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Topological concepts supported by PC multimedia presentation

Abstract. Multimedia support as a teaching tool for topological concepts in the combined course for primary school teachers is dealt with. Basic notions like "the neighborhood of a point", "an interior (exterior, border) point" are used to demonstrate this teaching tool. Specific aspects of the development and application of multimedia presentations in the lifelong learning are mentioned.

Introduction

The lifelong learning can have many forms. Some of them are distant courses, combined courses, Internet based study and e-learning as the most recent one. Another specific feature of lifelong learning is the fact that its participants are people of different age, qualifications, education background, health conditions and habits.

Both these facts have an important impact on the appropriate selection of teaching tools and methods. Hand in hand with fast development in IT the entire teaching process is becoming more and more dynamic, bringing more benefits as well as problems. One of the problems is a bigger share of self-education based on a wide range of tools without a direct interactive feedback with a teacher who could assist the student by modifying the explanation to suit better the student's needs and help him/her in better understanding of the subject matter. This particularly applies to a new topic, which is moore demanding in terms of the student's imagination. Therefore the tools designed for lifelong learning must partly substitute the missing feedback of other methods.

Some of these methods are potential visualization, simulation and presentation of the topic studied in the electronic format, available on the internet or CDs or another electronic form. In this way the student can view the subject matter from a different perspective in a different pace, going back to some points and make comparisons of the same subject matter explained by different teaching tools.

Visualization of topological concepts

As mathematics is one of the subjects where imagination is necessary for better understanding of some issues, it is a suitable area for the implementation of many teaching ideas and tools. One of these suitable areas is geometry. The above approach can provide a tool enabling better understanding of the concept of surroundings of a point in a set, its properties and applications.

In our demonstration we will use an example of topological concepts from the following textbook: Kuřina, F. Geometrie pro učitele 1.stupně základní Školy. Skriptum PF Hradec Králové 1977 — pages 45-46. (Geometry for Primary School Teachers)

...First we introduce some new notions.

Surroundings of a point in a set:

Definition 2.8: There is an empty set M, non-zero line segment δ, point $A \in M$ and a set of all points $Y \in M$, where $AY \cong \delta$. The set of all points $X \in M$, where $X \in AY$ is called δ-surroundings of point A in set M and it is expressed as $O_M(A, \delta)$.

Set M plays an important role in the definition of the surrounding of a point. It is obvious that δ, the surrounding of point A in space, is a sphere with its center in point A and radius δ (that is the spherical surrounding of a point) — $O_\pi(A, \delta)$, surroundings of point A in a plane $O_p(A, \delta)$ is a circle with its center at point A and radius δ (that is the circular surroundings of a point). If the set is line segment p, δ — the surrounding of point A ($O_p(A, \delta)$ is line segment BC, for which the following expression applies

$$AB \cong AC \cong \delta \wedge A, B, C \in p \wedge B \neq C \neq A. \quad \ldots \text{and} \ldots$$

Let us take a triangle XYZ in a plane. The triangle sides determine two areas in the plane, which are referred to as inside and outside the triangle. This can be again specified with the use of the concept of surroundings of a point.

Definition 2.9: Point B is an internal (external) point of object U in set M only if its surroundings exists that is (not) a subset of object U.

(To keep it clear and simple and for the purpose of the following multimedia presentation I will use the following expressions for point B instead of the more formal one: point B — border, point I — in, point O — out and object U is the triangle XYZ.)

Then:

Point I is an internal point of object U in set $M \Leftrightarrow \exists O_M(I, \delta) : O_M(I, \delta) \subset U$;

Point O is an external point of object U in set $M \Leftrightarrow \exists O_M(O, \delta) : O_M(O, \delta) \subset U$.

Definition 2.10: Point B is the border point of object U in set M if and only if in its surroundings there is at least one inner and one outer point of object U.

Point B is the border point of object U in set $M \Leftrightarrow \forall O_M(B,\delta) : O_M(B,\delta) \cap U \neq \emptyset \wedge O_M(B,\delta) \cap M \setminus U \neq \emptyset$.

The set of all internal (external) points of object U is called interior (exterior) of object U, the set of all border points of object U is called boundary...

The electronic visualization tools can have many forms, they can complement each other or overlap with each other.

1. A video simulating the teacher's explanation of the subject, a video program on a cassette or a video in a computerized version such as WMV. AVI, MPEG, MOV, RAM, EXE, ...;
2. A simple graphical format based on a graphical editor (such as analytical sequencing of supporting pictures);
3. Development of a linear sequence based on multimedia presentations (MS-PowerPoint, Corel-Presentation, Scala-multimedia, ...);
4. Animation based on suitable software such as FLASH with the possible presentation in HTML format for the Internet version or in EXE format for universal applications or based on another animation software;
5. Utilisation of special design tools such as M-CAD, CABRI etc;
6. Programming of an appropriate script in a SW environment (JAVA, C++, VISUAL BASIC etc.);

There are many other options depending on the teacher's choice and possibilities, creativeness, co-operation with authors etc. The options can be both static and dynamic and they can be accompanied by a sound track either with the explanation of the subject or a purely motivating one.

Individual steps of an explanation can be specified as the visualization scenario. The first example is the support of the concept "surroundings of a point in a plane" based on an animation in Flash and the other is the dynamic visualization of point positions in plane to object U based on the design tool CABRI.

Example 1:

1. First there is a non-empty set M (Fig. 1);
2. Then the dimension of line segment δ is determined and point A plotted (Fig. 2);
3. The distance δ is plotted gradually (linear or non-linear) from point A (animation — Fig. 3); by linear plotting a circular area is gradually drawn, in a non-linear plotting the plane is gradually filled with a circular area. In this way it becomes immediately evident that it will be a circular area and not a circle, which is not so obvious in a text, and therefore an example of border points can be better demonstrated in this case;

4. The circular area of all points X, which are part of AY, corresponds to delta of surroundings of point A (Fig. 4).

(see: the copies of screens — Fig.1 to Fig. 4 and enclosed is an example of a multimedia animation in Flash and FLA, SWF, HTML, MOV and EXE formats)

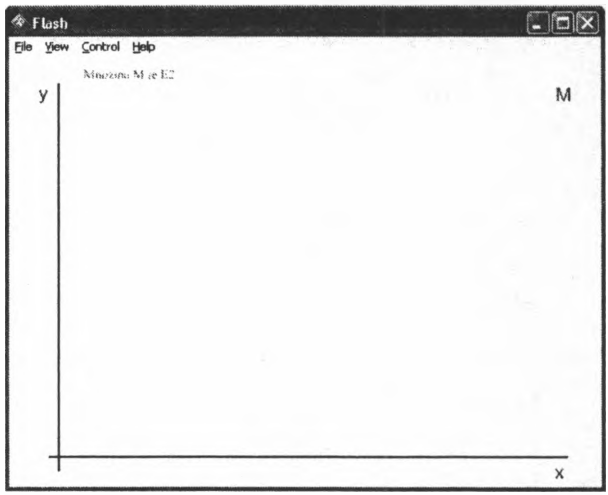

Figure 1.

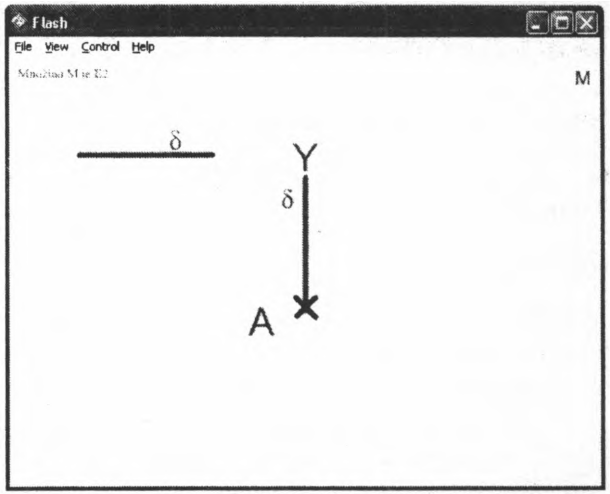

Figure 2.

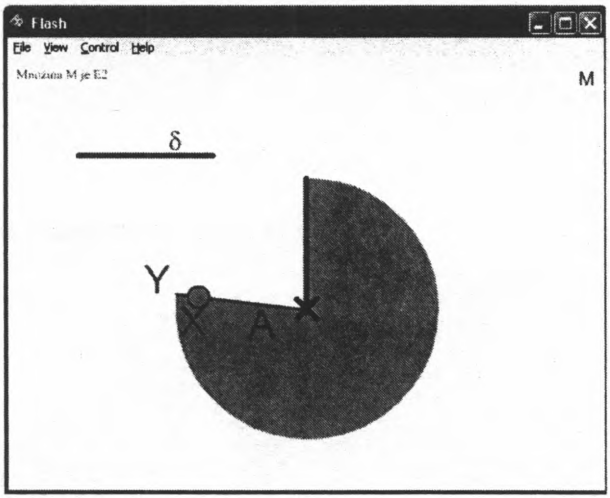

Figure 3.

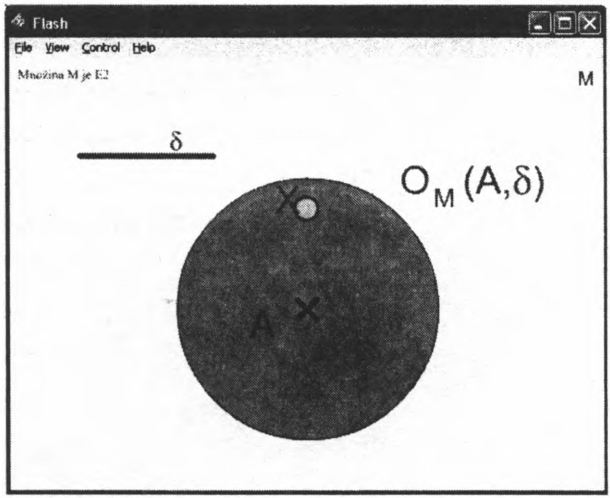

Figure 4.

Example 2:

1. In E2 there is an object U — triangle KLM and points B, I, O are situated in the following way: point B on side KM, point I inside the triangle and point O outside triangle KLM (Fig. 5);
2. We can display any surroundings of points B, I, O as general circles (Fig. 6);

3. For better clearness we shall plot at least two points X and Y close to point B at the end of the perpendicular line to side KM of the triangle (Fig. 7);
4. The animation tool called "spring" will allow the movement of the circle representing the surroundings of points and therefore the validity of the definition of internal, external and border points is very clear (Fig. 8).

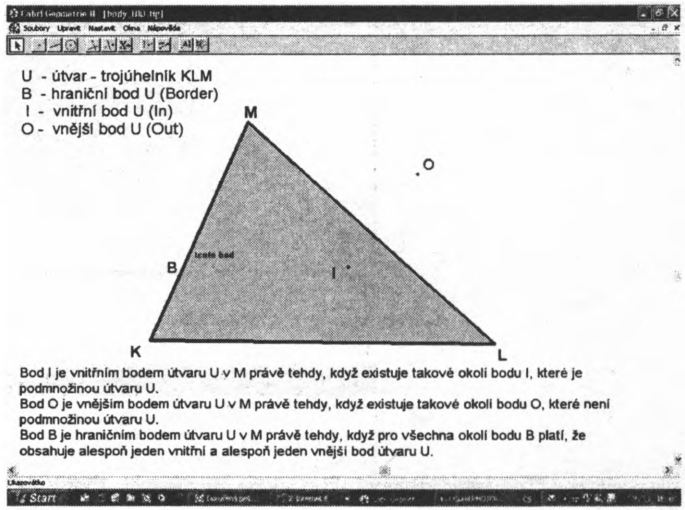

Figure 5.

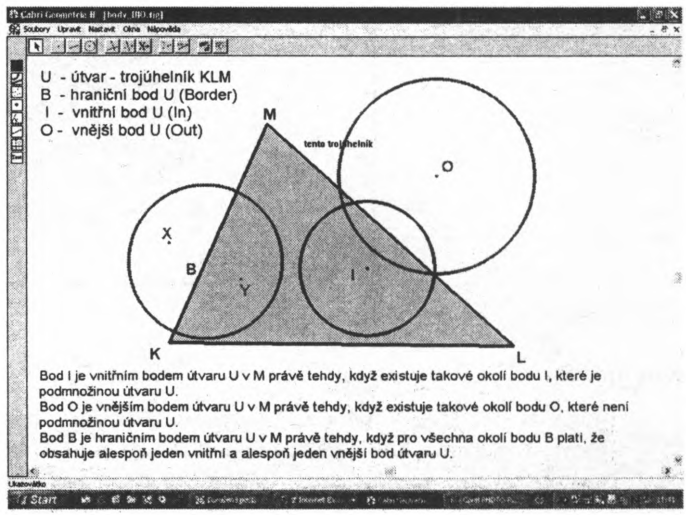

Figure 6.

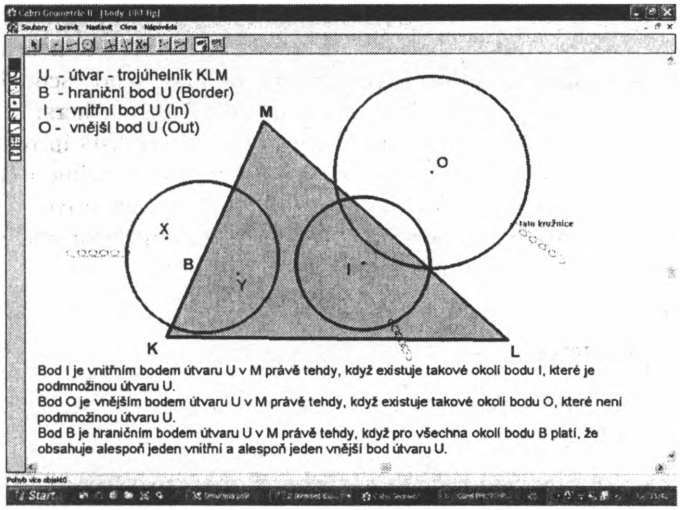

Figure 7.

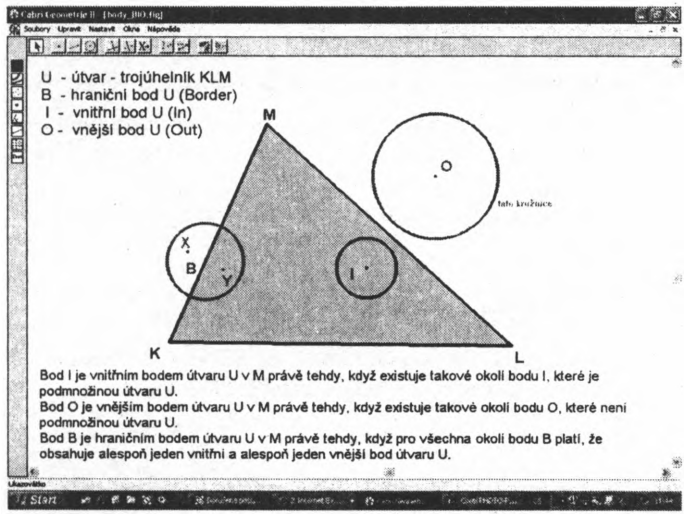

Figure 8.

Conclusion

It is evident that the visualization and multimedia support used in the teaching process can significantly enhance students' performance in long-life

learning. The key principle of perceiving by senses promoted by Komenský is implemented in this method as more senses are employed and the subject matter is tackled from several angles. Another Komensky's principle is also implemented and that is the "school by play" and "school in pictures".

This approach is also more demanding for teachers; it requires more effort, creativeness and co-operation with other specialists in related fields. However, this effort will almost certainly pay-off in the teaching and learning process by the time saved due to the more efficient and effective explanation of subject matters. At the moment it is the simplest and most efficient way of using the Internet and electronic network.

References

[1] M. Bělík, *Matematika pro studium učitelství 1. st. ZŠ*, Skriptum PF UJEP, Ústí n.L. 1996.

[2] F. Kuřina, *Geometrie pro učitele 1. st. ZŠ*, Skriptum PF, Hradec Králové 1977.

[3] Z. Pejsar, J. Soukup, *Multimediální prezentace ve výuce matematiky na prvním stupni základní Školy*, Sborník mezinárodní konference "Matematika v přípravě učitelů elementární Školy", Acta Universitatis Purkynianae, UJEP Ústí nad Labem., 2000, 114-117.

[4] J. Polák, *Vplýv technológie vzdelávania na kvalitu výuky*, in: Sborník 8. mezinárodní konference o kybernetické pedagogice, Hradec Králové 2000, 57-58.

[5] E. Poláková, *Medzinárodné interdisciplinárne štúdium cez Internet*, in: Sborník 8. mezinárodní konference o kybernetické pedagogice, Hradec Králové 2000, 58-59.

[6] J. Soukup, Z. Pejsar, *Jak dál ve výuce „Didaktické technologie"?*, in: Sborník mezinárodní konference PEDAGOGICKÝ SOFTWARE, České Budějovice, 1998, 273-275.

[7] J. Soukup, *Rozvoj kreativního myšlení za přispění multimediálního počítače*, in: Sborník MEDACTA'99, 1, Nitra 1999, 44-46.

[8] J. Soukup, *Začít se musí hned*, in: Sborník 8. mezinárodní konference o kybernetické pedagogice, Hradec Králové 2000, 65-66.

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