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FORMALIZATION OF COMPUTER-GRAPHIC MODELING
OF FLAT PARAMETERIZED LINEAR IMAGES

Topicality of the Research. Preferable task of education is thorough development of a personality, which demands top priority development of his or her intellectual abilities. As intellectual abilities of a person can become apparent during the cogitative activity and are evaluated according to the level of thinking development, the mentioned task is concretized by the need to develop person's thinking. It must, first of all, be logical, analytical, abstract, dimensional, constructive, critical, algorithmic.

The contemporary reality is characterized by dynamic changes, which are particularly visible in the computer science. It extorts from the human being of the beginning of the XXI century a need of adjustment to the initialized standards. It always puts new challenges in front of schools that consist in equipping a young man with knowledge and abilities, thus the competences enabling a dexterous motion in the social space, which percolates more clearly with a space marked by new technologies. The computerization becomes a part of a human being that decides not only about their degree of development, but also about their attractiveness at the job market[1].

All offered types of thinking are developed in the most effective way in the process of processing by person graphic information, in particular, linear formalized images, - symbols, drawings, diagrams, plans, maps, etc. That is why efficient means of development of person's thinking is teaching graphic literacy, conducting educational process in different directions of graphic preparation. Paying attention to the fact that the basis of making any graphic images, including flat linear ones, is parameterization and modeling (parametric graphic modeling), and taking into account comprehensive computerization of the society and all spheres of person's activity, one may conclude that teaching formalized computer-graphic modeling of flat parameterized linear images becomes today one of the most effective means of development of person's thinking in particular, and intellectual abilities of the personality in general. The topic of publication and corresponding research is topical due to the above mentioned information.

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[1] A. Kokiel, Ze wstępu, [w:] B. M., Барановська, *Формування інформатичних компетентностей майбутніх учителів початкових класів*, Chmielnicki 2013, s. 4.

Analysis of the Latest Research. Intellectual development of personality in the process of teaching attracted attention of pedagogues in all times and epochs, beginning with Plato, Aristotle, Y.A. Komensky, J. Dewey, K.D. Ushynsky and to the modern times (V.V. Davidov, B.D. Elkonin, L.V. Zankov, M.M. Statkin, O.Y. Savchenko, V.I. Bondar and others). Graphic activity has the biggest possibilities as for the development of intellectual abilities of the person and for the development of all times of person's thinking.

Development and general spreading of computer-informational technologies led to the rise and swift development of geometrical modeling as the most perspective and productive direction of objects, processes and phenomena modeling in all spheres of the person's vital activity. The above mentioned stipulated working out of the new methods, ways, means and algorithms of modeling and determination of characteristics (metric and positional) of geometrical objects of different origin. The leading components of geometrical modeling became parametrization of geometrical objects and algorithmization of calculation of their geometrical characteristics.

Modeling of the flat linear parameterized graphic images is the simplest component of geometrical modeling. That's why teaching of geometrical modeling should begin with its mastering in the context of intellect and thinking development of a young person.

Modeling of the flat linear graphic images is based on the method of parametrization of geometrical figures – method of M.F. Chetvertukhin, which is described in many publications[2].

A lot of works[3] is dedicated to algorithmization of geometrical modeling. The author's publications on the mentioned problem concern organization of educational process of the majors selective course, called "The Bases of Computer Graphic-Informational Technologies. Algorithmization of Graphic Structures"[4].

The Aim of the Research is to group characteristic points of the flat linear image by the manner (algorithm) of calculation of their coordinates for teaching senior pupils geometrical modeling of the flat parameterized linear images, in particular, formalization and algorithmization of coordinates of points calculation according to the typical algorithms.

The Main Results of the Research. Calculation of coordinates of characteristic (fixed) points of the flat linear image according to some numerical values of its parameters is a key aspect of *laboratory work* "Receiving of Analytical Dependencies of Calculating Coordinates of the Fixed Points of the Given Flat Figure and Composition of Proper Formulas in MS Word" course by choice (elective course) "The Bases of Computer Graphic-Informational Technologies. Algorithmization of Graphic Structures" for high profession-oriented school[5].

The aim of this laboratory work is to reproduce on the screen of the monitor or to print on the paper the flat linear image according to its geometrical model, that,

[2] In particular: *Engineering Geometrics with the Elements of Theory of Parametrization*; also: N.N. Ryzhov, *Parametric Geometry* – M.: MADI, 1988, p. 63.

[3] In particular: A. Fox, M. Pratt, *Computer Geometry*, M.: Mir, 1982, p. 304.

[4] Y.O. Doroshenko, *Computer Graphics in Higher Forms: Educational textbook*, K.: Publishing House "Shkilnyi Svit": Edition L. Galitsyn, 2005, p. 3-5.

[5] Y.O. Doroshenko, V.O. Ocheretnyi, *The Program of the Selective Course* "The Bases of Computer Graphic-Informational Technologies. Algorithmization of Graphic Structures", Informatics and Informational Technologies in Educational Establishments. – 2009. – No. 6, p. 22-34.

in its turn, provides performing mathematical processing of the graphic image, that is certain formalization of the process of element-by-element making of the image. Attaining of the desired goal provides for successive performing of such tasks.

1. Conducting of preliminary analysis of the given image, that is determination of its structure (lines), geometrical properties and conditions of mutual disposition of the elements of the image – appliance, parallelism, perpendicularity, contact, symmetry, etc.
2. Parametrization of the image.
3. Separating from the composition of graphic primitives the smallest, indivisible graphic elements (for example, point, arc, circle, straight line (vector), symbol and others), and marking their characteristic points – principal and pivotal.
4. Doing analytical formalization of making the graphical image, which consists of receiving formal dependences (mathematical formulas) for calculating coordinates of all characteristic points of the image.
5. Working out in MS Excel a calculator for calculating coordinates of the characteristic points of the variant of the flat linear graphical image by the set of numerical values of its parameters.
6. Working out a mathematical model of the image (in the form of the table)[6].
7. Reproduction of the image by its mathematical (geometrical) model. For example, in AutoCAD.

To organize purposeful teaching of the pupils to put down correctly analytical dependences for calculating coordinates of the points by the known meanings of the parameters, possible variants of creating characteristic points as a result of graphical primitives, which make the flat linear image, were analyzed.

The result of the mentioned analysis became group typification of the characteristic (fixed) points of the flat linear image, where algorithmic uniformity of their coordinates calculating was set as principles. 7 typical groups of points, offered in the table, have been singled out[7].

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[6] V.O. Ocheretnyi, *Teaching Graphic Algorithmization as a Component of Development of Logic – Algorithmic Thinking of Senior Pupils*, Annotated Results of Scientific-Research Work of the Institute of Pedagogics for 2009, K.: Pedagogical Thought, 2010, p. 254-255.

[7] Y.O. Doroshenko, V.O. Ocheretnyi, *Graphic Algorithmization of the Structure of the Flat Linear Images*, Materials of the International Scientific-Practical Conference "Modernization of Education: Research, Problems, Perspectives". – Kyiv – Pereyaslav-Khmelnytskyi, 2006, p. 125-128.

Table 1. Group Typification of the Characteristic Points of the Flat Linear Image.

Ordinal number	Graphic presentation of the point	Characteristics (description) of the point	Examples of the fragments of the images
1.		Simple, "autonomous" points – coordinates are determined directly (without any calculations) by the numerical meanings of the parameters (dimensions) of the image.	
2.		Point – the end of the segment of the straight given length and certain disposition (primary point 1 and the angle of slope α).	
3.		The point is situated on the straight line, set by the segment. It is determined by the condition of its disposition relatively the ends of the segment (within the segment or beyond its boundaries). As a rule, by parametric number α, where ($0 \leq \alpha \leq 1$) within the boundaries of the segment.	
4.		Characteristic point – point of intersection of two segments of straight lines, set by the end points, for example, 12 and 34.	
5.		Characteristic point – point of intersection of the straight line of separate location (vertical or horizontal) with a circle.	
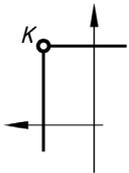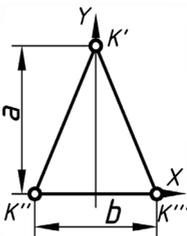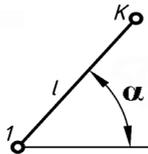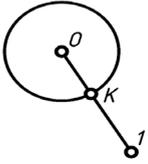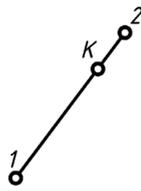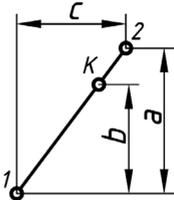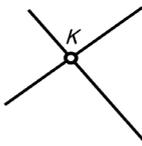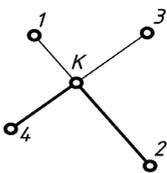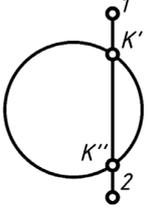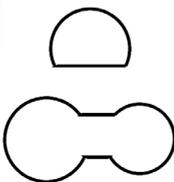
6.		Characteristic point – point of intersection of two circles, which centers are located on one vertical or horizontal line.	
7.		Characteristic point – point of contact of the straight line to the circle.	
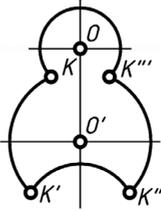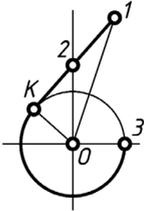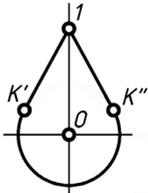
The next stage of the research should be receiving typical (standardized) mathematical dependences for each group points and working out of methods for teaching pupils adaptive writing down of such dependences for the particular fragment of the image with the singled out characteristic (fixed) point.

Conclusions. The conducted research allows us to typify characteristic points of the flat linear graphic image, which made it possible to teach pupils the bases of algorithmization during the process of working out the models of linear images and their computerized construction on the basis of proper unified algorithms.

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Włodzimierz Ocheretnyi

Formalization of computer-graphic modeling of flat parameterized linear images

The problems of personality's intellectual abilities development by means of development of his or her thinking have been cleared up in the article. The types of thinking, which are best developed with the help of processing of linear formalized images – symbols, drawings, schemes, plans, maps etc., have been offered. The analysis of the latest researches of personality's intellectual development in the process of teaching has been made. As an example, laboratory work which aims at reflection on the screen of the monitor or printing on the paper flat linear image according to its geometrical model in AutoCAD has been done. This research allowed us to typify characteristic points of the flat linear image, which lets us teach students bases of algorithmization during the process of working out models of linear images and their automatic construction on the basis of existing unified algorithms.

Keywords: intellectual abilities, algorithmic thinking, computer and graphic modeling, geometrical modeling, linear image

Formalizacja komputerowego modelowania graficznego obrazów parametrycznych

W artykule próbowano przybliżyć złożony problem rozwoju intelektualnego człowieka za pomocą przetwarzania obrazów – liniowych, sformalizowanych symboli, rysunków, schematów, planów itp. Analiza najnowszych badań realizowanych w tym zakresie umożliwiła charakteryzowanie znamiennych cech płaskiego obrazu liniowego pozwalającego w istocie na wdrożenie nauczania podstaw algorytmizacji w procesie tworzenia modeli liniowych obrazów i ich automatyczne tworzenie na podstawie istniejących jednolitych algorytmów.

Słowa kluczowe: zdolności intelektualne, umiejętności algorytmiczne, komputerowo-graficzne modelowanie

Tłumaczenie: Włodzimierz Ocheretnyi