Ensuring the principle of visibility in the development of didactic tools in graphic disciplines

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Abstract. The paper considers the theoretical and methodological aspects of ensuring the principle of clarity in the process of developing a complex of didactic means for graphic disciplines. The design features and presentation of visual training tools in the process of geometric and graphic preparation are analyzed. The importance of implementing the principle of clarity in the task of improving the effectiveness of training in graphic disciplines is shown. A classification of visual aids is presented, and the necessary conditions are indicated for a more productive implementation of the capabilities of visual aids as a potential resource for improving the teaching of graphic disciplines.

1 Introduction

Visibility is one of the basic principles of modern pedagogy. Formulated back in the 17th century by Komensky Ya. A., the principle of visibility in the context of the development of both information technologies and the improvement of the learning process has undoubtedly become a necessary attribute of modern educational technologies [1]. As the recent analysis of pedagogical and methodological literature shows, the design and use of visual didactic means in the educational process today have become integral conditions for increasing the efficiency of the educational process. At the same time, the fundamental role of the principle of visibility of didactic means is not disputed both at the initial stage of studying general technical disciplines [2,3] and when designing didactic means of final assessment [4].

Computer multimedia technologies expand the range of didactic visual aids. Currently, there is an extensive experience in the creation and use of computer visual aids in teaching various disciplines [5]. Besides, the didactic aspects of the use of multimedia visual aids in the study of graphic disciplines are not sufficiently studied, therefore, the issues of choosing visual aids in solving various pedagogical problems in geometric and graphic training, as well as analyzing the conditions for their effective use remain relevant.

2 Problem Statement

The purpose of this work is to study the didactic potential of modern information technologies for the development of a set of visual teaching tools that take into account the specifics of teaching graphic disciplines and fully meet the requirements of the FSHE standards.

The development of effective didactic support for the discipline is a fundamental task of the pedagogical design of the educational process. The choice of certain methods and means of controlling the cognitive activity of cadets will ultimately have a decisive impact on the quality of training of specialists and the level of formation of professionally significant competencies of future marine specialists.

The study of graphic disciplines at the university for the vast majority of first-year students is a difficult task. Of the many reasons for the existence of this problem that we pointed out earlier, one of the most interesting for us in the light of this study is the low level of development of abstract or spatial thinking of former schoolchildren. As a result, cadets poorly imagine the studied elementary graphic elements (point, line, plane), from which a real design object (part) is formed. In this regard, the teacher has a persistent feeling that the necessary level of abstract (spatial) perception of these simple graphic objects is much higher than the level of spatial representation in most first-year cadets. Undoubtedly, there is a differentiation of the level of abstract thinking among different students, however, one of the main tasks of the teacher of the graphic discipline, as we see it, should be not so much the verbatim learning of definitions and algorithms to solve problems, but the development of spacial-logical thinking. The successful implementation of this task, in our opinion, can be achieved only if a sufficient level of visibility of the didactic means used in the training of graphic disciplines is provided. In connection with the above, the study sets the following tasks:

- to review and classify visual aids to study graphic disciplines;
- to analyze the didactic potential of modern information technologies and graphic programs;

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– to develop a complex of didactic means that fully ensure the principle of clarity.

3 Results and Discussion

The term 'clarity' should be analyzed as the target concept of this work. Researchers point to the multidimensionality of the concept of 'clarity', it is considered by the representatives of different spheres of knowledge from different angles. However, it is generally accepted to evaluate the clarity of learning as one of the main principles of didactics, according to which training is carried out through visual perception (or perception by other senses) [1]. Some modern researchers, along with directly studied objects, also include in the concept of 'clarity' their graphic images (schemes, maps, drawings, graphs, etc.), symbols, signs, models that are a specific language of technical sciences studied in higher school.

The reason for this ambiguity in assessing the value of clarity, as we see it, can be the versatility of the principle of clarity and the existence of its various types. With regard to higher education, the following types of visibility can be distinguished, which have different didactic significance:

Illustrative (*familiarization*) visibility gives primary ideas on previously unknown objects. This type of clarity was in mind in the so-called "golden rule of didactics" and is mainly used to teach children. In addition to demonstrating the object itself, familiarity can be supplemented by highlighting individual elements of the object in different colors, making partial sections to familiarize with the functioning of units within the product, etc.

Visualization (*visualizing visibility*) is the process of displaying hidden features and properties of studied objects or relationships between them. This type of clarity includes graphs of studied processes, mathematical functions, as well as structural diagrams.

Associative visibility is designed to evoke associations that help to understand or solve certain problems.

Systematizing visibility allows showing the composition of the system and identifying those connections that provide special properties of the system when a given set of elements functions together.

Symbolic visibility reveals the properties of the studied object expressed by the means of formal language and is necessary during the creation and reading of drawings.

The main object studied by students in the process of geometric and graphic training is a drawing. This gives the duality of the concept of drawing, which, on the one hand, is a means of *symbolic clarity*, which in visual form absolutely accurately conveys information on the object, and on the other hand, the drawing is also an object of study within the graphic disciplines. This is also the specificity and problem of studying graphic disciplines, since a visual aid by definition is designed to help in understanding the object of study, but the visual information embedded in a flat drawing is encoded using a special formal language and is not clear to a person who is not familiar with the principles of education.

In the process of studying graphic disciplines, a student must learn how to create a drawing (abstract image) based on a real object (part, assembly unit), as well as perform the opposite task – to recreate its shape, dimensions, properties from the existing abstract image of the object. Visibility in this case becomes a tool through which spatial representations of students are developed, the ability to perform various mental operations with abstract objects is formed, i.e., a solid base to form competencies in drawing development and reading is created.

In the above definition of clarity, it is especially important in the light of the study of graphic disciplines to indicate the transition from specific to abstract and vice versa. After all, this transition is nothing more than the process of building a flat image of a specific object, and vice versa – restoring the image of apart from its drawing.

Next, let us look at some of the possible ways to ensure the principle of clarity in teaching graphic disciplines, such as descriptive geometry and engineering graphics.

Until recently, the principle of visibility in relation to geometric and graphic training was possible to implement through the use of only such traditional means of visibility as illustrative material, demonstration posters, layouts, full-scale samples, stands, etc. All these tools are still successfully used and, to some extent, indispensable during practical classes, which, unlike block lecture classrooms, are not equipped with a computer and a projector.

The modern level of development of information technologies allows expanding the number of visual aids, while increasing their capabilities. Modern means of improving visibility include training games, multimedia lecture presentations, computer modeling that simulate real conditions and situations.

The process of learning using modern information technologies is based on classical didactic principles, at the same time, replenishing and enriching them with new content.

One of the main advantages of using a computer compared to the above traditional visual aids is to expand the possibilities of presenting educational information, as well as creating conditions for the formation of a universal educational environment, i.e., an environment used to solve diverse didactic problems.

The capabilities of computer technologies expand the scope of the visual principle, their use makes it possible to dynamically illustrate the algorithm of graphic constructions, show a part in motion, and realistically convey its characteristics. Modern researchers note the pedagogical significance of visual aids created using information technologies. Recently, new terms have been introduced: display forms of visibility and computer visual aids [5]. Regardless of the name, with the help of graphics and presentation software, it is possible to create didactic software so visual due to its realism, that it will replace some traditional visual tools, such as model tools.

The greatest potential of computer technology, as we see it, is in the field of creating animated videos. To develop educational animated videos, we used the Compass-3D computer-aided design system. The choice of this program was due to the broadest capabilities of Compass-3D in the field of three-dimensional modeling of complex surfaces [6], as well as in the development of multimedia tools for teaching on descriptive geometry. In the process of developing animations, the following main tasks should be addressed: ensuring the visualization of construction algorithms; step-by-step training mode; possibility of returning to the previous frame, providing the required number of repetitions of the studied material [7].

When an idea of some issues of the technology of manufacturing, control and assembly of products. The success of mastering the entire drawing course is undoubtedly based on the understanding of such basic sections as views, cuts, and sections of parts. As part of this work, we created animated videos that clearly demonstrate the principles of cut and section formation. Thus, Figure 1 shows successive sample frames from one of such videos devoted to the formation of a simple cut.

Besides, it is of great importance from the point of view of clarity that the teacher presents graphic information on the educational board during the lesson. Such, at first glance, a simple technique as using chalk or felt pens of different colors when solving problems of descriptive geometry on a board also allows a sharp increase in the level of clarity of the principle of solving a problem. So we use the color scheme common to the department: the condition of the problem is white chalk (black felt pen), auxiliary constructions are green, and the final solution is red. If two or more objects are given in the task condition, then, if possible, different objects are drawn in different colors, except for green and red. Such a kind of standardization of the color scheme avoids students' misunderstanding of the educational material presented to them by different teachers, since in most cases lectures and practices are not conducted by the same teacher. In addition to color, the differentiation of the thickness of lines depicting projections of data and the desired objects also helps to increase visibility. These simple ways of improving visibility (color and thickness variation) allow clearly distinguishing objects in the drawing, and therefore better understanding the solution to the problem, especially in graphic problems.

As we can see, when studying graphic disciplines, two types of visibility play the most significant role: symbolic (directly the drawing itself and techniques for increasing its visibility), as well as illustrative (three-dimensional models with and without sections, various animations).

4 Conclusion

In conclusion, after analyzing the entire range of visual aids available in the arsenal of teachers of graphic disciplines, we offer the following classification shown in Figure 2.

Let us explain the division of classroom means. Classroom synchronous ones are used synchronously with the lecture or practical lesson and serve as a visual reinforcement of the teacher's words. While classroom static visual aids are constantly in the specialized classrooms of the department. These can be, for example, wall stands for standards and connections, examples, and templates for completing tasks.

Due to the increased functionality of modern smartphones that provide high-quality images, we have separately identified this means of presenting visual images among other material and electronic media.

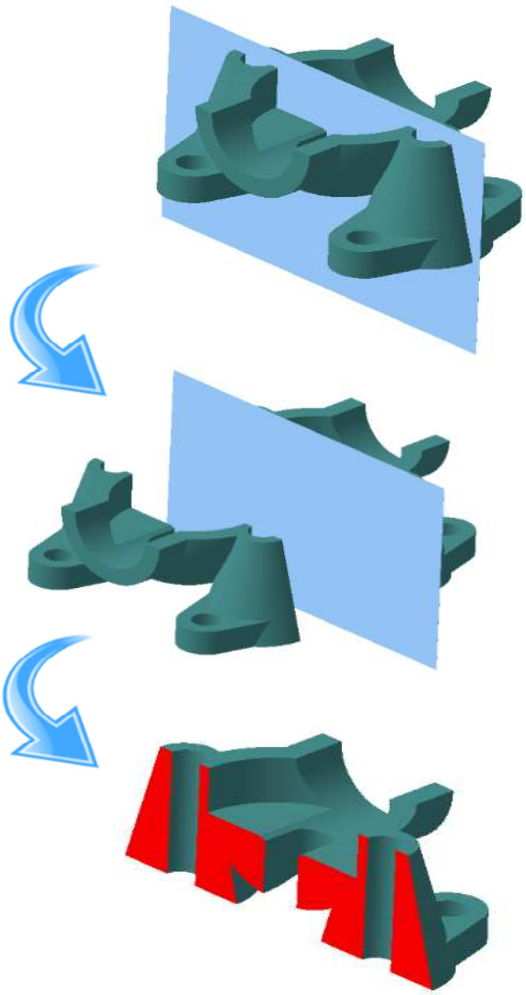

Fig. 1. Animation frames for Sections in CAD Compass 3D.

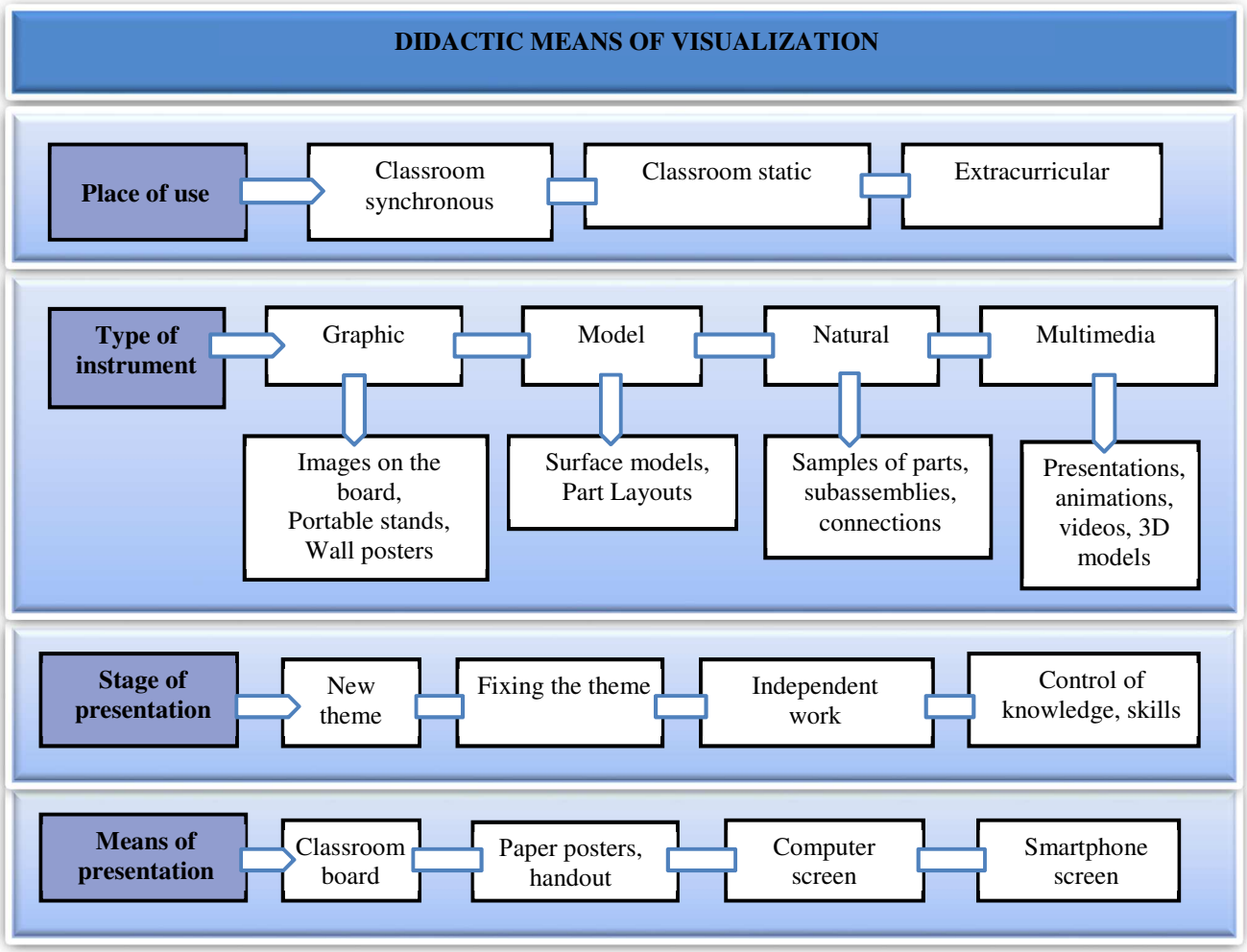

Fig. 2. Classification of didactic visual aids used in teaching graphic disciplines

Ensuring the completeness of the visibility of didactic support can be achieved only if all types of visibility are used comprehensively. So, during the classroom lesson in graphic disciplines, it is advisable to use graphic, model, field and computer tools, while not overloading the information flow.

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