Tünde BERTA, Budapest

Preparing teacher students for using and making visual aids (traditional models, computer animations)

Abstract
In Budapest I have a special course for third year teacher students, where I prepare high school tasks for them, with which I would like to make similar problem situation as their students will have in classroom. During these lessons we use and make concrete models, computer based worksheets and computer animations as help to solve these tasks. I will show you one of this tasks, how to make paper model easily by folding and how computer animation will help to understand and to solve this problem. In this short paper I would like to write some words about my teaching experiences with my students and with students in Jena too.

Hungarian school system

In 1990s the Hungarian school system changed. Beside the classical 8-year elementary schools and 4-year secondary schools a new system of 4-year and 6-year elementary schools and 8-year and 6-year secondary school was introduced.
- Primary and secondary formation:

Class	Age	Period	Institutions			
1	6-7	(Primary) 1st section	Primary School			Primary and Secondary School
2	7-8					
3	8-9					
4	9-10					
5	10-11	Upper Elementary 2nd section				
6	11-12					
7	12-13			6-year Secondary School	8-year Secondary School	
8	13-14					
9	14-15	Secondary "gymnasium"	(traditional) Secondary School			
10	15-16					
11	16-17					
12	17-18					

In accordance with the classification of three school grades, three kinds of math teachers' training institutions exist in Hungary
1.*Teacher Training Colleges for primary schools* – trains teachers for the lower elementary level (grades 1 - 4). Training period 4 year.
2.*Teacher Training Colleges for intermediate level* – i.e. for the upper elementary teachers (grades 5 - 8). Training period 4 year.

3. *Universities* – trains teachers for the secondary level (grades 9 – 12). Training period 5 years.
With the change of the school system the task of universities has been modified. The 8-year and 6-year secondary schools have given the universities a new task, namely to prepare math teachers-to-be for the upper elementary level.

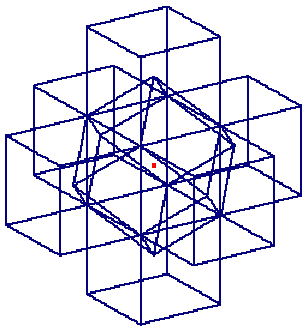
Demonstration and experimentation on math lessons
At Eötvös Loránd University third year students of mathematics who would become teachers have a subject demonstration and experimentation on math lesson. On these lessons we look at different problem situation. We would like to make similar problem situation as their students will have in classroom. In order to eliminate difficulties we use special combination of all levels of representations (enactive, iconic and symbolic in sense of Bruner). At the different levels of understanding the mathematical content is different. During manipulative lessons different levels can be realized.
In the teaching of mathematics demonstration is a hard task. The dialectics of the development of concepts range from individual to general, from static to dynamic, and from specific to abstract. It needs varied equipment comparable to children's world. Teachers rarely devote sufficient time and energy to demonstration with equipment that is of high quality (material, size, and price). On our lessons we try to inspire and help to our students to design and make models (manual, computer) and experimentation connecting to some secondary school mathematical problem.

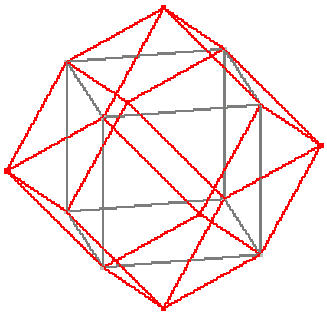
Concrete teaching lesson
As a topic of the concrete lesson I choose Archimedean solid Rhombic-dodecahedron. Rhombic-dodecahedron, there are many mathematics written about this solid on different levels (different genetic ways to get this solid, mathematics about half regular solids, space filling blocks, topology of this solid …)
I choose the following task from Hungarian geometry task book for secondary schools. Keeping in mind that the number of lessons for geometry is reduced, it is not usual to solve this problem on the regular lesson in secondary schools because it seems too complex. But using my models I think the students can be able to solve successfully this problem.

Task
Let's give a cube with edge length a. Reflect a cube on its all side. We get 6 new cubes. Connect the vertexes of a given cube with the mid-points of the new cubes. By this construction we get a new polyhedron.

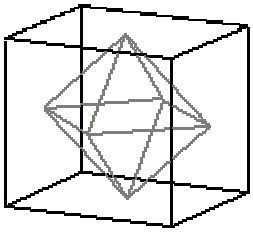
1. How many vertexes, edges and sides this new polyhedron has?
2. What kind of polygons composed it?
3. Is this new polyhedron a regular polyhedron?
4. What can we say about the length of the edges of this polyhedron, if we know that the lengths of the cube edges are *a*?
5. Calculate the angel of two connecting edges!
6. Calculate the angel of two connecting sides!
7. Calculate the surface area of this polyhedron!
8. Calculate the volume of this polyhedron!

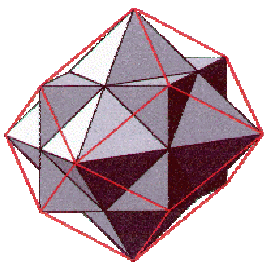
We start the lesson with this task. Students have to solve it question by question. We start with 1-3 questions and discuss it. At that moment student do not have any help. But during the discussion we start to work with models because all the time is a big discussion about number of edges and sides. Models help them to understand problem and see the whole body. For seeing the process of building up the polyhedron we use computer animations. First to build up cross in the space and second with removing part of six new cubes we have the searched body. For making this animation we use Cabri-geometrie .





After this discussion students have to solve the remaining questions. We change the order of questions, and we discus it also why. First we solve questions number 8, 4, 7 and after questions 5 and 6. If we have the solid the easiest question is question number 8, and the most complicated questions are 5 and 6, that is why we change the order. With university students we also think about another genetic ways how to get Rhombic-dodecahedron. With help of another animation we show how we get it with enlarging octahedron drawn in to the cube.





During this lesson every student makes himself by folding a Rhombic-dodecahedron. The steps of folding can be found under my name as a part of webpage http://mathdid.inhun.com. It is a specially prepared webpage for this lesson. Besides these origami steps you can find on it also mathematics about the Rhombic-dodecahedron, photos of models and concrete animations with which we worked. Special part of this side is about Rhombic-dodecahedron in real word, with photos of crystals and honeycombs. Students can see connection of mathematics with other subjects (biology, geology). It is also a very good discussion part of the lesson why bees built up combs from Rhombic-dodecahedron? You can speak about space feeling nature of this body, and you can build up the comb from folded Rhombic-dodecahedrons.

Experiences in Budapest and in Jena

I had opportunity make this lesson in Budapest at my University and in Jena at the Friedrich Schiller University too. There was a big difference in mathematical background. In Germany there is less geometry than in Hungary. What is evident for Hungarian students is not evident for German one. In Jena we have to build up step by step the definition of a regular solid and from that what is a half regular solid. In Hungary it was well know for everybody. In Jena we have problem with language too. I speak only English but not every student can speak it as well. Models and animations help much. I can see that models works like international language. Students in Jena use models and animations not only as a help to understand and solve the problem like student in Budapest, but also as a communication tool to speak with me. It was a very nice and memorable experience for me.

References

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