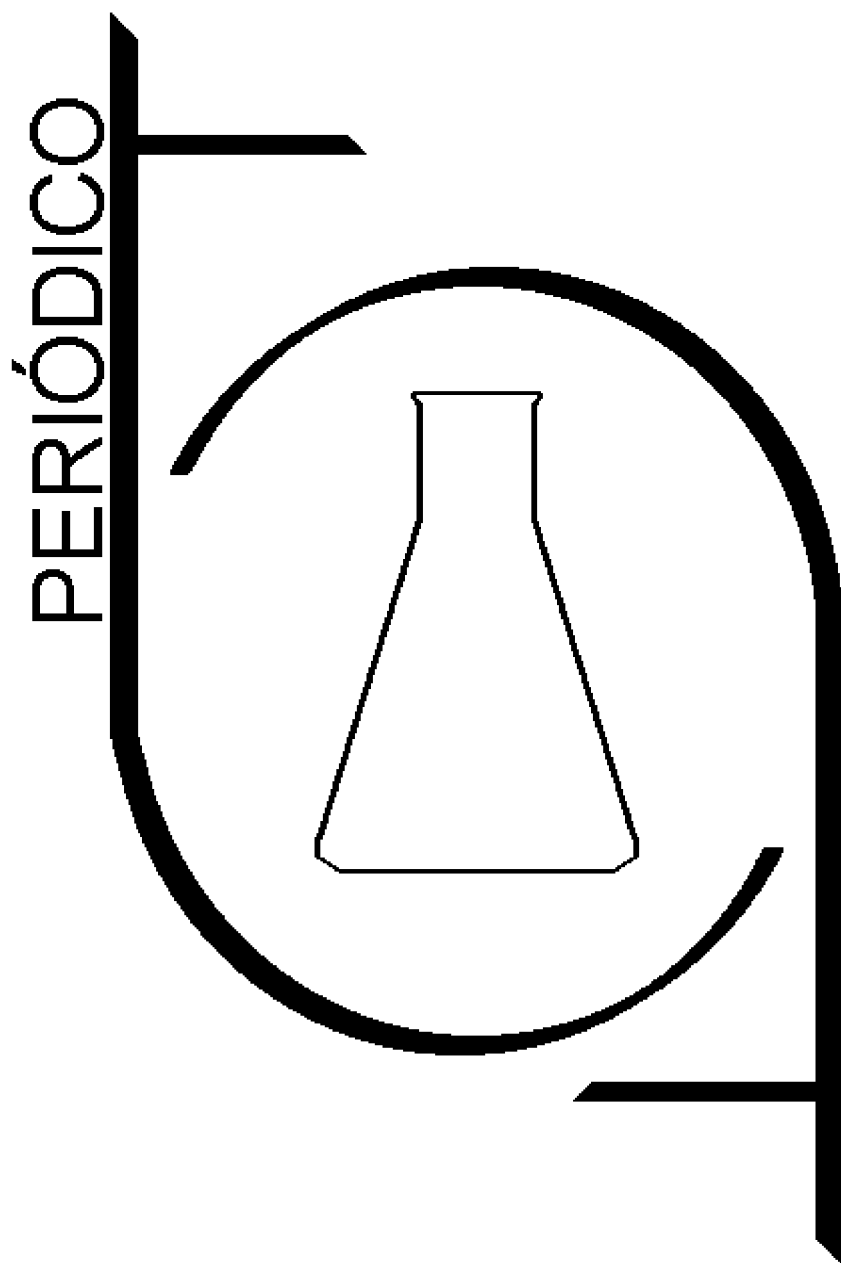


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Author instructions

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most recent pieces of information.**

Thank you. Editors.

WORDS FROM THE EDITORS

Dear readers and authors

On behalf of the editors and editorial board, we would like to inform you that we are going to make some important changes in the journal for the next year in order to improve not only the quality of the Journal but also fill some gaps we are facing regarding evaluation, costs, website, and other subjects.

1. **Make official the 100 manuscripts rule.** It is important to have a standard regarding the number of published papers per issue. Nowadays, we do not have any standard, and sometimes we make mistakes.
2. **Increase the periodicity of the journal from 2 to 3 editions per year.** With the implementation of this concept, we will limit ourselves to a maximum of 300 papers per year. Since this is a small journal, 300 papers would be a lot of material to us. At the same time, it will make us more selective. We have been receiving a few thousand manuscripts per year, and we can't publish them all. **After changing the periodicity from 2 to 3 issues per year, in 2020, we are going to launch the issues in March, July, and November.**
3. **We cannot publish every original manuscript that we receive.** Why? Some manuscripts are not related to the journal's scopes or objectives, so if you are an author, please observe it before making a submission. Other manuscripts have problems that when they are pointed out by the review board of the journal, the manuscripts are too hard to improve.
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8. **Letters of acceptance.** We will no longer provide this type of service in this journal. Why? It takes time to produce it, and it's an instrument that can be falsified and used improperly. Instead, we recommend the authors to present the e-mails that we exchange or present the publication itself in the journal.

Table 1. Sedimentation stability of CuPc aqueous dispersions stabilized by PiBA-PAA block copolymers

Polymer	Suspension stability (half-time of the sedimentation, days)	
	Without mechanical treatment	After ultrasonic treatment
PiBA ₇₂	3	10
PAA ₂₈	0.3	2
PiBA ₅₃ – PAA ₄₉	4	20
PiBA ₅₃ – PAA ₂₆	5	45
PiBA ₁₇ – PAA ₉₇	0.2	5
PAA ₁₇ – PiBA ₇₂ – PAA ₁₇	3	14

Table 2. Effect of ultrasonic treatment on the particle diameter d_{part} , and effect of ultrasonic treatment on the increase of the particle surface area (S_{tot}) as well as on the saturation concentration (SC) of added amphipolar copolymer as expressed by the corresponding S_{tot} and SC ratio; the indexes 1 and 2 refer to the non-treated (1) and ultrasonically treated (2) sample.

System	Averaged particle diameter d_{part} in μm .		Ratio between particle surface area with and without ultrasonic treatment $\frac{S_{tot\ 2}}{S_{tot\ 1}}$	Ratio between saturation concentration with and without ultrasonic treatment SC_2/SC_1
	Without ultrasonic treatment	After ultrasonic treatment		
CuPc + PiBA ₅₃ – PAA ₂₆	0.8	0.3	2.7	6

Table 3. Thicknesses d of the adsorption layer of the amphipolar copolymer on TiO₂ and CuPc surface for ultrasonically treated and non-treated dispersions as calculated on the basis of the saturation concentration SC obtained from the ESA measurements

System	Thickness d of the adsorption layer without ultrasonic treatment, nm.	Thickness d of the adsorption layer after ultrasonic treatment, nm.	Ratio between the thicknesses of treated and non-treated samples
CuPc + PiBA ₅₃ – PAA ₂₆	1	2.3	2.3

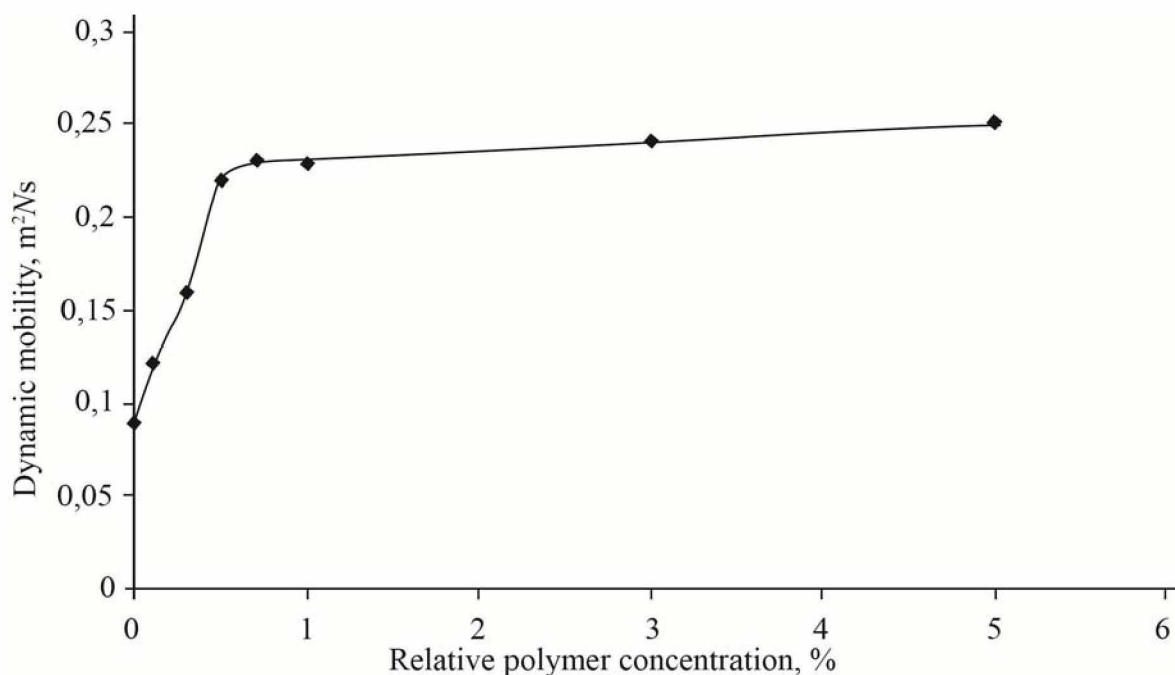


Figure 1. Dependence of the dynamic mobility on the relative concentration of $PiBA_{53} - PAA_{26}$ for 1 wt.-% CuPc aqueous dispersion without ultrasonic treatment

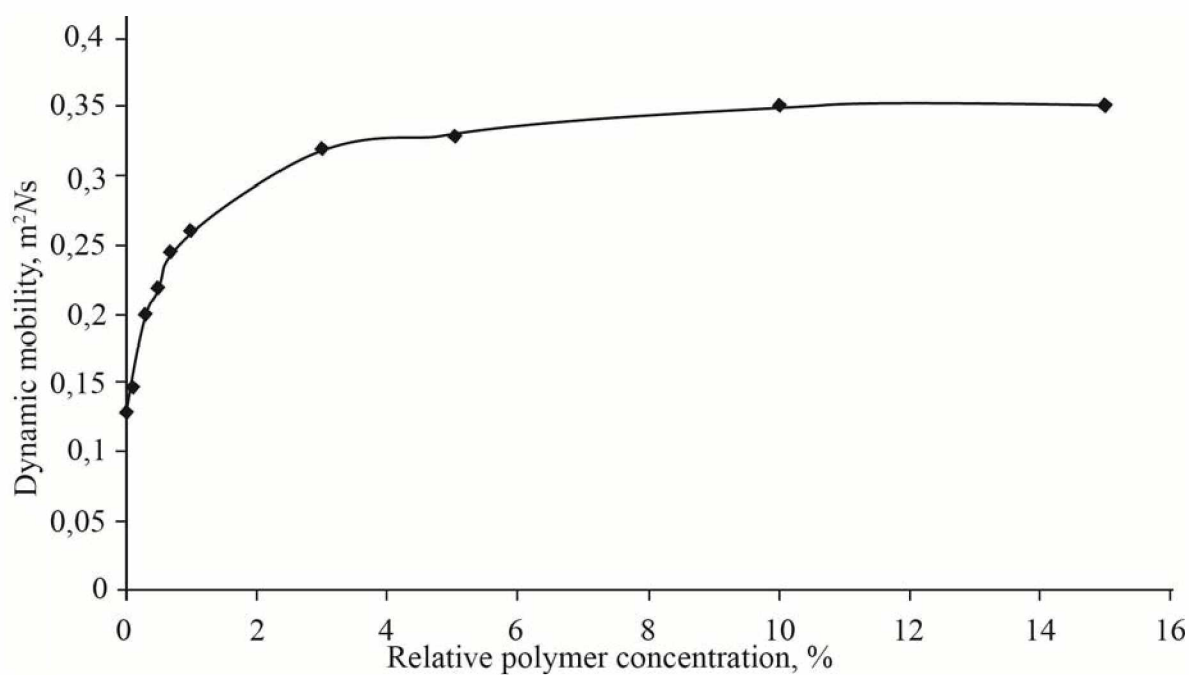


Figure 2. Dependence of the dynamic mobility on the relative concentration of $PiBA_{53} - PAA_{26}$ for 1 wt.-% CuPc aqueous dispersion after ultrasonic treatment

**MODELAGEM NO ESTUDO DE GRÁFICOS DE COMPUTADOR NA
FUNDAMENTALIZAÇÃO DA INFORMÁTICA****MODELING IN STUDYING COMPUTER GRAPHICS IN THE FUNDAMENTALIZATION OF
COMPUTER SCIENCE****МОДЕЛИРОВАНИЕ ПРИ ИЗУЧЕНИИ КОМПЬЮТЕРНОЙ ГРАФИКИ В УСЛОВИЯХ
ФУНДАМЕНТАЛИЗАЦИИ ИНФОРМАТИКИ**

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RESUMO

O objetivo do estudo foi desenvolver um método eficaz de ensino de computação gráfica usando modelos de informação. Os autores realizaram um experimento pedagógico, constituído de duas etapas: averiguação e ensino. O experimento envolveu 30 alunos e professores de ciência da computação. Na etapa de averiguação, analisou-se o estado dos conhecimentos práticos e habilidades dos alunos em computação gráfica. Os autores realizaram as seguintes tarefas na primeira etapa: desenvolver e descrever os componentes, critérios de avaliação e níveis de desenvolvimento da motivação para o estudo de computação gráfica; projetar um complexo de diagnóstico destinado a estudar o desenvolvimento dos principais componentes da motivação para estudar computação gráfica; identificar as características do desenvolvimento dos principais componentes e níveis de motivação para o estudo da computação gráfica em ambientes tradicionais de aprendizagem. O estágio de ensino permitiu verificar a eficácia do sistema de tarefas desenvolvido pelos autores, bem como a metodologia do autor de usar modelagem de informações em computação gráfica. Para testar a precisão da aprendizagem experimental, os autores usaram o método de comparar o nível de domínio do material educacional dos alunos nas classes controle e experimental e o método probabilístico. Para tanto, foram realizados testes de controle, cujos resultados foram submetidos à análise qualitativa. Os resultados do experimento pedagógico indicaram a efetividade do método proposto de utilização de modelagem de informação computacional no ensino de computação gráfica. Além disso, os autores desenvolveram um conjunto de tarefas de ensino e pesquisa aplicada.

Palavras-chave: Fundamentalização da educação, computação gráfica, modelo de informação, métodos, informática, pedagogia, experimentação.

ABSTRACT

The aim of the study was to develop an effective method of teaching computer graphics using information models. The authors conducted a pedagogical experiment, which consisted of two stages: ascertaining and teaching. The experiment involved 30 students and teachers in computer science. At the ascertaining stage, the state of students' practical knowledge and skills in computer graphics was analyzed. The authors had the following tasks at the first stage: to develop and describe the components, evaluation criteria and development levels of the motivation for studying computer graphics; design a diagnostic complex aimed at studying the development of the main components of the motivation for studying computer graphics; to identify the features of the development of the main components and levels of motivation for studying computer graphics in traditional learning environments. The teaching stage allowed to check the effectiveness of the task

system developed by the authors, as well as the author's methodology of using information modeling in computer graphics. In order to test the accuracy of experimental learning, the authors used the method of comparing the level of mastering the educational material of students in the control and experimental classes and the probabilistic method. For this purpose, control tests were conducted, the results of which were subjected to qualitative analysis. The results of the pedagogical experiment indicated the effectiveness of the proposed method of using computer information modeling in teaching computer graphics. Also, the authors developed a set of teaching and applied research tasks.

Keywords: *Fundamentalization of education, computer graphics, information model, methods, Computer science.*

АННОТАЦИЯ

Целью исследования является разработка эффективной методики обучения компьютерной графике с помощью информационных моделей. Авторами был проведен педагогический эксперимент, который состоял из двух этапов: констатирующего и обучающего. В эксперименте участвовало 30 учеников и учителей информатики. На констатирующем этапе было проанализировано состояние практических знаний и умений по компьютерной графике учащихся. На первом этапе перед авторами стояли такие задачи: разработать и описать компоненты, оценочные критерии и уровни развития мотивации изучения компьютерной графики; сконструировать диагностический комплекс, направленный на изучение развития основных компонентов мотивации изучения компьютерной графики; выявить особенности развития основных компонентов и уровней мотивации изучения компьютерной графики в традиционных условиях обучения. Обучающий этап позволил проверить эффективность разработанной авторами системы задач, а также авторской методики использования информационного моделирования в компьютерной графике. Для проверки достоверности экспериментального обучения был использован сравнительный метод уровня усвоения учебного материала учащихся контрольных и экспериментальных классов и вероятностный метод. С этой целью проведены контрольные тесты, результаты которых подвергались качественному анализу. Результаты педагогического эксперимента свидетельствуют о эффективности предложенной методики применения компьютерного информационного моделирования при обучении компьютерной графике. Также авторами был разработан комплекс учебно-прикладных исследовательских задач.

Ключевые слова: *Фундаментализация образования, компьютерная графика, информационная модель, методика, информатика.*

1. INTRODUCTION

The problem of fundamentalization of education is one of the priority areas of scientific and pedagogical research. V.V. Grinskun and I.V. Levchenko (Grinskun and Levchenko, 2009) define the fundamental nature of education as the focus of educational content on methodologically significant, backbone knowledge, invariant elements of human culture, contributing to the development and realization of the student's creative potential, ensuring a qualitatively new level of his intellectual and emotional-moral culture, creating an internal need for self-development and self-education throughout human life, contributing to the adaptation of the individual in the rapidly changing social, economic and information technology environments.

A very common position is to interpret the understanding of the fundamental nature of education as a more in-depth preparation of students in a given direction, the so-called

"education in depth".

Another view of the concept of "fundamental education" is the provision of versatile humanitarian and natural science education on the basis of mastering fundamental knowledge, the so-called "education in breadth". This position that fundamentality means a combination of factual, worldview, and methodological aspects of the study of the subject, produced on a scientific basis (Laptev and Ryzhova, 2002).

According to research (Ryzhova, 2000; Laptev and Shvetsky, 2000; Amirgaliyev *et al.*, 2017), the path of development of the fundamentalization of computer science education is reduced to the mathematization of the content of computer science education and the development of the formal component of activity; The central concepts of such a course are a computer and an algorithm.

The authors (Lednev, 1991; Kuznetsov and Zakharova, 2014; Beshenkov *et al.*, 2008;

Pervin, 2010; Kasatkin and Verlan, 1997) and others suggest a different way, proposing to build a computer science course from the phenomenon of information processes to methods of studying information models, using the computer as a means of managing information processes.

Research in the field of computer graphics education (Kheyfets and Vasilieva, 2017; Sacks and Barak, 2010; Bilynsky *et al.*, 2017) stresses that there are problems with the current introductory courses to the computer graphics, that there is no connection between theory and practice, it is proposed to use copyrighted software to overcome them.

Currently, pedagogical universities of the Republic of Kazakhstan practically lack a common opinion on the fundamentals of the Computer science discipline, and the Computer science course is faced with the problem of choice, which poses a serious methodological danger when teaching future Computer science teachers. Either future teachers of computer science will study computer science as a mathematical discipline studying the construction and study of mathematical methods and models, and the computer as for automating the processing of numerical information, or will study information processes in the broadest sense. Subsequently, the future teacher also carries his knowledge to the students who are being taught by him/her.

We state the facts that the overwhelming majority of university courses in Kazakhstan tend to be technological and applied, the programs are mainly focused on studying either the hardware and software tools of a personal computer and information technologies, or algorithmization and programming. There is a lack of a fundamental base, without which it is impossible to deepen the technological direction.

2. LITERATURE REVIEW

According to the fact that modern priority objects for studying Computer Science at school are information processes and information technologies, a more promising course is aimed at mastering the fundamental triad – information processes, modeling and formalization, information bases of management.

When studying graphic information, it's processing, in the course of Computer science, namely in the course of computer graphics, one of the methods used should be the construction of information models, using the computer as a

means of managing information processes. The use of information and computer modeling in the computer science course is the subject of many researchers in domestic and foreign practice.

R. Lesh and L. D English (Lesh and English, 2005) concluded that research on the development of the concept of model and modeling (M & M) is more than research on problem-solving; and, instead of being preoccupied with writing texts in textbooks and developing standardized tests, the authors focus on (simulations) solving the problems in "the wild nature".

P. Sengupta (2012) presents a new visual programming language based on the logo – ViMAP – and a sequence of learning activities related to programming and modeling, specifically designed to support seamless integration between programming and cinematics.

L. T. Louca and Z. C. Zacharia (Louca and Zacharia, 2015) explored ways in which novice K-6 modelers can participate in modeling-based learning in science education using rich modeling contexts, which present various modeling means and tools. The results showed that novice designers accept certain phases of learning differently than they are described in the literature for older students and / or expert designers and offer new more accessible and understandable materials for studying K-6 modeling.

V. L. Peters and N. B Songer (Peters and Songer, 2013) did a three-step usability test of a modeling tool designed to support students in-depth understanding of the implications of climate change for ecosystems. The design process included a repetition of the existing modeling technology used by professional scientists in a teaching tool specifically designed for secondary school students. As a result of problem-solving by students, the research identified two types of usability issues that prevented the students from using the tool productively: issues related to the use of data and information, and issues related to the use of modeling technology. The design was improved, leading to stronger usability results and improved student productivity.

The change in the role of teacher assessment of a student through the support of the mathematical reasoning of his students in the context of a new modeling assignment in data analysis was reviewed by H. M. Doerr and L. D. English (Doerr and English, 2006). The authors believe that in order to understand the mathematical content in modeling, the teacher

needs to play a new role, in close cooperation with students, i.e., focus on listening to and observing student ideas and ask questions for understanding and clarification.

M. S. Kim (2015) develops interactive, exciting and informal learning activities called Embodied Modeling-Mediated Activities (EMMA) to support not only in-depth study of Singaporean astronomy students but also the ability of teachers to use information and communication technologies, including multi-modal modeling tools.

I. A. Halloun (2007) considers modeling theory as a pedagogical theory that promotes mediated empirical learning and research in the field of science education. Students significantly improve academic performance in mediation modeling compared to traditional education (lectures and demonstrations), especially in high school and university courses.

V. Hoogerheide, S. M. M. Loyens and T. van Gog (Hoogerheide *et al.*, 2016) offer online tutoring with examples of modeling videos that demonstrate the human model and explain how to perform a learning task, is an effective learning method that is increasingly used today. These results suggest that the gender of both the model and the observer may be relevant in terms of affective variables that arise during training.

The article (McQuiggan *et al.*, 2008) explores an inductive approach to automatically constructing models of self-efficacy (effective physiological data) that can be used to inform pedagogical solutions to predict a student's self-realization level.

In a study (Kim and Kim, 2010), mathematical modeling was successfully applied to satisfy the various mathematical and cognitive requirements of gifted people with excellent learning ability and persistence in mathematics.

N. Barneal and Y. J. Dori (Barneal and Dori, 1999) developed and introduced a new computerized molecular modeling (CMM) learning environment for teaching and learning in Israeli universities, which is able to illustrate and explore phenomena in chemistry, equipped with the convenience and simplicity of creating molecules of any size and colors in several styles of presentation, bright animation of three-dimensional representations.

The study (Hogan and Thomas, 2001) proposes pedagogical strategies to support all types of students in studying the central scientific practice of model quantitative thinking, studying

the knowledge of five pairs of high school students over time when they compiled quantitative environmental models using the STELLA software. For modeling productivity, it is necessary: (a) focusing on the output of the model versus model input and individual relationships when building and revising the model, (b) studying the nature and effects of dependencies and feedback compared to simply creating them as sets of properties of complex systems and (in) use of variables in comparison with constants to represent continuous and periodic functions.

The results of the study (Soller, 2004) can help a teacher or a smart trainer in understanding situations in which groups of students collaborate remotely to share their knowledge. The study demonstrates how a probabilistic machine learning method can be used to model and analyze interactive knowledge exchanges. The approach is applied to hidden Markov models and multidimensional scaling for analyzing and evaluating the coded interaction sequences of online students. These analysis methods were used to train the system to dynamically recognize when students have difficulty learning new concepts that they share with each other and why they have problems.

3. MATERIALS AND METHODS

For an objective and evidence-based verification of the accuracy of the pedagogical hypothesis, a pedagogical experiment was conducted, which was carried out in two stages: ascertaining and teaching experiments.

Experimental training was conducted in four schools. Almaty (2015-2018). Students were divided into experimental and control groups.

The goal of the experiment was to analyze the state of practical knowledge and skills of students in computer graphics. The experiment involved 30 students and teachers in computer science.

When conducting an ascertaining experiment, we set ourselves the following specific tasks:

- 1) to develop and describe the components, evaluation criteria and levels of development of the motivation for studying computer graphics;

- 2) to design a diagnostic complex aimed at studying the development of the main components of the motivation for studying

computer graphics;

3) to identify the features of the development of the main components and levels of motivation for studying computer graphics in traditional learning environments.

Based on the analysis of the data of the ascertaining experiment, the following important conclusions were made for further work: 1) in the practice of computer graphics training, almost no models with practical content are built; 2) due attention is not paid to the formation of the simplest skills that make up general educational skills; 3) in about half of schoolchildren, these skills cannot be formed without the purposeful work of a teacher; 4) a differentiated approach to students with different levels of development of certain skills is required.

This once again confirms the correctness of the conclusion that it is necessary to apply the method of using information modeling in computer graphics proposed by the authors, which can eliminate some, "shortcomings" in the teaching of computer graphics in Kazakhstan schools and pedagogical universities.

The purpose of the training experiment (second stage) was to check the effectiveness of the developed system of tasks, and the method proposed by us for using information modeling in computer graphics.

To test the accuracy of experimental learning, we used the method of comparing the level of mastering the educational material of students in the control and experimental classes and the probabilistic method – the criterion χ^2 . For this purpose, control tests were conducted, the results of which were subjected to qualitative analysis. Each student was asked 30 questions in 3 versions.

Method – criterion χ^2 most often used in pedagogical research to compare the distribution of objects of two sets by the state of a certain property based on changes on the scale of the names of this property in two independent samples (Glass and Stanley, 1976) of the considered sets. Criterion Statistics Value χ^2 to compare the results of the control work is calculated by the formula (Equation 1), where I_1 – the number of works considered in the first sample; I_2 – the number of works considered in the second sample; R_{1i} is the number of relative estimates of the i -category in the first sample; R_{2i} is the number of relative estimates of the i -category in the second sample.

If a $\chi^2 > \chi_{kr}^2$, the difference between the

two distributions is significant; if a $\chi^2 < \chi_{kr}^2$ - not significant.

We randomly selected 40 works (test responses) in the control and experimental classes. The first sample we have presents the answers to the tests performed by students of the control classes, the second – the experimental classes. The results of the tests are recorded in table 1.

Table 1. The results of the tests

Relative assessment	Control classes	Experimental classes
$R \leq 50\%$	10	1
$50\% < R \leq 70\%$	19	6
$70\% < R \leq 80\%$	7	14
$80\% > R$	4	19

By virtue of the fact that in this case $I_1 = I_2$, it can be calculated by the formula (Equation 2).

The designations are the same as in the previous formula. Then we have (Equation 3).

From table 1 it turns out that the correspondence to the three degrees of freedom

of the value of χ_{kr}^2 at the 95% probability level is 7.81. Since $26.23 > 7.81$, it is possible to reject the null hypothesis and assume that there are significant differences in the results of the control test in the experimental and control classes.

4. RESULTS AND DISCUSSION:

When teaching computer graphics, before constructing a figure, it is necessary to build its information model, i.e., purposefully select information about the object, which reflects the essential properties of this object.

The tasks of construction arose in ancient times and were associated with practical needs. They train the mind, teach students to apply knowledge in a complex way, they bring up a non-standard approach to solving problems.

First, it explains that the graphic object has a form, dimensions, proportions, and color, then the concept of the design, the process of collecting the object and elements are given. To create a graphic image, an object, both flat and volumetric, can be moved, replicated, edited, rotated, reflected, resized, and proportioned.

Thus, the graphic information model is a visual way of representing objects and processes in the form of graphic images.

When observing students developing a graphical information model, it was obvious that the model was created and modified based on the information they had about real objects, processes, or phenomena. The ability of a student to correctly understand and process information largely determines his ability to understand the world around him and, as a result, his ability to create models.

It is necessary for the student to correctly understand how much and what kind of information is needed for the model. If the student clearly understands the purpose of the study, then it is sufficient to have the necessary information to present it in the proper form.

After building a graphic information model, a *computer model of an object, process, or phenomenon* is built using a computer. As a tool for computer graphic modeling today, a graphic editor is used. There are a lot of different computer environments studied in school: Paint, Corel Draw, Photoshop, AutoCAD, 3DS MAX, etc. For modeling in a graphical editor environment, you can use a generalized information model of a graphic object.

The main thing in building a graphical information model is that the resulting model matches the original object (prototype), correctly displays it. Otherwise, the building process is repeated (cyclical process) until the model is adequate to the real object.

The process of computer information modeling is complex and diverse, but, nevertheless, the following steps can be distinguished in it. The stages of computer information modeling will be presented in the form of a flowchart (Figure 1).

The modeling method is cyclical in nature (Rakhimzhanova *et al.*, 2012, 2015), therefore, for each specific model, all stages of the modeling methodology process are repeated, and the computational stage assumes that the model's parameters are cyclical in order to obtain new results or study the constructed model in different situations.

Modeling is the most modern and not fully developed teaching method, since it satisfies all the requirements of modern trends in didactic theory for the development of a student's thinking and intellectual activity, such as the method of undelivered problems, solving non-stationary

problems, acceptability of training, and so on.

Using the examples of tasks, we will consider the stages of computer information modeling on a graphic editor. The task is to draw a bicycle in a graphic editor.

Stage 1. Building an information model

- *Definition of purpose.* Create a two-wheeled bicycle on a graphical editor.

- *Structural analysis.* A bicycle is a two-wheeled structure consisting of two wheels connected by a frame, a base for a seat and a steering wheel, a seat, a steering wheel, forks from the handlebar to wheels, pedals, connecting stays for a chain (Figure 2).

- *Simplification of assumptions:*

- The wheels are oval, consisting of a cylindrical surface, in the middle a polygon to support the spokes.
- The frame consists of cylindrical surfaces.
- The fork consists of tubes; some have a polygon connector.
- The seat consists of connected n – squares.
- The handlebar consists of tubes interconnected by means of connectors, polygons covering the tubes.
- The pedals are in the form of connected cylinders, narrowed in the middle, along the edges of the ring and n -gons.
- The crank arms consist of cylinders with concentric bores connected by a bridge.
- All sizes must be selected from the bike statistics.

- *Refining the purpose and description of the model.* Drawing a graphic object – a bicycle, using geometric shapes of certain sizes, such as polygon, cylinder, oval, etc.

Stage 2. Computer modeling

1) *The use of graphic editor 3DS Max.* In the article, we will consider only fragments of using the program for drawing a bicycle fork, wheels, pedals, and a handlebar.

Bicycle fork. In "Create" – "Geometry" we create a new cylinder with a radius of 2.5, the height of 7, segments of height 4, segments of cover 1, sides 12 and place it using the tool "Select and move" (Figure 3) (Tutorials for 3ds Max, 2010).

An example of the cyclical nature of

building a model is that students do not always, in most cases, build the wrong connections between cylinders. Students simply bring figures to each other or make the junction as a circle, etc. After several attempts are made, it is necessary to explain that the junction of the cylinders is an octagon with a certain radius.

In "create", "create forms" we will make an n-gon with radius 2.1 and 8 sides and connect the next cylinder (Figure 4).

Adding another cylinder, in "Select" and "Turn at", we turn both times with the same amount – 30 along the Z-axis, etc.

Then we can make more copies, but this time, using the Select and Move tool straight down. Let's go to the perspective viewing window, and in the edge selection mode, select 4 edges. Using the "Select and Move" tool and holding Shift, copy them along the Z axis by – 1.876. The tapered end of the plug can be made with a planer on X, etc. As a result, we get a bicycle fork (Figure 5)

Wheels. In "Create, Geometry" select "Cylinder». Change the height segments to 1, the cover segments to 5, and the sides to 32. In the keyboard entry, leave X, Y, and Z to 0, change the radius to 30, the height to 3, and click Create (Figure 6). After creating the Cylinder, right-click on it, select "Convert to →" Convert to Editable".

We select the desired polygons, remove the excess, and convert to create holes for the spokes. From the "Create, form" create a new NGon with 8 sides and a radius of 3.5, by clicking and dragging on the screen. Use the Select and Move tool to position the NGON, as shown in Figure 7. Now, using the Cut tool, create 8 new edges, 4 on each side (Figure 8).

Holding SHIFT, rotate the object by 22.5 degrees along the Y-axis. Select the type of Copy object, 15 copies, and click OK. Activate the Attach tool and click on the other 15 objects to bind them together (Figure 9).

2) *We use graphic editors Paint or Corel Draw.* First, we show the outline of a bicycle, its main lines. That is, you and I should have two oval wheels connected by a frame, the basis for sitting and steering. We will make Oval-wheels wider. We will make handlebar using a smooth line. We will thicken the existing base of the seat and give it a shape. From the saddle we draw another line down, draw the front chain ring and pedals. Then we draw the thickness of the rubber tires. Above the rear wheel, there is a wing. Now, let's turn to the frame and the wheel fork. Design

the saddle, show the seat post. We turn to the handlebar: here handles and head tube. Now, let's pay attention to the details. We still lack the wheel rim with the valve. Next, we draw the cog set on the rear wheel and the chain. On the chain rings, we'll draw the holes. Let's make the pedals voluminous. On the handles of the bike – strips. On the saddle will draw a line separating its side. It remains not much to get to the goal. Namely, the box on the chain and spokes on the wheels. Now you can draw a bicycle on a computer (Figure 10).

Stage 3. Results analysis

When modeling a bicycle, all parts and their sizes are taken into account; the distance between objects is similar to a real object.

Stage 4. Computer experiment

You can conduct an experiment with a bicycle. Add it to the program to animate objects, etc.

It is important to show with the help of such tasks that the modeling method is cyclical in nature, that is, for each model being concretized, all stages of the modeling process are repeated, and at the computer model experiment stage it is assumed that the constructed information model is cyclical for different model parameters in order to obtain new results or studies of the constructed model in various situations.

5. CONCLUSIONS:

So, according to the results of a pedagogical experiment, it can be said with certainty that the proposed method of using computer information modeling in teaching computer graphics is effective.

The skill of the teacher consists in the selection of such tasks, in which schoolchildren could correctly determine the goals of the simulation.

The ultimate goals of modeling training are determined by significant changes in the theory and practice of pedagogical science related to making adjustments to the content of learning technologies that contribute to providing a qualitatively new model for training future members of the information society for whom creative thinking and cognitive interest will be the first vital need.

During the research, the following results were obtained

1. Approaches to the definition of "fundamentalization of education" were analyzed. When teaching computer graphics in the computer science course and in training future computer science teachers in pedagogical universities, as a way of developing the fundamentalization of education, the method of studying using information models is used, using the computer as a means of managing information processes.
2. A method of teaching computer graphic information modeling has been developed.
3. A complex of educational and applied research tasks for modeling computer graphic objects has been developed.
4. To test the results of the study and to obtain effective results on the use of the proposed methods, a pedagogical experiment was conducted in schools.

The fundamentalization of education, specifically, the course of Computer science, suggests that the course of Computer science must be built from the phenomenon of information processes to methods of their study using information models, using the computer as a means of managing information processes. In particular, the study of computer graphics in the course of computer science should be built using geometric information models, using graphic editors when building computer simulations.

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$$\chi^2 = \frac{1}{l_1 l_2} \sum_{i=1}^k \left[\frac{(l_1 R_{2i} - l_2 R_{1i})^2}{R_{1i} + R_{2i}} \right], \quad (1)$$

$$\chi^2 = \sum_{i=1}^k \left[\frac{(R_{2i} - R_{1i})^2}{R_{1i} + R_{2i}} \right], \quad (2)$$

$$\chi^2 = \frac{(10-1)^2}{10+1} + \frac{(19-6)^2}{19+6} + \frac{(7-14)^2}{7+14} + \frac{(4-19)^2}{4+19} \approx 26,23 \quad (3)$$

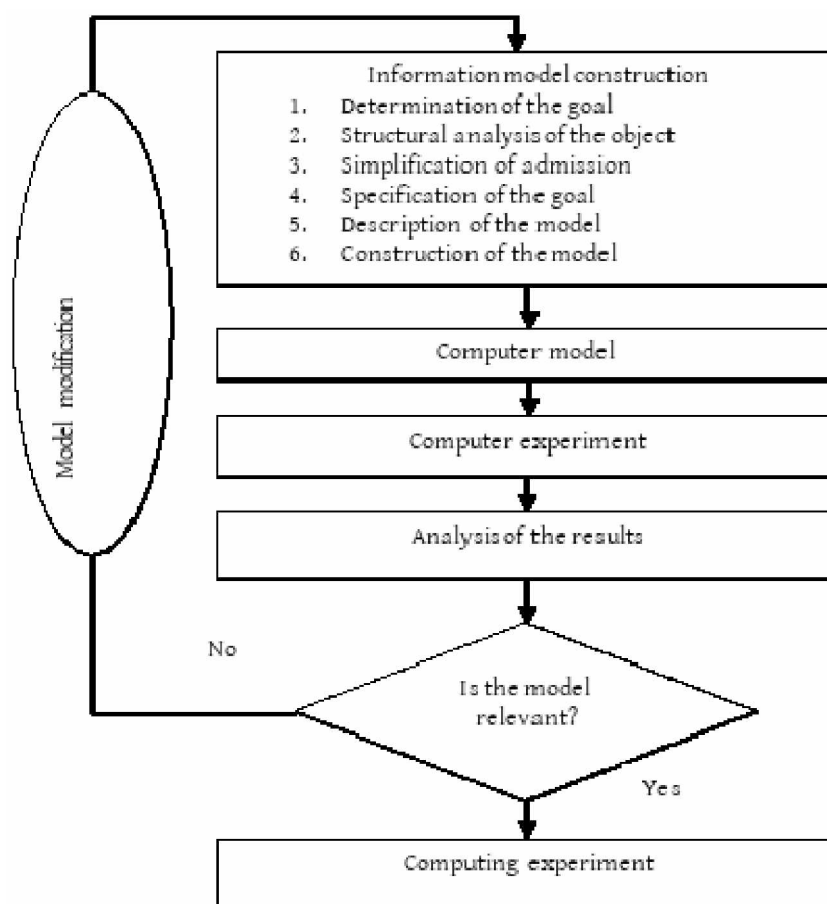


Figure 1. Computer information modeling stages

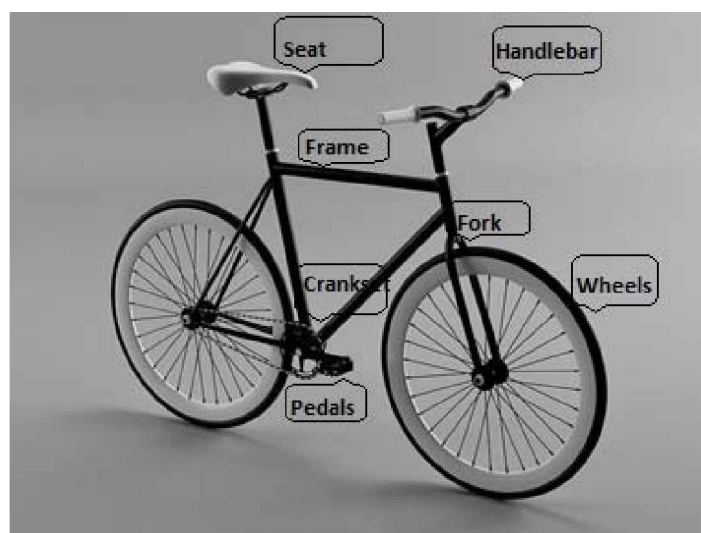


Figure 2. Bicycle parts

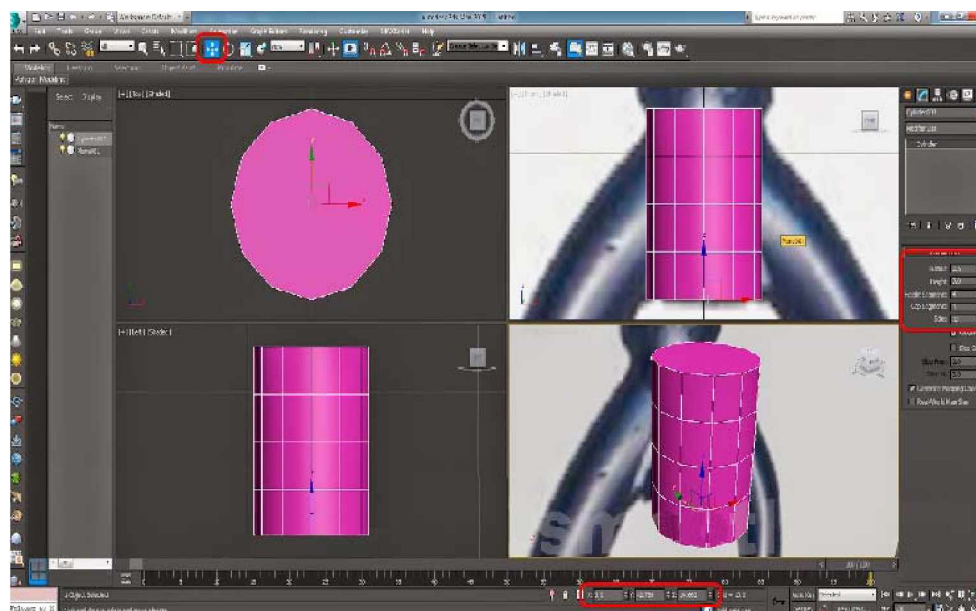


Figure 3. Using cylinder shape

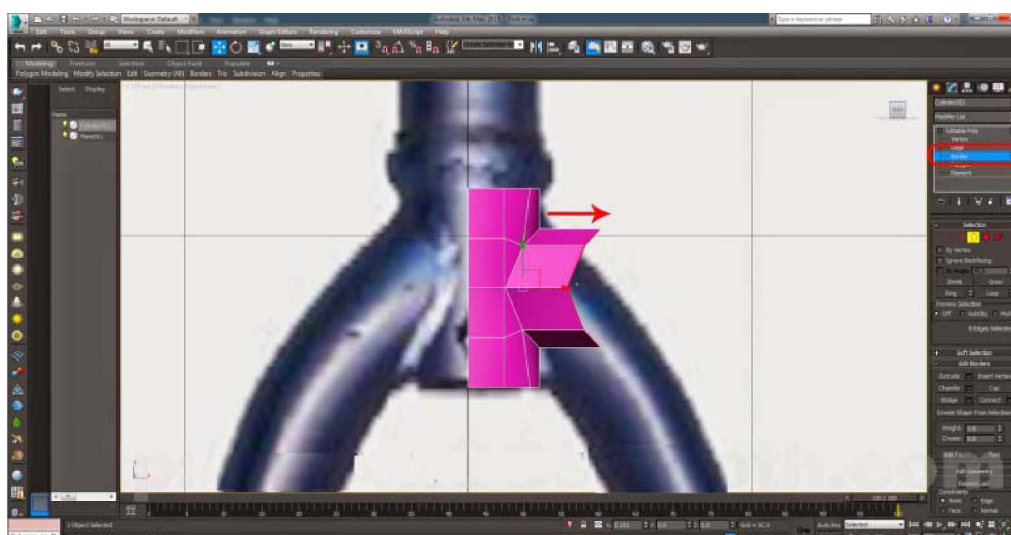


Figure 4. Intersection point of cylinders

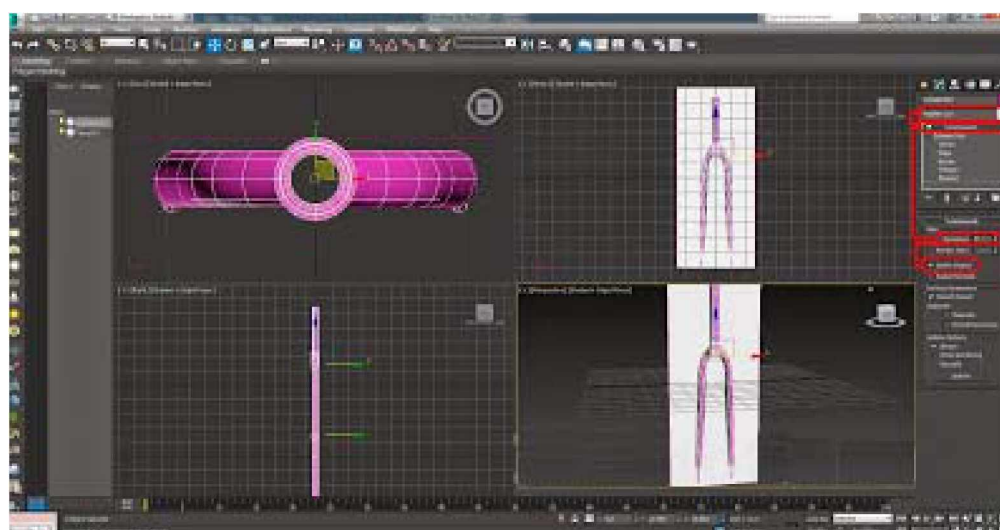


Figure 5. Bicycle fork

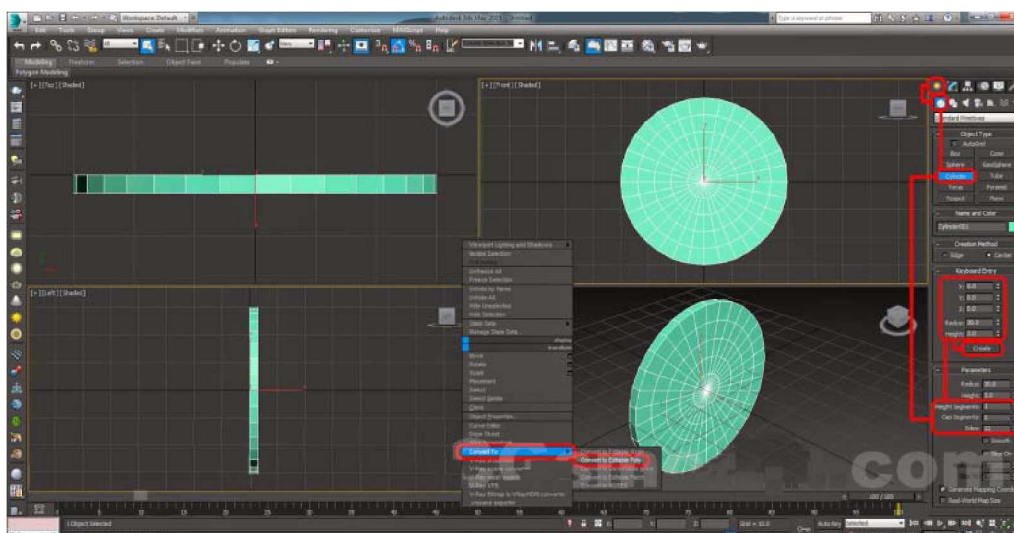


Figure 6. Bicycle wheel

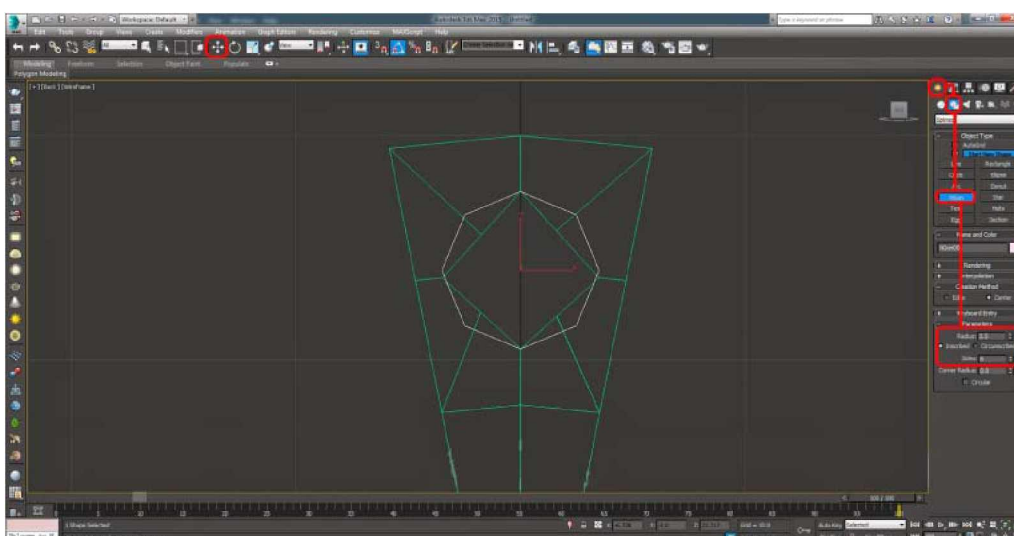


Figure 7. Polygon for bicycle spokes

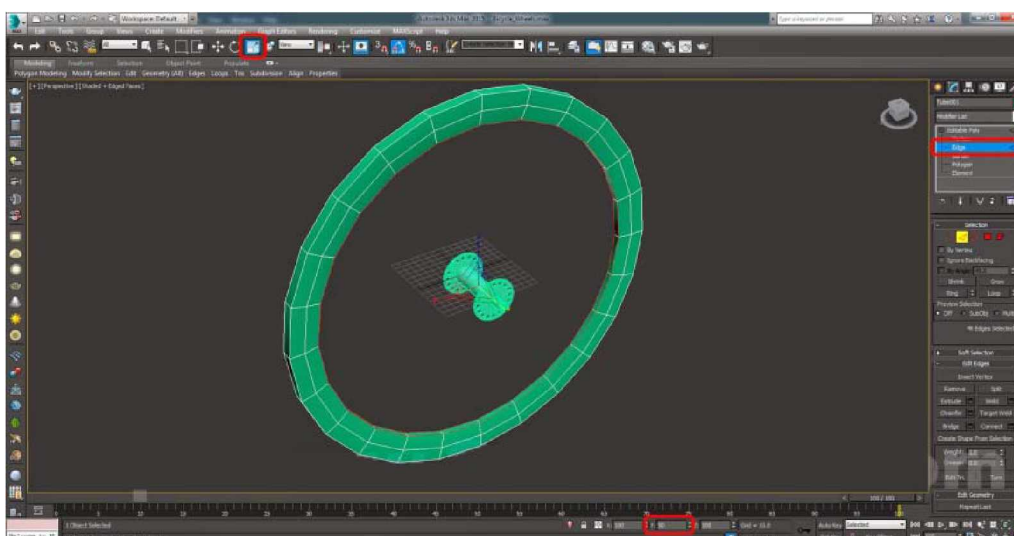


Figure 8. Center spokes

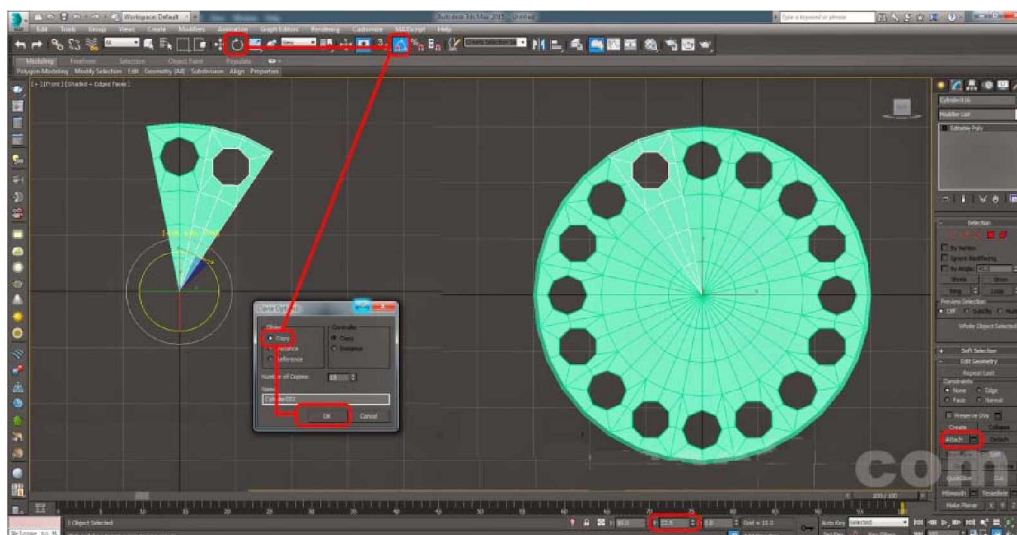


Figure 9. Wheel object copy

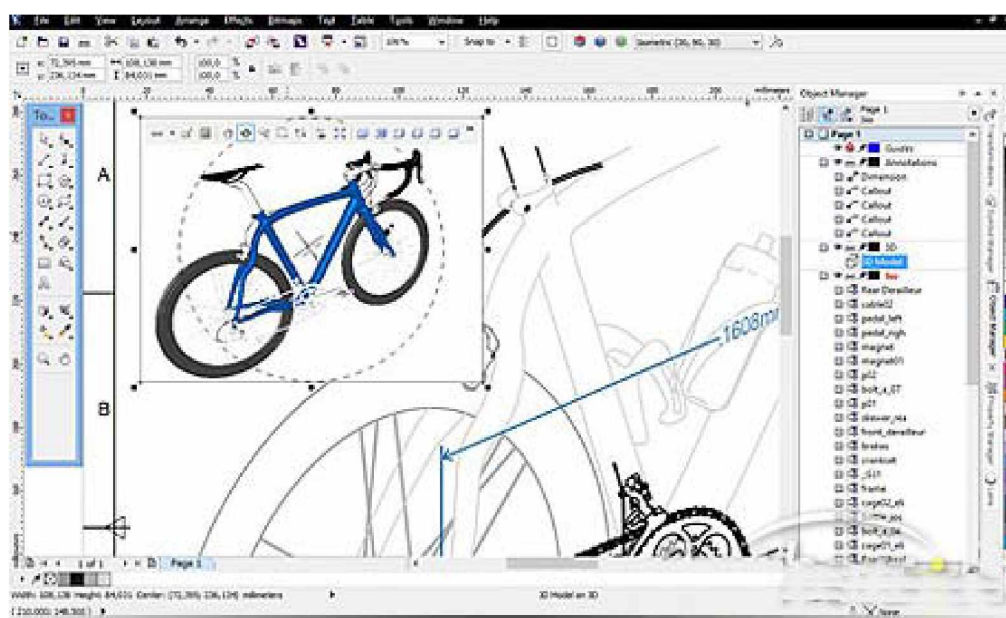
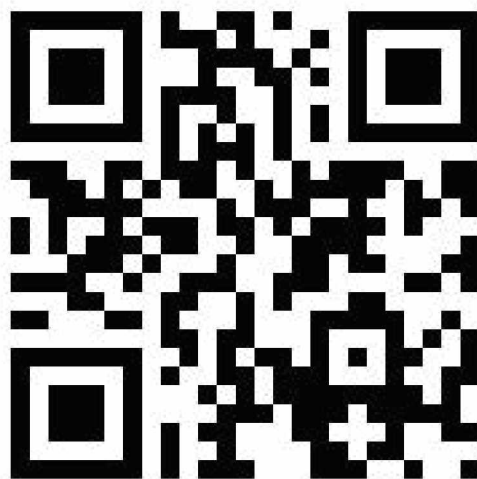


Figure 10. Corel Draw Bicycle



<http://www.tchequimica.com/>

