Methodical Specifics of Teaching Tertiary Students in the Conditions of Credit Technology

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\textbf{Abstract.} Higher education is closely connected with development of the whole society and is one of the means in solving the most important problems of the country and people. Transition to the credit system of education requires high-quality reorganization of teacher's work with students, change of methods and teaching techniques. In this article, we offer our teaching technique of computer graphics in the conditions of credit technology. The analysis and assessment of pedagogical experiment results are made.

\textbf{Introduction}

Modern computer graphics – rather difficult scientific and technical discipline that include methods, technologies and tools of creating two-dimensional and three-dimensional computer images of various nature (raster, vector two-dimensional, three-dimensional, fractal), as well as computer animation, video-tape editing, interactive and animation products, etc. [1].

The Decree of the President of the Republic of Kazakhstan dated October 11, 2004 No. 1459 approved State program of development of education in the Republic of Kazakhstan for 2005-2010 which provides: creation of complete three-stage model of the training (a bachelor degree - masters course - doctoral studies) based on accumulating credit system [2]. Accession of Kazakhstan to Bologna Process was to become the result of higher and postgraduate education reform.

Analysis of pedagogical aspects of teaching computer graphics of high school students has shown that the content and terminology of computer graphics has not been well established yet, currently existing techniques are focused on the study of a particular tool, a graphical editor. In this regard there is need to develop teaching methodology of technical specialties students of computer graphics to meet credit technology requirements, students who can work independently, creatively prepared for creation in the field of computer graphics software, intelligent products.

For this purpose, it is necessary to carry out a comparative analysis of traditional and credit systems of education of “Computer graphics” disciplines.

The traditional organization of teaching students (system of lecture notes and individual tasks) - it is a direct and well-established way to the same number of lectures and practical classes per week. There are 34 hours of lectures, 34 hours of practice in 17 weeks. And in credit technology of training the course of “Introduction to Computer Graphics” is taught in the amount of 3 credits (135 hours). 30 hours of them are lectures, 15 hours of laboratory works, 45 hours of tutorial, 45 hours of Students' Individual Work (SIW). We have transferred these results to table 1.
Table 1. Comparison of traditional and credit education systems in section of hours.

<table>
<thead>
<tr>
<th>Course name</th>
<th>Number of lectures in traditional teaching</th>
<th>Number of lectures in credit technology education</th>
<th>Number of practice in traditional teaching</th>
<th>Number of practice in credit technology education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to computer graphics</td>
<td>34 hours</td>
<td>30 hours</td>
<td>34 hours</td>
<td>105 hours</td>
</tr>
<tr>
<td>in percent</td>
<td>50%</td>
<td>22%</td>
<td>50%</td>
<td>78%</td>
</tr>
</tbody>
</table>

Having regard to the above, it follows that credit technology 78% of hours is allocated for practical work assigned to study disciplines, but in traditional system it is only 50%. A special part in credit system is assigned to Students' Individual Work that takes twice as much time than lectures and discussion sessions, which is distinctive feature of this system.

In this regard, Students' Individual Work is becoming increasingly important. The main components of our methods are motive of the studied subject, the action plan and the final result.

Statistical data processing has proved high efficiency of the developed methodical system of training students of computer graphics technology in credit technology.

Methodical Recommendations of Creation and Application of Electronic Teaching Materials

“Creation of electronic teaching materials is one of the major problems in credit technology. However, creation of electronic teaching materials of discipline and the organization of training courses with their use is quite complex technological and methodical challenge. Nevertheless, the industry of electronic teaching materials is constantly evolving due to their being in demand in education” [3].

On the basis of available scientific and methodical literature and electronic teaching materials methodical basis has been developed and electronic training package of discipline “Computer Graphics” and to work with a teacher, as well as for independent study and mastering practical skills by students of higher educational institutions has been developed” [4].

It is known that to increase teaching efficiency, first of all, it is necessary to teach students to absorb the knowledge effectively, that is to ensure its algorithm of actions for achievement of strong knowledge and skills. All course materials in the proposed electronic training package on the “Computer Graphics” are collected in a single complex and are methodological guidance for both teacher and students [5].

The complex includes:
1. Full training course of “Computer Graphics” (lectures, laboratory classes, SIW assignments).
2. Animated supportive notes for the lectures.
3. Tasks to laboratory classes.
4. Pupils' knowledge, abilities and skills performance rating (tests).

An important component of the electronic training package “Computer Graphics” is an interactive knowledge assessment of students.

The work is performed by means of Adobe Flash Professional CS5 program. Flash - a package of computer graphics and a format of its preservation in the file, a package for creation and a format for preservation of two-dimensional animated computer graphics generally intended to the publication on the Internet. This software tool has modern design and meets ergonomic requirements to computer training resources. Multimedia and hypertext technologies [4] have been widely used to satisfy the main requirements [4].

Theoretical material is stated in quite meaningful, concise, accessible way. There are supportive notes with animated presentation of the material to solve the practical tasks.

The structure of the electronic teaching materials “Computer Graphics” can be represented in the following diagram, shown in Figure 1.

One of reform aspects of modern education is creation of such computer packages (electronic textbooks, resource books, trainers, testers and so forth) availability of which will provide the same
computer environment at practical training in specialized audience, in the computer class of educational institution or the hostel equipped for independent work of pupils and also at home in a personal computer.

The electronic training package “Computer Graphics” is intended to study graphics programs. The textbook has a sufficiently clear and user-friendly interface. Control elements are convenient and noticeable, at the same time they do not distract a student from the main content.

**Methodical System of Studying Work of the Graphic Editor**

In this regard we have developed a new methodical system of studying of any graphic editor's work. Before studying a new graphical editor, it is necessary to divide all main tools into levels of methodological knowledge. For example, if we consider the section of two-dimensional vector graphics, we can distinguish common software elements:

- geometric primitives;
- work with geometric objects;
- means of processing accuracy of constructions;
- special effects.

On the basis of this classification it is possible to allocate methodological knowledge levels that must be applied when considering any graphics editor [6,7].

For example, when considering the vector program Corel DRAW it is possible to allocate and position methodological knowledge levels as follows:

1. Level 1 - geometric primitives: circle, rectangle, ellipse, circular arc, sector, polygon, grid, spiral, curve, text, etc.
2. Level 2 - work with geometric objects (methods of editing): object selection, copying, deletion, rotating, reflection, zoom, shading an object, an object outline, interactive tools for creation and simulation of 3D-objects, etc.
3. Level 3 – means of processing constructions accuracy: rulers, units of measure, layers, grid, guides, bindings, styles, templates, etc.
4. Level 4 – special effects: prospect, lens, Power Clip, extrusion, etc.

Let's consider positioning of methodological knowledge levels of vector program AutoCAD.

Let's consider positioning of methodical levels of vectorial AutoCAD program knowledge.
1. Geometric primitives: point, dimensions, hatches, block, polyline, line, circle, rectangle, polygon, spline, multilime, polyline, caption, and three-dimensional bodies and surfaces, ray, arc, sector, constructional ellipse [8].

2. Work with geometric objects: objects selection, facet, conjugation, copying, rotating, reflection, zoom, deletion, crossing.


4. Special effects: three-dimensional constructions and so on.

It may be noted that the methodological knowledge levels make it possible to navigate in each new graphical editor, while highlighting the main components - geometric primitives, working with geometric objects, means of processing precision constructions and special effects [9]. Methodological knowledge levels allow you to navigate quickly in the study of a new program when a student loading the program sees a huge number of buttons and nested menus. Methodological knowledge levels can be displayed as in Figure 2.

![Methodological levels of studying the graphic editor.](image)

**Methodology of Lectures**

Lectures on Computer Graphics should be conducted in an interactive environment using multimedia technology training. This technique compared to lecture-lessons traditional for higher education institutions, when a teacher presents the theme and students listen, look, remember or make notes from course material, the lecture, based on the proposed method has an important advantage - interactivity.

Using the principle of interactive learning allows students to get actively involved in the learning process: to ask questions, to get more detailed and available explanations according to sections and fragments unclear for them, of the training material stated by the teacher [10].

Thus, the two-way participation in the process of learning of a teacher and a student contributes to improvement in education quality. Using the proposed method optimizes the teaching process, awakens interest of students to study discipline and improves the efficiency of the educational process as a whole.

Interactive lecture combines aspects of traditional lectures and training game. Advantages of interactive lectures are:

- mutual cooperation of students and a teacher;
- the presentation which is prepared by the lecturer;
- active participation of students in training process;
- the lecture game assumes feedback of the lecturer and the audience;
- the teacher directly controls the level of interaction between students;

Information obtained passively is quickly forgotten. Information coming through an interactive lecture is actively processed and can be easily retrieved from memory after a long time [11, 12].

After starting the lecture the main window of interactive lectures on computer graphics appears on the screen (Figure 3).
When selecting sub-themes, for example “Definition and basic tasks of computer graphics” jumping letters register the name of the lecture on the screen (figure 4). Then a content of the selected theme appears automatically. By means of the button we can start a lecture with voice and regulate volume of sound by the slider, also there are possibilities of transition to the following and previous themes in this interactive window. For this purpose we can use the buttons.
Interactive lectures are made in Delphi 7 program, lectures are written by HTML (Hypertext Markup Language – “hypertext markup language”. This is a standard markup language of documents in the World Wide Web. Almost all web-pages are created using HTML).

Each lecture comes to an end with advancement questions, at the end of the lecture students have to answer the questions to consolidate the theme.

**Methods of Practical Training (As Exemplified by Corel DRAW Graphics Editor)**

Practical classes are intended for laboratory classes performance and independent performance of term papers on each subject.

It is necessary to understand that term paper is development of acceptances, actions of trainees in a certain sequence for objective achievement, namely solution of the problem, issued in the form of some final result.

The approximate list of term papers prepared within model of training methods of computer graphics university students is presented in table 2. Each term paper provides which primitives and editing methods will be used in the work, how the accuracy will be maintained, which special effects are necessary to be applied.

Corel DRAW Graphics editor is an integrated object-oriented software package for operation with vector graphics. The term “integrated package” means that the programs included in it are interconnected: can exchange data or consistently perform various operations over the same data due to that the package is multifunctional [13].

In the classes, students also study the theoretical basis of vector graphics, and work practically in Corel DRAW creation and editing outlines based on Bezier curve, as well as geometric objects of varying complexity. Each stage of the Corel DRAW course must be completed by performing practical tasks in complexity as much as possible approaching the work of professionals.

The advantage of this training method is a combination of educational and productive activities. This feature of the industrial training is due to the use of new forms, methods and means of training.

<table>
<thead>
<tr>
<th>№№</th>
<th>Term papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Vector graphic editor Corel Draw</td>
</tr>
<tr>
<td>1.2</td>
<td>Term paper 1.1 (Painting and interactive filling)</td>
</tr>
<tr>
<td>1.3</td>
<td>Term paper 1.2 (corporate style)</td>
</tr>
<tr>
<td>1.4</td>
<td>Term paper 1.3 (web-page design)</td>
</tr>
<tr>
<td>2.1</td>
<td>Raster graphic editor Adobe Photoshop</td>
</tr>
<tr>
<td>2.2</td>
<td>Term paper 2.1 (Painting)</td>
</tr>
<tr>
<td>2.3</td>
<td>Term paper 2.2 (collage)</td>
</tr>
<tr>
<td>2.4</td>
<td>Term paper 2.3 (color correcting)</td>
</tr>
<tr>
<td>2.5</td>
<td>Term paper 2.4 (Text effects)</td>
</tr>
<tr>
<td>3.1</td>
<td>Automated design system Auto CAD</td>
</tr>
<tr>
<td>3.2</td>
<td>Term paper 3.1 (electronic circuit)</td>
</tr>
<tr>
<td>3.3</td>
<td>Term paper 3.2 (three-dimensional model details)</td>
</tr>
<tr>
<td>4.1</td>
<td>Three-dimensional graphics and animation 3D max program</td>
</tr>
<tr>
<td>4.2</td>
<td>Term paper 4.1 (virtual world)</td>
</tr>
<tr>
<td>4.3</td>
<td>Term paper 4.2 (modelling)</td>
</tr>
</tbody>
</table>

At the time of this laboratory classes, students must already have sufficient conceptual reserves, possess basic operations on drawing shapes, lines, and change attributes of filling and outlines, Shape
tool and manipulating nodes curves, transforming and arranging objects, skills to work with Bezier curves. All this device represents necessary base for studying the given theme in computer graphics classes.

An Example of Term Paper. Creation of the Image of A Yurta

1. Create a new Corel DRAW document and set four guides: two vertical with coordinates 50 and 150 mm and with three horizontal coordinates 200, 225, 235 mm. First, move with a mouse the first guide from a vertical coordinate ruler, and adjust its position with an appropriate attributes panel counter. In the same way do the second vertical and three horizontal guides (move the last from a horizontal coordinate ruler). Turn the Snap To Guidelines mode (Snap to guides), having clicked on the third button of the attributes panel on the right. Choose the Zoom tool (Scale) and stretch a rectangle around the zone of guides crossing [14].

1. Using the Rectangle Tool draw a rectangle

1. Draw in top of the rectangles formed by crossing of guides, the ellipse flattened in the horizontal direction, having used the Ellipse tool. Begin with the lower left bottom corner of the rectangle and move the mouse cursor to its lower right bottom corner. This will help the user to snap mode to guides, dimensions built at the same time the ellipse will be exactly equal to 100 mm and 10 mm.

2. Select the Pick tool, using it select the built ellipse and while holding down the Ctrl key move it down so that it touches the bottom of the lower horizontal guide (at the time of a contact a part of the guide will be highlighted). Before releasing the left mouse button, press its right button, then the ellipse will be not simply moved, and will be copied in case of simultaneous relocation of its copy.

3. We will turn the top ellipse into a curve by the Convert to Curves command, which is on the properties panel of the selected object, as well as in the Arrange menu. Then move the upper edge until the shape of the yurt. At the top of the yurt depict small ellipse “Shanyrak”.

4. Using the Weld command, we will get the drawing shown below.

5. Let’s draw the right half of a door by the Rectangle command.

6. Copy the left half of the door, using the Mirror command, and we get the following picture.
7. Paint the door.

8. Let’s draw a canopy over the door “essyk zhabuy” by the Rectangle tool, then round off the corners, paint over gradient linear filling, establish it over the door.

9. Now we will decorate yurt with a national ornament. Let’s draw a rectangle by the Rectangle tool, then draw an ornament with the Freehand Tool, correct it the Shape Tool, use mirror reflection, join, multiply and paint over. As a result we will receive a beautiful ornament of any length.

10. Having done the command Arrange – Order – To Back of lauer “essik zhabuy” we will set in foreground.

11. Accordingly we decorate the yurt, make additional details (a lawn, smoke from a shanyrak, etc.).

So we have got desired result by doing practical exercises on creating elements of the yurt (Figure 5).
Thus, the method of artistic design as one of the technologies of personality-oriented education allows to reach the main objectives of the subject: to form in students' information and communication competence, as well as promote imagination and artistic taste.

The Methodology of Knowledge Control in Conditions of Credit Technology Education

Knowledge control block includes tests on theoretical material, as well as evaluation criteria of practical classes. Laboratory work evaluation, considered on a practical training, is the visual examination of the work performed by students and their comments to the work, and answers to the teacher's questions[15].

In the conditions of credit technology education the rating system has been developed for discipline “Introduction in computer graphics”, “Computer graphics”.

The rating – literal translation from English - assessment, some numerical expression of any quality indicator. Usually, the rating is defined as “the cumulated total score” or “assessment considering background”.

How to carry out control of classes? According to requirements of credit technology education students get points for each lecture and laboratory classes on computer graphics, and average value of these points is point for the current control. It is recommended to pay attention to the theoretical aspects of laboratory and practical classes. Control of practical classes has a role to play in education, although a student works according to the offered sample. Assessment of practical session consists of two stages: a visual preview of performed work and the protection of laboratory work. The work evaluation is recommended to be carried out by 100 point system.

Evaluation of independent work is similar to the evaluation of practical work.

How to assess the final work? The final grade of the course - the average total score of two ratings
and the exam rating. It is recommended to hold a group show of students' term papers to make a
group rating within a group.

Table 3 presents the criteria of a rating system for the discipline “Introduction to Computer
Graphics”.

The advantage of the proposed rating system, in our opinion, is the following:
• firstly, it takes into account student's current academic performance and thus considerably
intensifies his/her independent work;
• secondly, it evaluates student's knowledge more objectively and accurately using a fractional
100-point rating scale;
• thirdly, it provides a basis for a differentiated level of students' knowledge assessment, which
is particularly important in the transition to a multi-level system of education;
• fourthly, allows to obtain detailed information on performance of independent work
schedule by each student.

All of the aforesaid shows the value of credit technology education in computer graphics.

Table 3. Rating system for the discipline “Introduction to Computer Graphics”.

<table>
<thead>
<tr>
<th>Type of control</th>
<th>Week</th>
<th>Results of the 1st rating, R1</th>
<th>Week</th>
<th>Results of the 2nd rating, R2</th>
<th>Percentage of the final grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attendance (lecture)</td>
<td>1</td>
<td>0, 4</td>
<td>1</td>
<td>3,2</td>
<td>30%</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>0, 4</td>
<td>0, 4</td>
<td>0, 4</td>
<td>0, 4</td>
<td>0, 4</td>
</tr>
<tr>
<td>Tutorial performance</td>
<td>0, 4</td>
<td>0, 4</td>
<td>0, 4</td>
<td>0, 4</td>
<td>0, 4</td>
</tr>
<tr>
<td>Students' Individual Work performance (course paper)</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
</tr>
<tr>
<td>Midterm assignment performance</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
</tr>
<tr>
<td>Reports</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
</tr>
<tr>
<td>Written examination</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
</tr>
<tr>
<td>Final grade</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
</tr>
<tr>
<td>Percentage of the final grade</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
<td>0, 5</td>
</tr>
</tbody>
</table>

Analysis and Assessment of A Pedagogical Experiment Results

A pedagogical experiment has been carried out to check efficiency of this methodology.
An experimental group included 40 students. So, there were two independent selections of students
who have studied the subject, on discipline “Computer Graphics” according to two different
programs. It was necessary to determine which program is more effective in forming the students' skills of independent application of design tools and processing computer images, as well as learning how to apply their knowledge in computer graphics to meet the challenges of professional work.

Before starting the experiment the students' initial level of creation and editing computer graphics has been found out by interviewing and small practical work on computer. In general, it was about the same in both selections. Tasks of approximately identical difficulty were chosen by teachers based on students' areas of specialization profile. The results of the tasks - built computer graphics were evaluated by number of teachers of computer graphics, computer science, and the disciplines of the University specialization profile [16].

To prove the hypothesis we used Student Criterion (t-test) [17]. The criterion allows to define probability that both average values in selection belong to the same set. This criterion is most commonly used to test the hypothesis: “Averages of two selections belong to the same set”. When using criterion it is possible to allocate two cases. In the first case it is applied to check the hypothesis of equality of two independents' universe mean, untied selections (so-called two-sample test). In this case, there is a control group and experimental (test) group, the number of subjects in the groups may be different.

In the second case, when the same group of objects generate a numerical material to test hypotheses about mean, so-called paired t-test is used. Selection sure called dependent, connected [17].

The problem of comparison of two methodical training systems in computer graphics can be translated into statistics language as a problem of comparison in both selections of arithmetic mean value of ability to create and process the graphics connected with professional activity. Marks to all students were given by ten-point alphabetic system of credit technology education by the same group of expert teachers. Whereas the special table with calculation of the required statistics for 42 students of control group and 40 students of experimental group [18] was filled in.

According to personal results and mean values, shown by students of the control and experimental groups, mean grade and standard deviation (Table 4) were calculated for each group (table 4).

Table 4. Mean grade and standard deviation for control and experimental groups.

<table>
<thead>
<tr>
<th>Numerical characteristics</th>
<th>the 1st selection (control group)</th>
<th>the 2nd selection (experimental group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (number of students)</td>
<td>42</td>
<td>40</td>
</tr>
<tr>
<td>(x и y) (mean grade %)</td>
<td>71,571</td>
<td>81,050</td>
</tr>
<tr>
<td>σ (standard deviation)</td>
<td>9,334</td>
<td>9,454</td>
</tr>
</tbody>
</table>

Student t-test was used to process the experimental results, which allows to set similarities and differences between two empirical distributions. The results of the students' tasks performance were added into a matrix of the original data in the form of a separate computer file in MS Excel application.

Arithmetic mean calculation: \( X_{cp}=71,571; Y_{cp}=81,050 \)

Standard deviation: \( σ_x=9,334; σ_y=9,454 \)

We calculate a standard error of arithmetic mean difference by the formula (2):

\[
σ_{x-y} = \sqrt{\frac{3572.286+3485.900}{42+40-2}\cdot\left(\frac{1}{42} + \frac{1}{40}\right)} = 2.075
\]

Calculate criterion statistics:

\[
t = \frac{81,050-71,751}{2.075} = 4,568
\]

We compare the value t received in an experiment with the table value taking into account levels of freedom, equal on a formula (4) to number of examinees minus two (80).

Table value of \( t_{cp} \) is equals to 1,990 assuming possibility of risk to make a misguided notion in five cases out of hundred (significance level =5% or 0,05).

If the empirical value t received in an experiment exceeds table value, that is the bases to accept alternative hypothesis (H1) that students of the experimental group show higher average level of knowledge.
Thus, the experiment confirmed a hypothesis of learning efficiency to computer graphics within the offered methodical system with scientific and methodological approaches in the conditions of credit technology education. These approaches are oriented on technical training of specialists using possibilities of information and communication technology and consider creative activities and personal preferences of a student.

Conclusion
Educational and methodological support of computer graphics disciplines on the basis of “methodical levels” provides integrity in the organization of educational process, grade the training material to levels by complexity: the basic concept, working methods and means that allows to obtain more difficult graphic effects.

Methodical recommendations: methods of creating electronic training package on computer graphics; methods of conducting lectures; methods of carrying out students' individual work; methods of monitoring knowledge control in the conditions of credit technology education helps to increase the level of self-education and creative mastering of the course by students.

Statistical data processing, obtained during the experimental search, has led to the conclusion that the application of the developed methodology and set of methodological recommendations enhance the level of specialist's preparedness for professional work in the field of computer graphics.

The experimental operation on implementation of students training method in computer graphics in the conditions of credit technology allowed to achieve increase in progress of students from 3.8 to 4.3 grades. The quantitative analysis of the experimental data showed that quality of the experimental students' knowledge was higher than in control group in all indicators: there was more good and excellent marks, it was higher than GPA, knowledge gain was up by 10%.

The results of the research have been implemented in the learning process of Almaty Academy of Economics and Statistics, Almaty Technological University, Institute of Informatics Problems and Control of Ministry of Education and Science of the Republic of Kazakhstan.

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