The Role of Intuitive and Life-related Activities in Improving Teaching of Geometry in Primary School

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Abstract: This paper presents a set of activities to improve geometrical intuition in students and also to help them in understanding the application of geometry in real life. The main problem of teaching geometry by following traditional methods is that it is usually difficult for students to make connections between geometrical concepts and real life. This reduces the motivation of students and consequently causes their lack of success in learning geometry in primary and higher educational levels. The students can achieve deeper understanding of geometrical concepts when they are introduced with structural connections of these concepts and real life situations. Also, understanding the space and the space communication is an important factor in learning geometry and helps the students in visualizing their ideas. Having a profound understanding of geometrical principals is possible by using intuitive, applied, and visual activities which are followed by engaging in activities for creating and developing the space impressions. In this paper, we present a number of activities such as tiling, modeling, and knots which represent the relationship between geometry and life. Also some activities for developing the intuitive ability and imagination of students are introduced.
[Molouk Habibi. **The Role of Intuitive and Life-related Activities in Improving Teaching of Geometry in Primary School.** J Am Sci 2012;8(6):359-366]. (ISSN: 1545-1003). http://www.jofamericanscience.org. 44

Keywords: Visualization; Motivation; Constructivism theory; Van Hiele model; Intuition

1. Introduction

Studying of geometrical teaching methods is an important area of research as successful approaches can help students to improve their skills in imagination, critical thinking, intuition, problem solving, estimation, inductive proof, rational discussion, and spatial reasoning. Furthermore, geometry helps pave the way for acquiring a good understanding of scientific principles (NCTM, 2000). Geometry enables us to visualize concepts which we encounter while studying math. Also it increases our ability in visualizing 3D and 2D shapes. Also, it is helpful in developing other subfields of mathematics and mathematical sciences such as Set theory, Graph theory, the study of functions, statistics, and so on.

Similarly, geometry plays a crucial role in modeling concepts and problems in various other sciences such as chemistry, engineering, biology, physics, astronomy, art, manufacturing technology, and many other scientific areas. As a result of the extensive usage of geometry in science, designing efficient geometrical teaching methods has become an interesting area of research.

Considering various aspects of geometry, mathematicians believe that learning geometry should be started in childhood and be continued at different stages of education.

Our previous studies of a sample of the students in Primary schools of Iran reveal that many of these students are struggling with geometry and merely memorize the formulas without completely understanding their usages. This problem stems from the fact that educational system focuses on knowledge rather than skill and attitude. As a result, students have more problems in geometry in Guidance school and High school.

Several questions come to mind in this regard:

- Why can't most of the students apply geometry in real situations of life?
- Why aren't students interested in geometry homework assignments?
- How can we strengthen the self-confidence of students in their geometrical knowledge?
- Does geometry have any roles in our life? And how can it change the human life?
- In which part of human life does geometry play a specific role?

There are no clear and definite answers to these questions. Another question is that which educational program can increase the quality of teaching students and can help them to achieve a better understanding of the geometrical concepts?

To answer this question we should say that geometry in Primary school is not deductive and doesn't base on axioms and accumulation of rules and definitions in mind, but it is intuitive accompanied with experiment, discovery, and conclusion. So, substituting the traditional teaching methods to active approaches, which exploits the intuitive and applied activities related to life, can lead to the success of students in learning geometry.

Constructivism theory is the theoretical focus of this study. Van Hiele model has been one of the important models of teaching geometry and has

been introduced in three levels of visual, descriptive, and theoretical. In this work, we propose methods to implement this model in practice.

For implementation of visual and descriptive levels of this model it is necessary to plan and perform some activities. Van Hiele believes that the level of geometric thinking is associated with geometric success.

Also, another goal of geometrical education is to develop practical skills of geometry in real life and other sciences and improve the spatial skills of students. The study of space and space communications is an important part of geometry which leads to involving in activities for creation and development of spatial perceptions. Some areas of Non-Euclidean geometry (e.g. geometric topology, geometric knots) and some activities for improving the intuition of students and some activities of Euclidean geometry usage in life such as tiling, modeling, and knots have been presented. These activities are better to be done collectively in form of a group project or problem solving, because these activities play an important role in acquisition of basic living skills like problem solving, communication, and reasoning which are the major bases of education. These activities can be performed in form of activity games or in part of the art classes in the schools.

Performing the mentioned activities motivates students to progress. Also, they can appropriately use the acquired knowledge in other aspects of life in the future.

This study investigates the role of geometrical education in primary schools in life and also the role of intuition in improving the learning of geometry.

2. Theoretical principles

Constructivism theory was applied in this paper for active learning and doing geometry activities focusing on different steps of Van Hiele model. According to this attitude, teaching will be effective and sufficient when students discover and product knowledge through experiences, trial and error, engaging in topics, and solving problem (Blais, 2000).

Brooks and Brooks (1999) described the strategic principles of constructivism as follows:

1- Design issues that students can relate to it.
2- Organize learning process around the basic concepts. Encourage students that by transforming a concept into its components make it meaningful and avoid creating a whole from its parts.
3- Note that students' deductions are derived from their own points of view.
4- Develop the curriculum so that students' background and progress are covered.
5- Evaluate students learning in teaching contexts.

The standards of teaching geometry in the world have changed and Van Hiele model is one of the prominent trends in this matter. This model contains three levels including visual, descriptive, and deductive (Van De Walle, 2007). As visual and descriptive levels of this model are involved in teaching geometry at Primary schools, it should be practical and based on visualization and intuition. In other words, the visualization of learner should be reinforced and simple and applied problems should be used. Moreover, students must be prepared to enter the theoretical level by adopting an active method of teaching. Van Hiele has come to the conclusion that students are struggling with the theoretical level in at High school, because they don't acquire any experience of visual and descriptive levels which are prerequisite of high school official thinking. Children enter the primary school t the first level of geometry (visual level) and have no progress during this period which is due to the lack of descriptive and analytic experiences (Spitler, 1995).

3. Application of geometry in life and other sciences

If we study the history of geometry, we can see that it came into existence with respect to human needs and its application and was scientifically developed by the Greeks. So, a teaching method of geometry based on its applications would be enjoyable for students. This not only increases their motivation to learn but also improves their ability to apply geometry and expands geometry beyond some formulas just for memorizing.

The first real-life experiences of geometry in children are gained involuntary. When a child moves from a point to another one he/she experiences the concept of measuring. They also become familiar with the concept of similarity through the ceramics of floor, images on bills, and so on. They find symmetry in paintings, carpet, foliage, beehive, etc. They see two-dimensional and three-dimensional geometric shapes like ceramics, kite, brick, tissue box, birthday hat, ball, glass, plate, and so on without knowing their name. These experiences should be used for teaching geometry and children's involuntary learning should be developed to practical and applied learning by already-designed activities. One of the ways which leads to this goal is the project method. In this method learners provide the necessary arrangements, plan the project, and organize to do it accurately, and start and finish the project according to objectives and timetable.

During the high school applied learning shifts to theoretical learning. The levels of learning are inseparable, because children's thoughts are related by the formation of experiences and performance.
Since geometry is intuitive as the intersection point of mathematics, the modeler of natural phenomena, and an effective and useful tool in providing innovative and creative applications, students become familiar with the applications of geometry by presenting the usages of geometry in life and also their creativity develops.
Tiling: Tiling is an ancient art of civilization history. From the time human started decorating their buildings, tiles, ceramic, and stone were used to cover walls and floors of houses. They also designed different patterns and this way the art of tiling gradually emerged (Tabesh, Haji Babaei, Rastgar, 1379).
Geometry of designs has many applications in various sciences especially in modern ones. So, it is necessary to teach the basics of this field of mathematics which can be started from Primary school and completed at High school. Learning these patterns can enhance students' creativity and make them more interested in geometry. The drawn designs on tiles have been formed by the view of an artist and are influenced by the culture and traditions of the community. They were drawn according to a series of principles and rules, most of which come from geometry. Artists used horizontal and vertical lines and simple geometric shapes such as square, circle, triangle, and polygons to draw these designs. The method of tiling project (two-dimensional using geometric shapes like triangle, square, etc.) and bricking (three-dimensional by putting cardboard bricks) are some samples of applicable activities from Primary school for greater recognition of polygons and three-dimensional shapes.
We want to cover a specific surface with the ceramics in shape of regular polygons. Tell us which these shapes (three regular polygon, regular tetrahedron, regular pentagon, and regular hexagonal) are applicable in this project?
Pasting the pieces of cardboard in form of geometric shapes to paper in their own groups, this conclusion comes to mind that pentagon is not applicable, because only a maximum of three pentagon are placed around a point that the sum of angles is less than 360° and an area of screen remains blank (Dehghannejad, 1387). But the screen can be covered with square, triangle, and hexagonal to infinity.

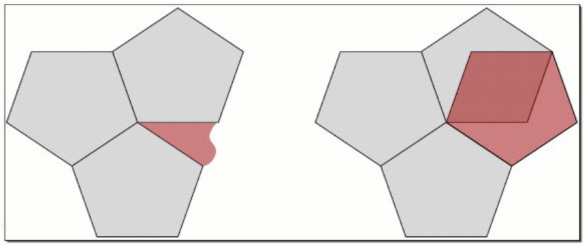


Figure 1 The screen cannot be covered with pentagonal

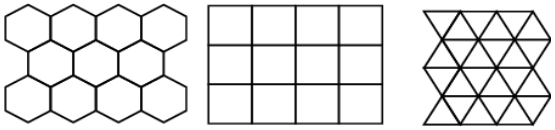


Figure 2 The screen can be covered with square, triangle, and hexagonal

Generable examples to design wall paper, tile, fabric, carpet, and so on can be created by students:
Maquette: Model and maquette making in other sciences is another application of geometry. Students can make models and maquette of their surroundings in form of a project. For example, making models of some objects like till, drawer, etc using two-dimensional and three-dimensional shapes. This makes students familiar with some professions such as architecture, industrial design, graphic, and so on and also the usages of polygons and geometric shapes in life and their properties in practice (Owen, 1995).

4. Some typical activities for the application of geometry in life

The best way to implement these activities is the project method. It is recommended that these activities be done in Art class which is combination of art and geometry. This gets students to pass from a geometric model of Van Hiele and become familiar with the properties geometric shapes in practice and also their creativity improves.

4.1. The activity of making maquette: In this activity students are supposed to be introduced to the shapes that architects use to make maquettes. They try to build their dream house using these shapes.
Objective:

- Explaining how an architect uses these shapes
- A collaborative work to create a project and its development
- Making cone, cube, and cylinder by students
- Using at least three three-dimensional shapes in their dream house

Materials:

- A plan for three-dimensional shapes
- Construction paper
- Sturdy cardboard
- Liquid glue
- Scissors

Preparation:

Ask students the following questions:

1- How many of you do you know that what an architect does?
2- Which shapes do they use for making maquettes?
3- They are two-dimensional or three-dimensional shapes?

Students plan a model of their dream house as an architect in each group and act as follows:

1- Form groups of 4 before you start and each member of group writes the name of shape he/she can make.
2- Show that how make cube, cone, cylinder, and rectangular cube using the copy of designs you have.
3- Give students enough time to discuss their plans for dream house which contains at least three three-dimensional shapes.
4- Let them if they want to make another plan than you asked them.
5- Show the made model to all to enjoy it.

Evaluation:

- What did you learn of this activity?
- Who can tell us what we study?
- What do the architects do?
- What are three-dimensional shapes? (Haggarty, 2002)

Additional activity:

Ask students to find the pictures of ancient or modern buildings from the internet or magazines, detect the space or flat shapes of them, and briefly write the name of geometric shapes, name of building, usage of building, name of city, and its history if it is ancient.

5. The use of symmetry and rotation in life

Symmetry and rotation which are known as geometric transformations are used in industry and manufacture of appliances. For example, symmetry is used in carpet weaving and drawing its designs and also in Islamic architecture. Rotation is also used in pottery and ceramics.

The importance of intuition and imagination in teaching geometry:

The human mind is such that they cannot think of anything even without a "physical embodiment" thinks.

The study of space develops the skills of learning geometry in Primary school through practical activities such as drawing, measurement of real objects, imagination, and fabrication of available geometric educational tools.

Space reasoning helps students to understand the everyday usages. For instance, finding directions and map reading are some samples of the usage of understanding two-dimensional and three-dimensional objects.

Joint mathematical council (JMC) suggests the followings as the purposes of teaching geometry:

1- Developing spatial awareness, geometric intuition, and visualization capabilities.
2- Providing a wide range of geometric experiences in two-dimensional and three-dimensional space.
3- Developing knowledge and understanding for the ability to use geometric properties and theorems.
4- Encouraging and developing the application of estimation and inductive reasons.
5- Developing the skill of applying geometry in models and solving real life problems.
6- Developing the ICT skill and specific geometric issues.
7- Creating a positive attitude towards mathematics.
8- Developing the knowledge of history and cultural heritage in society and the application of geometry in contemporary sciences.

Applied activities are used to achieve the purposes number 1, 2, 5, and 8 in this paper. Developing geometric and spatial reasoning is an important issue of teaching geometry in Primary school, while we see that spatial reasoning doesn't receive much attention in Primary school and students' experiences are mostly on calculation and measurement. Concentrating on geometry and emphasizing on development and the usage of spatial concepts, students learn to react to their world. The space where a child lives, breathes, and moves is the space he/she should learn how to understand, discover, and defeat in life.

Practical exercises help students develop their intuition. Although there is no definition of intuition, geometric intuition is defined as a skill for visualizing, creating, and mental manipulation of geometric shapes when solving problem. Although some mathematicians like Hilbert and Poincare have written positive articles about the role of geometric intuition, it is generally considered as a main component of mathematical thinking by many of famous mathematicians. "More research are needed to study the relationship between intuitive, inductive, and deductive ways for achieving the goals of geometry purposes," said Fujita, Jones, and Yamarmoti (2004).

Considering that the curriculum should include homework which develop the geometric intuition of students, the problem we face is this that such homework has been neglected in the curriculum. In reports of Meran (1905) and Coleman (1942) intuitive and practical ways of learning geometry have been greatly taken into account. Recent study about teaching geometry conducted by UK concluded that the development of teaching geometry can be achieved through developing an appropriate teaching model which is supported by detailed planning of activities and resources. Arcavi suggests that "Visualization" is a process of creativity including interpretation and using figures, pictures, and graphs in our mind, reflects of which on paper or by technological tools are supposed to visualize and sort the information, think about and develop the previous unknown ideas, and promote understanding.

Recently, some of mathematics educators have tried to clarify the role of intuition, view, and imagination in teaching and learning geometry.

6. Some examples of practical activities to develop the geometric intuition

The geometry of modes and its teaching at school, according to the conditions of the present century that students should be provided with very rich and valuable experience in a wide range of spatial forms and flexibility and its importance in the topological structures, can be a suggestion for development of spatial ability in learning process. Knots subject is one of the best exercises for shifting from intuition to experience. Students at Elementary school enhance the ability of their hands and the coordination of eyes and hands by observation, tying knot, and playing with knots. Learning of knots geometry can be started at the age of 9-10.

In a survey conducted on 30 students of grade 2 to 5, only the students of grade 2 had difficulty with it.

6.1. Knot activity

There is a great emphasis on teamwork in the proposed plan and the chance of discovery is given to students through different steps (Reihani, 1386).

1- Hand knot

2- Double knot

3- The vestibule

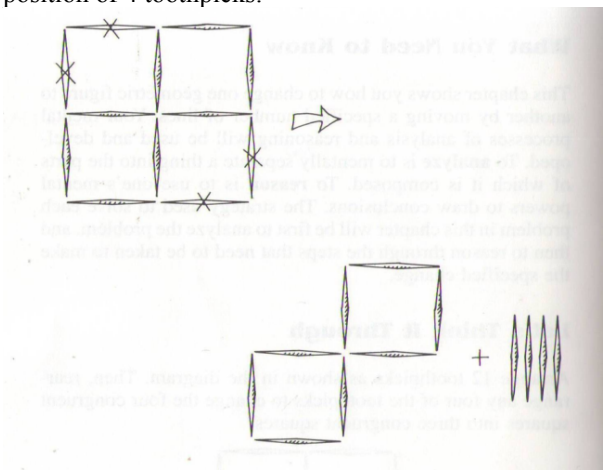
6.2. Geometric board

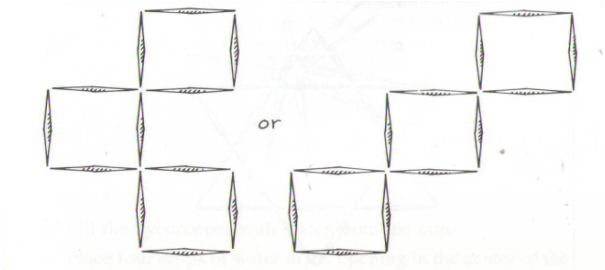
Students create the geometric shapes on geometric board. For example a square and then change it to a triangle. Create some shapes such as rectangular, diamond, and trapezoidal and discuss their differences and similarities. They also can draw the shapes of objects they see every day like traffic signs, directions, and so on with the help of geometric board.

6.3. The magic of toothpick (Vancleaves, 1994)

This part shows you that how change a geometric shape to another one by moving a few lines. This part also helps you improve the process of analysis and intellectual reasoning. Analysis means the separation of an object by thinking and then combination with other parts to make a new shape. Proving is using the power of thoughts to get results. In this process the problem is analyzed at first and then the needed items to build a new form are determined by reasoning.

12 toothpicks are shown in the picture. Transform four squares into three squares by changing the position of 4 toothpicks.

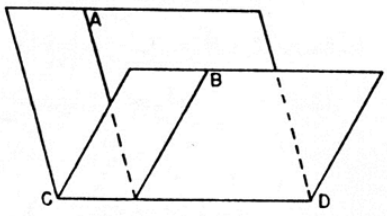




6.4. Origami

It is a good way for geometric visualization and paper and pencil are the only required tools. It is better to use tick oil paper so that a with line remains when you fold it. Each part of mathematics is based on basic principles. The principles of paper and fold geometry are summarized as follows:

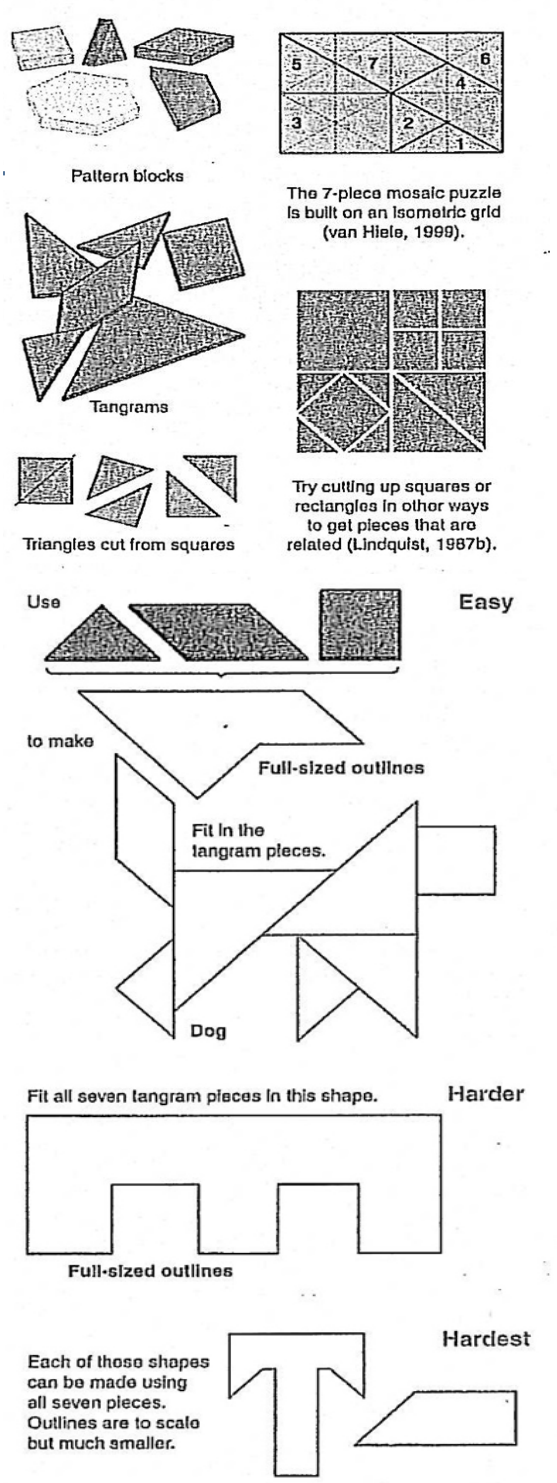
- The effect of a straight line remains on paper if you fold it.
- A line can be passed from one or two points by folding the paper.
- A point can be put on another point in the same paper by folding it.
- A line can be put on another line in the same paper by folding it.
- Segments and angles can be put on each other on a paper by folding it. If they completely cover each other, we can they are equal (Johnson, 1367).
- Many of properties of quadrilaterals and line relationship are achievable with the help of Origami.
- An example: Drawing a line perpendicular to another line:
- Fold the paper so that the given AB line folds on itself.
- Put the lines on each other with your fingers.
- Press the paper with your thumb and forefinger to be folded.
- Why did a right angle form from the intersection these two lines?



6.5. Puzzle

Give students the designed blocks in form of geometric shapes like triangle and rectangular with different dimensions. Ask them to write the name of shapes, make their desired plan in one minute, and finally choose a name for their plan.

Peer Van Hiele (1999) explained a set of tiles which named them mosaic table. This is another appropriate set for making a set of triangles cut out of squares (Van De Walle, 2007).



7. The role of intuitive and life-related activities in motivation for progress

Motivation as the most important factor in learning is one the emotional area in education and is related with the pervasive sense towards the

education. A motivated student is eager to learn, devoted, curious, studious, and serious. Such student overcomes the problems and obstacles and spends more time for studying and doing homework. Generally, it is agreed that educational motivation can positively affect the performance of students. So, active methods accompanied with doing life-related activities in education can play a major role in increasing the motivation of students.

The objective of education in this area is this to spread the motivation in students in order to master the acquired skills. As motivating greatly affects the progression of students, more time and attention should be paid to it. A student enters school with the incentives of reading, writing, and learning, but the situation of school, classroom, and family affect these incentives and mostly demote them (Brown, 1998).

There are two types of incentives for people including internal and external. As far as the external incentive is regarded, an external factor encourages a person to do a job. External incentive is not our intention (Behaviorists' ideas) in this case. In terms of internal incentive (Cognitivists idea), when a person do a job by internal incentive, he/she does that activity due to itself and doesn't seek another result. This is a psychological state which is achieved when people find themselves eligible to understand. If you create motivation in students, their self-confidence will enhance and they will be encouraged to acquire knowledge.

One of internal incentives is the understanding incentive which makes students join the process of learning because of the joy lies in investigating and acquiring new knowledge. Ding intuitive and life-related activities and also other courses can be effective in creating internal motivation.

8. Recommendations

- Planners and administrators set on-the-job training on active methods of teaching geometry for teachers in order to increase their academic ability.
- As students actively make their knowledge, teachers try to enhance their geometric ability through planning rich and appropriate programs.
- Teachers make geometry reachable to students by linking the academic geometry to the real life.
- Improving intuition and doing the intuitive activities can be effective in achieving a conceptual understanding of geometry.
- Teaching methods based on constructivism and Van Hiele model are recommended for learning geometry.
- Teaching mathematics and especially geometry should be based on the intuition of students to let them experience the actual objects, gain a deep understanding of geometric concepts, find similarities between geometric components and tangible areas, and finally apply geometry in their real life.

9. Conclusions

The present study shows that the active methods of teaching geometry accompanied with life- related and intuitive activities can be effective in improving teaching geometry. Students' problems with geometry at elementary school can attributed to the lack of understanding of geometric concepts and elements, the inability of students in solving problem, and lack of motivation in learning geometry. These problems are because of the following reasons:

1. Traditional and passive method of teaching of geometry. This method concentrates on memorizing formulas and doesn't let students to pass the attitude and skill levels.
2. Being non-functional and disassociation of teaching geometry with real life situations.
3. Not using training aids and being non-visualized.

How practical application of geometry in life can be achieved at primary school?

Some solutions for teaching the applications of geometry at primary school have been presented.

As constructivism is the basis of the present study, it is necessary that teachers plan and perform some activities.

As the levels of teaching geometry at elementary school include visual and descriptive, the training of Van Hiele model of teaching geometry should be practical and based on visualization and intuition. In other words, the visualization of learners should be enhanced and simple, clear, applied, and life-related activities and practices should be used and education should be accompanied with activity, action, and experience and based on visualization and intuition.

The relationship of geometry with life: As the disassociation of geometry with life has been mentioned as one of the causes of failure in geometry in previous research, concentrating on its applications is enjoyable and increases the motivation and ability of students in learning geometry. Hence, teaching through life-related geometric activities in form of a project like the followings is recommended:

Tiling that not only enhances the Iranian culture but also increases the motivation of students for learning and progress.

Making maquette increases the ability of geometric understanding and motivation of students

and also their ability in solving problem, because they deal with numerical and applied issues such as area, surface, and volume.

The practical importance of the present paper is that the activities intended to apply in Primary school are executable. As the time allocated to math is low and lack of time is one of the difficulties of teachers for doing activity, more time can be spent for doing these activities by combining geometry with other courses like art, sport, and social skills.

Due to the extensive communication with life and complexity and diversity of teaching methods of geometry, more research is required.

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5/11/2012