtained results showed that it is possible to combine two different approaches and extract the benefits from one and other approach. Moreover, according to the authors demonstrated assumptions where fulfilled and confirmed by the results presented in this paper.

4.7.   References

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Modern modeling techniques and processing of multidimensional data using Oracle tools

5.1. Introduction

Today's the modern education and research institutions need tools that provide support for data analysis. The high costs of carrying out a marketing campaign and its preparation time will need a tool to facilitate this task. The overall aim of such activities is to maximize profits at the lowest cost. There are many ways to reach customers. The development of information technology has enabled the analysis of data for company profile.

Clients of institutions that use BI tools also received new offers dedicated to their expectations. New technologies based on an analysis of data will save the time needed to complete tasks.

Education institutions need tools to support management of student teaching and examinations remotely. Companies gain a competitive advantage in the market by the more fit the profile of their activities to the customers' expectations. Educational institutions wishing to improve the quality of teaching are forced to offer students new educational products. Capture trends in education's business such as the existing terms of the dynamics of growing offer teaching it is now possible with the use of data analysis techniques. Each education product has its own characteristics and cannot be addressed to all students. This situation requires tools to support corporate control of learning processes, checking knowledge and its quality management.

An approach based on data mining techniques and expertise allows analysts to capture certain features in common students, to offer dedicated education's products for the groups. Based on student behavior can be concluded about his tendencies to certain products of education.

Multidimensional data analysis techniques based on OLAP cubes and the construction of warehouse and data modeling are presented in this article using Oracle tools.

5.2. Modeling the Business and multidimensional structures

OLAP consists objects that are a part of dimensional model. The dimensional data model (include: dimensions, attributes, levels, hierarchies, measures and cubes) is highly structured and implies rules that govern the relationships among the data and control how the data can be queried. The fact table is referred to a cube, and the columns (in table) are referred to measures. The cube has edges, which are referred to dimensions. The fact table

include measures that are linked to a dimensions. Each dimension is a grouping of related columns from one or more tables. Analysts know which business measures they are interested in examining.

Dimensions and attributes make the data meaningful, and how the dimensions of their business are organized into levels and hierarchies.
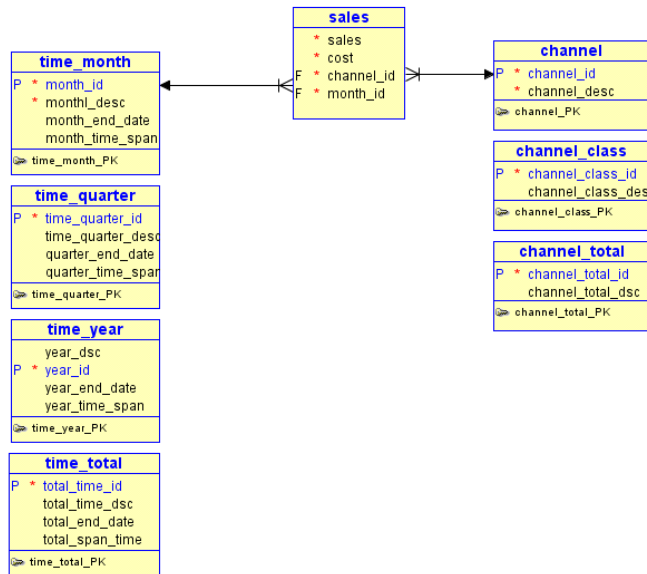
Fig. 1. Diagram of a Relational schema.
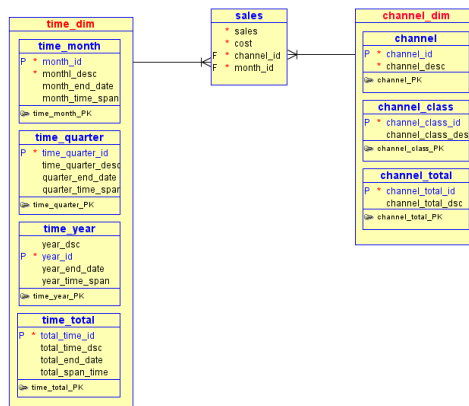
Fig. 2. Multi-dimensional schema.

Cubes are the physical implementation of the dimensional model and are highly optimized for dimensional queries. The OLAP engine that underlies cubes is based on an indexed multidimensional array model, which provides direct cell access. Diagram of a relational and multi-dimensional schema are presented on Fig. 1 and Fig. 2.

The OLAP engine manipulates dimensional objects and are optimized for analysis, analytic and row functions can be calculated much faster in OLAP than in SQL.

5.3. Overview of the Multidimensional Data Model

The dimensional objects include cubes, measures, dimensions, attributes, levels, and hierarchies (Fig. 3).
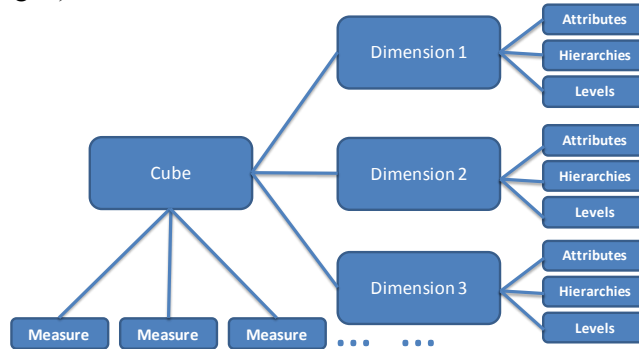
Fig. 3. Diagram of the OLAP Dimensional Model.

Dimensions:

Dimensions contain a set of unique values that identify and categorize data, they form the edges of a cube. Base-level dimension values correspond to the unique keys of a fact table.
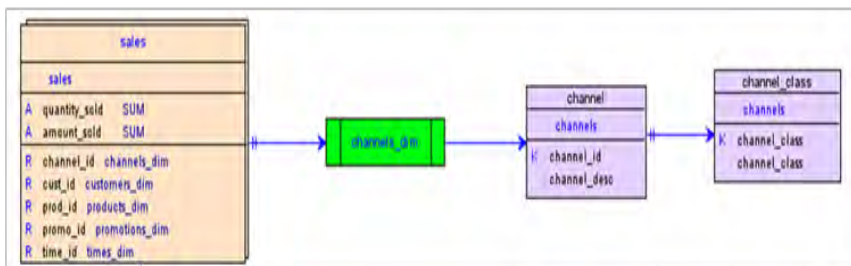
Fig. 4. OLAP multidimensional model.
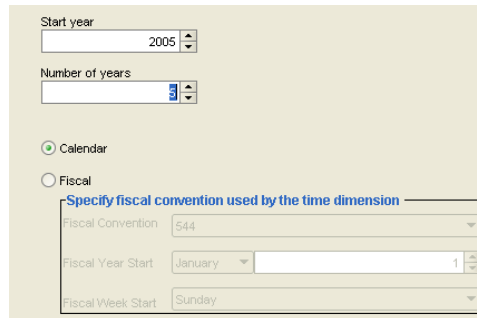
Time Dimensions:

Time dimension require additional information about the members in terms of each member's time span and end-date. With these additional attributes multidimensional model is able to provide additional features compared to other dimensions such as:

- Prior Value,
- Difference from Prior Period,
- Percent Difference from Prior Period,
- Future Value,
- Moving Average,
- Moving Maximum,
- Moving Minimum,
- Moving Total,
- Year to Date.

It is possible to automatically define the time dimension using OWB environment and fill it with data from a given range of years. To do this, perform the following steps using the Create Time Dimension Wizard:

- provide a name and description (e.g. time_dim)
- set the storage type (MOLAP – multidimensional storage, ROLAP – relational storage). If you have high volumes of data combined with high refresh rates or if you have detailed high volume data. Choose MOLAP to store aggregated data that is used for analysis.
- defined the range of date stored in the time dimension as Fig. 5.
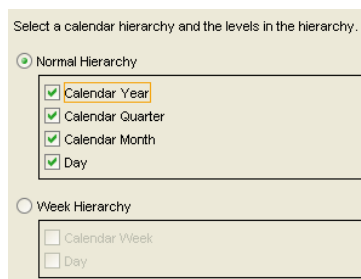
Fig. 5. Parameters window for the dimension of time.

- choose the levels in the hierarchy (Fig.6.)

Fig. 6. Time hierarchy and levels window for the dimension of time.

The time dimension, giving levels, hierarchies, attributes are presented in Fig. 7.
Fig. 8. presents the mapping of the logical structure to the physical structure of time dimension, which is stored in a database.
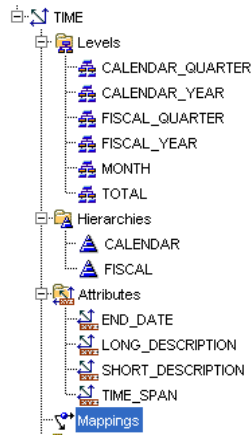
Fig. 7. Dimensional Time – Structure.
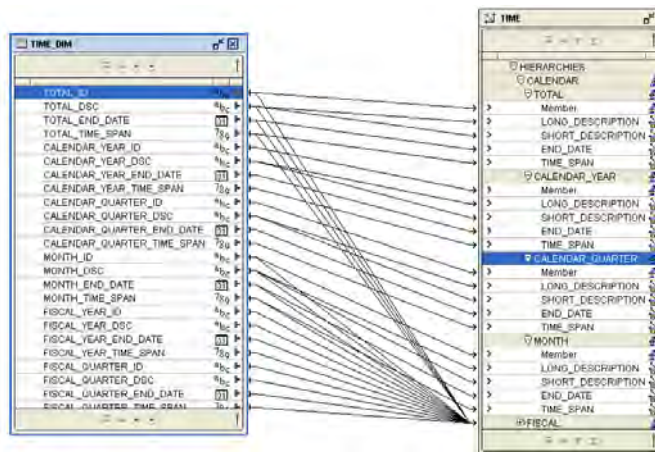
Fig. 8. Dimensional Time – Mapping.

Hierarchies and Levels:

A hierarchy (Fig.9.) is a way to organize data at different levels of aggregation. In viewing data, analysts use dimension hierarchies to recognize trends at one level, drill down to lower levels to identify reasons for these trends, and roll up to higher levels to see what affect these trends have on a larger sector of the business.
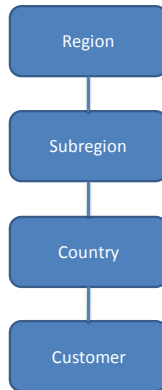
Fig. 9. Levels in a Dimension Hierarchy.

Attributes:

An attribute provides additional information about the data. Some attributes are used for display. You might also have attributes like package, sizes etc.

Time attributes can provide information about the Time dimension that may be useful in some types of analysis, such as number of days in each time period.

Each attribute corresponds to a column in dimension table.

Cubes:

Cubes provide a means of organizing measures that have the same shape, they have the exact same dimensions. A cube corresponds to a single fact table.

Measures:

Measures populate the cells of a cube with the facts collected about business operations. Measures are organized by dimensions, which typically include a Time dimension.

An analytic database contains snapshots of historical data, derived from data in a transactional database, legacy system, syndicated sources, or other data sources. Three years of historical data is generally considered to be appropriate for analytic applications.

Table 1. Calculated measures.

Group Name	Calculation Name
Basic Arithmetic	Addition
	Subtraction
	Multiplication
	Division
	Ratio
Advanced Arithmetic	Cumulative total
	Index
	Percent Markup
	Percent Variance
	Rank
	Share
	Variance
Prior/Future Comparison	Prior Value
	Difference from Prior Period
	Percent Difference from Prior Period
	Future Value
Time Frame	Moving Average
	Moving Maximum
	Moving Minimum
	Moving Total
	Year to Date

5.4. Defining OLAP objects

The following Oracle tools to define the analytical workspace (AW) are available: Oracle Analytic Workspace Manager (AWM), Oracle Warehouse Bulider (OWB), Oracle SQL Developer Data Modeler and other package.

All objects can be created in a dedicated and most powerful tool, which is Oracle Warehouse Bulider (including the model of ROLAP and MOLAP warehouse in the structure of a star or snowflake). OWB can perform the Extraction Transformation and Loading (ETL) engine using Oracle Workflow in order to fill the data warehouse. It allows both logical and physical design of the warehouse.

5.5. The modeling process by using Oracle SQL Developer Data Modeler

Oracle SQL Developer Data Modeler allows modeling the logical structure of warehouse in star or snowflake schema. Entity tab allows to select (on object definition) the type classification as Dimension or Fact. The next step is to set the definition of the Entity Attributes and Data Type. Each object in the form of such Dimension or Cube should also be set to a Unique Identifiers. Cube object usually has not unique identifier key. It is also necessary to carry out the mapping process, which is performed by selecting one type of relation 1: N relation, relation 1:1, M: N relation.
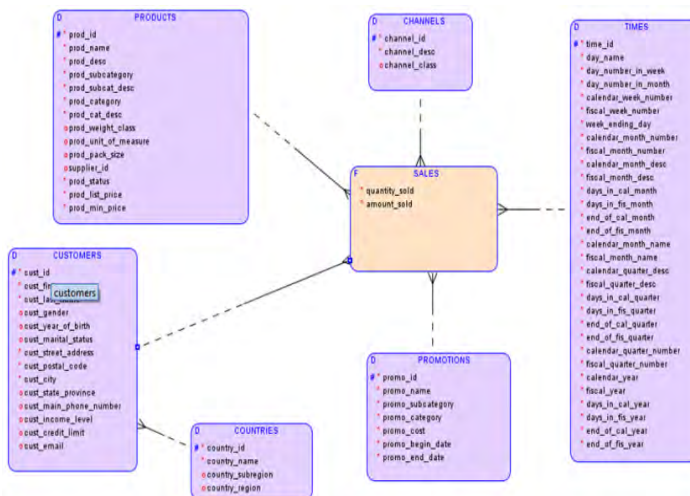
Fig. 10. Warehouse logical schema in the form of a snowflake.

The logical model is transformed to the relational schema (Engineer to Relational Model). In the process, you can choose which objects will be involved in transformation (Fig. 11).
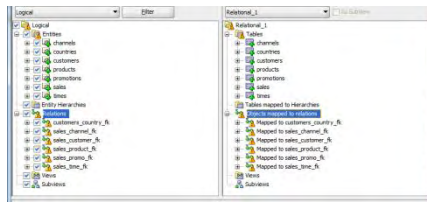
Fig. 11. Engineer to Relational Model process.
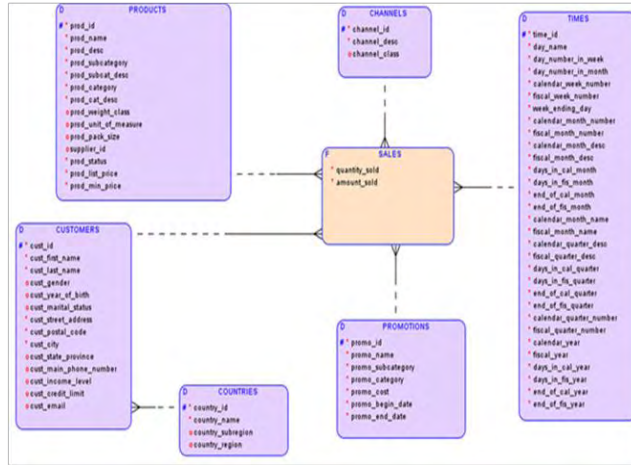
Fig. 12. Relational schema after transformation process of the logical model.

The next step is to create Multidimensional Model (MD) from the Relational Model (RD) in which is defined Physical Models based on the: attributes, levels and hierarchies. Such defined structure, for example, can be exported to Analytical Workspace (Oracle AW) and also be viewed in the AWM editor or can be modified as objects of OLAP.
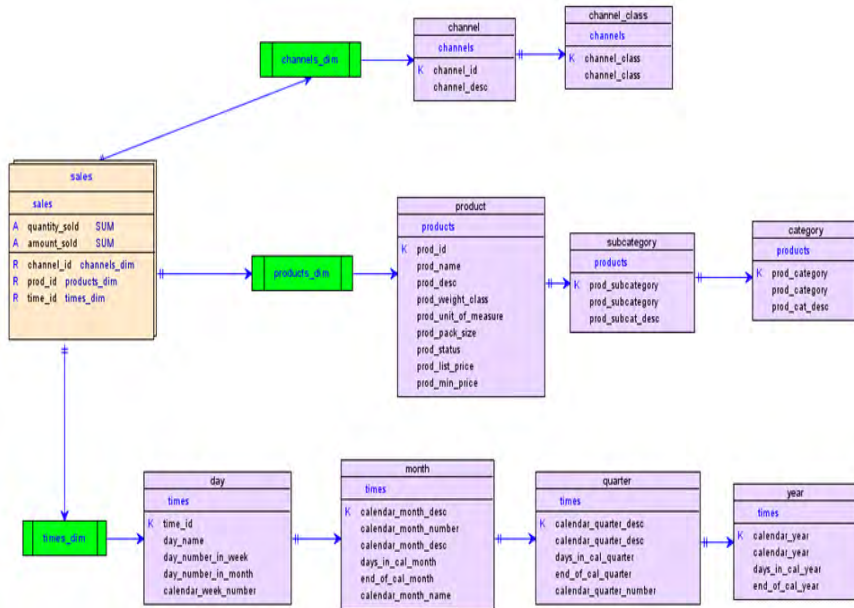
Fig. 13. Multidimensional Model.
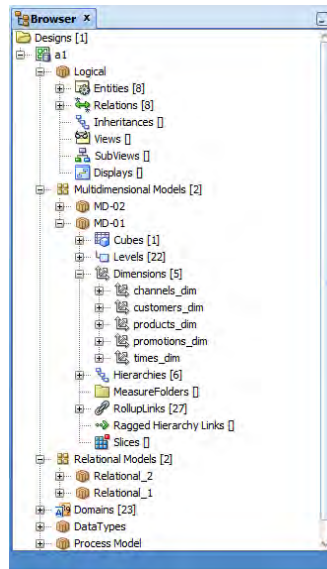
Fig. 14. Multidimensional Model.

5.6. Designing ETL

When source and target objects is defined in Oracle SQL Developer Data Modeler then the process of data movement and transformation logic should be started (ETL). ETL stands for Extract, Transform, and Load. ETL is designed in Warehouse Builder (OWB) and is used to create mappings to extract data from sources, transform it, and load it into targets. ETL process flows logic that interrelate mappings sources with targets and other activities can be designed using the OWB Process Flow Editor.

To build ETL process logic the Workflow Server should be started. The Mapping Editor (Fig.15.) interface in Warehouse Builder is used to design a mapping. You select operators from the Mapping Editor Palette panel and place them on the canvas.
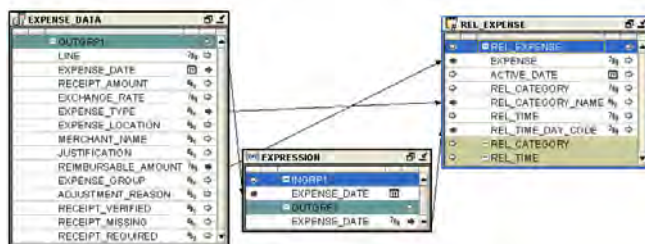
Fig. 15. The process of mapping sources with targets objects.

When mappings is done (that define the operations for moving data from sources to targets) the process flows can be created and defined. Process flows interrelate mappings and activities external to Warehouse Builder. In OWB, a process flow is used to manage the execution of mappings and related activities.

The activities editor of process flow includes a variety of activities that can be added and then connected with transitions to designing of a flow. Transitions indicate the sequence and conditions in which to launch activities, an activity represents units of work in a process flow and these units can involve components internal or external to Warehouse Builder.
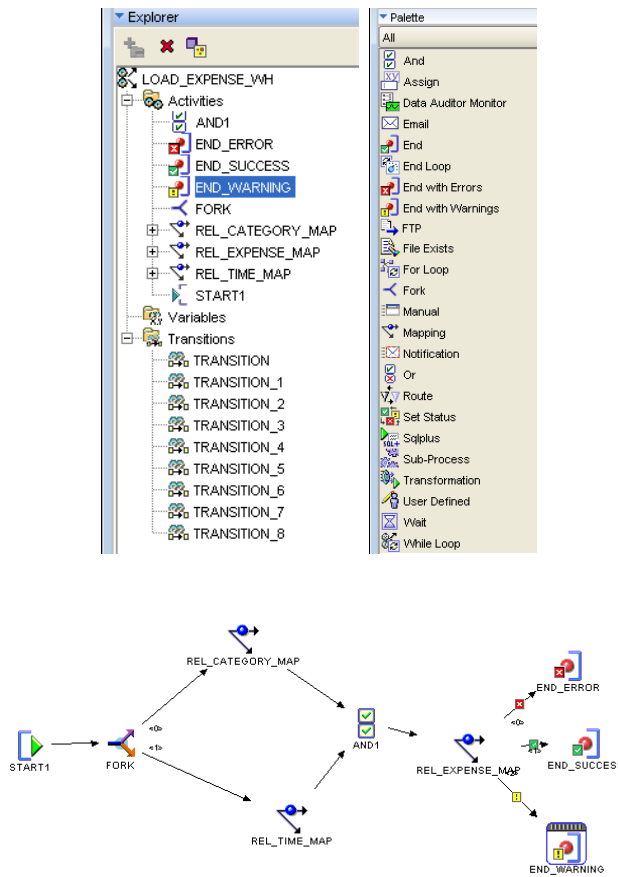
Fig. 16. Design a Process Flow in OWB using ORACLE Workflow Server.

The AWM application can present data in tabular or graphically form. Such applications are used by business analysts to make decisions about functioning of the company and its development strategy. The analysts can manipulate cube objects with use of drag and drop methods. They may also limit the scope of the presented data using filters that limit data on individual dimensions, hierarchies and levels. The OWB has a similar methods of data presentation. Another way is to build own application with an interface to the data warehouse structure, e.g. using JDBC OCI8.
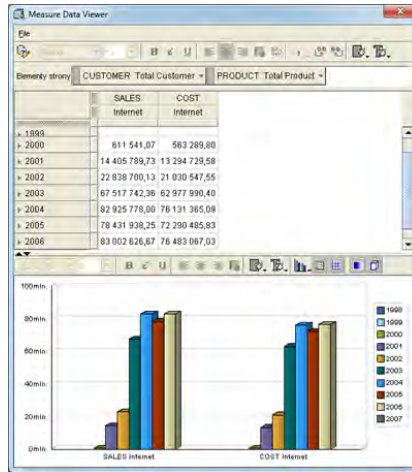
Fig. 17. Sample data from OLAP cubes (AWM or OWB application).

In the window Measure Data Viewer, data can be presented in the form of many types of charts (eg bar, line, pie). Fig. 18. shows the possibility to present data in a pie chart.
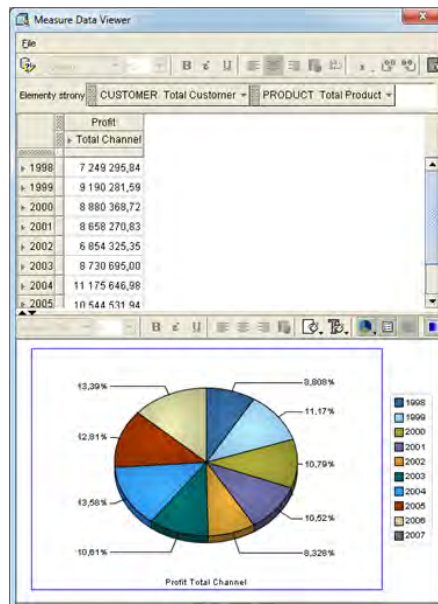
Fig. 18. Sample data from OLAP cubes (pie chart).

Fig. 19. presents a method to build reports based on the Excel worksheet in which the imported data retrieved from the materialized views created in the process of maintenance OLAP cubes. All necessary data is stored in a xls file. Reports can be created in a dynamic manner depending on the needs and presented graphically. The xls file consists all imported data from Cube.
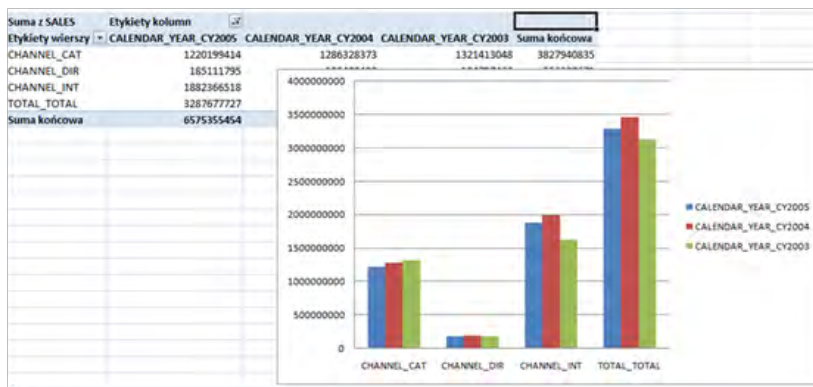
Fig. 19. Sample data from OLAP cubes in Microsoft Excel.

5.7.   Data exploration with Oracle Data Mining

Data mining is the analysis step of the "Knowledge Discovery in Databases" process. Data mining is the computational process of discovering patterns in large data sets involving methods at the intersection of artificial intelligence. The overall goal of the data mining process is to extract information from a data set and transform it into an understandable structure for further use. Data exploration operation is performed using tools Oracle Data Mining.

The most popular data mining techniques are:
- statistical modeling,
  - o   linear models,
  - o   regression models,
  - o   discriminant analysis.
- decision trees,
- neural networks,
- genetic algorithms.

The Business Intelligence systems, data mining techniques are widely used to solve practical problems, such as:
- evaluation of teaching ability based on the personal data and the student's predisposition and its history of its learning outcomes,
- risk analysis, identification of students who have a predisposition to take more advanced topics from different areas and the selection of these areas in terms of student,
- search hidden trends contained in time intervals such as the detection of variations in the process of acquiring knowledge,
- segmentation is grouping students with similar profiles and behaviour.

Classification is one of the most used data mining techniques. It consists in creating of a model called classifier. Classifier can be assign a new, previously unseen object on the basis of the experience gained during the exploration of the provided data.

Two algorithms for data classification namely, Naive Bayes and Support Vector Machine (SVM) are some of the most commonly used algorithms from such area. Figures 20 and 21 show Predictive Confidence for Naive Bayes algorithm and SVM.
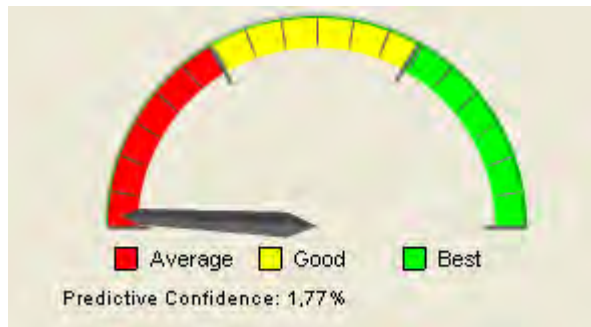
Fig. 20. Predictive Confidence for Naive Bayes algorithm.
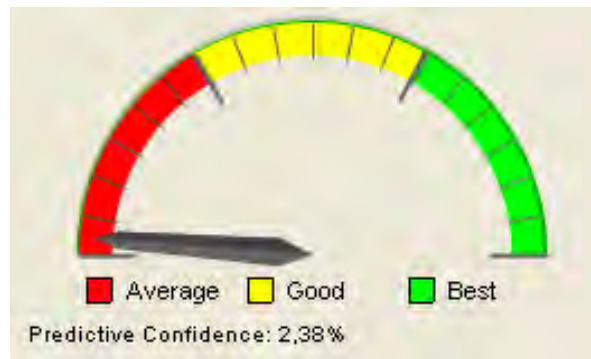
Fig. 21. Predictive Confidence for SVM algorithm.

5.8. Summary

The paper presents modern techniques of data modeling and processing, collected by the education institutions. It presents the process of multidimensional data modeling (include the transformation of logical structure to relational structure and next transformation to Multidimensional Model of warehouse in star or snowflake schema). It also shows the ETL process and methods of creating OLAP cubes by use of ORACLE tools to support decision making by business analysts. An approach based on data mining techniques allows analysts to capture certain features in customers, to offer dedicated products for the customer groups. Based on customer behavior can be concluded about his tendencies to their certain behaviors and preferences.

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Data integration in remote teaching and testing systems in the InfoSphere Federation Server environment

6.1.   Introduction

Modern educational, scientific and research institutions need tools to ensure the integration, transformation and processing of data in distributed systems. The ultimate goal of such activities is the opportunity to work on complete data, and thus, a full analysis of the trends and a search for existing relationships. The development of information technology has facilitated this task.

Wishing to improve the quality of teaching, educational institutions are forced to offer customers new educational products, regardless of their geographical location. This imposes a need to work in distributed systems, often with existing hardware and software environments (database environments). Each region may be specific and can be addressed to a specific group of listeners. This situation requires tools of educational institutions to support the process of data integration. Such an approach is particularly important in the development of a proper structure of a data warehouse and provides for its subsequent use with Business Intelligence tools.

Within the standard DB2 licence installed on Linux, UNIX and Windows (DB2 LUW for short), we can federate data with other databases DB2 LUW and Informix databases.

To combine data from databases of other manufacturers, we need to install additional libraries on DB2 to access these databases. Commercial libraries are offered in the InfoSphere Federation Server. This product was once named the WebSphere Federation Server, when the IBM introduced the brand InfoSphere, which grouped products and tools for data integration,

Libraries giving access to databases produced by other manufacturers can be installed on the existing DB2 installation. When we install the InfoSphere Federation Server we indicate the place where DB2 has been installed. Each independent DB2 installation is also referred to as a DB2 copy. This is due to the fact that DB2 allows multiple DB2 installation in different directories. Each installation can be independently updated with Fix Packs.

Of course, libraries giving access to other manufacturers' databases cannot exist without the local DB2 installation, therefore the InfoSphere Federation Server installer informs that if necessary, it can install DB2 in the Enterpise edition. Included with the InfoSphere Federation Server it can be applied only to a limited extent, i.e. it can be used to create a federated database (all the data is stored on external databases), but you cannot use this licence for local storage and data management. In this case, you need to have an appropriate DB2 licence.

6.2.   Installing IFS on the existing DB2 infrastructure

When installing the components of the Information Integration product group, they should be linked to the DB2 copy. Starting with version 9.1, there can be a number of DB2 copies installed on the same computer. After clicking <Next> one will be prompted to link the components of the Information Integration programme with the DB2 copy. The components of the Information Integration programme will be installed in the same directory as the related DB2 copy.

During the installation process it is reported that there are components of the IBM Information Integration product in the system. Then, choose one of the following options:

- Install the components of the Information Integration product with an additional DB2 copy.
- Update the installation of the IBM Information Integration product, which is associated with the existing DB2 copy.
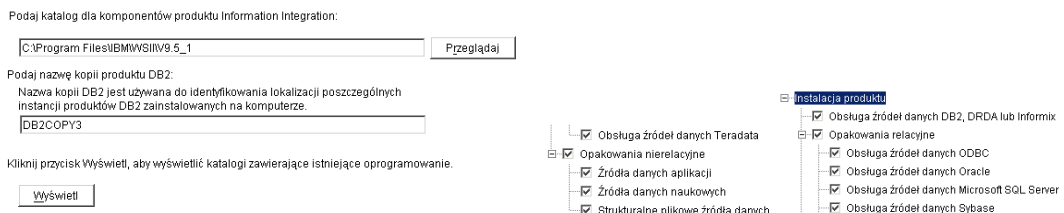
Figure 1. A view of the catalog selection and the components installed.

The installation process allows selecting relational and non-relational data source wrappers. Relational wrappers provide access to relational databases of other manufacturers. Non-relational wrappers allow creating connections to non-relational data sources, such as flat files, for example, Excel.

Relational wrappers
- manage the following data sources: Oracle, Microsoft SQL Server, Sybase, Teradata allows, which enables the users and the applications to transfer distributed requests for data managed by these systems.

Non-relational wrappers
- manage application data sources, which means using the application in order to access non-relational base data. Raw data can be saved in many standard and non-standard formats. The management of application data sources includes such wrappers as: BioRS, Entrez, WBI and Web Services.
- the management of scientific data sources has been developed specifically for use in connection with natural sciences, such as genetic engineering, protein engineering, bioinformatics and chemical informatics. It includes such wrappers as: BLAST, HMMER and Script.
- the management of structural data sources provides access to files with content in the form of tables. It contains text file wrappers with content presented in tables, Microsoft Excel and XML.
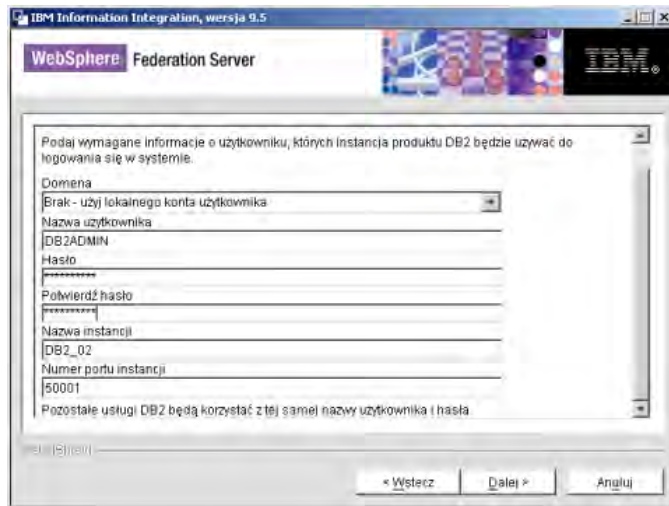
Figure 2. A view of an authorization window.

In cases where DB2 installation is done with the federation server, in the Windows system we must specify the user who will be used to start the DB2 services. (The user must belong to an already existing group DB2Admins).

During the installation you need to add a licence to the installed products.

Checking current licences is available in the option DB2 Licence Center or using the command *db2licm-l.*
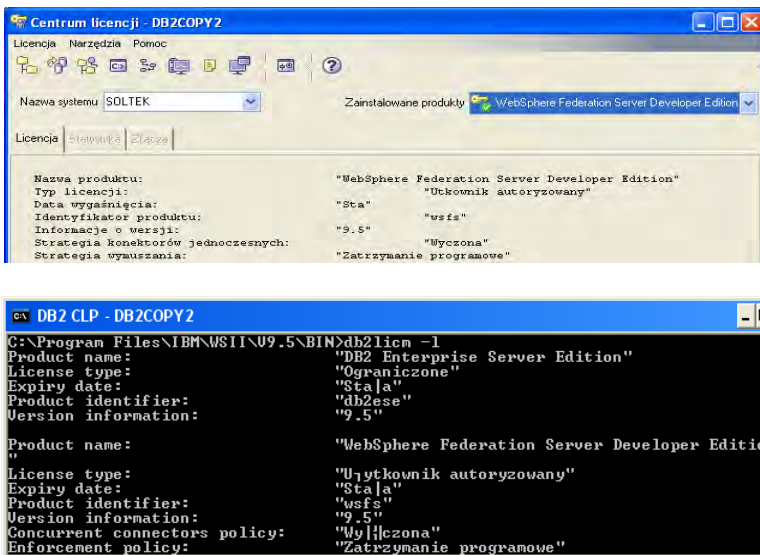
Figure 3. A view of the License Center and a window with the db2licm command.

6.3. IFS configuration for cooperation with the associated environment

By default, for security reasons after the installation of the IFS, the federated server option for the DB2 instance is disabled. The option should be activated with the command presented in Listing 1. Figure 4 shows the result.

```
db2 update dbm cfg using FEDERATED YES
```

Listing 1. The command to activate the federated server in the DB2 instance.

Figure 4. A view of the command to configurate the server – FEDERATED.

6.4. Creating objects of the federated database in the ORACLE system

The InfoSphere Federation Server (IFS) requires a specific procedure in order to obtain the federated database environment. The application refers through the IFS to heterogeneous data and obtains a fully transparent data structure. It does not penetrate the dialect notation of the SQL language, which is so different for environments (e.g. PL / SQL - Oracle, Transact SQL - MSSQLServer, SQL, PL-DB2).

It is possible to apply the definition of the ORACLE federated server on condition that together with the DB2 instance (IFS) you install a client application with an established TNS handle for the ORACLE database.

The TNS configuration can be performed using the ORACLE NetManager graphical environment (Fig. 5), which makes an entry in the tnsnames.ora file, located in the client application. Such an entry can be done manually in this file.
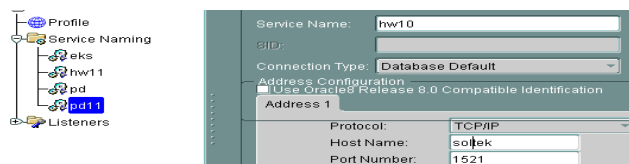
Figure 5. A view of the Naming Service Configuration in the Oracle Net Manager.

A sample configuration of the TNS connection in the Oracle environment is presented in Figure 5 and Listing 2 .

```
# Generated by Oracle configuration tools.
HW10 = (DESCRIPTION = (address_list =
(ADDRESS = (PROTOCOL = TCP) (HOST = Soltek)
(PORT = 1521)))
(CONNECT_DATA = (SERVICE_NAME = h)))
```

Listing 2. The contents of the configuration file tnsnames.ora in the Oracle environment.

The configuration of a heterogeneous environment using IFS is carried out according to the following steps:
- the definition of the server for the data source and the selection of the library (wrapper) used for access to this source

In case of no environment variable setting: ORACLE_HOME, it can be set in the file .. \ IBM \ OldVillage \ V9.5 \ cfg \ db2dj.ini.

If there are several client applications installed on your computer (client: 10.g, 11.g, Developer), you can specify in this file from which tnsnames.ora the service name will be taken. This file defines the path with the settings of the client application directory.

A sample entry in the db2dj.ini file is presented in Listing 3

```
ORACLE_HOME = C:\ora\product\11.1.0\client_1
```

Listing 3. db2dj.ini file content.
- the definition of nicknames for remote data source objects.

The steps involved are given in sections 4.1 – 4.6, as an example of connecting the DB2 and Oracle environments.

6.4.1. Determination of data sources and wrappers

Identification of the data source and the name of the wrapper is implemented by following the instructions shown in Listing 4

```
CREATE WRAPPER NET8 LIBRARY 'db2net8.dll';
```

Listing 4. Identification of the data source and the name of the wrapper
The settings of the wrapper are shown in Table 1

Table 1. Options of wrapper settings.

Parameter	Description
DB2_FENCED	Determines whether the package runs in the protected mode or in the trusted mode. The default value is 'N' – the wrapper operates in the trusted mode.
DB2_UM_PLUGIN _LANG	Specifies the language for the user mapping plug-in. Valid values are 'Java' and 'C'. Default value is 'Java'.
DB2_UM_PLUGIN	Specifies a string which is case sensitive for the name of the class that corresponds to the mapping of the repository class by the user.
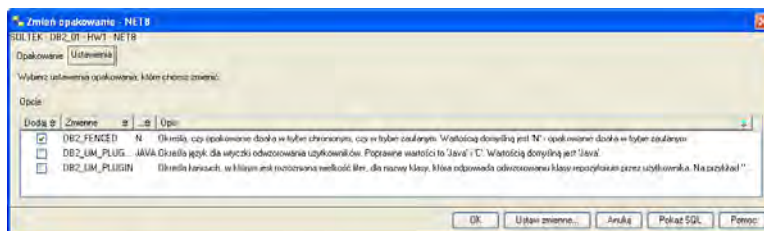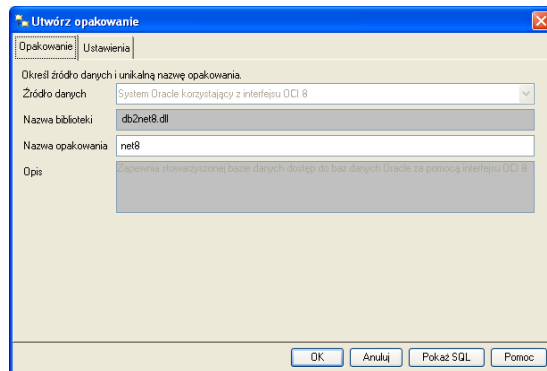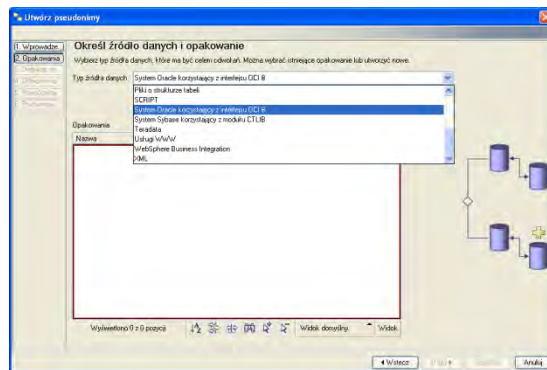
Figure 6. A view of the specification of the data source, wrapper and wrapper setting options.

6.4.2. The definition of the server for the data source

For defining the server for the data source use the instructions presented in Listing 5

```
CREATE SERVER TYPE HW ORACLE POLSKA '10g 'WRAPPER NET8
OPTION S (ADD NODE' HW ');
```

Listing 5. Defining the server for the data source.

Figure 7 shows a graphical interface for the server definition for the ORACLE data source.
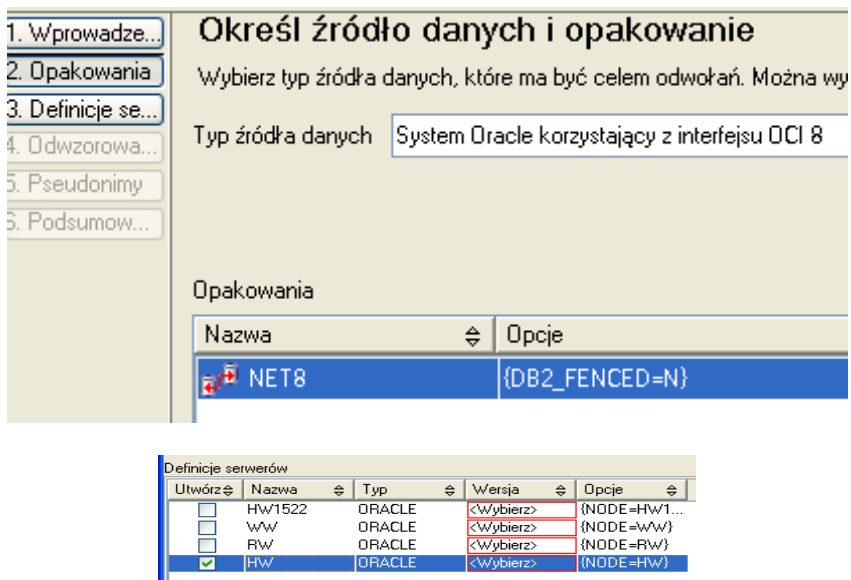
Figure 7. A view of the ORACLE data source and server definition.

The settings of environment variables for the data source server definition are presented in Table 2.

Table 2. Options of environment variables settings.

Parameter	Description
ORACLE_BASE	Specifies the root directory of the Oracle client directory tree.
ORA_NLS33	Specifies the location of NLS data files for Oracle Version 8 and 9
TNS_ADMIN	Specifies the location of the tnsnames.ora file, if it is not on the default path.
ORACLE_HOME	Specifies the full path to the directory in which you installed the Oracle client software.
NLS_LANG	The wrapper uses this value to convert the Oracle code page.

6.4.3.   User mappings used to establish a remote connection (the mapping of the rights)

Defining user mapping to establish a connection with a remote data source server is implemented by the instruction shown in listing 6.

```
CREATE USER MAPPING FOR SERVER HW DB2ADMIN OPTIONS (ADD
REMOTE_AUTHID 'scott', ADD REMOTE_PASSWORD 'tiger');
CREATE USER MAPPING FOR HENRY HW SERVER OPTIONS (ADD
REMOTE_AUTHID 'scott', ADD REMOTE_PASSWORD 'tiger');
```

Listing 6. Instructions for user mapping to establish the remote connection.

Figure 8 shows the graphical interface of user mapping when making a connection with a remote data source server (Oracle).
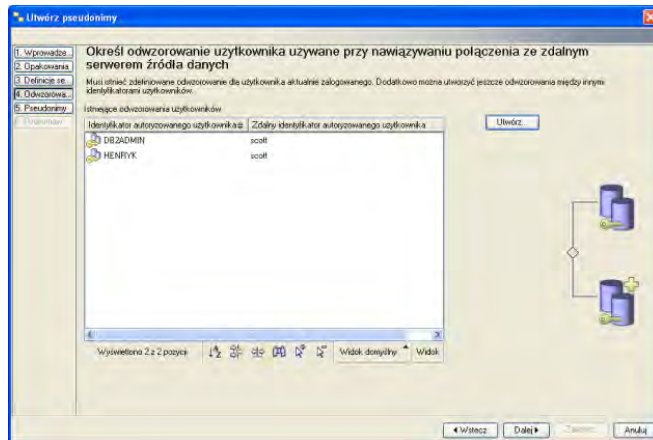
Figure 8. A view of user mapping when making a connection with a remote data source server.

User mapping settings are shown in table 3

Table 3 User mapping setup options

Parameter	Description
USE_TRUSTED_CONTEXT	Specifies whether the user mapping is trusted.
REMOTE_PASSWORD	Specifies the password for REMOTE_AUTHID.
FED_PROXY_USER	Specifies the authorization ID used to establish all outbound trusted connections when the incoming call is not trusted.
REMOTE_AUTHID	Specifies the remote user ID to map onto the local user ID.
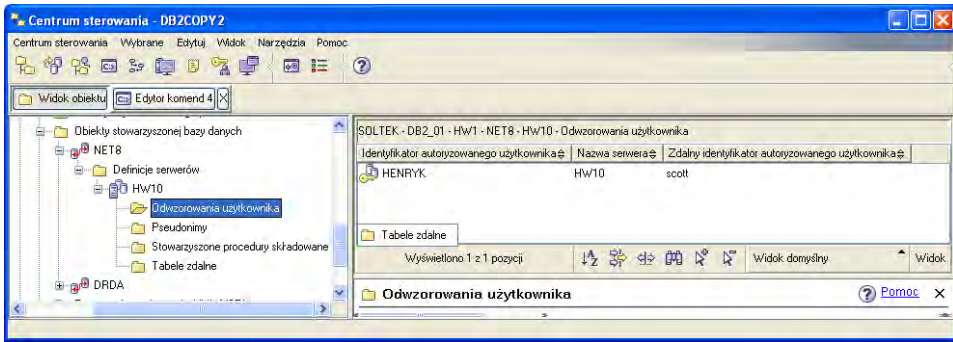
Figure 9. A view of mapping authorized users.

6.4.4. Defining nicknames for remote data source objects

To define nicknames for any of the tables from the SCOTT schema, use the instruction CREATE NICKNAME. Sample instructions for the definition of nicknames are presented in Listing 7.

```
CREATE NICKNAME FOR HENRYK.DEPT_O HW.SCOTT.DEPT;
CREATE NICKNAME FOR HENRYK.EMP_O HW.SCOTT.EMP;
CREATE NICKNAME FOR HENRYK.BONUS_O HW.SCOTT.BONUS;
CREATE NICKNAME FOR HENRYK.SALGRADE_O HW.SCOTT.SALGRADE;
```

Listing 7. Sample definitions of nicknames for the tables from the SCOTT schema.
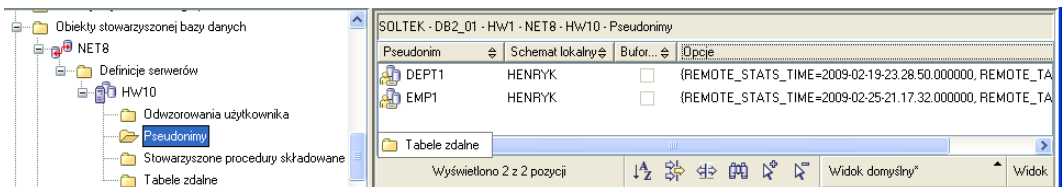
Figure 10. A view of the nicknames defined.

6.4.5. Defining associated stored procedures

To define an associated procedure (existing on the remote ORACLE server), use the instruction CREATE PROCEDURE. A sample instruction of defining an associated procedure is presented in Listing 8.
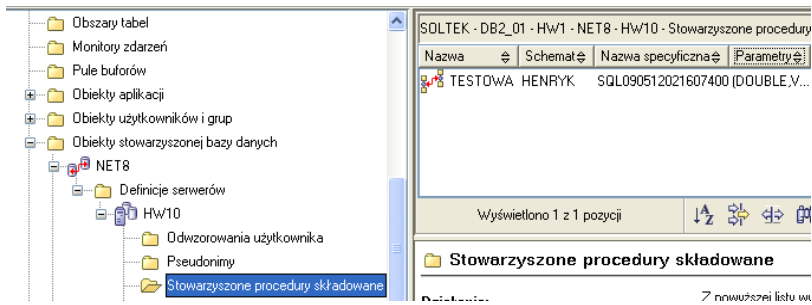
Figure 11. A view of associated stored procedures.

```
CREATE PROCEDURE HENRYK.TESTOWA SOURCE SCOTT.TESTOWA
NUMBER OF PARAMETERS FOR SERVER HW10 3
MODIFIES SQL DATA NOT DETERMINISTIC EXTERNAL ACTION
```

Listing 8. The attachment of the associated procedure existing on a remote server.

The definition of a sample procedure on the Oracle server is shown in Listing 9.

```
CREATE OR REPLACE PROCEDURE TEST
(A1 IN NUMBER, IN VARCHAR2 a2, a3 IN VARCHAR2 DEFAULT
'Lodz') AS
BEGIN
insert into scott.dept values, (a1, a2, a3);
Exception
when others then rollback;
END;
```

Listing 9. An example of the definition of an associated procedure (ORACLE).

The calling of the procedure on a remote server is presented in Listing 10

```
call test (12, 'aaa', 'bbb');
```

Listing 10. Calling a procedure on a remote server.
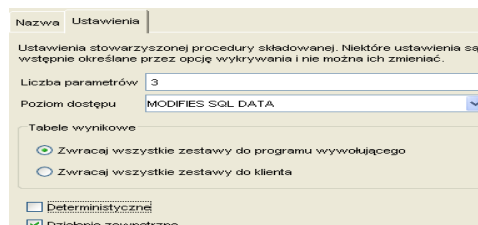
Figure 12. A view of the properties of the associated stored procedure.

The setting page of the properties of the associated stored procedure presented in Figure 12 contains the following choices:

Access level
- determines the level of access to data for SQL statements contained in the stored procedure in the data source. If there is a discrepancy between what was specified for the associated stored procedure and what is actually executed by the stored procedure in the data source, data inconsistency may occur. For options not available in the data source, select the value MODIFIES SQL DATA. If this option is specified but it is not consistent with the value of the stored procedure in the data source, error is returned.

It is possible to set the following values:
- NO SQL
- CONTAINS SQL
- READS SQL DATA
- MODIFIES SQL DATA

Result tables
- - this option specifies the location to which result sets from the stored procedure are returned. Result sets can be returned to the customer or to the calling program.

It is possible to set the following values:
- WITH RETURN TO CLIENT ALL (returns all sets of tables to the executing program)
- lack of options (returns all sets of tables to the client)

Deterministic
- this option specifies for the stored procedure if the same results are always returned - if this value is not consistent with the value of the stored procedure in the data source, error is returned.

It is possible to set the following values:
- DETERMINISTIC
- NOT DETERMINISTIC

External action
- determines whether the associated stored procedure performs an action changing the state of an object that is not managed by the database manager. If this option is removed, the federated database applies optimization. The optimization strategy assumes that the associated stored procedure has no external effects. If this value is not consistent with the value of the stored procedure in the data source, error is returned. Do not change this value if it has been generated by the detection option.

It is possible to set the following values:
- EXTERNAL ACTION
- NO EXTERNAL ACTION

6.4.6. Defining remote tables

In federated objects it is possible to create tables and constraints on the remote server. To add a new column to the remote table, use the Add Column window. On defining the table, define the parameters of the columns.

Figure 13. A view of the remote table definition window.

An example of a remote command to create a table is shown in Listing 11.

```
CREATE TABLE HENRYK.DEPT_REMOTE
(Deptno BIGINT NOT NULL,
DEPTNAME VARCHAR (20) NOT NULL,
LOC VARCHAR (18) WITH DEFAULT 'Lodz')
OPTIONS
(REMOTE_SERVER 'HW10', REMOTE_SCHEMA 'SCOTT',
REMOTE_TABNAME 'DEPARTMENT1');
COMMENT ON TABLE HENRYK.DEPT_REMOTE IS 'table on
Oracle';
```

Listing 11. A remote command to create a table.

An example of a remote command to create constraints for the table is presented in listing 12.

```
ALTER TABLE HENRYK.DEPT_REMOTE
PK_DEPT_REMOTE ADD CONSTRAINT PRIMARY KEY (deptno);
```

Listing 12. A remote command to create constraints for the remote table.
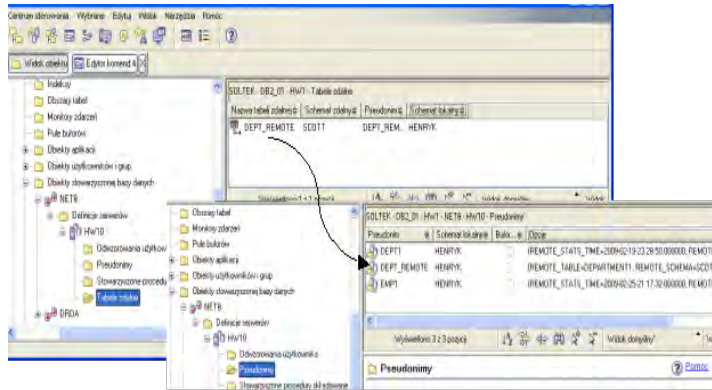
Figure 14. A view of the remote table definition visible under a nickname.

6.4.7. Examples of the use of associated objects (collecting data and transactions)

Object EMP1 is a nickname referring to the EMP table from the SCOTT schema (of the ORACLE database system).

Since object EMP1 is placed in schema HENRYK, the basic inquiry takes the following form (Listing 13)

```
SELECT ENAME, SAL, DNAME
FROM HENRYK.EMP1 E INNER JOIN HENRYK.DOSTAWCY D
ON E.DEPTNO = D.DEPTNO ORDER BY 2 DESC;
```

Listing 13. A request based on the local table and a synonym of the remote object.

An example of the execution plan for the inquiry above is shown in Figure 17. Purple indicates the operation on the remote data source.
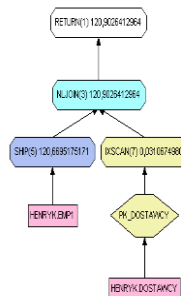
Figure 15. A view of the query execution plan.

An example of a joint inquiry UNION ALL for local and remote data sources is shown in Listing14.

```
SELECT E.ENAME, 'Rem' FROM HENRYK.EMP1 E
UNION ALL
SELECT E1.LASTNME, 'Loc' FROM EMPLOYEE E1
ORDER BY 2 DESC;
```

Listing 14. A request for local and remote data sources.

An example of a distributed transaction (the first command disables the autocommit option) is shown in Listing 15.

```
update command options using c off;
insert into dept1 values, (10, 'd1', 'W-wa');
insert into dept values, (11, 'd2', 'W-wa');
insert into dept1 values, (12, 'd3', 'W-wa');
delete from dept1 where deptno> = 10;
commit - or rollback;
```

Listing 15. An example of a distributed transaction.

In the above example the nickname DEPT1 defines the ORACLE remote data source while the DEPT table is a synonym of the local table DEPARTMENT (a sample SAMPLE database - DB2 system).

6.5.   Conclusion

The chapter presents the possibility of cooperation of heterogeneous database environments with each other. The presented commercial product InfoSphere Federeation Server by IBM is an effective platform for information exchange. The distributed database, existing physically on different hardware and software platforms, can be treated as a unity, i.e. as one coherent whole for client applications which cooperate with it. The distributed system operates as a normal centralized system. In distributed database systems the user does not know that the data they work with come from different computers and databases. Integration and access to distributed data allows you to perform a complete business analysis for educational, scientific and research institutions.

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GeoGebra possibilities in solving statistical tasks used by students

7.1. Introduction

Participants of the process of teaching and learning have more and more programs at their disposal to facilitate and support this process. There are both free and commercial programs. Mathematical programs can greatly facilitate calculation and sometimes also allow visualization of the problem. It is known that it is easier to understand and hence solve the task when we see a problem not only imagine. For solving school and matriculation tasks sudents can successfully use GeoGebra [1]. This program can also be used by both pupils and students to explore new areas of mathematics not covered in the curriculum [2].

In this work we will focus on the use of GeoGebra to solve problems in statistics both at the level of matriculation and at the level of studies. The following picture shows the possibilities which GeoGebra gives in this field of mathematics.

Screen 1. Statistics in GeoGebra.

Source: the authors' own.

Theoretical information is not as useful as its application in practice. Below the reader will learn about using GeoGebra to solve specific tasks in statistics.

Task 1 [3].

The median of a non-decreasing set of six numbers 1, 2, 3, a, 5, 8 equals 4. Then:

A. B. a = 2 and a = 3 C = 4 and D = 5

Using the possibilities of the slider, you can easily determine the value of the searched number a. GeoGebra will help us answer the question from the task, however, in this particular task the student should use it as a tool which supports and verifies the correctness of the calculations made in the traditional way - on paper.

Screen 2. Solving matriculation statistics tasks using GeoGebra.

Source: the authors' own.

Task 2 [4].

The following table presents some statistical data:

Table 1. Contractual statistics.

value	-3	-1	1	3	5
number	1	2	2	5	10

Source: the authors' own.

a) Calculate the arithmetic mean of the data.
b) Determine the variance of the data.
c) Calculate the standard deviation of the data with an accuracy of 0.01.

Screen 3. Solving a task in statistics using GeoGebra.
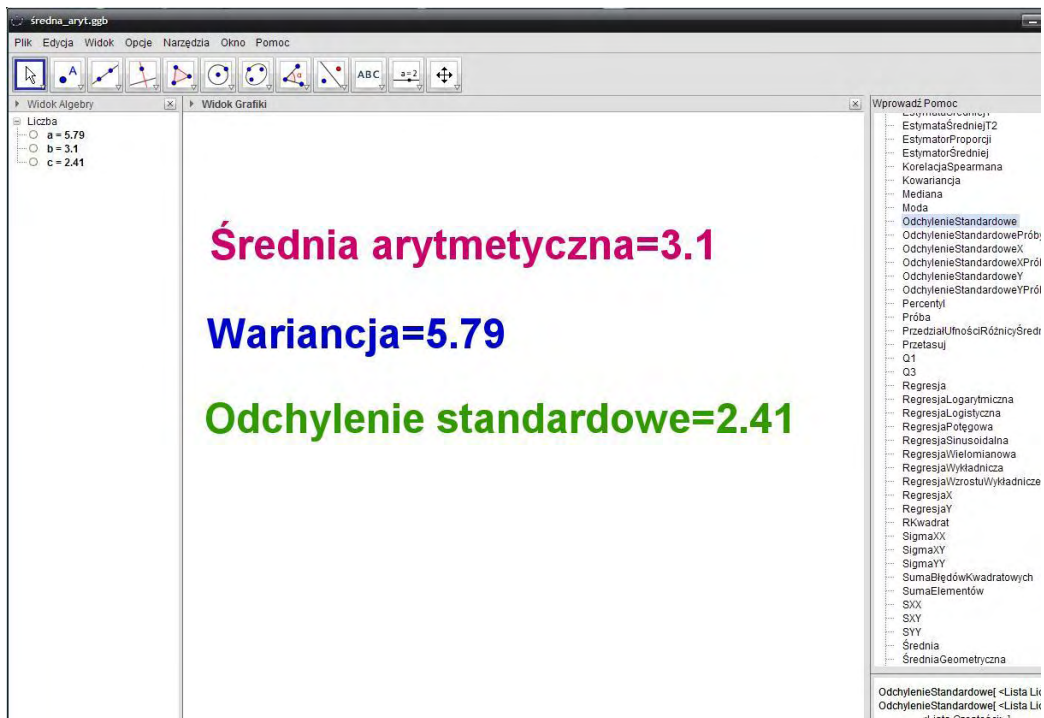
Source: the authors' own.

It should be noted that GeoGebra gives all the calculations with an accuracy to two decimal places. Thus, in this task the student received directly the standard deviation with the desired accuracy.

When examining the population in terms of two features at the same time, which are in mutual relationship, one deals with a two-dimensional analysis. With more characteristics we deal with a multidimensional analysis. The study of the relationship between several traits is carried out by correlation and regression analysis. Correlation analysis measures the strength and direction of the relationship, whereas regression analysis describes the shape of the relationship [5] . GeoGebra has a module that allows to carry out regression analysis. The following model shows contractual values of the two features: X and Y.

Screen 4. A linear regression model, statistical parameters and a scatter plot in GeoGebra.
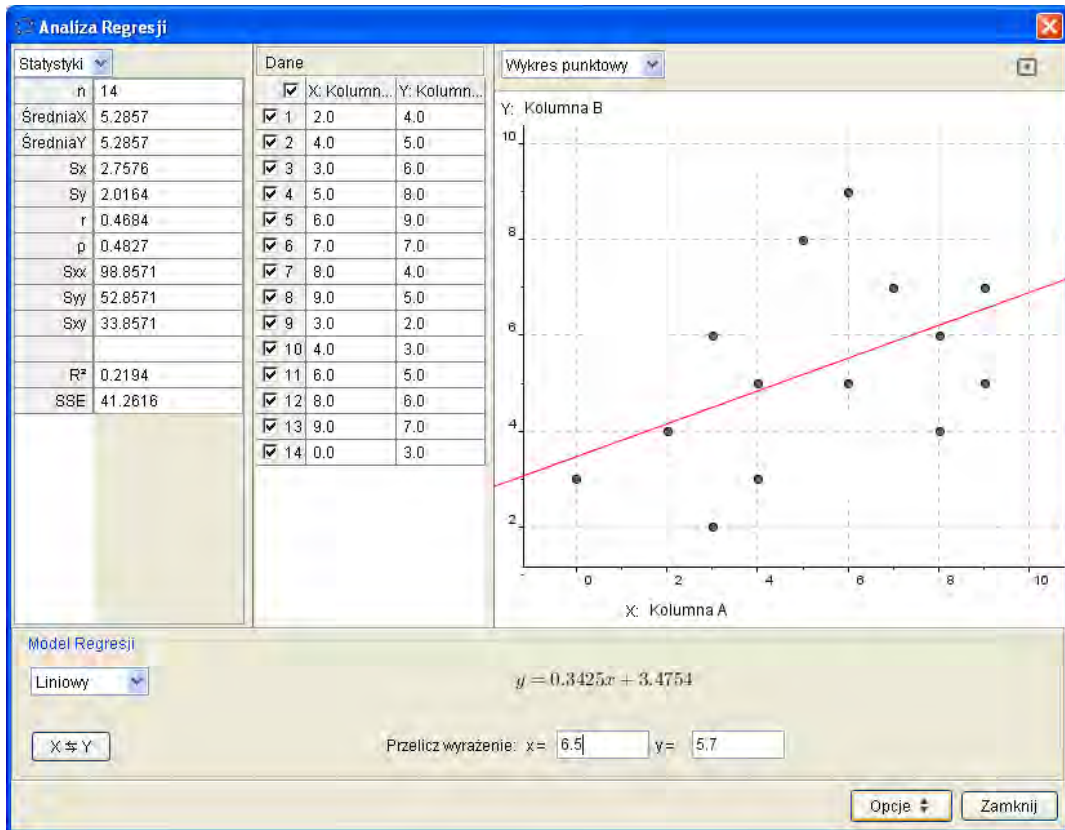
Source: the authors' own.

In this program it is possible to predict [6] or forecast, look at the middle bottom part of the screen "Calculate the expression"

Screen 5. A regression model (a form of a polynomial of degree 2), statistical parameters and a scatter plot in GeoGebra.
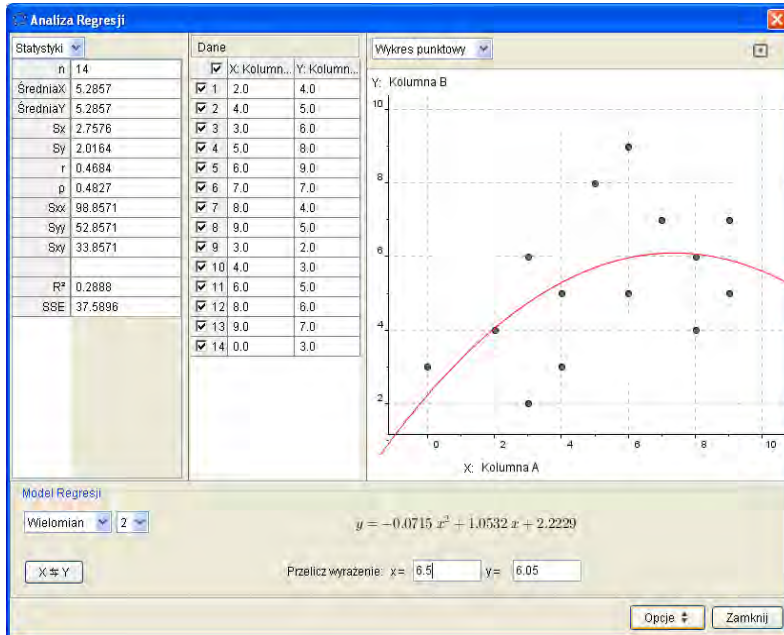
Source: the authors' own.

Screen 6. A regression model (polynomial of degree 4), statistical parameters and a scatter plot in GeoGebra.
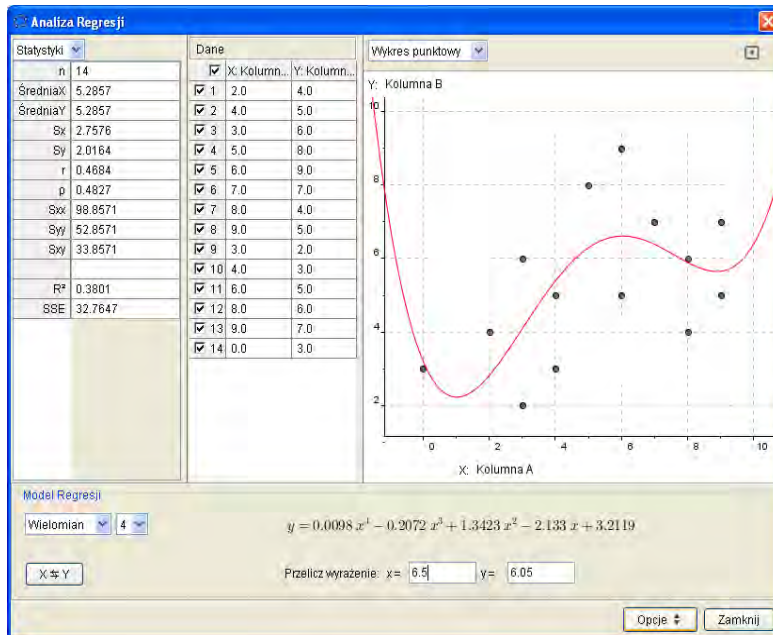
Source: the authors' own.

The Module *"Statistics of one variable"* allows the calculation of the basic characteristics of descriptive statistics and provides data in the form of a histogram (where the number of columns depends on the number of classes (categories) adopted for the analysis. Numerical characteristics called descriptive parameters are used for the quantitative comparison of statistical properties. Discriptive parameters of a statistical population are numbers which synthetically define the characteristics of the surveyed population. The main task of these parameters is to determine the properties of the distributions of the tested population and compare several communities in terms of the same feature and the same population in terms of a number of different features [7].

Screen 7. Basic characteristics of descriptive statistics and a histogram (6 classes) in GeoGebra.
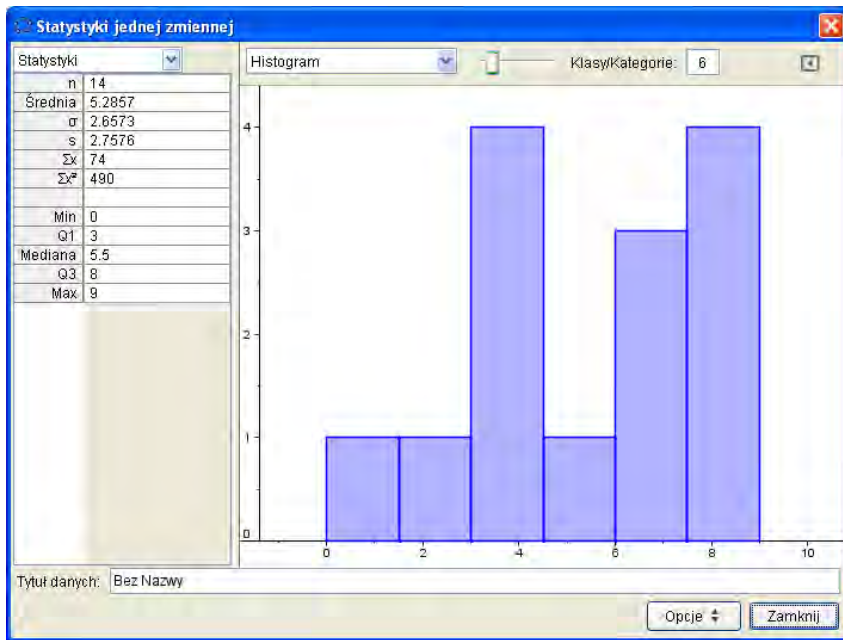
Source: the authors' own.

Screen 8. Basic characteristics of descriptive statistics and a histogram (9 classes) in GeoGebra.
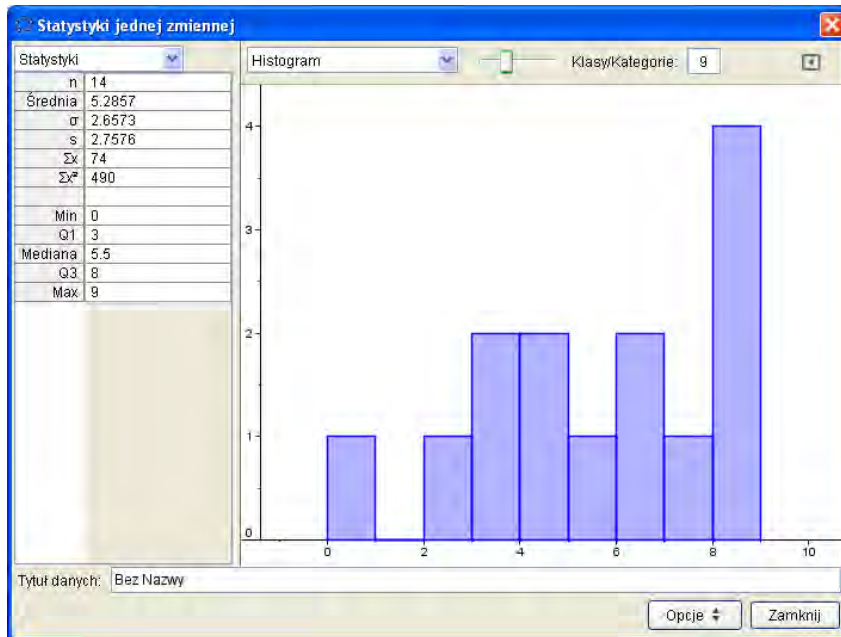
Source: the authors' own.

In addition, there is a possibility in GeoGebra to draw conclusions about the entire population based on a statistical sample, that is its portion. Statistical inference or mathematical statistics consists in:

- estimation, ie, estimating distribution parameters of the studied characteristic in general population,
- verification (testing) of statistical hypotheses concerning the distribution of the characteristic in general population, the relationship between the measured traits or the compliance of the schedules of the studied traits [8].

Screen 9. The confidence interval for the mean - normal distribution Z and a histogram GeoGebra.
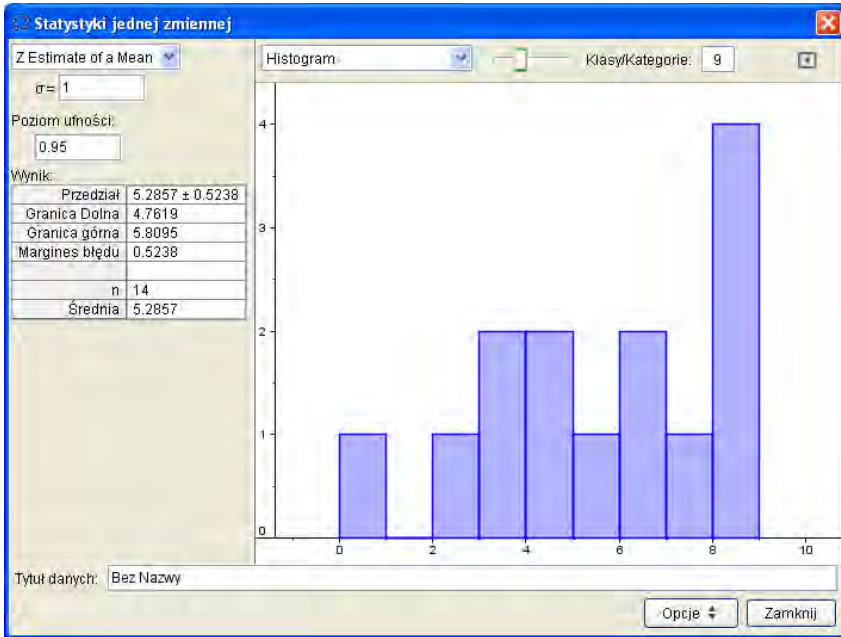
Source: the authors' own.

Screen 10. A test for the mean - normal distribution Z and a histogram GeoGebra.
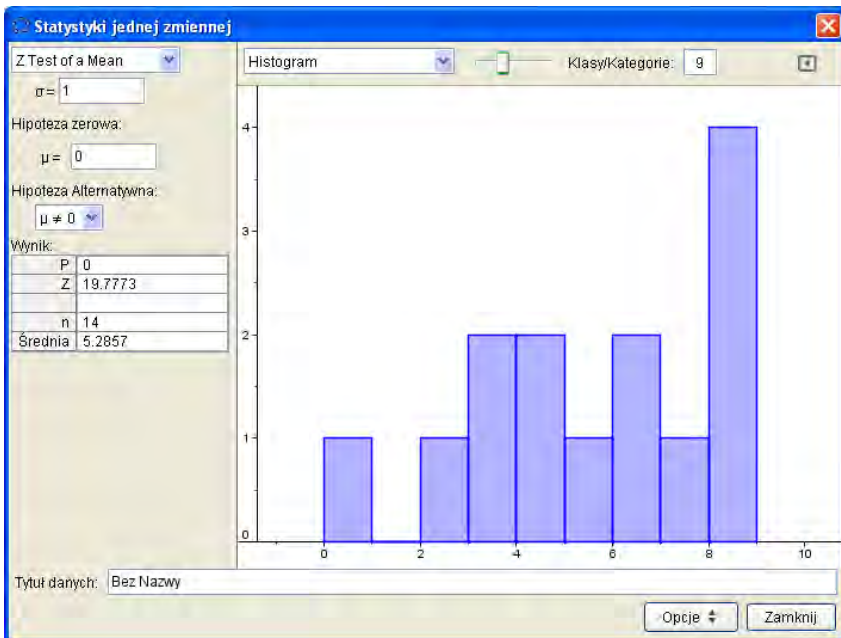
Source: the authors' own.

Screen 11. A test for the mean (small sample) and a histogram in GeoGebra.
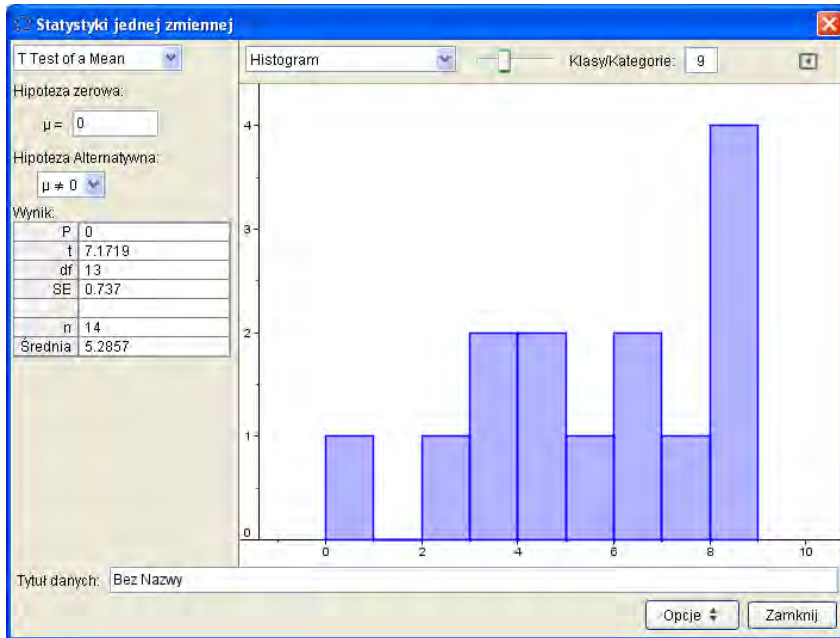
Source: the authors' own.

Screen 12. Box plots of two variables in GeoGebra.
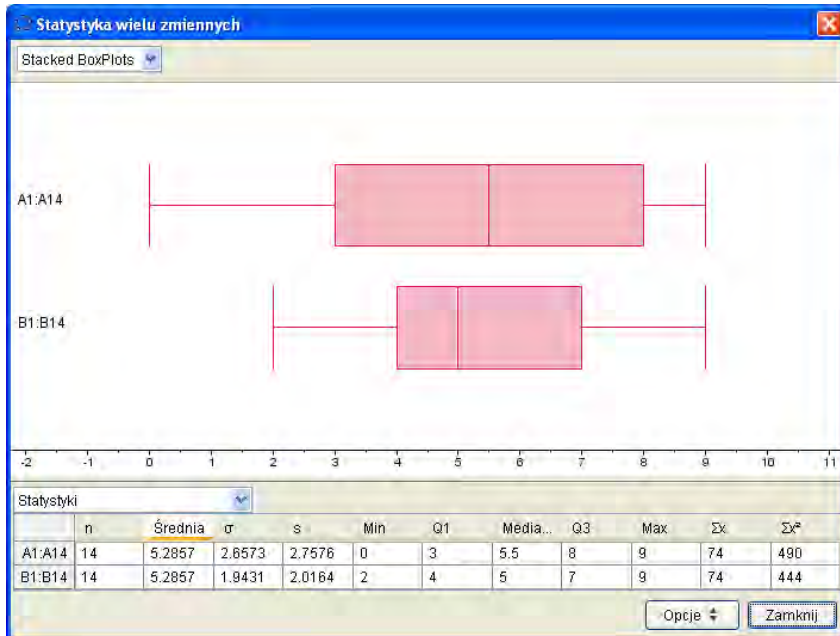
Source: the authors' own.

Screen 13. A test for the mean (small sample), a histogram and a frequency table in GeoGebra.
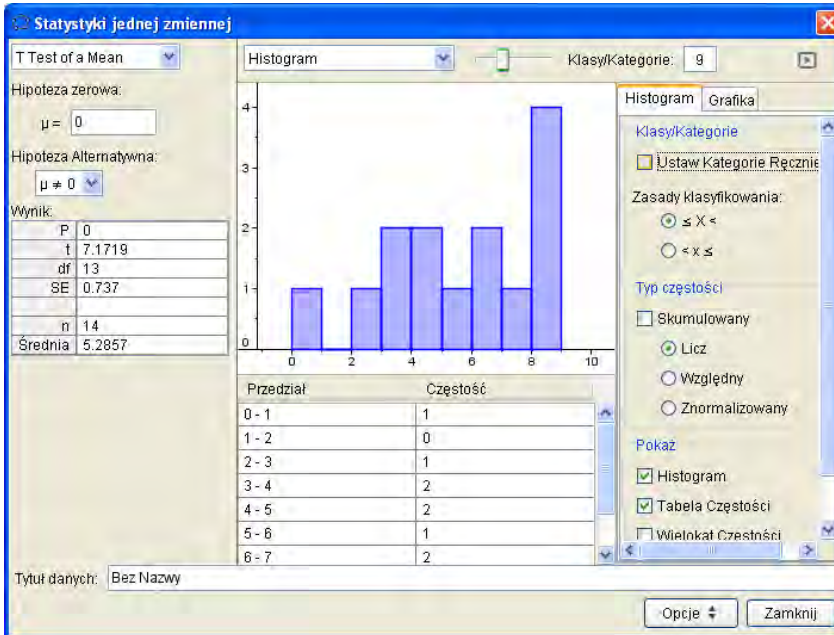
Source: the authors' own.

Screen 14 A t-student's test - the case of connected (dependent) variables, and box plots of variables in GeoGebra
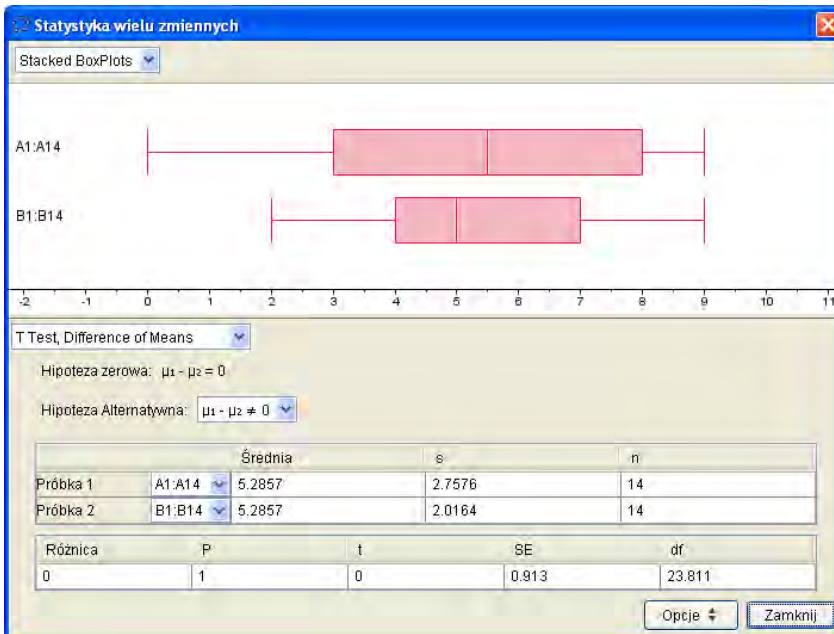
Source: the authors' own.

Screen 15. Estimation - the case of connected (dependent) variables, and box plots of variables in GeoGebra.
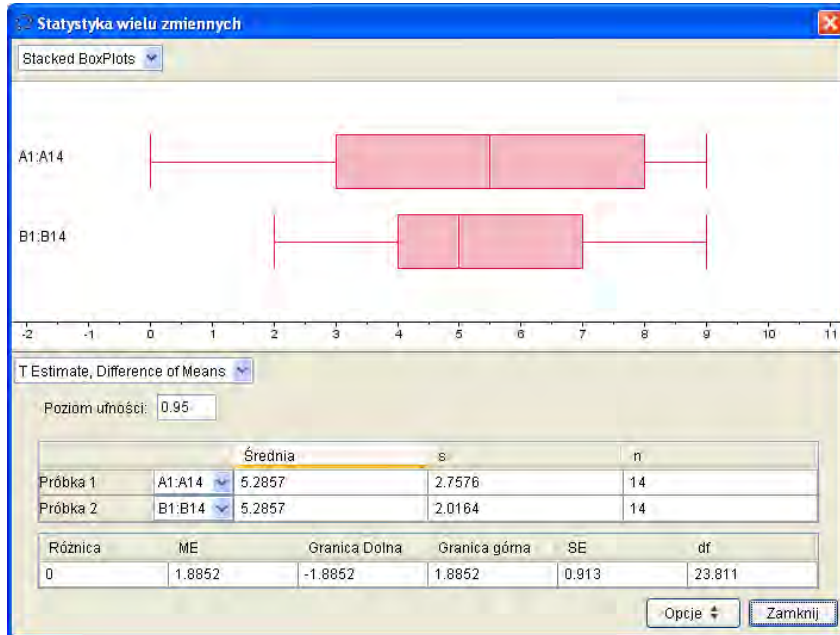
Source: the authors' own.

Screen 16 A sample distribution of students' height with the expected value of 172 cm and a standard deviation of 10 cm and P ($160 \leq X \leq 182$) in GeoGebra
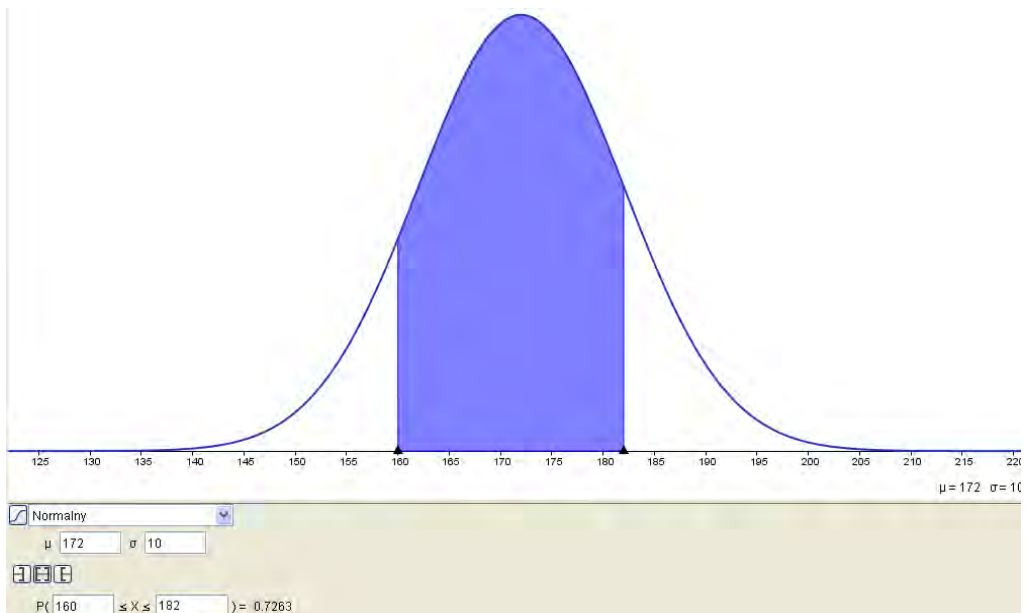
Source: the authors' own.

Screen 17. A sample distribution of students' height with the expected value of 172 cm and a standard deviation of 10 cm and P (X≤160) in GeoGebra.
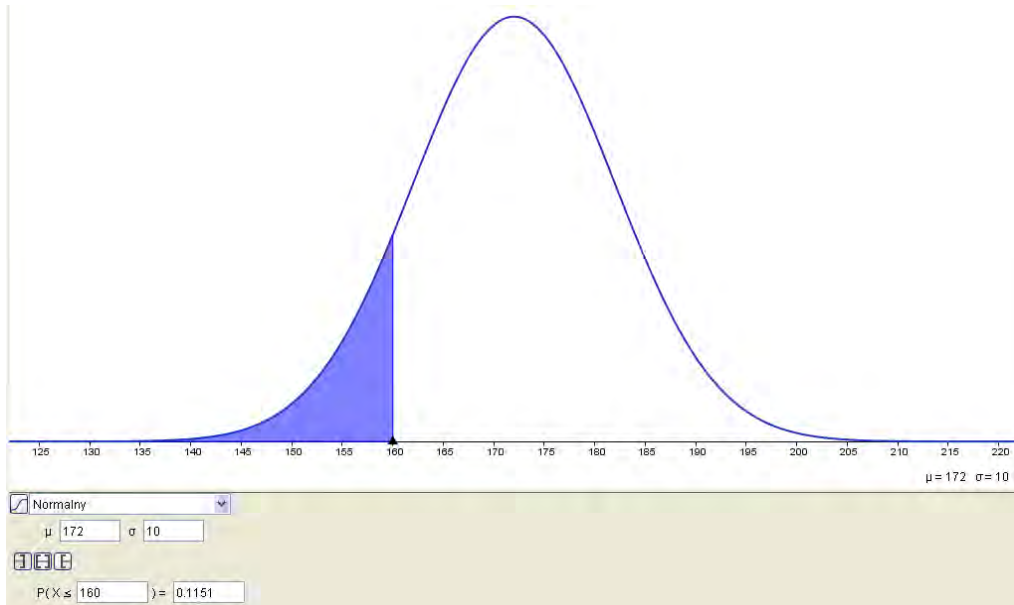
Source: the authors' own.

Screen 18 A sample distribution of students' height with the expected value of 172 cm and a standard deviation of 10 cm and P (190≤X) in GeoGebra
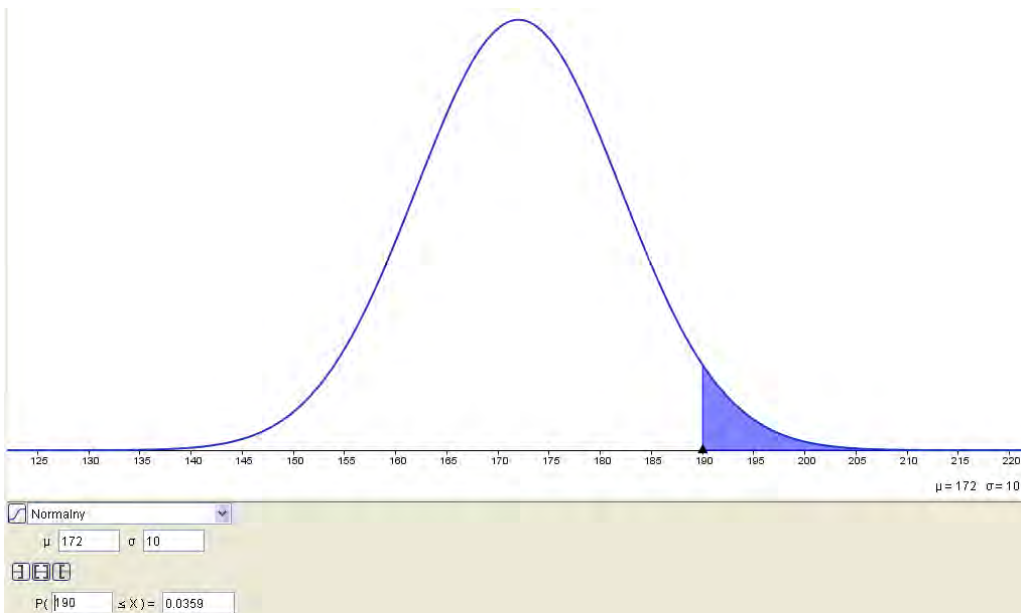
Source: the authors' own.

Poisson's distribution

Poisson's distribution was applied, among other things, in nuclear physics, for example, to record particles by the Geiger-Muller counter, the dissociaton of radioactive elements but also the timing of incoming telephone calls, etc.

Task [9].

There was a study of the distribution of flying bombs that fell on London during the Second World War. One area was divided into $N = 576$ parts of an area equal to ¼ km each. The following table shows the number of N_k of these parts, hit by exactly k bombs:

$$\left(T = \sum k N_k = 537, \lambda \approx \frac{T}{N} = 0{,}9323 \right)$$

k	0	1	2	3	4	5 and more
N_k	229	211	93	35	7	1
$N \cdot p(k;0{,}9323)$	226.74	211.39	98.54	30.65	7.14	1.57

Compliance with the model $\dfrac{N_k}{N} \approx p(k, \lambda)$ is striking.

Exponential distribution

Task [10].

Random variable X has an exponential distribution and $VarX = \dfrac{1}{9}$.

Write the density of probability, calculate the quantile of order $\dfrac{3}{4}$.

It is easy to see that $\lambda = 3$ and so the probability density is:

$$f(x) = \begin{cases} 0 & dla \quad x < 0 \\ 3e^{-3x} & dla \quad x \geq 0 \end{cases}$$

Screen 19. A chart of probability density for the variable of exponential distribution with the use of GeoGebra.
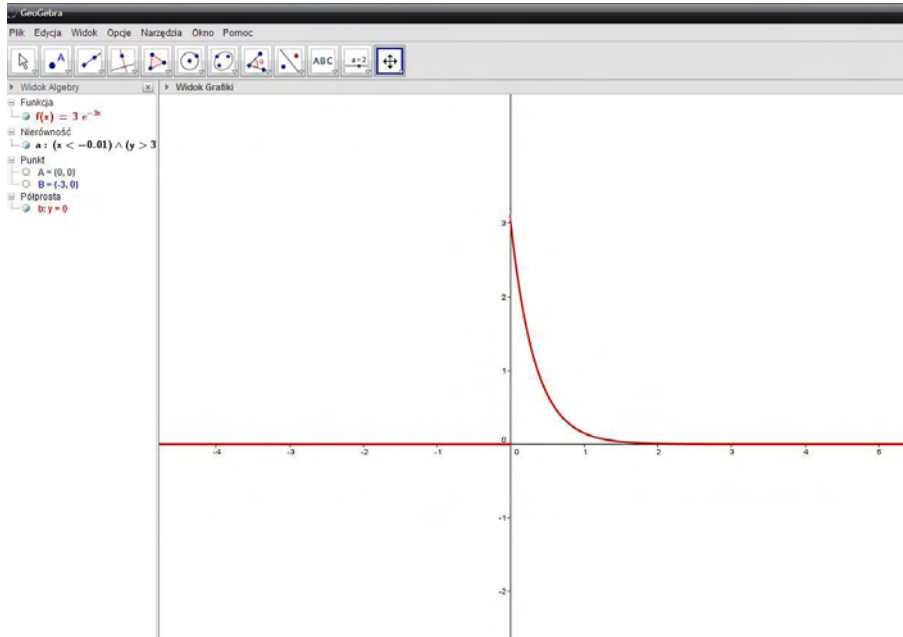
Source: the authors' own.

Screen 20 Determination of the quantile of order 3/4 using GeoGebra
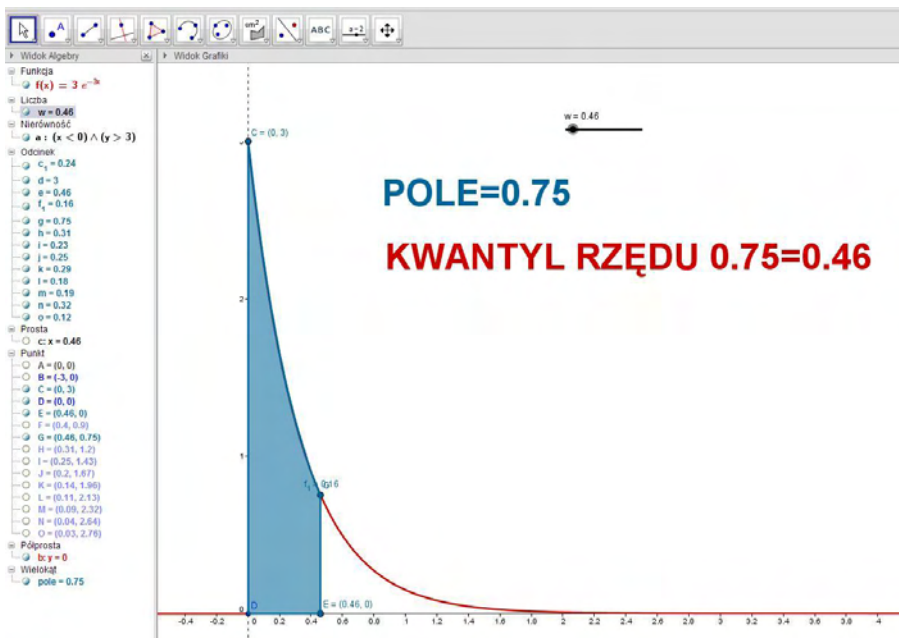
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7.3.   Footnotes

1. Kucner J., Galewska E., Kisiel K., Stosowanie darmowego oprogramowania matematycznego do rozwiązywania zadań maturalnych, w: System informatyczny zdalnego egzaminowania - strategia, logika systemu, architektura, ewaluacja (platforma informatyczna e-matura) (red.) Wiak S., Szumigaj K., Wydawnictwo Politechniki Łódzkiej, Łódź 2013, s. 142-167.
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Teaching mathematics using a learning platform

8.1. Introduction

A great number of pupils learning in high schools have difficulty in solving matriculation exam problems. Those occur not only at extended exam level but also when the basic level is concerned. What prevents a student from solving a problem are a lack of time as well as deficiencies in knowledge and abilities. What should not be forgotten is the fact that not every problem can be dealt with using repetitive methods. Some examples require unorthodox methods and clever calculating technics. Frequently, a pupil left to solve a problem fails to do so and, instead, realises they lack the ability to succeed. Sometimes, however, it is merely a tip that will allow a pupil to achieve their goal. In such a case, e-learning turns out to be a successful method of conveying knowledge. The project "Mathematical Emergency E-Services" is an example of learning platform being extremely useful. Within the scheme pupils of Łódź Voivodeship were offered help in solving matriculation exam problems and the assistance was available at learning platform 5 times a week, 5 hours a day. It is of great significance that students were not supplied with complete solutions to their problems, but rather given some hints suggesting right approach. This thesis is to analyse a few examples of problems introduced by students.

8.2. Analysis of the interaction

This thesis will give a detailed account of the methods used during the given meetings on the learning platform. It will also provide an analysis of an interaction between a pupil and a tutor.

- Study of interactions: student Marcin - tutor

  Marcin joined in the conversation.

  Marcin [20:09:08]: Is anybody there?

  Wait for user acceptation

  Tutor1 [20:08:32]: Explain your problem with the exercises, please

  Marcin [20:09:35]: I have got the problem with quadratic equation

  Marcin [20:09:52]: with one exercise to be precise

Tutor1 [20:09:25]: Can you present me this exercise, I will solve it with pleasure

Marcin [20:10:25]: yes, ok

Tutor1 [20:10:28]: I am waiting for an exercise

Marcin [20:11:23]: **The surface area of rectangle is 12 m^2, one of its side is 1 m shorter than the secornd side. Calculate the perimeter.**

Marcin [20:11:36]: it should be solve by quadratic function

Tutor1 [20:11:05]: I will solve it soon

Marcin left the conversation.

Marcin [20:13:40]: I do not understand this p(x)

Marcin [20:13:40]: that p(x)

Marcin [20:13:54]: What does it mean?

Tutor1 [20:13:46]: You have to notice that the area is the function of variable x, but if you do not want, you don't have to write this

Marcin [20:14:50]: yes

Marcin [20:14:51]: ok

Tutor1 [20:14:06]: now you have to solve the equation

Marcin [20:15:01]: I know

Tutor1 [20:15:50]: You take to the consideration only possitive solution, do you know why?

Tutor1 [20:17:02]: Is it clear for you?

Marcin left the conversation.

Tutor1 [20:17:02]: Is it clear for you?

Marcin [20:21:27]: I have just lost connection and i do not know why only possitive

Marcin [20:21:38]: is taken

Marcin [20:21:38]: in to consideration

Tutor1 [20:20:58]: Possitive because the lenght of sides are possitive

Tutor1 [20:21:10]: Do you see what is on the tablets screen?

Marcin [20:22:08]: Yes

Marcin [20:22:12]: I see

Marcin [20:22:25]: hmmm

Marcin [20:22:28]: good

Marcin [20:22:42]: tommorow I am having a test

Marcin [20:22:45]: and already

Marcin [20:22:50]: if I have the equation

Student is using e-learning platform in order to prepare for a test. He has started from the exersice with content. It is known that this kind of exerices is not the easiest for students. Understanding more difficult exercies may provide to understanding the topic of quadratic function. The next exercise is definitely easier that the one before. Below is the text of the conversation:

Tutor1 [20:22:03]: I am asking you about the next exercise

Marcin [20:23:20]: **x^2 -25=0**

Marcin [20:23:30]: is it connected with some multiplication formula

Marcin [20:23:32]:yes

Marcin [20:23:35]: ?

Marcin [20:23:40]: and after the solution

Marcin [20:23:42]: it is over

Tutor1 [20:22:53]: yes, sure

On the figures 1, 2, 3, 4, 5, 6, 7, 8 are shown fragments of the solved quadratic function exersices.
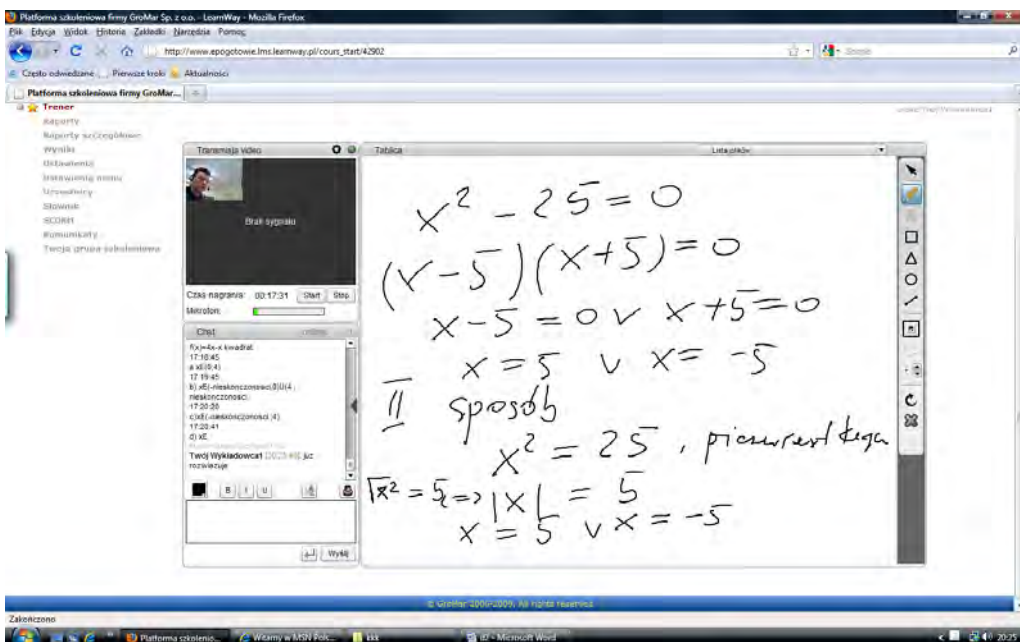
Fig. 1. Solving the school-leaving exercise from the topic of quadratic function with using my e–learning platform. Own elaboration.

Marcin left the conversation.

Marcin joined in the conversation.

Marcin left the conversation.

Marcin joined in the conversation.

Marcin left the conversation.

Marcin joined in the conversation.

Marcin left the conversation.

Marcin joined in the conversation.

It should be notice that student knows how to solve the exercise but in this case, he needs only acceptation of his idea. He only wants to be sure that his way of thinking is correct. Sometimes we need support and affirmation of our skills, that conversation gives students that possiblility.

Marcin [20:26:27]: **2. function f(x)=4x-x^2**
a) xE(0; 4)
b) xE(-infinity; 0)U(4; infinity)
c) xE(-infinity; 4)
d) xE

Marcin joined in the conversation.

Tutor1 [20:25:48]: I will solve it soon

Tutor1 [20:27:37]: Can you write the whole exercise content

Tutor1 [20:28:11]: Or is this an inequation?

Marcin [20:29:32]: It means

Marcin [20:29:42]: this is

Marcin [20:29:46]: something where we have to

Marcin [20:29:51]: write where x is

Marcin [20:26:27]: **2. function f(x)=4x-x^2**
a) xE(0; 4)
b) xE(-infinity; 0)U(4; infinity)
c) xE(-infinity; 4)
d) xE

Marcin [20:30:36]: There is nothing more :(

Tutor1 [20:29:53]: just a moment

Tutor1 [20:31:40]: Once more, I am asking you about where whole exercise content because this execise do not have sense

Marcin [20:26:27]: **2. function f(x)=4x-x^2**
a) xE(0; 4)
b) xE(-infinity; 0)U(4; infinity)
c) xE(-infinity; 4)
d) xE

Marcin [20:33:00]: In my opinion

Marcin [20:33:02]: we have to

Marcin [20:33:07]: chage the places

Marcin [20:33:12]: and count Δ

Marcin [20:33:32]: or in brackets

Tutor1 [20:32:44]: I will solve an equality

Tutor1 [20:32:57]: Is this the point?

Marcin [20:34:08]: no

Marcin [20:34:12]: I think = 0

Marcin left the conversation.

Marcin joined in the conversation.

Marcin left the conversation.

Marcin joined in the conversation

Marcin [20:26:27]: **2. function f(x)=4x-x^2**
a) xE(0; 4)
b) xE(-infinity; 0)U(4; infinity)
c) xE(-infinity; 4)
d) xE

Marcin [20:35:11]: ok

Marcin [20:35:15]: so what is the answer

Tutor1 [20:34:35]: if there is an inequality

Marcin left the conversation.

Marcin joined in the conversation.

Marcin left the conversation.

Marcin joined in the conversation

Tutor1 [20:36:49]: Do you know now why without this information that exercise do not have any sense

We have to notice that the lack of accurate content means lack of solution. The teacher during the lesson or instructor during virtual meeting not always is able to fill gaps in the exercise content. In this case the solution of the exercise should be postpone. The student goes to the other exercise with content.

Marcin [20:37:48]: **3. equation x^2+5=9**
a) do now have any roots
b) has got two possitive roots

c) has got two negative roots
d) has got one possitive root and one negative root

Marcin [20:38:10]: And I completely do not understand this, what roots are?

Marcin [20:38:11]: ??

Tutor1 [20:38:01]: Roots are the solotions of this equation.

Marcin [20:39:12]: aha

Marcin left the conversation.
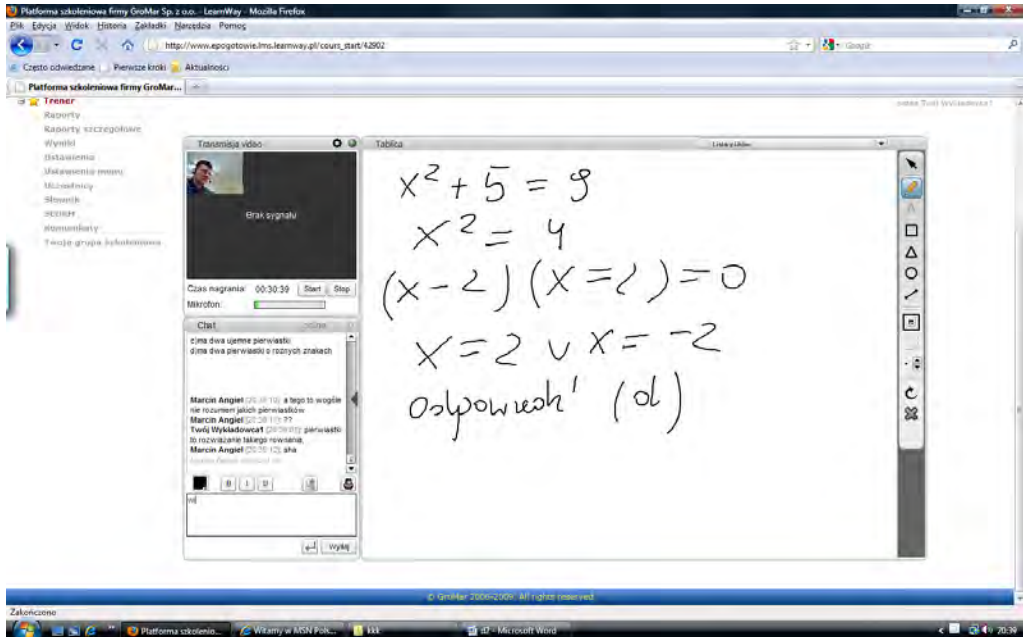
Fig. 2. Solving the exercise from the topic of quadratic function with using e-learning platform.
Own elaboration.

Tutor1 [20:39:39]: I would like to return to the previous exerecise

Marcin joined in the conversation.

Marcin [20:40:45]: ok

Marcin left the conversation.

Marcin joined in the conversation.

Marcin left the conversation.

Marcin joined in the conversation.

Marcin left the conversation.

Tutor1 [20:42:08]: The author could forget that there has to be an equality or $4x-x^2>0$ or $4x-x^2<0$

Marcin joined in the conversation.

Marcin left the conversation.

Fig. 3. Solving the exercise from the topic of quadratic function with using e-learning platform.
Own elaboration.

Fig. 4. Solving the exercise from the topic of quadratic function with using e-learning platform.
Own elaboration.

Tutor1 [20:45:23]: Did you notice it?

Marcin [20:46:31]: yes, I understand

When it comes into learning with traditional methods or e-learning time plays crucial role. Time was needed to return to the previous exercise which was postponed. Lack of whole and accurate information provided that the exercise was solved in broaden variant. This lesson will definitely helps student especially if he prepares himself to the test.

Tutor1 [20:45:36]: Could you write the next exercise, please?

Marcin [20:47:32]: x^2

Marcin [20:48:08]: the sign of less is not working

Marcin [20:48:17]: and Yours

Marcin [20:48:17]: ??

Marcin [20:48:20]:

Tutor1 [20:47:29]: it is ok, just write what you are able to

Marcin [20:48:51]: No, everything is alright

Marcin [20:49:12]: **x^2+x+8>0**

Marcin left the conversation.

Fig. 5. Solving the exercise from the topic of quadratic function with using e-learning platform. Own elaboration.

Tutor1 [20:50:01]: Every x satisfies this inequality , what will be in the case of inequality $x^2+x+8<0$

Tutor1 [20:50:30]: what will be in the case of inequality $x^2+x+8<0$

Marcin joined in the conversation.

Marcin left the conversation.

Marcin joined in the conversation.

Tutor1 [20:53:12]: Do you see an inequality with opposite sign?

Marcin [20:54:33]: yes

Tutor1 [20:53:55]: What will be the solution of this?

Marcin [20:55:14]: empty set?

Tutor1 [20:54:18]: very well
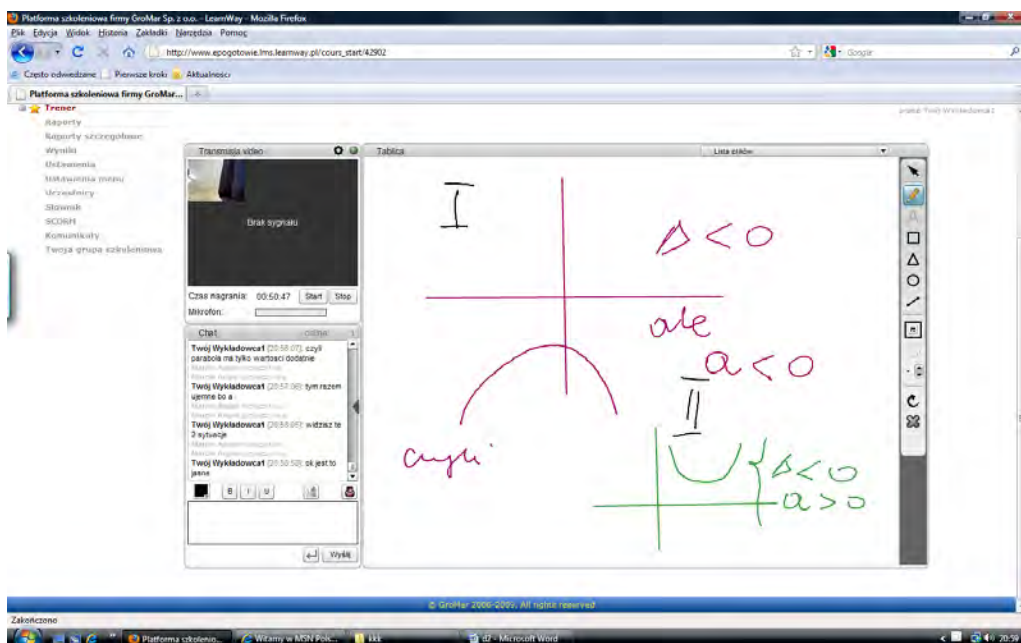
Marcin [20:55:28]: but

Marcin [20:55:45]: but why if delta is there?

Marcin [20:55:46]: ??

Tutor1 [20:54:47]: The next exercise

Tutor1 [20:55:46]:if delta is negative, the chart do not have common points with axis x and if additionally a>0 it is above the axis.

Fig. 6. Solving the exercise from the topic of quadratic function with using e-learning platform. Own elaboration.

We have to notice that student has got doubts and is not certainty if he understood teachers explenation correctly, he asks once more. It means that he connected with platform not only in the order to have only solution of the one exercise but in the order to be sure how changes the solution when the content changes. After teachers explenation student goes to the next exercise.

Marcin [20:57:03]: **x(3-x)-(2+x)^2+(x-1)(x+1)**

Tutor1 [20:56:07]: so, parabola has got only positive values

Marcin left the conversation.

Marcin joined in the conversation

Tutor1 [20:57:06]: This time negative because a

Marcin left the conversation.

Marcin joined in the conversation

Tutor1 [20:58:05]: do you see those two situations?

Fig. 7. Solving the exercise from the topic quadratic function with using e-learning platform.
Own elaboration.

Marcin left the conversation.

Marcin joined in the conversation

Tutor1 [20:58:58]: I hope it is clear for you

Marcin [21:00:17]: yes

Marcin [21:00:24]: I know now

Tutor1 [20:59:27]: This time is the exercise

Marcin [21:00:42]: I??

Marcin [21:00:48]: but I am not able to write

Marcin [21:00:50]: on the blackboard

Tutor1 [21:00:14]: Unfortunately only we can, that is the platform

Marcin [21:01:31]: **$-x^2+64>0$**

Tutor1 [21:00:44]: and the previous exercise

Marcin left the conversation.

Tutor1 [21:01:45]: Is this an equation?

Marcin joined in the conversation

Marcin left the conversation.

Marcin joined in the conversation

Marcin [21:03:51]: no

Marcin [21:03:54]: inequality

Marcin left the conversation.

Marcin joined in the conversation

Marcin [21:04:13]: >

Marcin left the conversation.

Tutor1 [21:04:09]: $(a+b)^2=a^+2ab+b^2$

Tutor1 [21:06:34]: you have to use brackets

Marcin joined in the conversation

Tutor1 [21:07:49]: Do you see the system of solving on the tablets screen?

Marcin left the conversation.

Tutor1 [21:09:05]: These disconnections are upsetting for me too

Marcin joined in the conversation

Marcin left the conversation.

Marcin [21:11:10]: exactly

Marcin joined in the conversation

Tutor1 [21:10:22]: I hope, the are not more disconnections

Marcin left the conversation.

Marcin joined in the conversation

Marcin left the conversation.

Marcin joined in the conversation

Marcin left the conversation.

Marcin joined in the conversation

Tutor1 [21:13:09]: Do you see what is on the tablet screen?

Marcin [21:14:30]: yes, now I can see it

Marcin [21:14:42]: Thank you

Marcin [21:14:42]: for your help

Tutor1 [21:04:09]: You use (a+b)^2 formula and brackets !!!!

Tutor1 [21:13:57]: I thank you for cooperation and the last exercise

Marcin l [21:15:19]: Thank you

Marcin [21:15:21]: I think

Marcin [21:15:24]: I will solve it

Tutor1 [21:14:19]: ok, best regards

Marcin l [21:15:32]: after your help

Marcin [21:15:33]: :)

Marcin [21:15:45]: Goodbye and maybe more precise goodnight

Tutor1 [21:14:46]: Goodnight

The next two exercises were connected with square function. After getting information from teacher student do not have more problems and questions. Even a lot of disconnections were not able to disincline student to learning.

- Study of interactions: student Katarzyna, Anna - tutor (appointment nr 1)

Katarzyna, Anna joined in the conversation.

Wait for user acceptation

Tutor1 [21:40:32]: Explain your problem with the exercises, please

Katarzyna, Anna [21:42:36]: **write the area and solve the operation 12 x to the power of 2 -72x+108 everything divided by 6 x to the power of 2 +6x-72**

Tutor1 [21:49:28]: I am painting for a comment

Katarzyna, Anna left the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna stopped the conversation.

Tutor1 [21:50:33]: I am waiting for an answer

Katarzyna, Anna joined in the conversation.

You have to mark the user which do you want to block or unblock.

You have to Mark the user which do you want to block or unblock.

User Katarzyna, Anna was unblocked.

Tutor1 [21:51:36]: Is there everything clear for you?

Katarzyna, Anna [21:51:58]: I Am sorry, it is my fault, I had got lack of answer on this page and it stopped to work but I am finally again

Katarzyna, Anna [21:52:03]: yes :)

Katarzyna, Anna [21:52:18]: thank you very much :)

Tutor1 [21:52:00]: Have you rewrited everything from tablet?

Katarzyna, Anna [21:52:36]: not yet, just a moment

Tutor1 [21:52:45]: but everything is on its place not disappeared

Katarzyna, Anna [21:53:20]: no, everything is on the tablet

Tutor1 [21:53:28]: the last solution is 2(x-3)/(x+4)

Tutor1 [21:53:42]: area :R\{-4,3}

Fig. 8. Solving the exercise from the topic of quadratic function with using e-learning platform. Own elaboration.

On the figures 1, 2, 3, 4, 5, 6, 7, 8 are shown fractions of the polynomial and rational expressions exercises

Fig. 9. Solving the exercise from the topic of polynomials with using e-learning platform.
Own elaboration.

The student was focused on division of polynomials. In this case division was not necessary. Common fraction should be taken before brackets, after that we have to use shortened multiplication formulas, rewrite polynomial as a product and finally make reductions. If we do these steps correctly the solution should be right.

Tutor1 [21:54:11]: The next exercise, please. I hope I will finish it before 10 p.m.

Katarzyna, Anna [21:55:07]: Yes, I was not able to solve it myself even with having the answer.

Katarzyna, Anna [21:55:16]: ok, I rewrote from blackboard

Tutor1 [21:55:07]: The next exercise, please

Tutor1 [21:56:20]: I am waiting for the next exercise

Katarzyna, Anna [21:56:41]: **the same command but there is t 8 x to the power of 3 +12x to the power of 2 +6x+1 everything divided by 4x to the power of 2 +4x+1**

Tutor1 [21:57:15]: Everything ok?

Katarzyna, Anna [21:57:51]: yes

Tutor1 [21:59:57]: Something Has blocked me, one more time

Katarzyna, Anna [22:00:22]: ok

Tutor1 [22:01:36]: $(8x^3+12x^2+6x+1)/(2x+1)^2$

Katarzyna, Anna left in the conversation.

Tutor1 [22:01:48]: tablet did not work for a moment

Tutor1 [22:02:00]: I will write on the chat

Katarzyna, Anna joined the conversation.

You have to mark the user which do you want to block or unblock.

Katarzyna, Anna was unblocked.

Katarzyna, Anna [22:02:56]: good

Tutor1 [22:07:40]: $8x^3+12x^2+6x+1=6x(2x+1)+(2x+1)(4x^2-2x+1)=(2x+1)(6x+4x^2-2x+1)=(2x+1)(4x^2+4x+1)=(2x+1)^3$

Tutor1 [22:08:31]: You have to use the cube difference formula: $a^3-b^3=(a-b)(a^2+ab+b^2)$

Tutor1 [22:08:47]: and finally we have

Tutor1 [22:09:13]: $(2x+1)^2/(2x+1)=2x+1$

Katarzyna, Anna [22:09:44]: yes:)

Tutor1 [22:09:34]: area:2x+1 different from 0 so

Tutor1 [22:09:43]: $R\setminus\{-1/2\}$

Tutor1 [22:09:57]: Is it clear for you ?

Katarzyna, Anna [22:10:34]: Yes, I only have to rewrite

Katarzyna, Anna [22:10:45]: Now it is, thank you

Tutor1 [22:10:31]: ok.

The connection problems with platform may happened very often. Chat communication can be very helpful alternative. In this way the appropriate information may be served and guided to the solution of the exercise. Lets see how it works in practice.

- Study of interactions: student Katarzyna, Anna - teacher (appointment nr 2)

Katarzyna, Anna joined in the conversation.

Wait for user acceptation

Tutor1 [20:19:32]: Could you write the exercise, please

User Katarzyna, Anna was unblocked.

Wait for user acceptation

Tutor1 [20:19:32]: Could you write the exercise, please

Katarzyna, Anna [20:25:01]: **write the area and simplify: x^4+x^2+1/x^3+1**

Tutor1 [20:25:03]: I will solve soon
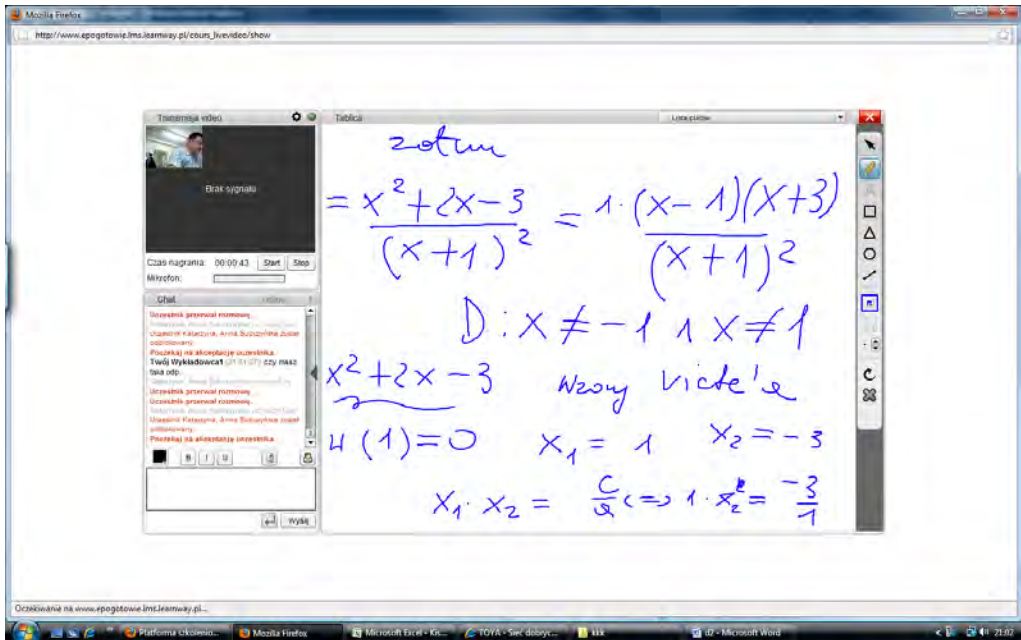
Tutor1 [20:26:01]: Everything is ok ?

Katarzyna, Anna [20:26:33]: yes

Fig. 10. Solving the exercise from the topic of rational expressions with using e-learning platform.
Own elaboration.

Tutor1 [20:28:55]: After that we have to do something more difficult

Tutor1 [20:30:57]: We are going to use square sum formula but before this we have to add something and subtract the same value, if we do this the result of the operation is still the same

Fig. 11. Solving the exercise from the topic of rational expressions with using e-learning platform.
Own elaboration.

Katarzyna, Anna left the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna stopped the conversation.

Tutor1 [20:31:06]: Do you understand this?

Katarzyna, Anna joined in the conversation.

You have to mark the user which do you want to block or unblock.

User Katarzyna, Anna was unblocked.

Wait for user acceptation

Tutor1 [20:32:36]: Do you see what is on the tablet screen?

Katarzyna, Anna [20:33:12]: Yes and I understand what is on the bottom of the page

Tutor1 [20:33:27]: Which formula will you use in this case ?

Katarzyna, Anna [20:34:45]: hmmm... $(a+b)^2$

Tutor1 [20:34:35]: not exactly

Tutor1 [20:35:05]: Do you see it now?

Katarzyna, Anna [20:36:25]: yes

Tutor1 [20:36:27]: May i go to the next screen?

Katarzyna, Anna [20:36:56]: yes

Tutor1 [20:37:38]: We have got the square difference formula

Tutor1 [20:39:44]: What do you think aboutt it ? Do you have that answer?

Katarzyna, Anna left the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna joined in the conversation.

User Katarzyna, Anna was unblocked.

Wait for user acceptation

Katarzyna, Anna [20:42:14]: yes

Tutor1 [20:42:05]: so the next exercise, please

Katarzyna, Anna [20:43:40]: **solve the operations :x^3+x^2-5x+3/x-1 * 1/x^2+2x+1**

Tutor1 [20:44:45]: Is this an answer ?

Katarzyna, Anna [20:45:19]: yes

Tutor1 [20:46:05]: At the beginning lets solve the first one

Tutor1 [20:47:11]: It is know that polynomial has got roots only amid divisors of 3

Fig. 12. Solving the exercise from the topic of rational expressions with using e-learning platform.
Own elaboration.

Tutor1 [20:47:23]: What are the digits ? What do you think?

Katarzyna, Anna [20:48:27]: -1,+1,+3,-3

Tutor1 [20:48:12]: very good

Tutor1 [20:48:40]: The next step is checking which one to fulfill a polynomial

Tutor1 [20:48:52]: when the roots are 0

Tutor1 [20:48:57]: Do you agree?

Katarzyna, Anna [20:49:26]: Is there method of Horner?

Katarzyna, Anna [20:49:29]: yes

Tutor1 [20:49:34]: There can be Homers or Bezouts methods

Tutor1 [20:49:47]: W(1)=0

Tutor1 [20:51:16]: near the highest power we rewrite

Tutor1 [20:51:45]: 1*1

Tutor1 [20:51:49]: 1+1

Tutor1 [20:51:58]: 1*2

Tutor1 [20:52:07]: -5+2

Tutor1 [20:52:44]: we multiply by the root = 1

Tutor1 [20:54:37]: polynomial is the result of division

Tutor1 [20:54:50]: by binomial x-1

Tutor1 [20:54:56]: Is it clear for you?

Katarzyna, Anna left the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna joined in the conversation.

User Katarzyna, Anna was unblocked.

Wait for user acceptation

Katarzyna, Anna [20:56:56]: Will it be something like that ? (x-1)(x^2+2x-3)

Tutor1 [20:56:45]: That is right

Tutor1 [20:57:06]: you understand Horners method

Katarzyna, Anna [20:57:40]: yes

Fig. 13. Solving the exercise from the topic of rational expressions with using e-learning platform. Own elaboration.

Katarzyna, Anna left the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna joined in the conversation.

User Katarzyna, Anna was unblocked.

Wait for user acceptation

Tutor1 [21:01:07]: Have you got the answer?

Katarzyna, Anna left the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna joined in the conversation.

User Katarzyna, Anna was unblocked.

Wait for user acceptation

Katarzyna, Anna [21:03:23]: Should I count delta in the order to be able to count his equation on the top ?

Tutor1 [21:04:02]: Yes you can do his using Vieta's formulas or Homer's method.

Tutor1 [21:04:25]: Do you see the final solution in blue ?

Katarzyna, Anna [21:05:04]: yes

Tutor1 [21:04:55]: Is there that answer ?

Katarzyna, Anna [21:05:33]: I have solved it just a moment ago and got the same answer.

The student during the conversation got to know many different ways of solving the problem and offered some of them. Not every exercise can be solve in only one way.

Tutor1 [21:05:21]: The next exercise, please

Katarzyna, Anna [21:06:25]: **1/x^3-108x+432:x-6/x+12**

Tutor1 [21:07:09]: Did I write it correctly?

Katarzyna, Anna [21:08:10]: not exactly there is x-6 / x+12

Katarzyna, Anna [21:08:25]: formula x-6 jest is in the numerator

Tutor1 [21:08:42]: Now ?

Katarzyna, Anna [21:09:10]: yes

Tutor1 [21:17:23]: May I go to the next screen?

Tutor1 [21:18:15]: I am waiting for an answer.

Katarzyna, Anna [21:18:54]: just a moment

Tutor1 [21:18:35]: ok

Katarzyna, Anna [21:19:38]: not

Tutor1 [21:23:11]: Is it clear for you?

Fig. 14. Solving the exercise from the topic of rational expressions with using e-learning platform.
Own elaboration.

Katarzyna, Anna left the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna joined in the conversation.

User Katarzyna, Anna was unblocked.

Wait for user acceptation

Katarzyna, Anna [21:26:31]: hmmm.... and $x^3-108x+432$ can be reduced to $x^2-12x+36$?

Tutor1 [21:27:34]: Do you agree with this?

Katarzyna, Anna [21:28:18]: now, yes

Tutor1 [21:28:24]: Is the answer correct?

Katarzyna, Anna [21:28:56]: yes

Tutor1 [21:29:05]: so, the next exercise

Katarzyna, Anna [21:30:17]: I **have got small problem with this, in denominator I have correct value but in numerator the result is wrong: $5x/x^2-4x+4 + -x/x^2-4$**

Tutor1 [21:30:49]: Is there the answer?

Fig. 15. Solving the exercise from the topic of rational expressions with using e-learning platform. Own elaboration.

Katarzyna, Anna [21:31:22]: yes

Katarzyna, Anna left the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna joined in the conversation.

User Katarzyna, Anna was unblocked.

Wait for user acceptation

Tutor1 [21:36:38]: Do you see everything?

Katarzyna, Anna left the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna joined in the conversation.

User Katarzyna, Anna was unblocked.

Wait for user acceptation

Tutor1 [21:38:48]: Is there that answer?

Tutor1 [21:39:10]: You have to remember about formula, when you want to have common denominator

Tutor1 [21:40:08]: Everything is ok

Katarzyna, Anna left the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna joined in the conversation.

User Katarzyna, Anna was unblocked.

Katarzyna, Anna [21:41:55]: yes

We have to notice that the student solved the exercise, but the solution she had got was not correct with this in the book. Conversation guided her the correct way and explained where she did mistake, besides she knows what should be taken into consideration when it comes to this kind of exercises.

Wait for user acceptation

Tutor1 [21:41:58]: I can solve one more exercise

Katarzyna, Anna [21:43:17]: **I have got problem with this 2/x+3 i x+1/x^2+3x**

I need to have common denominator

Katarzyna, Anna [21:43:37]: I tried to solve this but I did not get correct solution

Tutor1 [21:44:20]: You always multiply numerator by the factor which is not in the denominator

On the figures 16, 17, 18, 19, 20, 21. We present some chosen examples from school-leaving exam.

Fig. 16. The example of school-leaving exam exercise, reducing fractions to a common denominator. Own elaboration.

Tutor1 [21:46:31]: Is there that answer?

Tutor1 [21:47:39]: Is it clear for you?

Tutor1 [21:49:23]: I am waiting for an answer

Katarzyna, Anna left the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna joined in the conversation.

User Katarzyna, Anna was unblocked.

Wait for user acceptation

Katarzyna, Anna [21:50:54]: aha ,now it is clear for me

Tutor1 [21:50:45]: This answer do you have?

Katarzyna, Anna [21:51:39]: yes

Tutor1 [21:52:03]: In this case, see you on sunday, this kind of education is worth-using

Katarzyna, Anna [21:52:54]: ok, thank you very much, goodnight

Tutor1 [21:52:38]: goodnight

Katarzyna, Anna left the conversation.

Katarzyna, Anna stopped the conversation.

Katarzyna, Anna stopped the conversation.

Besided facts which have been already subscribed a lot of students was using e-platform, they especially had got quastions and problems with polynomials. There were others areas of mathematics where students were uncertaintly about their knowledge. Below some examples of them:
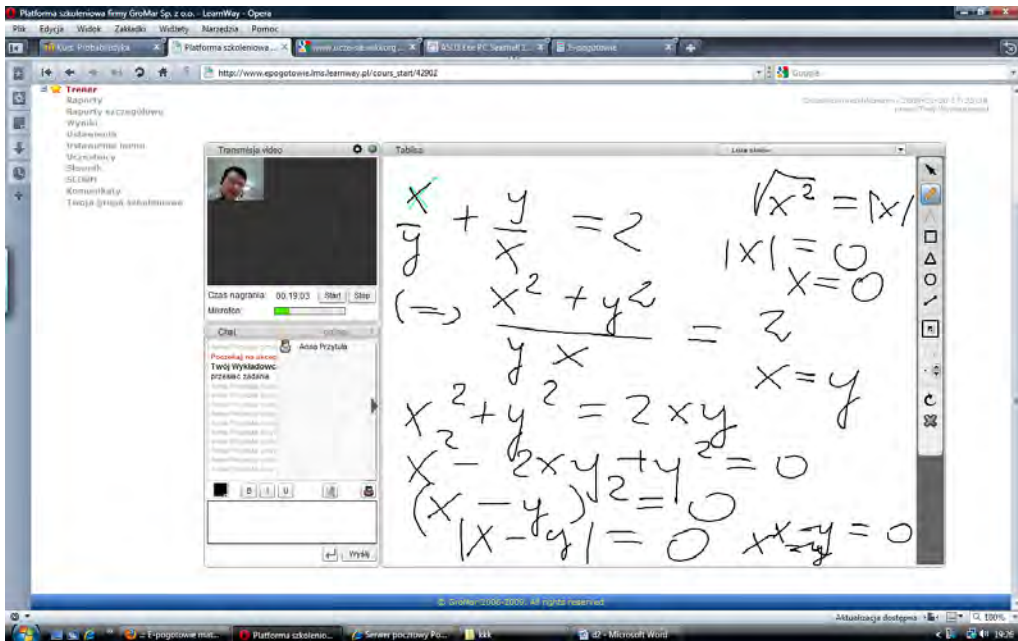
Fig. 17. The example of school-leaving exam exercise, solving an equation. Own elaboration.

Fig. 18. The example of school-leaving exam exercise, changing decimal fractions into common fractions. Own elaboration.

Fig. 19. The example of school-leaving exam exercise, division of fractions. Own elaboration.

Fig. 20. The example of school-leaving exam exercise, fastness. Own elaboration.

Fig. 21. The example of school-leaving exam exercise, rational expressions. Own elaboration.

8.3. Conclusions

Today it is often the case that a number of pupils in class is high, frequently above 30 students. Whereas this factor makes it really difficult to approach each pupil individually, those students who participated in the project "Mathematical Emergency E-Services" had a chance to benefit from individual approach. Within platform's opening hours a student presented their tutor with an exam problem and received a tip indicating the way of solving it. Closer examination of the first example indicates that pupils used the assistance provided by the platform when preparing to their current tests. Undoubtedly, thanks to systematic work and preparations better matriculation exam results were achieved. Students had unlimited access to the platform. How often it was attended depended on students' decisions based on their needs, still, the length of the connection was also influenced by the tutor. That is to say, some problems required merely a hint, others, however, had to be approached from a different point of view and for this reason sometimes a meeting went beyond platform's open hours, that is after 10pm. During the meetings on the platform students were supplied with comprehensive answers to their questions and, on many occasions, with more than one solution. And it is availability of various solutions that is of paramount importance before the matriculation exam especially as it may be impossible to solve an exam problem using repetitive methods. Therefore, a given problem may require a method student has not hitherto encountered. To find such a solution various skills and broad knowledge are needed and those were obtained in the course of solving problems via a learning platform.

8.4. Reference

1. Kisiel K., Galewska E., Kucner J., Szumigaj K.: „*Support the teaching of mathematics in secondary school based on modern information technologies in the context of e-matura*", a chapter in a monograph: The information system remote-examination strategy, the logic of the system, architecture, evaluation, Technical University of Lodz, 2013

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Internet lessons to prepare for maths exam within the framework of the project "E - emergency mathematical"

9.1. Introduction

Distance learning is a method which from year to year is becoming increasingly more popular, more effective and more efficient. It is also readily available for many people who want to raise not only their skills, but level of education as well. We believe distance learning would be useful not only for students, but for adults too. Courses, training, postgraduate studies, as well as supporting traditional teaching are only some of the opportunities offered by e-learning.

In this thesis we will focus on the remote teaching of young students, who were preparing for their final exams in mathematics. These activities took place within the framework of the project "E-emergency math", which was implemented at the Technical University of Lodz. The project involved 30 schools from the Lodz region. One class was selected from each school for the project . In total, there were approximately 1,000 students who benefited from the opportunities offered by the e-learning platform and from the help of teachers from the Technical University of Lodz participating in this project.

The platform could be used by students from Sunday to Thursday, in the afternoon between 5 pm and 10 pm, so after a day of classes and after some rest, they were starting with a platform for e-learning. This time flexibility was crucial here, giving students a choice of conference times, so as not to discourage them from learning.

Moreover, students communicated with the platform only if they had a problem with a particular exercise matriculation. The hours of operation of the platform were always supervised by 4 lecturers. During which, their time was devoted exclusively to these students. This was important due to the unpredictability of the topics covered In the course of the meetings. Namely, the tasks discussed and resolved at the meetings were not previously prepared by teachers, but by the students themselves. In general, high school graduates have reported elementary problems that had to be explained from the beginning. It should be noted that the students did not simply obtain solutions to the task, but only clues leading to the solution of the problem. This leaves the impression that they resolved the problem and the lecturer only assisted in this process.

Presented below are some actual example meetings which took place on the e-learning platform. The scripts can give an example of what can be observed such as students reasoning, communication and interaction with the lecturer. Furthermore the guidance notes given by the lecturer can be noted, as well as directing the students reasoning. The original script has been kept.

Case study: pupil Patryk

Pupil has joined.

Patryk [18:44:36]: Welcome

Patryk [18:45:47]: ??

Tutor1 [19:02:52]: Welcome

Tutor1 [19:03:01]: How can I help you

Patryk [19:03:50]: Welcome

Tutor1 [19:03:54]: ok???

Patryk [19:04:13]: I have few exercises with analytic geometry

Tutor1 [19:04:04]: Please go ahead

Tutor1 [19:04:08]: ok

Patryk [19:04:40]: Is this board working?

Tutor1 [19:05:10]: Yes but only myself can write on it for now.

Tutor1 [19:05:35]: Do you have a microphone and headphones ?

Tutor1 [19:05:37]: ???

Patryk [19:06:00]: Only headphones ?

Patryk [19:06:09]: Unfortunatelly I've no microphone

Tutor1 [19:06:11]: Can you hear me?

Tutor1 [19:06:19]: ?

Patryk [19:07:26]: I can't hear you at all

Patryk [19:07:38]: There is no signal

Tutor1 [19:07:46]: That's a pity

Tutor1 [19:07:58]: So let's use chat

Patryk [19:08:21]: Light beam sent from point A = (5,9) is reflected from the x-axis at point B = (2,0), then reflected from the y-axis. Find the equation of a straight line, after which moves ray after reflection from the y-axis

Patryk [19:09:37]: I understand, if light ray is given, then the angle of incidence equals the angle of reflection?

Tutor1 [19:09:40]: yes of course, of course

Patryk [19:11:01]: I calculated, equation of a straight line is: y=3x-6

Tutor1 [19:11:07]: I will check in a minute

Tutor1 [19:11:11]: Yes it is correct

Patryk [19:11:28]: Thus the slope of the final straight line is equal to 3

Patryk [19:11:37]: But how can I find free term?

Tutor1 [19:13:03]: yes yes

Tutor1 [19:17:38]: one moment

Patryk [19:17:54]: ok

Tutor1 [19:18:14]: I have some technical problem

Tutor1 [19:22:32]: I hope that you can see my clumsy lines

Tutor1 [19:22:42]: Please confirm

Patryk [19:23:03]: yes yes yes I can see everything

Tutor1 [19:23:55]: If you know the slope of a straight line, it is enough to know one point on the straight line

Tutor1 [19:24:09]: For example, a point on the y-axis

Tutor1 [19:24:14]: Right? Is it truth?

Patryk [19:24:33]: yes

Tutor1 [19:24:47]: can you find the coordinates of this point

Patryk [19:25:29]: not really

Tutor1 [19:26:35]: This point is also the point of a straight line on which it runs ray reflected from the x-axis, is it right?

Patryk [19:27:28]: exactly, yes exactly

Patryk [19:27:41]: because it is kind of a specular reflections

Tutor1 [19:27:45]: exactly, yes exactly! That's it!

Tutor1 [19:28:20]: can you give any point of this " specular reflections " ?

Patryk [19:28:53]: Yes, now I can

Tutor1 [19:29:24]: Does it mean that you can handle it by yourself from now on?

Patryk [19:30:12]: aha so after substituting this point to the straight line with equation $y = 3x + b$ I get the result?

Patryk [19:30:25]: yes I can handle it, thank you very much

Tutor1 [19:30:21]: exactly

Tutor1 [19:30:30]: so the next exercise ?

Patryk [19:31:01]: Yes I will send you in a minute

Patryk [19:31:48]: One of the two parallel straight lines passes through the origin of co-ordinates, and the second passes through the point A = (1,3). Find the equation of these straight lines knowing that the distance between them is equal the square root of 5

Tutor1 [19:32:48]: just a moment, I will solve it first

Patryk [19:34:02]: My understanding is that somehow I have to find slope of the straight line , arrange simple equation of the straight line with an unknown "a" and substituted into the formula for the distance parallel lines

Patryk [19:34:38]: one will be y=ax for sure but I don't know how find the other one

Patryk has disconnected.

Patryk has disconnected

Patryk has joined. Patryk has joined

Patryk has disconnected. Patryk has disconnected

Tutor1 [19:39:35]: Can you see what I've just written down?

Patryk has joined. Patryk has joined

Patryk has disconnected. Patryk has disconnected

Patryk has joined. Patryk has joined

Patryk [19:41:31]: Yes, I can see it

Tutor1 [19:41:58]: from the fact that one of the straight line passes through (0.0) implies that y = ax, which is C = 0, if we take the general form the equation straight line

Patryk [19:42:38]: yes oh yeah

Patryk [19:42:52]: b=1?

Tutor1 [19:42:52]: you had the general form of the equation straight line

Patryk [19:45:54]: yes y=ax then -ax+1y+0=0, then "a" leave -a, b=1, c=0?

Tutor1 [19:50:48]: Let's do this exercise by using another method

Tutor1 [19:50:59]: Do you follow the screen?

Fig. 1. We can see the process of determining the equations of the straight lines using the distance formula between them

Fig. 1. The solving of the exercise from the analytic geometry using the e-learning platform.
Own elaboration.

Patryk [19:51:27]: Yes I can see it

Patryk has disconnected. Patryk has disconnected

Patryk has joined. Patryk has joined

Patryk has disconnected. Patryk has disconnected

Patryk has joined. Patryk has joined

Patryk has disconnected. Patryk has disconnected

Patryk has joined. Patryk has joined

Patryk has disconnected. Patryk has disconnected

Tutor1 [19:55:31]: I used a simple formula for the distance of parallel straight line, please notice that they only differ by free terms c_1, c_2

Patryk has joined. Patryk has joined

Patryk has disconnected. Patryk has disconnected

Tutor1 [19:57:33]: Can you see it?

Patryk has joined. Patryk has joined

Tutor1 [19:57:56]: we have to solve the equation

Patryk [19:58:22]: Yes I know

Patryk [19:58:47]: Can you explain me one more thing? Why simple yet l is in such a form?

Tutor1 [19:58:44]: Did you copy it?

Tutor1 [19:59:08]: we will solve the equation soon

Patryk [19:59:35]: I had some problems with web browser

Tutor1 [19:59:49]: ok, but can you see what's written on the screen ?

Patryk [20:00:20]: Yes I can see it

Tutor1 [20:00:39]: we are going to solve this equation now

Patryk [20:02:09]: But why C2=3-a?

Tutor1 [20:02:44]: I'm explaining right now

Patryk [20:06:21]: Ahh now I understand

Patryk [20:06:59]: I apply the formula for the distance and calculate "a"

Tutor1 [20:07:10]: Yes

Patryk [20:07:23]: and then we can solve the equation

Patryk has disconnected. Patryk has disconnected

Patryk has joined. Patryk has joined

Patryk has disconnected. Patryk has disconnected

Tutor1 [20:08:12]: you can raise both sides to the square because both sides are non-negative

Patryk has joined. Patryk has joined

Patryk has disconnected. Patryk has disconnected

Tutor1 [20:11:50]: can you see that? In a moment I will show you the another method

Fig. 2 We can see the graphic illustration of determining the equation of the straight line.

Fig. 2. Solving exercise with analytic geometry using e-learning platform. Own elaboration.

Patryk [20:12:23]: ok I can see it

Tutor1 [20:12:32]: Thus, we have the equation of the straight line which is :

Tutor1 [20:12:56]: y=1/2 x,y=1/2x+5/2

Patryk [20:13:25]: yes, exactly yes, exactly

Tutor1 [20:19:22]: Then, we can solve this exercise nicely using other method

Patryk has joined. Patryk has joined

Tutor1 [20:20:06]: Did you understand it?

Patryk [20:20:59]: Yes I can understand those calculations

Patryk [20:21:15]: But not the triangle quite yet

Tutor1 [20:21:07]: Give me the next exercise

Patryk [20:21:59]: I have no more for today

Patryk [20:22:19]: But in a few days time I will benefit once more

Tutor1 [20:22:17]: in this triangle you draw a hypotenuse 1 and 2, rest follows from the Pythagorean theorem

Tutor1 [20:23:17]: right angle follows from the distance

Patryk [20:23:33]: So 1 you have to take?

Tutor1 [20:24:27]: yes, 1 fits best in this case and it's most effective solution of this task

Patryk [20:25:16]: Great!

Patryk [20:25:22]: Now I understand

Patryk [20:25:36]: Thank you for your help

Patryk [20:25:49]: That is everything for today

Tutor1 [20:25:41]: we predicted this 1

Tutor1 [20:25:52]: Ok, regards

Patryk [20:26:26]: I will definatelly use the platform again soon

Patryk [20:26:39]: the same to you, bye

Tutor1 [20:26:30]: bye

As part of the e-class the pupil could have asked questions and drawn conclusions from the guidance of the teacher. Exchange of information between the student and lecturer could end up in this case, after obtaining the solution of the problem, but due to lack of time constraints intended for one student, as it did in the case of Patryk, a professor suggested another way to solve the same task. Another approach to the problem is certainly an interesting experience for the student.

Case study: the pupil Justyna

Justyna [17:34:50]: Good afternoon

 Please wait for the acceptance of the participant.

Tutor1 [17:35:04]: I'm waiting

Tutor1 [17:35:39]: can you hear me

Justyna [17:36:03]: It is disconnecting

Tutor1 [17:36:01]: Specify the exercise with which you've got a problem, Please, give exercise on chat

Justyna [17:36:27]: In the xy plane, point A has coordinates (-5,2) and point B has coordinate (4,4) and straight lines k, l form with the y = 0 angles with equal measures.

a) designate a straight lines equation k, l
b) calculate the tangent of the angle beta

Tutor1 [17:36:31]: I'll answer in a moment

Justyna [17:37:13]: I have also a picture

Justyna [17:37:15]: fot this one

Justyna [17:37:23]: Do you want me to show you?

Tutor1 [17:37:41]: I will do the picture myself, not to worry

Justyna [17:38:21]: the straight line k passes through the point (−5, 2)

Justyna [17:38:33]: and straight line " l" passes through the point (4, 4)

Tutor1 [17:38:41]: ok .

Tutor1 [17:40:45]: straight lines which form angles with equal measures have the same slopes

Justyna [17:41:19]: and not the opposite signs?

Justyna [17:41:55]: Because that's how it looks from the figure

Justyna [17:42:17]: straight lines k, l intersect in the poin (x,0)

Justyna [17:42:37]: in the second quadrant

Tutor1 [17:42:35]: But was it given in the task?

Justyna [17:43:00]: No, it follows from the figure

Tutor1 [17:43:23]: That's what I thought. I will draw a graph and you confirm if it's correct with the content of a task because it has to be

Justyna [17:43:45]: ok

Tutor1 [17:44:06]: Do you mean those angles,yes?

Justyna [17:44:35]: straight lines k, l intersect in the poin (x,0)

Justyna [17:44:53]: on the x-axis

Justyna [17:45:03]: on the negative side

Tutor1 [17:46:00]: yes, that's what I meant

Justyna [17:46:36]: yes, but those angles are vertically opposite angles

Justyna [17:46:56]: and the angle beta is between them

Tutor1 [17:47:51]: it is this angle

Justyna [17:48:20]: and the angle at the top

Justyna Dróżdż [17:48:38]: yes

Justyna [17:48:41]: now seem's correct, yes

Tutor1 [17:48:46]: I will do the graph again

Justyna [17:49:06]: ok

Tutor1 [17:50:13]:-more less

Justyna [17:50:32]: yes

Justyna [17:50:56]: angle beta and the alphas complement to 180 degrees

Tutor1 [17:51:19]: yes of course, vertically opposite angles are equal

Tutor1 [17:53:09]: just give me a minute

Justyna [17:53:32]: ok

Justyna has joined.

Tutor1 [18:08:27]: so you have a straight lines passes through two points, you can easily find them by using the well-known formula

Justyna [18:08:51]: yes

Tutor1 [18:09:51]: The slope of the line is then calculated as 2/3 for line k

Justyna [18:10:26]: yes i 2/3 3 for line l

Justyna [18:10:52]: the equation will be y=2/3x-4/3 for line l

Tutor1 [18:10:53]: That's right

Tutor1 [18:11:34]: but the second straight line has another slope

Justyna [18:12:13]: with a minus sign

Tutor1 [18:12:18]: yes

Justyna has disconnected.

Justyna [18:13:14]: there should be a plus though

Justyna has joined.

Tutor1 [18:13:26]: you need to read the angles from the tables

Tutor1 [18:13:57]: please notice that the period of tangent is pi and tangent is odd

Justyna [18:14:33]: ahh yes

Justyna has joined.

Justyna [18:15:08]: yes

Tutor1 [18:15:07]: give the next exercise

Justyna [18:15:30]: I will give them in a minute

Justyna [18:17:01]: straight line **x+3y-17=0** is tangent to the circle with center at the point of S = (-1, -4)

a) calculate the coordinates of the point of tangency of the straight line with this circle
b) calculate length the radius of the circle

Tutor1 [18:18:28]: determine straight line which is perpendicular to the tangent and passes through the center of the circle

Tutor1 [18:18:45]: next the point of intersection of these straight lines

Justyna [18:20:15]: I marked equation of a straight as 1

Justyna [18:20:26]: I got the result: y=3x-1

Tutor1 [18:21:05]: yes

Justyna has disconnected.

Justyna has joined.

Justyna has disconnected.

Justyna [18:22:01]: point of intersection which is the point of tangency

Justyna [18:22:09]: (2,5)

Justyna has joined.

Tutor1 [18:22:25]: it's easy to check when we put this point to the system of equations

Justyna [18:22:47]: yes

Justyna [18:23:06]: to calculate the radius we need the length of the segment

Justyna [18:23:12]: SP

Justyna [18:23:19]: if P is a point of tangential

Justyna [18:23:26]: straight line and circle

Tutor1 [18:23:37]: Now you can calculate the radius as the length of SP

Justyna [18:24:34]: the square root of 90

Justyna [18:24:44]: that is 3 times the square root of 10

Tutor1 [18:25:03]: I didn't calculate it but I think that is a good result, give the next exercise

Justyna [18:26:53]: find the values of the parameter m, for whom circles **x^2+y^2=4x-2my=m^2=0 i x^2+y^2=2** are tangential

Justyna [18:27:11]: in the first equation there is plus as usual :)

Justyna [18:27:18]: before the m^2

Tutor1 [18:27:13]: ok

Justyna [18:28:15]: we use the formula for short multiplication?

Justyna has disconnected.

Justyna has joined.

Tutor1 [18:28:45]: yes

Justyna [18:30:25]: we obtain (x+2)^2 = (y- the square root of 2m)^2=m^2+4?

Tutor1 [18:30:32]: just a moment

Justyna [18:30:50]: ok

Justyna has disconnected.

Justyna has joined.

Justyna [18:32:14]: I forgot there by: = -2m^2

Tutor1 [18:32:03]: you obtained this after transformation

Justyna has disconnected.

Justyna has joined.

Justyna [18:34:53]: Could you explain to me the last formula?

Justyna [18:35:16]: m will be the coordinates of the circle then ?

Justyna [18:35:24]: center

Justyna [18:36:19]: aha it's a trivial, this is the sum of their radius?

Justyna has disconnected.

Justyna has joined.

Justyna has disconnected.

Justyna has joined.

Tutor1 [18:39:04]: there will be two possibilities

Justyna has disconnected.

Justyna has joined.

Justyna has disconnected.

Tutor1 [18:39:56]: can you see it

Fig. 3 we can see the process of determining the equations of the tangent circles.

Fig. 3. Graphic illustration of circles tangent for using e-learning platform. Own elaboration.

Justyna has joined.

Justyna [18:40:21]: I can see it

Tutor1 [18:40:43]: check your calculations again, give the next exercise

Justyna [18:41:24]: Everything seems to be right

Tutor1 [18:41:46]: I calculated quite quickly but the important thing is a method, give the next exercise

Justyna [18:42:10]: I'm fine for now, thank you, have nothing at the moment I have problems with

 Justyna [18:42:15]: thank you very much:0

Justyna [18:42:21]: :)

Tutor1 [18:42:17]: thank you

Justyna [18:42:38]: have a nice day

Justyna has disconnected.

Tutor1 [18:42:38]: same to you

As you can see with this way of communicating with the teacher, while the student is at distance, completes the data from the task relatively quickly and allows to discuss the geometric interpretation of the task, which does not need to be imagined because it's displayed. It requires commitment and creative thinking from the student.

Case study: the pupil Marta

Wait for the acceptance of the participant.

Tutor1 [21:17:09]: Specify the exercise with which you've got a problem, please

Marta has joined.

Tutor1 [21:17:57]: Specify the exercise with which you've got a problem, please

Tutor1 [21:18:10]: I'm waiting

Marta has disconnected.

Marta has joined.

Tutor1 [21:19:53]: I'm waiting for the exercise

Tutor1 [21:21:02]: is the message visible

Tutor1 [21:21:23]: put the exercise in the chat

Tutor1 [21:22:08]: Please give the answer

Marta [21:22:15]: calculate the total surface area of the cone, volume of a cone is 96 cm 3, height of the cone is 2 cm larger than the radius of the base

Marta [21:22:33]: please here you go

Tutor1 [21:22:40]: I will solve it in a minute

Marta [21:23:06]: ok

Marta has disconnected.

Marta has joined.

Marta has disconnected.

Marta has joined.

Tutor1 [21:25:15]: can you see it

Marta has disconnected.

Marta has joined.

Marta [21:28:22]: yes

Tutor1 [21:28:39]: can you calculate r

Marta [21:28:51]: no, not really

Marta [21:29:02]: I was trying but without result;/

Tutor1 [21:29:28]: I'll explain that to you

Marta [21:29:34]: ok

Marta [21:29:49]: ok

Marta has disconnected.

Marta has joined.

Tutor1 [21:35:04]: can you see it

Fig. 4 We can see the process of determining the radius of the cone, cleverly we use the distribution of prime numbers.
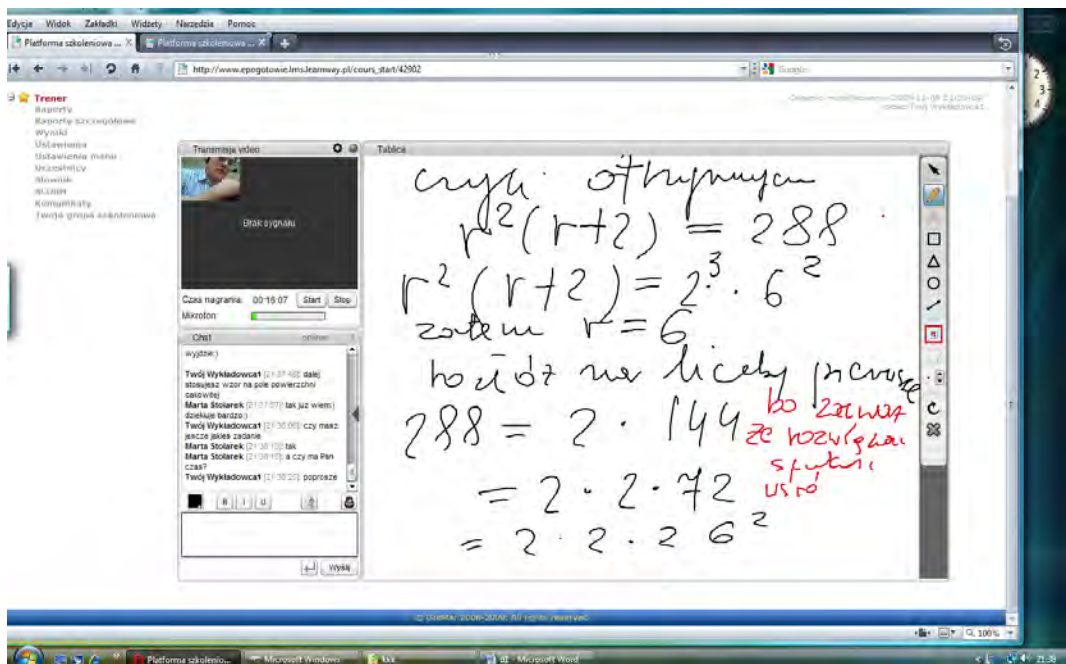
Fig. 4. Illustration of the distribution of prime numbers. Own elaboration.

Marta [21:35:22]: I can see it but i can't read it property ;-)

Marta [21:36:54]: I understand

Tutor1 [21:37:15]: r^3+r^2-288=0

Marta [21:37:22]: So I'll get the height and everything else ;-)

Tutor1 [21:37:48]: further you use formula on the total surface area

Marta [21:37:57]: I can see it now ;-) thank you very much ;-)

Tutor1 [21:38:06]: Have you got more exercises ?

Marta [21:38:10]: yes

Marta [21:38:16]: and have you got time for me?

Tutor1 [21:39:16]: of course

Tutor1 [21:38:20]: go ahead

Marta [21:39:23]: The ratio of the total area of the cone to the lateral surface area is 3:2. Find the angle of aperture of the cone

Tutor1 [21:40:33]: give me a moment

Marta [21:41:19]: ok

Marta has disconnected.

Marta has joined.

Tutor1 [21:45:23]: can you see it

Fig. 5 We can see the process of the determination of the lateral surface area of the cone.

Fig. 5. Illustration of calculating the total surface area of the cone. Own elaboration.

Marta [21:45:34]: yes

Marta has disconnected.

Marta has joined.

Tutor1 [21:46:11]: triangle is equilateral

Marta [21:46:18]: yes

Tutor1 [21:47:35]: this exercise is clear

Marta [21:48:22]: not quite;/

Tutor1 [21:48:38]: ok, I am going to explain right now

Marta [21:48:43]: ok

Tutor1 [21:49:51]: the slant height of the cone is 2r, look at the picture, triangle must be equilateral, then ts angles are equal and have a measure of 60 degrees each

Fig. 6 we can see the process of the determination of the lateral surface of the cone.
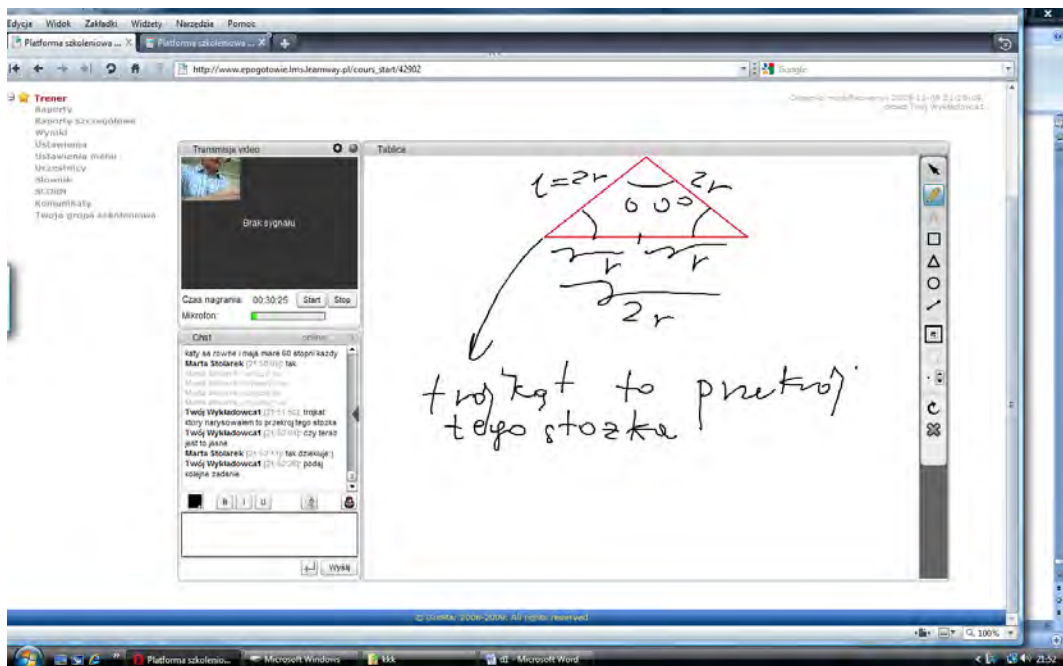
Fig. 6. Illustration of triangle equilateral. Own elaboration.

Marta [21:50:05]: yes

Marta has disconnected.

Marta has joined.

Marta has disconnected.

Marta has joined.

Tutor1 [21:51:50]: we see that the triangle is a cross-section of the cone

Tutor1 [21:52:04]: And now is it clear?

Marta [21:52:11]: yes thank you:)

Tutor1 [21:52:26]: give the next exercise, please

Marta [21:53:23]: how much carbon lies on a mound in the shape of cone, circumference of the base of the cone is 30 m and the slant height of the cone forms with the plane of the base an angle of 50°

Tutor1 [21:53:39]: I'm calculating

Marta has disconnected.

Marta has joined.

Marta has disconnected.

Marta has joined.

Marta has disconnected.

Tutor1 [21:58:08]: can you see it?

Fig. 7 We can see the process of determination of the area.
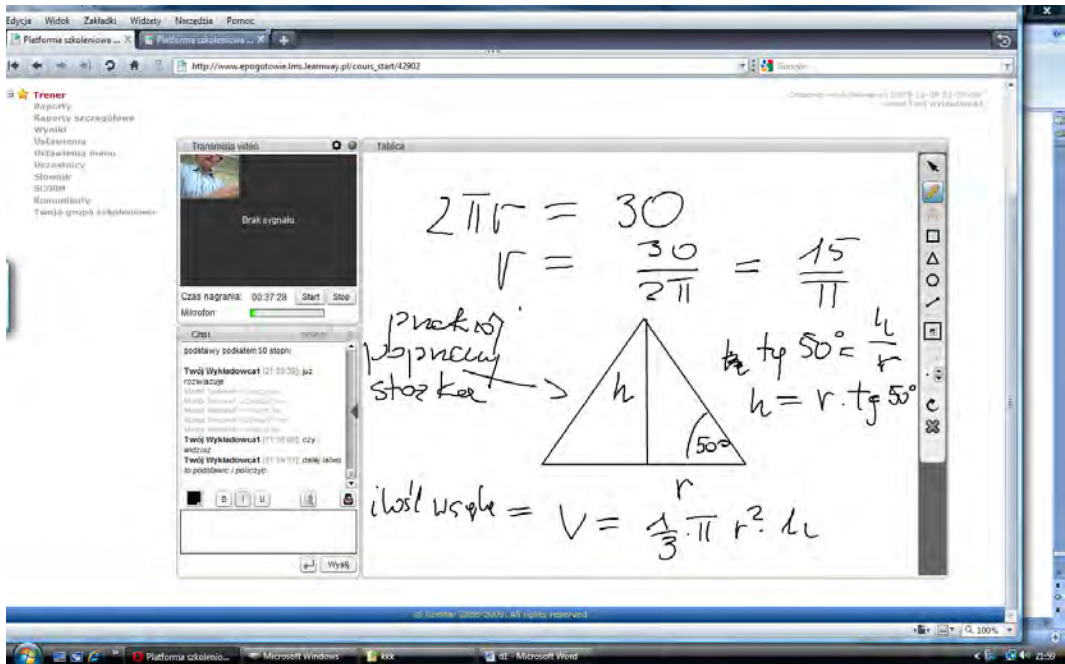
Fig. 7. Illustration for the exercise. Own elaboration.

Tutor1 [21:59:37]: further it's easy to substitute and calculate

Marta has joined.

Marta has disconnected.

Tutor1 [22:00:24]: can you see it

Marta has joined.

Marta [22:01:47]: yes I can

Marta [22:01:58]: My internet keeps getting interrupted

Tutor1 [22:02:13]: I have the same problem but we have to keep trying

Marta [22:02:28]: :)

Tutor1 [22:02:38]: is it clear, I think that further calculations you can do by yourself

Marta [22:02:59]: Can I ask for a small hint?

Tutor1 [22:03:10]: yes,

Marta [22:03:10]: What should I do now?

Marta has disconnected.

Marta [22:03:45]: tg 50 degrees is equal to 1,1918

Marta has joined.

Tutor1 [22:04:05]: yes, you need to read it from the mathematical tables

Marta has disconnected.

Tutor1 [22:05:18]: And is it clear now?

When people on both sides of the platform have been involved in the process of learning and teaching, even with connection issues and the lack of proper diction (that is compatible with the rules of Polish orthography and punctuation), these did not pose to be obstacles in order to understand the indications leading to the solution of the problem.

Note that students connecting to the platform usually focused on tasks from one specific area of mathematics. In the case of the pupil Marta was planimetry. It indicates planned and systematic repetition of the material for the leaving cert exam.

9.2.   Conclusions

Thanks to the project "E - emergency Math" students had the opportunity in the comfort of their own home and at their own convenience, although at a predetermined time, to consult with lecturers from Technical University of Lodz. Communication problems due to either the lack of audio or interruption of the connection made it more difficult, but not a substantial obstacle in order to obtain the student's answers to their questions. During the meeting on the platform, the pupil was always under the care of only one teacher. They could ask the teacher questions, which sometimes they may not do in a traditional class setting and using the platform made it easier for them to do so. In addition, the pupil at the meeting could formulate conclusions, as well as, asking questions. In the absense of student input, the teacher was asking questions with the purpose of guiding the student to solve the task. The pupil has also obtained tips for tasks which they found problematic, without which, they would have had great difficulty figuring it out alone. Understanding of one type of task often causes the subsequent tasks of a similar type to become become much simple. It shows how important fast and systematic assistance of teachers is, in helping the students to obtain the answers to their questions. "E - emergency Math" was providing reassurasnce for students participating in the project. It was supplemental to traditional teaching and contributed to better prepare students for exams in mathematics, both on an elementary level and advanced.

9.3.   Bibliography

1.   Kisiel K., Galewska E., Kucner J., Szumigaj K.: ” *Support the teaching of mathematics in secondary school based on modern information technologies in the context of e-matura* ", a chapter in a monograph: The information system remote-examination strategy, the logic of the system, architecture, evaluation, Technical University of Lodz, 2013

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The on-line vs traditional lesson

10.1. Introduction

Nowadays it is hard to imagine, especially for young generation how the life would look like without smartphones, computers, tablets, useful applications. Young people more often use modern information technology tools when compared with the adults. Thus it is no surprise that education also resorts to information technology and its useful tools. Distance learning - motivated by the speed of life, constant progress in computer science and the need of obtaining new competencies - becomes more and more popular. Within the framework of distance learning in the Lodz University of Technology two projects designed for secondary school pupils were introduced, namely (in Polish) „E-matura" and „E-pogotowie matematyczne" [1]. These could be called (in English) "E- secondary school-leaving examination" and „E-mathematical emergency". In this note we aim the showing that on-line teaching methods are comparable to traditional ones. It is obvious that traditional learning and teaching would not be eradicated since face-to-face between teacher and pupil discussions are indispensable in the whole educational process. Both methods, traditional and on-line, have their advantages and disadvantages and obviously supporters and opponents. Everybody who has started education on any level is aware of how traditional teaching looks like, while only few know how the things are with on-line learning. Thus in this note we will focus on on-line lessons which were taught within the project, aiming at supported by EU Commission within the framework of EU Structural Funds with provision of assistance in reducing the disparities between pupils in high schools. We justify that the on-line lessons overcome the traditional ones.

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[1]   Kisiel K., Galewska E., Kucner J., Szumigaj K.: " Wspomaganie nauczania matematyki w szkole ponadgimnazjalnej w oparciu o nowoczesne technologie informacyjne w kontekście e-matury", rozdział w monografii: System informatyczny zdalnego egzaminowania - strategia, logika systemu, architektura, ewaluacja, Politechnika Łódzka, 2013

Common aspects of traditional and distance learning.

1. During both types of lessons pupils see their teacher. The internet camera is used while the on-line lesson is considered.
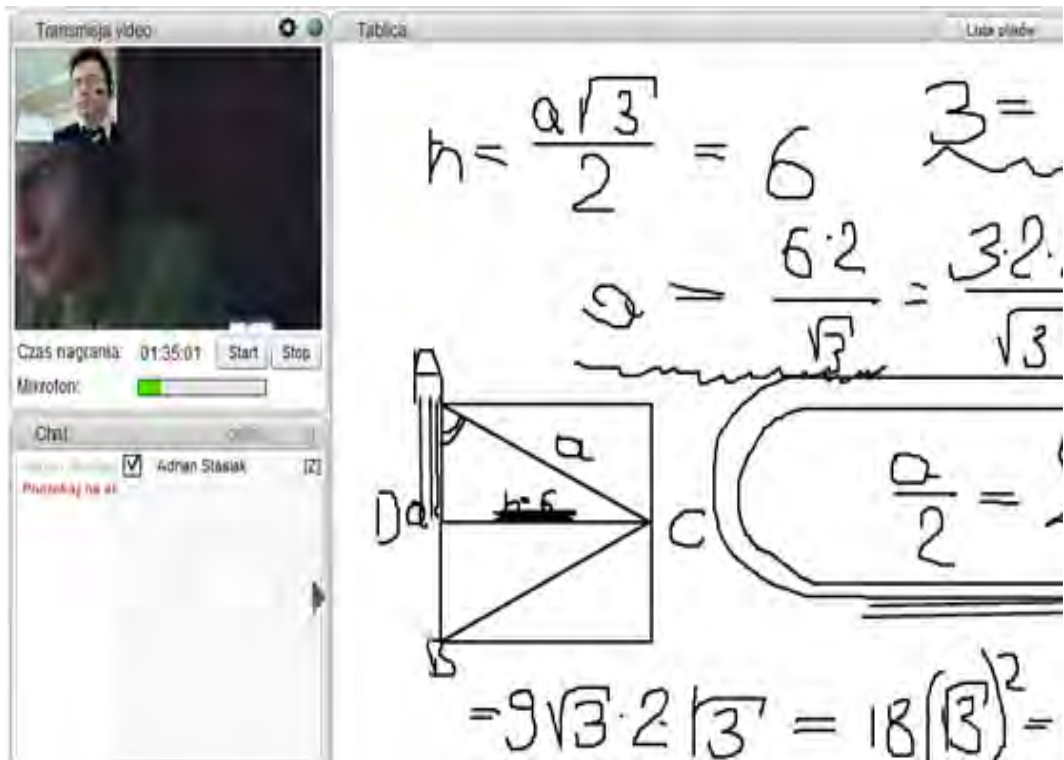

Figure 1. Finding the surface area.

2. Pupils can listen to their teacher - provided they have a microphone and the headphones. This additional and relatively equipment (approximately 5 Euro) improves the communication level between a pupil and an teacher.

3. Pupils see formula on the screen (when mathematics or physics is being taught) or other figures (e.g. human nervous system) exactly in the same manner as on the traditional school blackboard.
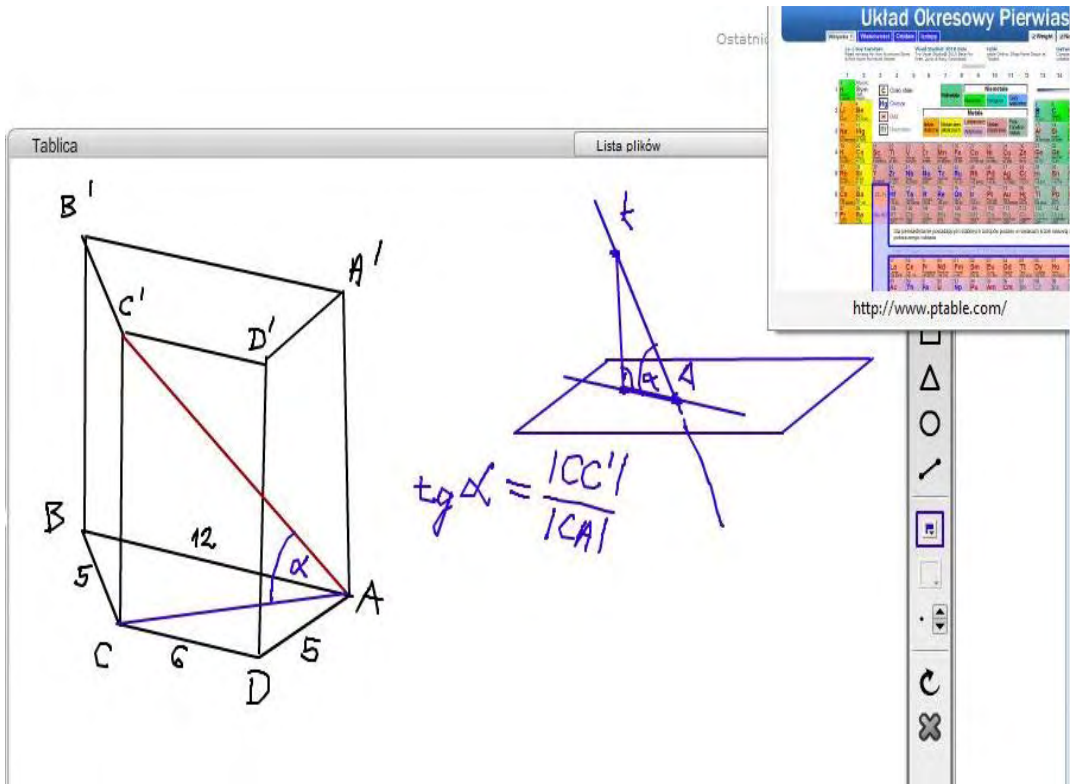
Figure 2. Classification of the elements is presented in the right corner and on the left it is depicted the angle between the diagonal of the prism and the diagonal of its base.

4. Both pupils and a teacher can write on the screen with the computer mouse as if they were using the chalk on the classical blackboard.

Figure 3. Inequalities and equations solving.

5. Pupils can take part in the lesson by pressing suitable button (while during traditional lesson they simply held their hands up). On the other hand a teacher decides who is allowed to speak by pressing the button the name list given in the right (during traditional lesson a teacher simply calls the pupils by their name and family name).

6. The pupil-teacher discussion can be listened to by other pupils as in traditional class.
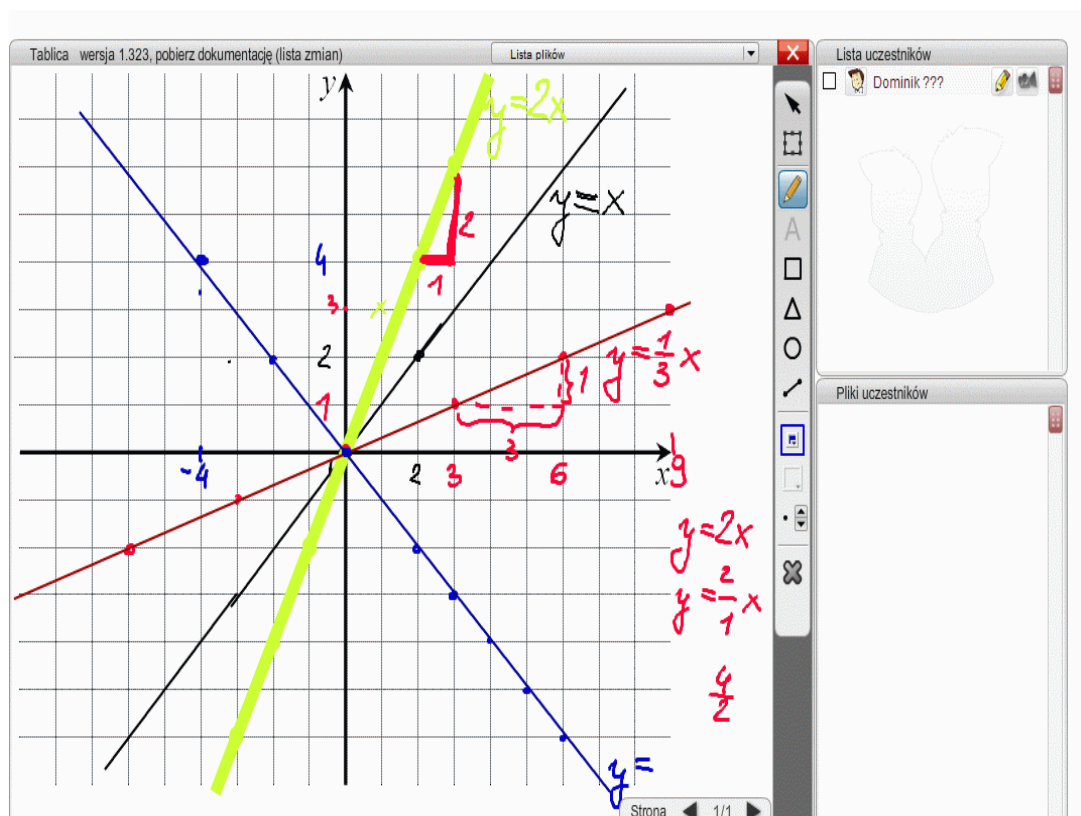
Figure 4. Writing the equation of a line.

7. A teacher can support the pupil with private advice which are not heard by the others. In the class teachers also explain problems to certain pupils while the others are working on their tasks. During on-line lesson pupils also work on their tasks putting solutions on the screen.

8. On-line lesson starts with checking who is present exactly as the traditional class. A teacher calls the absent pupils in order to explain the reasons for their absence.

9. In case the on-line lesson cannot be taught due to independent reasons on the part of the organizer (e.g. problems with internet connections) another date is fixed.

10. In case a pupil has problems with their computer, the internet connections or there occur other reasons for their absence, the project coordinator is not to be blamed for these. **The lesson would be anyway recorded so that pupils would have access to it at any time.**

11. **Platform facilities.** The e-learning platform is supplied with various tools helping in teaching not only mathematics lessons:

- It allows for drawing geometric figures (segment, triangle, circle, eraser instead of cir, ruler and sponge)
- It allows for opening files whose content is being seen by pupils on the screen (electric circuit, picture of the battle at Grunwald, map, Classification of the elements table and so on)

During on-line lesson the learning outcomes can even be easier achieved when compared to the traditional one. One may use animation, various figures, short educational films or other multi-media materials. Summing up during on-line lesson teachers use versatile teaching methods relying on information technology which is mainly not possible in traditional classroom teaching.

Figure 5. Solving polynomial inequality.

In the Internet there are very many educational materials. Several scholars supply their research and courses with additional e-materials. One can find even filmed lessons showing how teachers solve concrete problems. However, this method of teaching mathematics does not work since it contains no interaction between pupil and tutor. On the other hand, the internet e-courses motivate pupils to through studying. They can ask questions at any time, check homework and so on.

Outline of e-lesson. The e-lesson follows the steps below:

- Checking attendence
- Checking homework
- Half an hour introduction to new topic
- Solving problems connected to the topic of the lesson (pupils obtain suplementarny materials a week ahead)
- Homework assignment

All class follows in the real time.

- o Pupil will also take part in traditional lessons with the teacher who is involved in the e-lessons.
- o The aim of internet courses is to reduce the disparities between pupils in high schools, especially from outside of big cities. In the country side to access to education might be impeded. In several countries with advanced economy, such as the USA, Australia, where distances between educational centres are huge in some parts, e-learning becomes more and more popular and efficient educational mean.

The advantages of distance learning. e-learning becomes more and more popular and efficient educational mean throughout the world. The reasons are as follows:

- o It is time saving (you do not waste your time commuting to schools)
- o It is money saving (you do not need money for commuting to schools and other possible fees)
- o Wheather does not influence the attendence
- o It is convenient (you need not leave your home).
- o It makes you relaxed (it is very often tiring to go to school, have classes and come back)

- **System Requirements.** Necessary for teaching over the Internet is**:** computers must be equipped with web browsers with Flash plugin installed the newest version.
- minimum Internet bandwidth should be 20 KB/s for communication only with the help of **chat** and **whiteboard**
- minimum Internet bandwidth is 50 MB/s for communication with chat, whiteboard and **audio**
- **Thus, the bandwidth should be twice the above-mentioned values:**

40 KB/s, 100 KB/s, 200 KB/s.

Then videoconference runs fluid and dynamic.

10.2. Bibliography

1. 1 Kisiel, K., Galewska E., Kucner J., Szumigaj K.: "Supporting the teaching of mathematics in secondary school based on modern information technologies in the context of e-baccalaureate", a chapter in a monograph: The information system remote-examination strategy, the logic of the system, architecture, evaluation, Technical University of Lodz, 2013

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Database servers in remote learning platforms

11.1. Introduction

The fast rate of changes taking place in the modern world forces us to continually expand our knowledge. It is inevitable especially in case of those who deal with information technology, where the incidence of modifying or creating new technologies is really high. Unfortunately, work and other responsibilities make it impossible for many people to study. A solution to this may be distance learning - e-learning. This popular term is a system based on the achievements of science, which allows for an individual adjustment of time, progress and rate of assimilating knowledge to suit anyone interested (1).

The e-learning system is a repository which stores educational materials in an electronic version and provides them for those who need them. At the same time such a system has to fulfill additional functions, like monitoring the studying progress. Such requirements call for the introduction of control points, i.e. different kinds of tests and quizzes.

The main advantages of such systems are (2):

- cost reduction, mainly by eliminating typical expenses associated with stationary training, such as the rental of premises, commuting, the cost of the lecturer's working hours. The cost of such training per person decreases drastically with the increasing number of trainees, as opposed to classroom training, where it is constant and proportional to the number of participants.
- independence of the cost of implementation of the number of recipients. In e-learning systems there is no limit of persons admitted to the course. There is no difference for the system if there are 10 or 10,000 people being trained.
- time savings associated with the reduction of steps needed to organize and conduct the course.
- improving the quality of training due to the possibility of modeling it in accordance with the current demand.
- the possibility of immediate verification of knowledge by means of control mechanisms. E-learning systems provide various forms of testing and checking progress.
- no imposition of strict time frames - it is up to the student to decide when and how long he/she will be taught.

In contrast, the essential disadvantages are:

- e-learning systems are not the most efficient in all areas of education. In practice, not all fields can be taught without contact with the lecturer.
- high initial cost of implementing the system. Making a profit is possible only in case of a larger audience. A solution to this problem would be to hire courses in companies providing such services.
- not every person is able to use this method of acquiring knowledge. This is due to different levels of motivation and organization skills.

From the point of view of the formal structure, the lowest level of the system is always the database server that stores materials, test sets along with a database of questions and answers, provides data for registration and authentication of the participants. It also contains data including test results, the state of performing tasks and progress of knowledge. In contrast, at the user side, it is necessary to develop a client terminal, which allows for communication, service and access to the collected data. Today, virtually all of them are implemented in the form of pages, web sites, which can be programmed using one of many different programming languages that offer this functionality.

11.2. Basic structure of solutions available on the market

There are many platforms supporting the process of distance learning. There are both commercial platforms, dedicated, as well as tools available on the basis of a free licence. Due to a high demand and a rapid development of tools there is a large number of software created and used at universities. A representative example can be the e-Matura platform developed at the Institute of Mechatronics and Information Technology Systems (3). It fulfills all the tasks to be undertaken by tools of this type, both in terms of material supply and testing the results. In addition, it meets the criteria for secure access and an efficient administration system. It also allows complex reporting and implementing a comprehensive analysis of the results(4). Many positive features of this approach stem from the use of a strong, commercial database server and a commercial development environment.

However, the market is dominated by the Moodle platform provided on the basis of an open licence. It is popular not only because of no purchasing costs, but also because of its high flexibility and generality, which allows its adaptation to the specific requirements of those who implement the system (5).
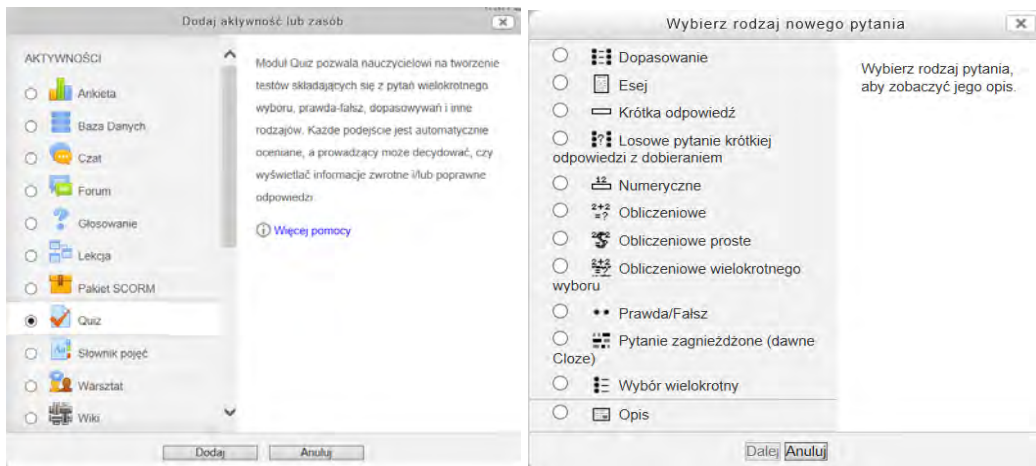
Figure 1. Moodle platform defining the resource and adding a question to the test.

In addition, it does not require high costs associated with hardware infrastructure because it can be installed on very simple equipment. Also, many Web domain administrators allow installing the platform on shared resources. The main reason is simple, free MySQL database, which provides data for the platform, and which is provided and managed by web service providers. Figure 1 shows the Moodle environment when adding a resource (test) and a question. Note the multiplicity of questions, not only involving selection but also matching or giving the calculation result.

For each system, an application based on a database can be given a general scheme of construction, which is shown in Figure 2. The same rules apply to e-learning systems which are a specific type of software. One of the basic problems of implementation involves the placement of the business logic. If processing takes place at the end of the client, we deal with the so-called thick client, if the opposite is true and the client is limited to the presentation role, this is a thin client. In practice, we never deal with a clear option and tasks associated with business logic are placed partly on each side, as illustrated by the lower arrow in Figure 2. In most solutions a thick client is used, as a result of the fact that there are better tools for higher order languages, for versioning, creating repositories and frameworks. They facilitate teamwork, which speeds up and reduces the cost of software development. This approach was also applied in the case of Moodle, but it also refers to many other existing solutions.

Figure 2. The basic structure of application.

The transfer of business logic onto the database allows using built-in server tools, such as inquiry optimizers, which improves performance. It is also possible to use the elements of procedural SQL extensions, which has an impact on performance but also on the security of the system. As a rule, such a solution substantially reduces the size

of the data transmitted over the network. Unfortunately, this requires the use of more powerful database servers, usually commercial, that implement necessary functionalities. Practically, apart from versions of Express on commercial servers, which offer limited but still significant functionalities associated with some procedural and transactional aspects of programming, the only freeware database server which could compete with the pay versions seems to be PostgreSQL. Unfortunately, due to the scarcity of supporting tools, creating such solutions requires a lot better meritorical preparation of the team, which increases the costs.

However, possible benefits of such solutions have given rise to e-learning tools with a thin client, which constitutes the basis for writing this article.

11.3. Objectives of the system and bases of its implementation

The e-learning platform "eLearn" has been implemented in the multi-tier J2EE pattern. (6) The system is divided into four tiers:

1. **Presentation tier** - located on the client side. This tier uses JSP technology to create appropriate views.
2. **Presentation logic tier** - located on the application server, associated with the processing of queries from the views into appropriate inquiries to the business logic tier. This tier uses the Struts Framework to provide the MVC model standard.
3. **Business logic tier** - responsible for all data processing operations. This tier is based on the PL/SQL stored procedures and is closely related to the data source tier.
4. **Data source tier** - based on RDBMS Oracle 10g and responsible for data storage.
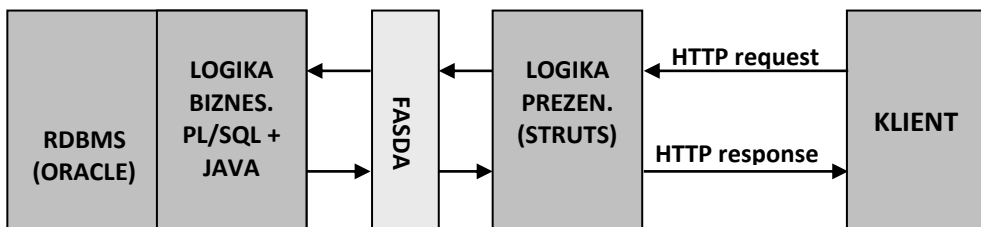
Figure 3. Architecture of the "eLearn" platform.

From the point of view of architecture a crucial element is communication between the various tiers. In the case of "eLearn" communication occurs between the following tiers:

- **Data source tier and business tier.**

Due to the fact that all the processing is performed on the database using the PL / SQL stored procedures, the data tier and business tier are closely related. In addition, within the business tier there is also communication between the PL / SQL business tier and Java business tier. Since one of the main objectives of creating the eLearn platform was a total separation of the business tier from the presentation tier, an overlay has been

created which maps the actions performed by the stored procedures onto actions performed by Java. Communication between these tiers takes place by means of Java Data Base Conectivity.

- **Business logic tier and presentation logic tier.**

Due to the fact that business logic and the data tier constitute the core of the application, there has been introduced the so-called business logic facade, collecting all the publicly available functionalities. The business logic facade is the external interface of the system to which the other tiers refer. With this approach, if you change the system inside, the person who programs the outer tiers does not have to change his/her code. As a result of applying the above-described design pattern, the business logic tier and the presentation tier communicate over the facade.

The system is divided into functional modules that manage certain functionalities:

The lecturer's module is used to manage the major repositories: materials and users - Figure 4. Thanks to it the lecturer is able to create his/her own courses / subjects, prepare appropriate hierarchies of sections and lessons. With the help of this module the lecturer can enable or disable classes or sections of the course curriculum. Additionally, they can impose a progress control mode in lessons, which may force the student to follow the sections of the course in a certain order. The contents of all the lessons is stored in the database in a form which is interpretable for the web browser, that is in the form of the HTML code. Since not every teacher can create documents in that language, the system has a built-in WYSIWIG editor (What You See Is What You Get), which allows creating lessons by using a tool similar to a typical text editor. This module is also responsible for allocating permissions to students to participate in individual courses /subjects. At any time the lecturer may check the current list of participants.
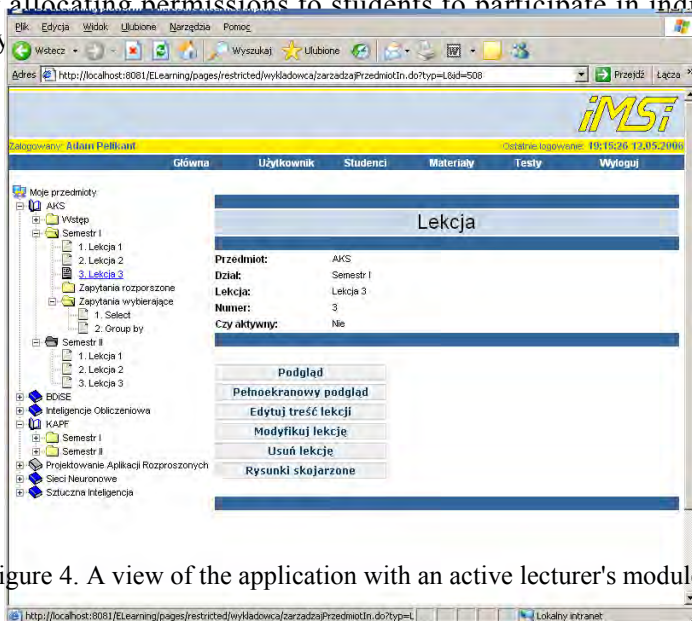
Figure 4. A view of the application with an active lecturer's module.

The student's module is used for educational purposes. With its help the student receives a list of all the courses for which he/she was assigned - Figure 5. All the materials are placed in a java script tree, which is generated automatically for the student upon entry

into the system. With this tree the student can navigate through the hierarchical structure of the materials, and browse through the lessons. The system provides two modes of viewing materials: a standard mode which places educational materials in a window next to a tree and a full screen mode. This module is only for reviewing materials. From this level the student view the content
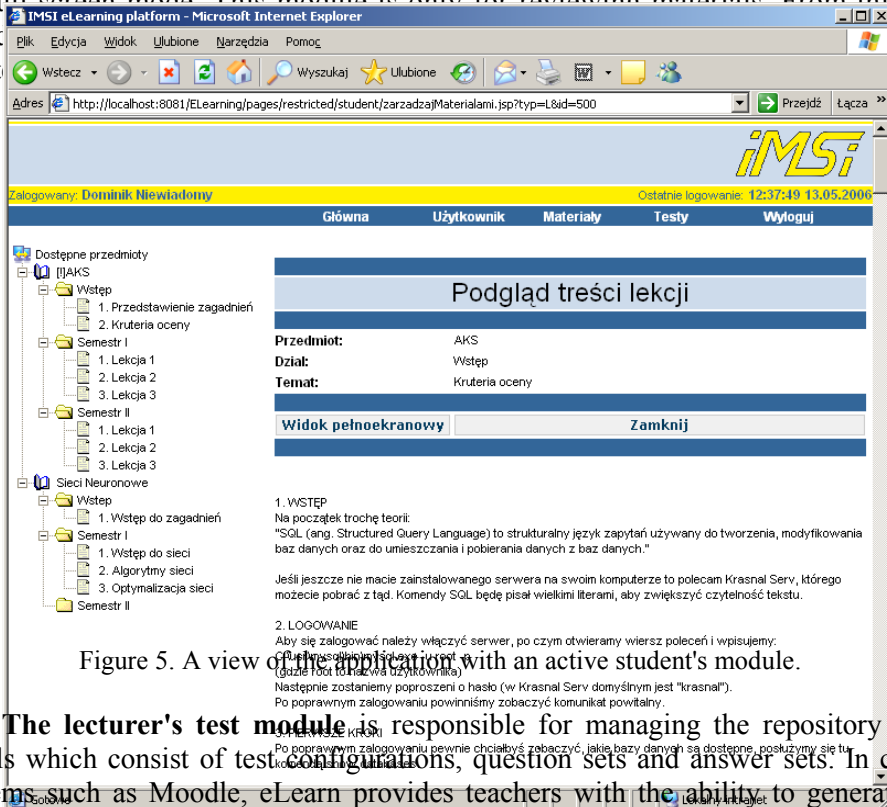

Figure 5. A view of the application with an active student's module.

The lecturer's test module is responsible for managing the repository of test materials which consist of test configurations, question sets and answer sets. In contrast to systems such as Moodle, eLearn provides teachers with the ability to generate fully customizable tests. The system allows setting the number of questions as well as correct and incorrect answers for the exam. In addition, the lecturer can assign to each test its duration time and severity of assessment - the standard level of assessment or the one with negative points for incorrect answers. Exam questions are drawn from the repository of test materials, which makes cheating in a collective exam pointless. From this module the lecturer can also generate and view statistics. These statistics can include, among others, the passing rate of individual exams or the number of attempts at tests.

The student's test module is used to conduct examinations. On the basis of his/her permissions, the student receives a list of tests available to him/her. After logging on to the test by using the password allocated by the teacher, the student can take the exam. Immediately before the start the exam is prepared by a special random generator, acting on the basis of the configuration of the test. This operation is performed for each student individually. The generated test is ready to run. Since the test can be an important document in the course of teaching, the system has been protected against accidental closing. In a situation where a student fills in a one-hour exam containing 200 questions, and after 45 minutes he/she closes the web browser by accident, they do not lose the selected answers. A mechanism synchronizing the test with the database while filling has been used here. This increases exam security.

The administrator's module is used to define users' accounts and allows assigning appropriate permissions to them. In the case of students, it allows assigning them materials and tests that they should pass after acquiring a certain amount of knowledge.
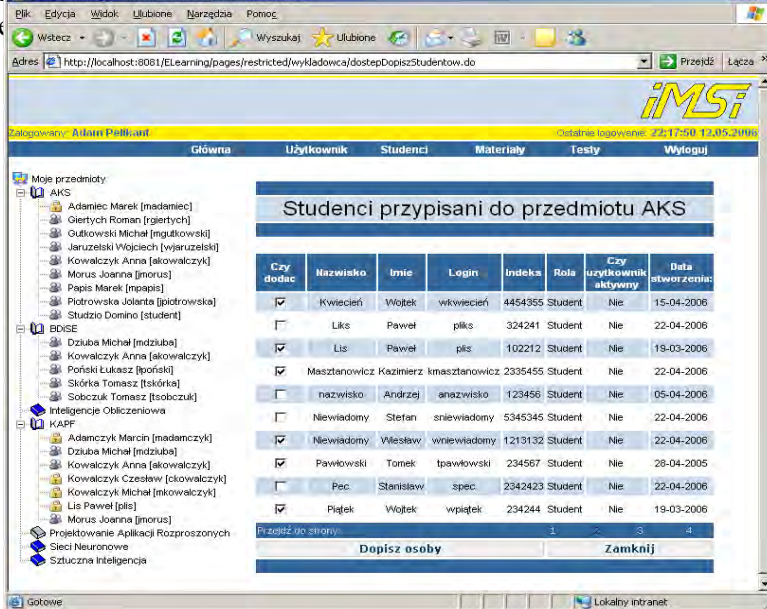

Figure 6 A view of the application with an active permission module

A similar solution has been used in a competitive software developed at the Institute of Mechatronics and Information Technology Systems (7). The main emphasis was put here on the current review of progress by means of tests carried out after a predefined section. Therefore the collected resources have been divided into three logical levels:

1. items
2. departments
3. lessons

1 Items

First, the materials are divided thematically into subjects, it is the highest level of grouping data stored in the subsystem. The subject may contain one or more branches. Each subject has its lecturer who is entitled to edit the materials at lower levels of the hierarchy. Students are assigned to subjects and at this level they receive access to view the materials.

2 Sections

The next level of classification are sections. They are connected in a tree structure, similar to the directory structure on the computer disk. Sections may include other sections and one or more lessons.

3 Lessons

The lowest level of grouping materials are lessons, the only units which contain educational content.

Including some sections within others is related to the aforementioned progress control, which is achieved by arranging the sections relatively to each other. Two basic cases are shown in Figures 7 and 8 with the corresponding graphs describing the availability of the next "batch" of material.
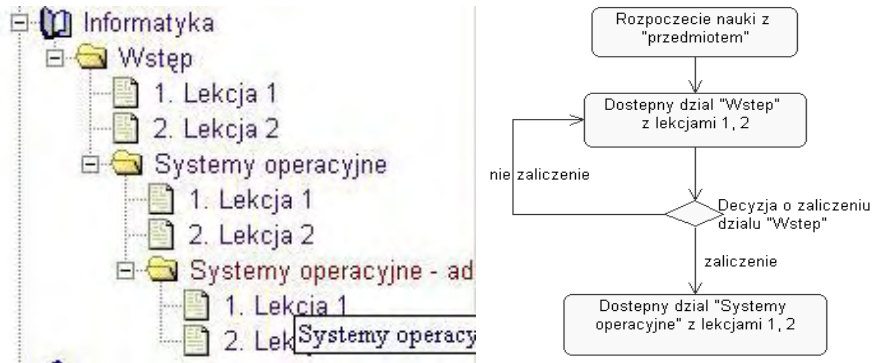
Figure 7. The hierarchy and a graph showing the availability of the next lessons with a serial organization of lessons.
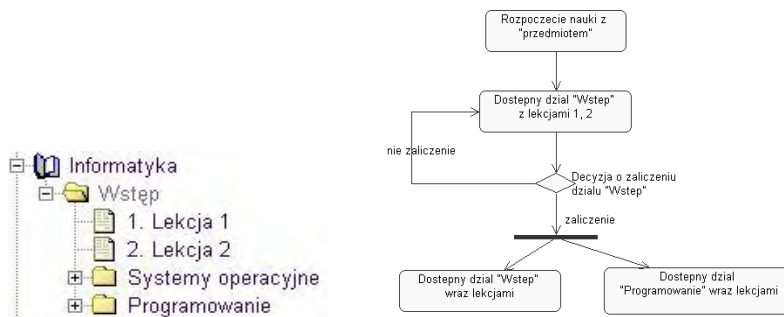
Figure 8. The hierarchy and a graph showing the availability of the next lesson with a parallel organization of lessons.

As shown in Figures 7 and 8 there are two possible solutions:
o   creating an educational path which the student must follow as planned by the lecturer
o   giving the student a choice of one of the dedicated educational paths
Additional functionality allows for a more detailed verification of the student's actions, namely the downloading of each lesson will be recorded, and only after downloading all the lessons within the section will the test be activated.

11.4. −Test generator

As it has been pointed out earlier, the key element of each of the proposed solutions is the ability to check knowledge. Also developers of commercial and free solutions, such as Moodle, have this goal in mind. However, they propose tests with a fixed base of questions and answers. The only element differentiating their presentation for subsequent startups or parallel sessions is changing the display order of the questions, and within individual questions changing the display order of the answers. Admittedly, this limits the possibility to copy from a neighbor during tests carried out in a common room, but leads to a situation in which it is possible to memorize mechanically the correct answers in case of retaking the test, as is the case in remote testing. The situation could be remedied by drawing a set of questions from a large pool for a specific user or session. Such a solution is proposed in the eMatura system (8). However, also in this system the set of responses is fixed and only its order changes. A postulated solution is to draw not only questions but also answers from a wider pool. It is assumed that at least one of them will be correct. In addition, configuration parameters determine the maximum number of correct responses, in extreme cases, all of them (9). The above assumptions have been taken into account in both of these solutions. The schematic diagram of generating tests is shown in Figure 9.
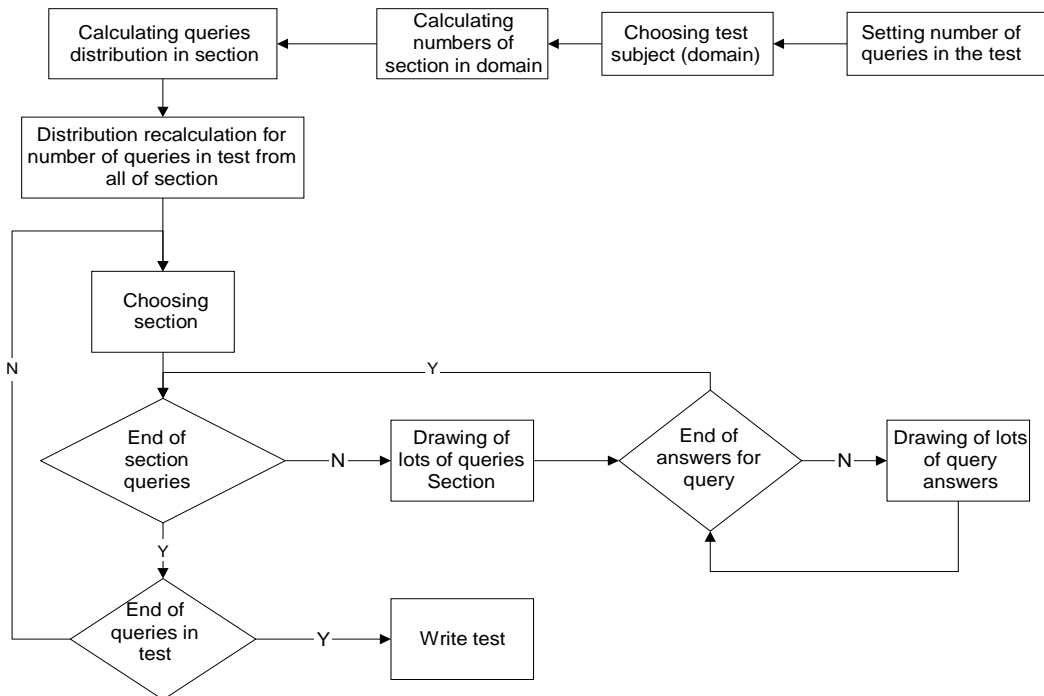
Figure 9 A block diagram of the test generator

A generator developed at the database level is designed to allow the dynamic creation of differentiated tests for each student. From a vast pool of questions, each of which is assigned to a specific section, and a pool of responses, we will make the draw.

Each question is assigned to a set of good and bad responses. Having such a resource, the lecturer can generate any number of tests, in which the number of questions does not exceed the number of questions in the database, and the number of responses is not greater than the smallest of the sets of answers to the downloaded questions. For a sufficiently large set of questions it is possible to generate non-repetitive tests.

Tests can be generated at two levels: section and subject. The default generation is the subject, but there has been introduced a test configuration mechanism. Namely, it is possible to determine the percentage of questions from each section within the subject in the generated test. Hence, the lecturer has an impact on the importance of each of the sections for the test (the percentage of questions) and can prepare tests for each section separately.

There are four available methods of test assessment:

Method 1
Subject to evaluation are specific questions with a positive verification component. In this case the basic unit is the whole question, not only the answer. Final assessment consists of only positive points obtained during the verification of individual questions. Checking takes place according to the following algorithm: if all the correct answers within the question were ticked, and no wrong answers were ticked, the system grants one point. Errors when marking responses to questions imply a zero score for the question.

Method 2
Each question is subject to evaluation, wherein the verification component can take the following values $\{-1, 0, 1\}$. In this case the basic unit in the assessment process is the whole question. Final assessment consists of both positive and negative points obtained during the verification of individual questions. If all the correct answers within the question were ticked, and no wrong answers were ticked, the system grants a positive point. If there is no answer given (refraining from answering the question), the system grants zero points. If a wrong answer was ticked (not all the good answers were marked or wrong answers were marked) the system grants minus one point. This rating system is designed to prevent "shooting" when filling the test.

Method 3
Only answers, not whole questions, are subject to evaluation. In this configuration the verification component can take the following values $\{-1, 0, 1\}$. In this case the basic unit for the assessment process is the response, not the question. Final assessment consists of both positive and negative points obtained during the verification of individual responses. If the selected answer is correct, the system grants one point; if the selected answer is wrong, the examinee receives minus one point; not ticking the wrong answer means zero points; not ticking the correct answer is also zero.

Method 4 (the so-called stricter version of number 3)
Only answers are subject to evaluation. Assessment method 4 is a stricter version of method 3. If the selected answer is correct, the system grants one point; if the selected answer is wrong, the examinee receives minus one point; not ticking the wrong answer means zero points; not ticking the correct answer is minus one point (the only difference with method number 3).

Test generator, like other parts of the e-learning application, is based on the Oracle database. The simplicity and elegance of the applied solution is illustrated with a sample PLSQL code of the procedure generating a test in a defined section for a specified student.

```
CREATE OR REPLACE FUNCTION TESTGENERATOR
(IN_CONFIGURATION_ID IN NUMBER
, IN_TEST_ID IN NUMBER
, IN_STUDENT_ID IN NUMBER
, IN_TEACHER_ID IN NUMBER)
RETURN NUMBER
IS

- a cursor returning all the departments that are supposed to
- form part of the test, along with a specific number of
- questions to be selected from a particular section

CURSOR Domain_cur (param_config_ID IN NUMBER,
param_question_number IN NUMBER) IS
SELECT domain_id, ROUND (percent/100 *
param_question_number) Question_Number Percentage FROM
WHERE Config_ID = param_config_ID
ORDER BY percent;
val_Domain_cur Domain_cur % ROWTYPE;
To_Draw NUMBER (4,0);
Already_Draw NUMBER (4,0);
Position_counter NUMBER (4,0);
Domains_number NUMBER (3,0);
ret_value NUMBER (1,0);
Test_generation_error EXCEPTION;

BEGIN
SAVEPOINT TestGenerator;

- creating a test header in the table TESTS

INSERT INTO Tests (test_id, student_id, Teacher_ID,
Config_ID, Starting_date, Correctly_created )
VALUES (IN_Test_ID, in_Student_ID, IN_Teacher_ID,
in_Config_ID, SYSDATE, 0);
- collecting the total number of questions to be included in the test

SELECT INTO Question_Number T o_Draw Configuration FROM
WHERE Config_ID = in_Config_ID;
Already_Draw: = 0;

- checking how many divisions are included in the test

SELECT COUNT (domain_id )Domains_number INTO FROM WHERE
Percentage Config_ID = in_Config_ID;
OPEN Domain_cur (in_Config_ID, To_Draw );
```

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- a loop after the sections to be included in the test

```
FOR Position_counter IN 1. Domains_number LOOP
FETCH INTO Domain_cur val_Domain_cur;
IF THEN Position_counter = Domains_number
```

- The number of questions to be selected from the last chapter
- is calculated in a different way.
- From the total number of questions in the test we subtract
- the number of questions drawn so far
- this is to avoid a situation,
- in which, by rounding, the final number of questions in the test
- differs from that established by the teacher

```
ret_value: = ChoseQuery (val_Domain_cur.Domain_ID,
IN_Test_ID, To_Draw - Already_Draw );
ELSE
```

- calling the procedure responsible for drawing questions with
- relevant parameters defining the section,
- the test identifier, the number of questions to be selected within the
- designated section

```
ret_value: = ChoseQuery (val_Domain_cur.Domain_ID,
IN_Test_ID, val_Domain_cur.Question_Number );
END IF;
Already_Draw: = + val_Domain_cur.Question_Number
Already_Draw;
```

- establishing the error resulting from the execution of the function CHOSEQUERY

```
IF ret_value = 0 THEN
CLOSE Domain_cur;
RAISE Test_generation_error;
END IF;
END LOOP;
CLOSE Domain_cur;
COMMIT;
RETURN 1;
EXCEPTION
```

- error management

```
WHEN OTHERS THEN
ROLLBACK is TestGenerator;
DBMS_OUTPUT.PUT_LINE (' Error In TESTGENERATOR ');
RETURN 0;
END;
```

In the body of the procedure that generates a single test, a procedure is used which draws a single question from the set in such a way as to avoid duplicates. The code PLSQL cited below is as simple as the previous one and equally elegant.

```
CREATE OR REPLACE FUNCTION CHOSEQUERY
( IN_DOMAIN_ID IN NUMBER
, IN_TEST_ID IN NUMBER
, IN_QUESTION_NUMBER IN NUMBER)
RETURN NUMBER
IS

- a cursor that contains all the questions that have not been drawn
- from the given chapter for the given ID of the generated test
CURSOR questions_cur (param_Domain_ID IN NUMBER,
param_Test_ID IN NUMBER) IS
SELECT FROM Question_ID Questions WHERE domain_id =
param_Domain_ID
AND active = 1 AND Question_ID NOT IN (SELECT FROM
Question_ID Question_temp
WHERE test_id = param_Test_ID );
val_question_cur questions_cur % ROWTYPE;
Chosen_questions NUMBER (3,0);
Chosen_to_choose NUMBER (3,0);
Drawn_number NUMBER (4,0);
Position_counter NUMBER (4,0);
RETURN_CODE NUMBER (1,0);
To_few_questions EXCEPTION;
answer_generation_error EXCEPTION;

BEGIN

- checking the cardinality of the set of questions
- (i.e. how many questions there are in the section)

SELECT count (* )FROM INTO Chosen_to_choose Questions
WHERE domain_id = in_Domain_ID AND active = 1;

- if there are too few questions, error is returned

IF Chosen_to_choose < in_Question_Number THEN
RAISE To_few_questions;
END IF;
Chosen_questions: = 0;

- a loop responsible for the next draw of questions

FOR Chosen_questions IN 1. In_Question_Number LOOP
OPEN questions_cur (in_Domain_ID, IN_Test_ID );
```

- defining the range of the number to be drawn

```
SELECT COUNT (Question_ID )Chosen_to_choose INTO FROM
Questions WHERE domain_id = in_Domain_ID
AND active = 1 AND NOT IN Question_ID
(SELECT FROM Question_ID Question_temp
WHERE test_id = IN_Test_ID );
```

- drawing the range of the question

```
Drawn_number: = ROUND (dbms_random.value (1,
Chosen_to_choose));
```
- selecting the question with the drawn number

```
FOR Position_counter IN 1. Drawn_number LOOP
FETCH INTO questions_cur val_question_cur;
END LOOP;
CLOSE questions_cur;
```

- saving the drawn Question

```
INSERT INTO Question_temp (test_id, Question_ID)
VALUES (IN_Test_ID, val_question_cur.Question_ID);
```

- Finding answers to the drawn questions
- (both correct and incorrect answers will be drawn
- in accordance with the configuration of the test)

```
RETURN_CODE: = Chose_answer
(val_question_cur.Question_ID, IN_Test_ID );
```

- verifying if the process of drawing answers
- has been completed successfully

```
IF RETURN_CODE = 0 THEN
```

- failure to draw answers
- reporting a bug at a higher level

```
RAISE answer_generation_error;
END IF;
END LOOP;
```

- the process of drawing questions ended with success

```
RETURN 1;
EXCEPTION
```

- error management

```
WHEN OTHERS THEN
RETURN 0;
END;
```

No procedure of drawing answers has been presented, but it is similar to the above procedure of drawing questions. An additional limitation, apart from lack of duplicates, is only providing at least one correct answer and not exceeding the maximum number of such responses indicated in the test configuration.

11.5. Analytical processing of test results

The e-learning platform is a repository of both educational materials and tests. Any action related to the generation of the test and the completion of its course is stored in the database. At the request of the student the system generates a set based on the configuration of questions and answers described in the two preceding paragraphs. A set generated in this way is stored in the database and kept as an archive of the student. This applies to all tests, both completed and interrupted. Each test is characterized by the subject to which it belongs, its name and the starting and completion date. For each test there are four possible actions:

- Checking the configuration description associated with the test. This action allows viewing test details, such as: number of questions, number of responses, duration and assessment method.

- An overview of logons to the test. The system allows teachers to view statistics for logons to a particular test for a particular user. The lecturer is able to check how many times the student attempted at the test. Additionally, the lecturer receives information about the date of the first and last logon to the test performed by the student. All this may be useful to lecturers at the time of assessment. Information about the number of logons to the test may be an additional assessment criterion.

- An overview of test results and their contents. All this gives a full view of all the tests that took place in the system and have been generated on the basis of the configurations created by the teacher. Each test is described by ten characteristics. These features include the student's personal data, such as name and index number, information about the generation state, termination and cancellation of the test, data characterizing the test time and the percentage score achieved by the student with the proposed grade - Figure 10.

Figure 10 Test archive

Since each user may log on to the test repeatedly, and over time there are more and more users, the number of tests in the archive rapidly increases. With the increase in the number of tests, the paging mechanism ceases to be efficient enough to work without being connected to other mechanisms. In order to solve this problem, paging has been integrated with data filtering. For this purpose, the mat that displays the list of archive tests has been equipped with two filter fields representing the minimum and maximum starting date of taking the test by the student. These fields take strings which show the date in the form of YYYY-MM-DD. In order to increase the convenience of using the filter, a calendar component based on javascript has been introduced. This component allows easy navigation through the calendar, showing additional information, such as the current date and week number of the year. If no data is introduced into the filter fields, all the tests from the last year are retrieved by default. If you enter only "Date to", all the tests which began before the date mentioned in that field are displayed. If you enter only "Date from", all the tests from this date to the present are displayed.

When viewing the test archive, the lecturer can use two actions: one allows browsing the contents of the test, the other one allows grading or cancelling the test.

The test will be fully completed when the user receives a grade or the test is cancelled. The lecturer gets a tip about the method of assessment, the percentage of correct answers and suggested evaluation on the basis of a set of grades assigned to the test.

In order to make it more convenient for the teachers, the system is equipped with the ability to check the statistics of grades obtained by the students. This statistics is generated on the basis of all of the tests generated on the basis of the selected configuration.
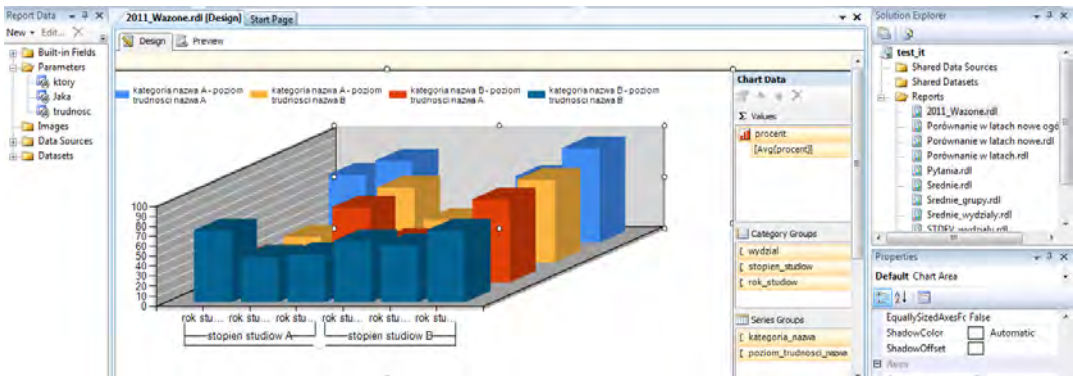
Figure 11. The use of Reporting Services for reporting and analytical processing.

Besides using reports created programmatically for the needs of a particular application, using strong database servers as a data store for the application of distance learning allows the use of integrated reporting environments which are highly integrated with them. In case of the MS SQL Server it is Reporting Services (10), an example of its operation is shown in Figure 11. Worth noticing is the possibility of parameterization and dynamic filtering of the processed data, and in newer versions the possibility of direct use of maps (vector graphics - Spatial), which enables the use of this environment for analysis and visualization of phenomena related to spatial location. A corresponding solution for Oracle is Business Intelligence Publisher.
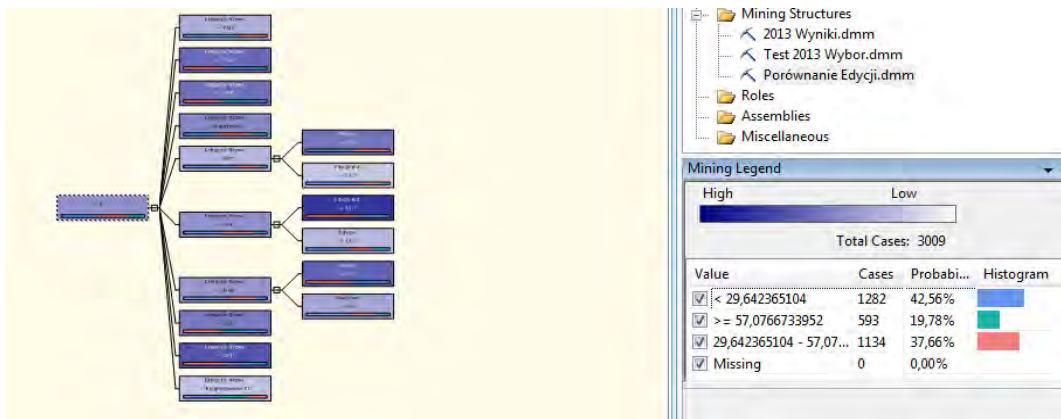
Figure 12. The use of Analysis Services to extract information.

In addition to reporting, it is possible to use more sophisticated tools to conduct research and data mining; for the SQL Server such a tool is Analysis Services. Its operation results for the decision tree describing test results for the next editions are shown in Figure 12. In addition to the exploration of the data, this tool provides the ability to create multidimensional analysis. In case of Oracle we can take advantage of the Analytical Workspace Manager (data warehousing) or Ora Data Miner (eksploration).

11.6. Summary

According to psychologists, despite its many advantages e-learning cannot be the only form used in the teaching process (11,12) The future belongs to mixed trainings, which will combine all types of training - full-time, virtual and out-door - in one training program (the so-called blended training). The eLearn platform is well suited to the blended training, just because the teacher is equipped with a wide range of capabilities of transfering and testing knowledge. It allows creating both simple and short preparations for outdoor training and enhanced academic learning paths. The eLearn system can also be used as a source of extra materials for lectures conducted by traditional methods, which makes it useful also in the normal didactic course at schools or colleges.

11.7. Footnotes

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3. Sławomir Wiak, Dominik Jeske, Maciej Krasuski, Rafał Stryjek: Simulation of the Behavior of Disc-Spring Valve Systems with the Fuzzy Inference Systems and Artificial Neural Networks, Artificial Intelligence and Soft Computing, Springer 2012,ss. 634-644,

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12. Zheng Yan, Heping Hao, L. Jon Hobbs, Ning Wen: The Psychology Of E-Learning: A Field Of Study, Journal of Educational Computing Research, Volume 29, Number 3 / 2003, pp. 285 - 296

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3.   Sławomir Wiak, Dominik Jeske, Maciej Krasuski, Rafał Stryjek: *Simulation of the Behavior of Disc-Spring Valve Systems with the Fuzzy Inference Systems and Artificial Neural Networks*, Artificial Intelligence and Soft Computing, Springer 2012,ss. 634-644,
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5.   Sabine Graf, Beate List: *An Evaluation of Open Source E-Learning Platforms Stressing Adaptation Issues*, Proceedings of the Fifth IEEE International Conference on Advanced Learning Technologies (ICALT'05)
6.   Jurek A., Plichta D., Szymański M., Pelikant A.: *Platforma e_learning w technologii Oracle*, 1st Polish and International PD Forum – Conference on Computer Science 2005, Bronisławów 2005
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Solving secondary school exams problems by gifted students via e-learning system

12.1. Introduction

Nowadays the usage of information technologies in teaching becomes a must. Distance learning helps students broaden their knowledge to a growing extent. High schools' teachers try to help their students in exam preparation but it is not always with limited time awarded to each subject. In order to support pupils with studying for secondary school leaving exams (which allow them to enter universities of their choice) some additional classes are being organized. It is obvious that distance learning may prove very profitable in this process. Distance learning which uses modern information technologies and which is based on internet connections is a natural tool for young people who often resort to new technologies and appliances in solving concrete problems. Distance learning allows for courses which are conducted after typical school hours. Students may attend e-classed not leaving their homes which truly helps them in their preparations. Those living in big cities do not waste time on traveling and those from smaller towns are allowed to have courses otherwise unavailable. In this note we concentrate on teaching mathematics on a high school level and we present methods applied in working with gifted students. Several secondary level schools applied for the project. In every participating school one class was chosen and in each class several mathematically gifted students were selected. This small groups were working with instructors via distance learning platform. E-courses were conducted in the evenings so that the students have no school commitments. This follows the suitably designed scheme. Each e-lesson consisted of a number of selected exam problems of a more involved nature. Each problem is presented on the platform. Pupils can write with a special pen their partial solutions. Each pupil can be asked for providing a partial solution by an instructor. This could be done with a special asking tool provided by the e-learning platform. Such a lesson appears very attractive to the mathematically gifted students and provides them with new experiences and abilities. The small group in which pupils work and more informal nature of an internet class helps also a lot. Pupils can also communicate problems which they are unable to solve and which are further discussed in a group. Such discussions may become interesting and fruitful. The aim of a teacher is not to provide students with solution but to advice them how to reach a solution themselves. Such an educational model make students find solutions themselves and helps them develop interpersonal skills. The idea of e-lessons is welcomed by both pupils and their parents. The project is supported by EU Commission within the framework of EU Structural *Funds with* provision of assistance in reducing the disparities between pupils in high schools. This project is addressed to pupils which cannot allowed

for attending additional courses which have to be paid for and also which live outside of big cities where such courses are simply not available. *In some parts of Poland, especially the north-west or on the eastern border there are much more poor people than in central parts and distances to educational centers are larger. This best suggests the e-learning may prove a good educational option in* reducing the disparities between pupils in high schools.

We have ascertained ourselves how efficient e-learning is when having courses on the e-platform within the project „Mathematical e-emergency" (in Polish E-pogotowie matematyczne) which was aimed at preparing pupils for their secondary school exams. This project was very successful which can be justified by the following quotation:

One can find a number of websites offering payable services for solution tasks of mathematics.

Students take advantage of this questionable form of assistance even more frequently. They receive ready-made solutions without understanding them. The former Polish Minister of Education prof. Zbigniew Marciniak had an idea of introducing 'state tutoring' that ought to solve the problem of private lessons in primary schools for the class range IV-VI. State tutoring includes obligatory classes of two main subjects: Polish and Maths. In other words, the government wanted to equalize the chances of education and attenuate the common problem of private tuition. Unfortunately, many parents send their children for private lessons, since they are not certain whether school provides their children with appropriate education or not. It results from the fact that school fails to live up to their increasingly high expectations. The problem of private tuition is also increasing in secondary and high schools, with regard to mathematics and foreign languages in particular. Being employees of Technical University of Lodz, we have been familiar with this problem since 2009. From that time we have been working on the project *Mathematical Emergency E-services*, which is entirely financed by the EU funds. The goal of the project is to provide a real-time, immediate assistance in the field of mathematics for students of secondary schools. Every week from Sunday to Thursday, from 5 PM to 10 PM four teachers provide assistance using a special computer system. The student, who has a problem with the solution of his homework in mathematics or does not understand some issues, may connect to the teacher using the Internet. The student will not get the ready solution, he must actively take part in the discussion with the teacher. In the are of Lodz 30 schools are covered by this program, from which more than 1000 students can get the assistance. The project will come to an end in September, 2011. Every day teachers are faced with many problems which their students come across.

In this chapter we will present some of them. They are authentic conversations provided in real time. Thanks to the sound on the platform, the conversations are not fully quoted but saved as a comment.[1]

Solving secondary school exams problems via e-learning system. Apart from their regular teacher pupils have classes with lecturers of mathematics from Lodz University of Technology**.** We would like to describe such classes basing on our personal experience. On such e-class we present problems with a fixed level of difficulty. Suitably

---

[1] K. Kisiel, Jacek Stańdo, *How can ICT effectively support educational processes? Mathematical emergency e-services – case study.* DICTAP 2011, Part II, CCIS 167, pp.473-482, 2011. Springer – Verlag Berlin Heidelberg 2011.

prepared figures – for example in GeoGebra mathematical software – are being displayed during a lesson. This is a great help in solving geometric planar and space problems. Pupils can see a correct and figure which helps them both better understand and solve the problem. The lecturer performs a role of a chairman during such a lesson since a school teacher is also present and involved into the whole learning process in a classical manner. Pupils discuss the problem as they do in traditional class. The lecturer can ask any pupil allowing them either to speak or to write a partial solution. This is done with suitable designed tools available at the e-platform. The most involved pupils are graded at the end of the lesson.

The advantages of e-learning have already been mentioned. The disadvantages are of technical nature. It happens that the lecturer cannot see pupils on his/her screen. This forces them to log-in again and slows the whole process down. It is caused by some internet connection problems, over-usage of servers and with using Wi-Fi. Such problems arise very rarely.

We describe a few model problems discussed in a group of five selected pupils from various schools:
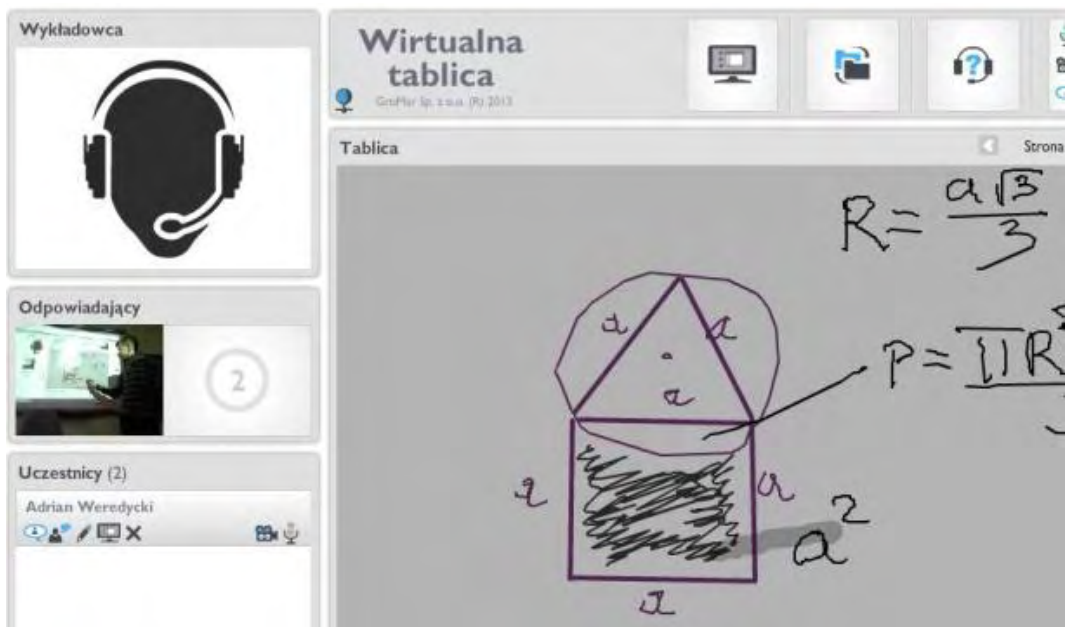
Figure 1. Solving secondary school exams problems. Own elaboration.

Figure 1 depicts a portion of e-lesson. Instructor using suitable tools provided places a figure illustrating the considered problem. Due to the interactive blackboard available in the classroom all solution steps can be performer by pupils. Instructor provides pupils with hints only and not with even a partial solution. The aim of both the lecturer and the teacher is to make pupils work on the problems themselves. While discussing the problem pupils suggest different solutions which are further verified by the lecturer. In the case of figure 1 pupils suggested the solution in a fruitful discussion which

was followed by a solution process. We can see, as the final part of the solution, the colored region whose area is to be calculated. The pupils arrived to this solutions themselves instructed by the lecturer and their teacher only when some problem is encountered or if their reasoning is not correct. The most involving pupils are awarded.

Figure 2. Solving secondary school exam statistic problem. Own elaboration.

Figure 2 depicts a portion of e-lesson conducted for 5 mathematically gifted pupils in the evening hours. Pupils are seen on the left. Pupils connect to the platform from their homes. The lecturer can ask any pupil allowing them either to speak or to write a partial solution. This is done with suitable designed tools available at the e-platform. The work of pupils must be supervised at each step of a solution. Each student must take active part in a lesson and each student tries to solve problem independently on his/her screen. On the screen we can see how students calculate certain statistical estimator which is not trivial to them but it is also not as difficult as expected to be. It must be underlined that pupils not only communicate by speaking or writing on a screen but they also use chat in order to discuss the problem. Since the voice sometimes cannot be heard chat becomes the only form of communication.

Figure 3. Solving secondary school exam probabilistic problem. Own elaboration.

Figure 3 depicts a portion of e-lesson on probability conducted for 5 mathematically gifted pupils in the evening hours. Firstly pupils describe the specific probability space, next they calculate probability. Chat conversations provided in the figure concern the results which are commented by the lecturer. Video transmission is not used since the chat method proved to be quicker and more dependable.

Figure 4. Solving secondary school exam statistic problem. Own elaboration.

Figure 4 depicts a problem on statistics. This problem is a simple one, but proved to be difficult for pupils. This suggests that before solving specific problems it is advisable to give students several presentation on the theory. In the case of Figure 4 some introduction to statistics would be welcomed.

Figures 5 to 7 provide a quick introduction into statistics in Polish.
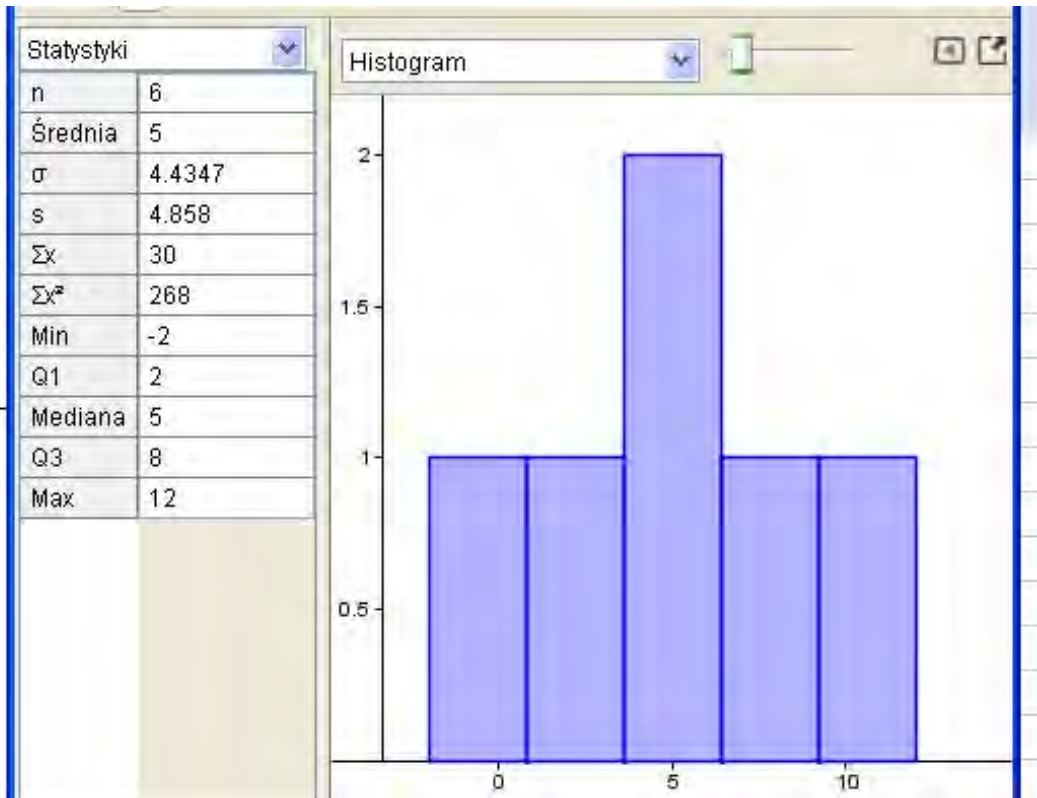
Figure. 5. Histogram with some statistical parameters. Own elaboration.

Przykład 16. *Dziesięć osób zapytano o czas, jaki poświęcają na dojazd do pracy. Otrzymano następujące dane w minutach:*

$$5, \quad 10, \quad 15, \quad 20, \quad 20, \quad 30, \quad 35, \quad 45, \quad 60, \quad 60$$

$$Me = \frac{1}{2}\left(x_{\frac{n}{2}} + x_{\frac{n}{2}+1}\right) = \frac{20 + 30}{2} = 25$$

Oznacza to, że połowa badanych osób poświęca na dojazd do pracy nie więcej niż 25 minut, a druga połowa nie mniej niż 25 minut.

Figure 6. An exercise to calculate the median. Own elaboration.

Przykład 19. *Badanie dotyczące liczby czasopism kupowanych tygodniowo przepro-wadzono wśród 200 losowo wybranych mieszkańców osiedla. Otrzymane dane zestawiono w tabeli. Obliczyć medianę.*

Nr klasy	Liczba czasopism x_i	n_i	n_{isk}
1	0	15	15
2	1	38	53
3	2	75	128
4	3	46	174
5	4	13	187
6	5	11	198
7	6	2	200
Razem		200	

(dane umowne)

Liczba obserwacji w powyższym szeregu wynosi $N = 200$, zatem mediana jest średnią arytmetyczną elementów szeregu o numerach $\frac{N}{2} = \frac{200}{2} = 100$ i $\frac{N}{2} + 1 = \frac{200}{2} + 1 = 101$. Ponieważ $x_{100} = 2$ oraz $x_{101} = 2$,

Figure 7. An exercise to calculate the median. Own elaboration.

Figure 8. Provides the solution of probability problem. Pupils find out some interesting idea of illustrating the space of elementary events by using a suitable table.

Figure 8. Solving exercises of probability of using e-learning platform. Own elaboration.

Figure 9. Concerns analytic geometry. Thanks to interactive table the lecturer supervises the whole solution process.

Figure 9. Solving exercises with analytic geometry using e-learning platform. Own elaboration.

12.2. Conclusions

The idea of supplying traditional learning with e-learning is most welcomed by pupils, especially mathematically gifted ones, and their parents. Very often pupil encounter problems that are too difficult for them to be solved without some help. The more often it happens, to more likely it is that pupils will not progress in mathematics on expected level and and the assumed learning outcomes will not be met. The online platform would provide a tool for discussion of most difficult problems, suggesting different ways of solutions. Pupils readily use the platform and benefit from it a lot by taking part in discussion panel. They not only communicate with a teacher but also with their fellow students. The small groups allow all pupils to take active part in the class. The convenient lesson hours are also the advantage. Moreover,

- It is time saving (you do not waste your time commuting to schools).
- It is money saving (you do not need money for commuting to schools and other possible fees).
- Weather does not influence the attendance.
- It is convenient (you need not leave your home).
- It makes you relaxed (it is very often tiring to go to school, have classes and come back).

It is expected that e-learning will become more and more popular and efficient educational mean throughout the world involving more and more pupils and teachers.

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Krzysztof Kisiel
Michał Kucner
Hanna Drabik - Zalewska

Solving stereometry problems using a learning platform

13.1. Introduction

In recent years growing interest in online education have been observed. What accounts for this is willingness to gain knowledge, higher qualifications and experience. This situation is also influenced by constant advancements in the field of IT, as those allow to meet students' expectations. The Lodz University of Technology conducted projects "Mathematical Emergency E-Services" and "E-secondary school-leaving examination**"**[1] as a learning-support method aimed at pupils of high schools. The latter allowed to examine participants from the distance. Moreover, similarly to "Mathematical Emergency E-Services" it gave them a chance to benefit from online tutorial sessions. Some students used this assistance when preparing to their current tests. Others, however, took advantage of it on the regular basis to revise in a systematic manner material covering both basic and extended matriculation exam. This thesis is to elaborate on actions the project "Mathematical Emergency E-Services" consisted of.

Organisation of platforms work. Pupils of the chosen high schools were offered the assistance available at learning platform 5 times a week, 5 hours a day. Every day during platform's working hours four tutors were on duty and each of them had only one student to take care of. The length of a session was unlimited and it was determined by each student's knowledge and needs. What should not be omitted is the fact that the number of connections with platform was not restricted and how often it was attended depended on students' decisions.

On-line help. Tutors were presented with problems of various types and levels of difficulty. This thesis is to address only streometry problems. What is stereometry?
Stereometry: the measurement of volumes and other metrical elements of solid figures —distinguished from *planimetry* [2].
It is often the case that a student fails to imagine a geometrical object in a three-dimensional space. Consequently, they fail to imagine the relations described by the problem. Moreover, the sketches they draw are often not accurate enough to enable noticing those

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[1]Kisiel K., Galewska E., Kucner J., Szumigaj K.: "Wspomaganie nauczania matematyki w szkole ponadgimnazjalnej w oparciu o nowoczesne technologie informacyjne w kontekście e-matury", rozdział w monografii: System informatyczny zdalnego egzaminowania-strategia, logika systemu, architektura, ewaluacja, Politechnika Łódzka, 2013
http://www.merriam-webster.com/dictionary/stereometry
[2]http://www.merriam-webster.com/dictionary/stereometry

relations. Using mathematical programs such as, for instance, GeoGebry[3]. would make solving this type of problems considerably easier due to the fact they supply the user with clear drawing. Although a neat sketch may significantly facilitate noticing some of the relations the given problem is not already solved. What a pupil needs apart from a clear drawing is frequently support offered during the attempt to solve it. It is also feedback which will allow them to comprehend mistakes they have made and somebody who can give a hint that are very helpful for a student. And it was project "Mathematical Emergency E-Services" that provided them with such a comfort.

Exercise 1. Tutor written data of the task and made the appropriate figure. It uses the tools of the educational platforms. During the videoconference student and tutor discussed the exercise. Then the student has used the data contained in the problem and trigonometric functions. In the next step he calculated the length of the proper segment. Tutor wrote a solution to the screen as presented in Figure 1.

Figure 1. Source: "Mathematical Emergency E-Services". Solving tasks - calculate the length of the lateral edge of the pyramid.

Exercise 2. Tutor drew a rectangle on the panel platform, which is vertical cross section of the cylinder. For the rectangle in this exercise conditions are satisfied. Student applied the Pythagorean theorem and calculated the radius of the base of the cylinder. With these data the student easily calculated as the volume of the cylinder. The student made the same calculation. With a screen just check the correctness of the calculations. The process of solving the problem shown in Figure 2.

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[3]Kucner J., Galewska E., Kisiel K.: „Stosowanie darmowego oprogramowania matematycznego do rozwiązywania zadań maturalnych", rozdział w monografii: System informatyczny zdalnego egzaminowania-strategia, logika systemu, architektura, ewaluacja, Politechnika Łódzka, 2013
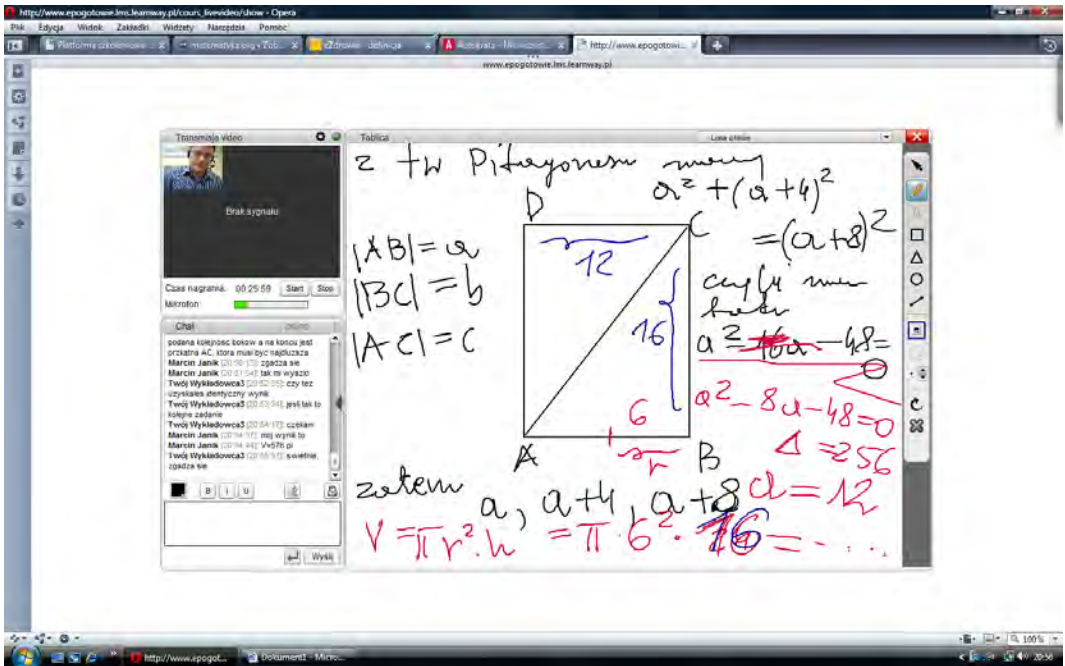
Figure 2 .Source: "Mathematical Emergency E-Services". Solving exercises
- calculating the volume of a cylinder.

Exercise 3. In this exercise the drawing is also necessary. Using the platform tools tutor drew the regular quadrangular pyramid and using a pen charted data from the task. After an exchange of questions and answers student applied the Pythagorean theorem and calculated the length of the diagonal of the base. Not all calculations are given Figure 3. The student did some calculations on a piece of paper.
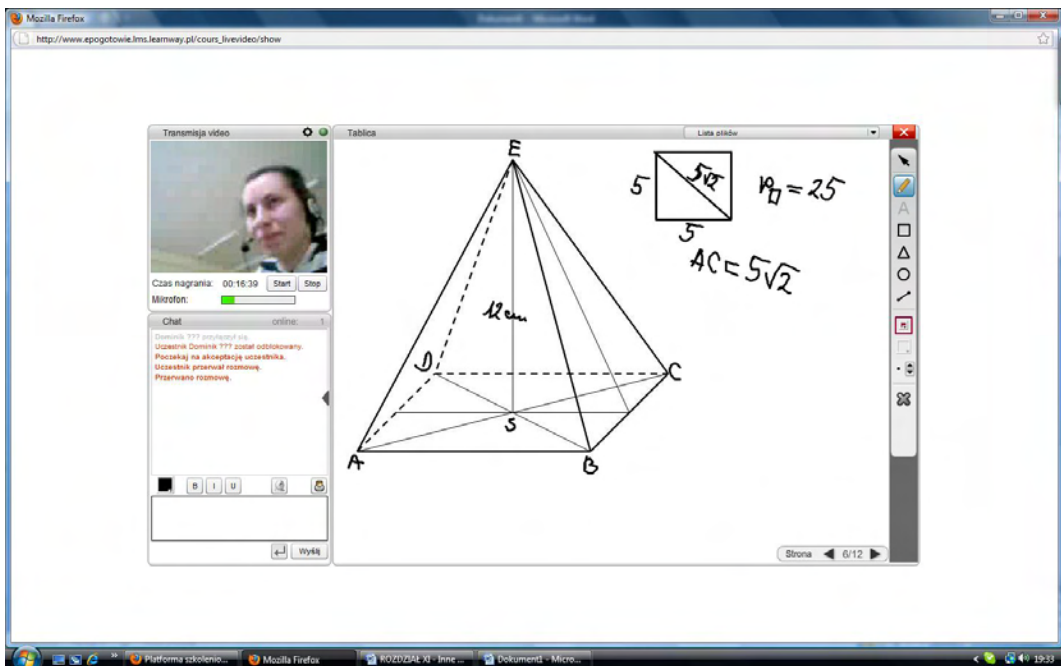
Figure 3. Source: "Mathematical Emergency E-Services". Solving exercise - calculate the length of the base of the regular quadrangular pyramid - teacher Hanna Drabik-Zalewska.

Exercise 4. In the next exercise is considered quadrangular prism and appropriate rectangle. Figure 4 helps to solve exercises.
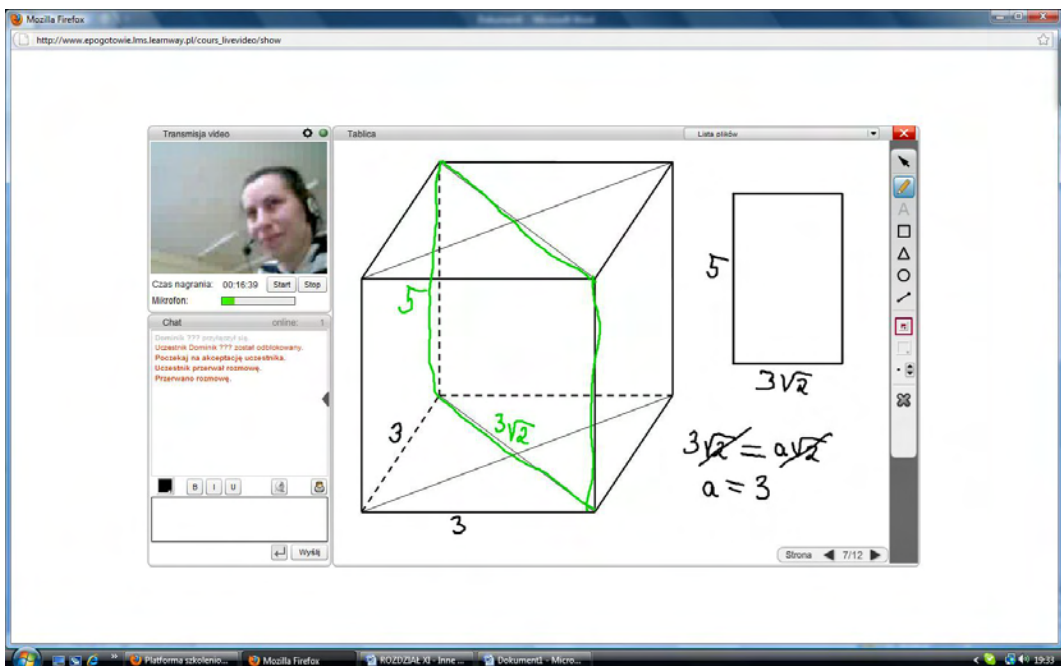

Figure 4. Source: "Mathematical Emergency E-Services". Solving exercises - calculate the length of the base quadrangular prism - teacher Hanna Drabik-Zalewska.

Exercise 5. We started of course from the application of the data of the exercise. The teacher drew of the cone and appropriate angle. The student noted that the vertical cross section of the cone is an isosceles triangle. Using the information contained in the problem the student has calculated the vertical cross section area of a cone. Fragment of solving the problem is presented in Figure 5.
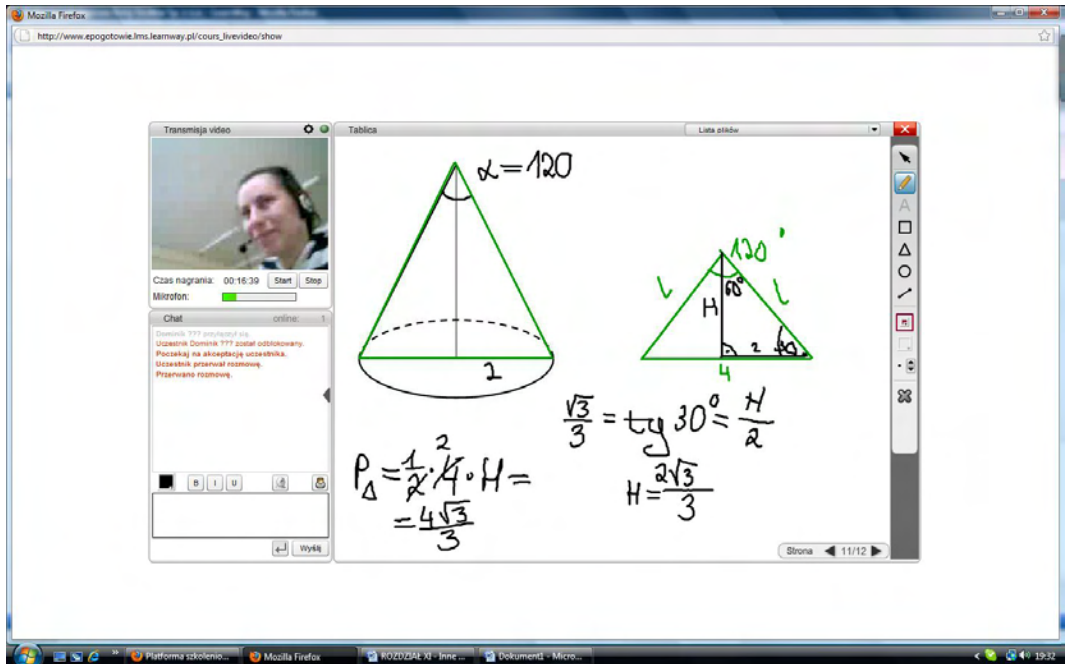

Figure 5. Source: "Mathematical Emergency E-Services". Solving exercises - the calculation of the vertical cross section area of a the cone - teacher Hanna Drabik-Zalewska.

Exercise 6. Students log on to the platform. The student had a problem with the calculation of the volume of a regular quadrangular pyramid. Solution exercises started by drawing the pyramid satisfied the conditions of exercise. After discussion and exchange comments and questions the student realizes the different steps leading to the solution of the problem. Figure 6 shows a portion of solution of the problem.ia.
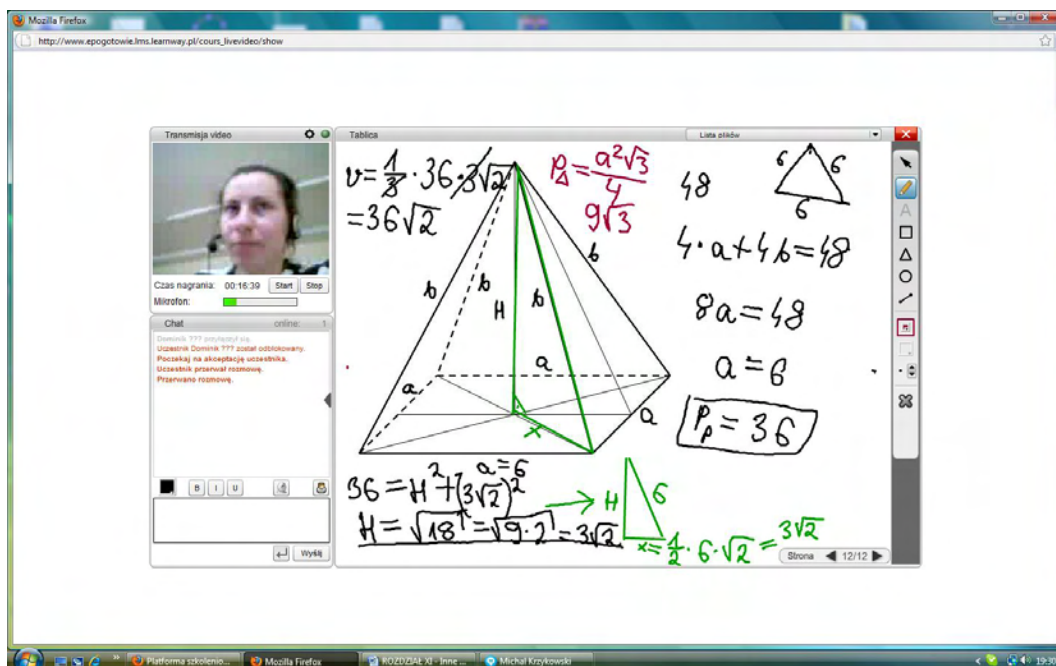
Figure 6. Source: "Mathematical Emergency E-Services". Solving the exercise - calculating the volume of the pyramid - the teacher Hanna Drabik-Zalewska.

Exercise 7. After preparing Figure 7 and the discussion the student quickly noticed what to do to solve an exercise.
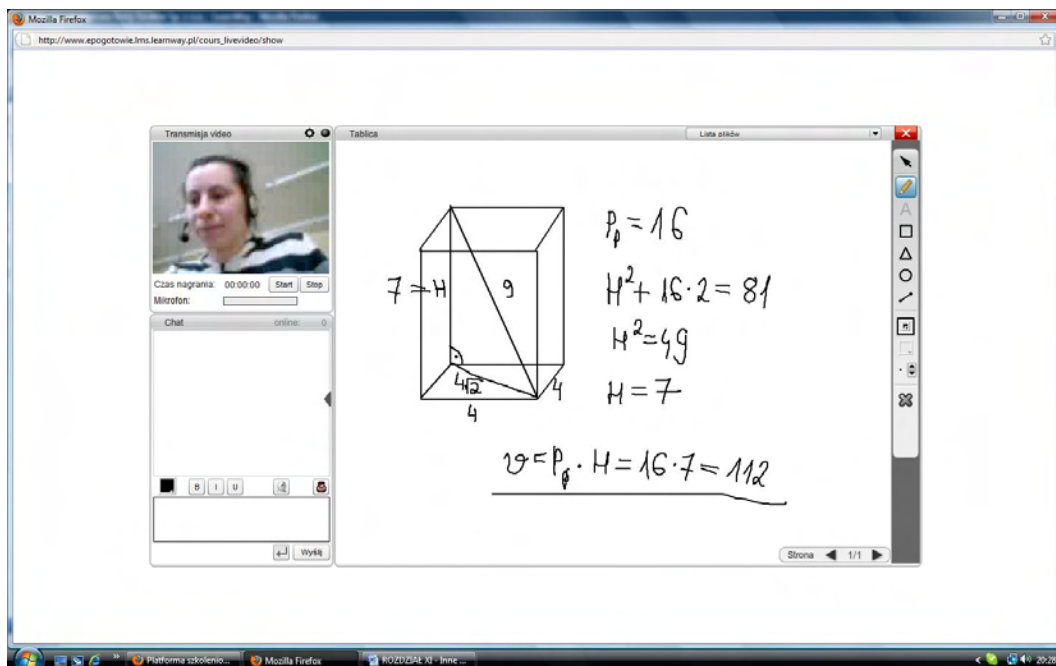

Figure 7. Source: "Mathematical Emergency E-Services". Solving exercises - calculating the volume of the prism - teacher Hanna Drabik-Zalewska.

13.2. Conclusions

The platform gives users the opportunities to see the exercise in space. It allows also to fast check if students ideas, way of thinking and methods of solving are correct. When it comes to the sterometry that fact is crucial. Student is not always able to imagine the object in space, moreover is not able to see connections between the element. Those possibilities of platform and their orginal way of solving exercises help students to understand the topic of sterometry. The tutor asked, marked leght and angles on the pictures, wrote the formulas, tried to help students in finding properly way of solving exercises. In the case of platform cooperation between tutor and student, that second received almost immediately information about hers/his progress in learning. The knowlegde about self achevements is very possitive for them. It guided into having higher self-esteem and better learning progress.

13.3. References

1. Kisiel K., Galewska E., Kucner J., Szumigaj K.: "Wspomaganie nauczania matematyki w szkole ponadgimnazjalnej w oparciu o nowoczesne technologie informacyjne w kontekście e-matury", rozdział w monografii: System informatyczny zdalnego egzaminowania-strategia, logika systemu, architektura, ewaluacja, Politechnika Łódzka, 2013
2. http://www.merriam-webster.com/dictionary/stereometry
3. Kucner J., Galewska E., Kisiel K.: „Stosowanie darmowego oprogramowania matematycznego do rozwiązywania zadań maturalnych", rozdział w monografii: System informatyczny zdalnego egzaminowania - strategia, logika systemu, architektura, ewaluacja, Politechnika Łódzka, 2013

The general idea of distance learning and examining systems is to include both a test and open-ended questions. Students valued the application of the latest technologies that enables animations in given questions, as well as the instantaneous availability of results. Teachers received the results of all their students. The characteristics and features of the project facilitate in depth and precise statistical analysis of the answers given by students to improve the quality of education. Such projects are still under continuous development, to be even implemented for use on a large scale, but the overarching goal is more than to create a reliable system to conduct examinations at a distance.

Further, based on the results of a mathematical diagnosis, the system could help students and teachers to prepare for the examinations by implemented an e-tutoring module. Since teachers have access to a mathematical diagnosis of their students, they will be able to monitor the progress of students' knowledge and assign a variety of tasks for them to solve. The e-tutoring module will make it possible to test students' knowledge, in the same format as the final test, on this platform. In addition to completing tasks assigned by teachers, students can solve tasks in those areas that cause them the most problems, and they can monitor their progress and how much more they still have to learn.

One of the important contribution to set of systems is E-matura created at the Technical University of Łódź, Poland. Thousands of students from all over Poland took the matriculation examination in mathematics at the same time via the Internet.

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