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Promoting Meaningful Learning in Studying Mathematics with Traffic Signs

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Abstract
Mathematics is one of the major subjects in the curriculum and is perceived as one of the most complex fields. The present paper presents research and recommendations for activities tested and tried in class, which are designed to promote and develop mathematics knowledge, based on visual illustrations. The activities combine acquaintance with the various traffic signs and mathematics studies, geometry and arithmetic. Activities like those, as a multi-disciplinary practice, will entail pupils' better and more meaningful comprehension of mathematics and will enrich knowledge of this subject.

Keywords: Geometric activities, Meaningful learning, Traffic signs.

1. Theoretical background

Traffic signs serve as an international language for the world population. This language is represented by geometric figures – visual images without words. The first traffic signs placed at the side of the roads existed already during the centuries B.C. and these were the "milestones" erected by the Romans. On these "milestones", located in all countries of the Roman Empire, travelers could read information about the distance from their current position to the capital – Rome. During the Middle- Ages, signs were put at road junctions throughout Europe, indicating the direction of journey to major cities. The first traffic signs of warning or instruction were created only at the end of the 19th century. The need for these signs resulted from the development of swift and quiet vehicles which endangered pedestrians and bicycle riders. Bear in mind that an approaching horse and cart or a carriage could be heard from a great distance, whereas cars were much quieter. In the past, it was customary to station policemen in noisy traffic locations for the purpose of directing vehicles. With the increase in the number of vehicles, it became necessary to use automatic means such as street lights and road signs for guiding the traffic. Starting at the beginning of the 20th century, traffic signs have become the international "language" which every civilized person should know. Consequently, studying "caution on the roads" rules is now an inseparable part of the curriculum in elementary school in Israel(Ministry of Education, 2003, 2012) and, later on, in high school during theory and practice driving lessons. The State of Israel invests extensive efforts and resources in promoting "caution on the roads" studies, reducing the

number of road traffic accidents and educating the next generation for appropriate conduct on the road.

This paper describes activities that combine acquaintance with the various traffic signs and mathematics studies. The aim is to demonstrate the learning of different arithmetic and geometric contents. This is done by emphasizing the shape of the traffic sign and understanding the function thereof with relation to transportation and traffic. The notion of combining the two subjects - "caution on the roads" and mathematics - stems from a recommendation included in the rationale of the curriculum in mathematics (Ministry of Education, 2006) as well as the recommendation of the National Council of Teachers of Mathematics (NCTM, 2000). These two documents explicitly indicate that teaching in a way which renders learning relevant to everyday life, evokes interest (Patkin & Levenberg, 2012). Moreover, it might be conducive to meaningful learning and, hence, to a better comprehension of both disciplines. The traffic sign shape, meaning its colors, its function as a warning or instruction to drivers and pedestrians, constitutes an inseparable part of experiencing mathematical activities.

The traffic signs which we have used, serve as illustration aids and a bridge in the transition from visual presentation to abstract mathematical terms, enhancing a more meaningful and understandable learning. Moreover, they present mathematics as a useful and important subject which could also be lifesaving. In this way, at the first stage of learning, students develop their drawing and painting skills as well as their observation ability. At the second stage they develop the ability to implement familiar mathematical contents, building an infrastructure for learning advanced and new contents. In addition to developing cognitive skills, students learn out of interest, motivation and pleasure.

The aim of the activities which are described in the paper was to promote questioning as part of developing creative thinking of the participants. Another aim was to strengthen their knowledge in geometry, without repeating questions familiar to them from textbooks.

2.Research Population

The activity “Geometry with Traffic Signs” was submitted to a group of 23 participants aged 12-14 years old, (grades 7-8), with high achievements in mathematics, participating in the unique class of “Mathematics enrichment”.

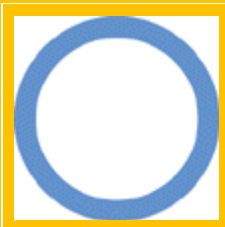
3. Pre-research activities

For the mathematical activities, several traffic signs were examined, mainly those familiar also to young students. The mathematical questions associated with the traffic signs were built in a gradual way in order to demonstrate the various options of presenting questions, from 1st grade until higher grades of elementary school. It is possible and even recommended expanding to high school where students start learning the theoretical part of driving. The questions level can be from the recognition level, according to Van Hiele's theory (Van Hiele,1987, 1999) and up to questions requiring wider knowledge in both arithmetic and geometry. According to this theory, development in the study of geometry progresses in a hierarchical order along levels of mastery, where partial mastery at a particular level is necessary, but not sufficient for understanding on a higher level. Furthermore, students cannot function on a particular level if they have not achieved mastery of previous levels.

Developing visual competence aims to increase learners' mathematical power and promote their ability to solve mathematical problems. Furthermore, emphasizingthe aesthetic aspect might improve learners' comprehension, increase their awareness of the importance attributed to observation and exploring view - and, consequently, change their attitudes towards the subject (Patkin & Levenberg, 2012).

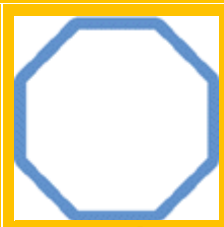
3.1. Getting acquainted with traffic signs

All traffic signs are represented by geometric figures[1]. The shapes are various polygons like triangle, square and rectangle.


Circular signs.


Triangular signs.


Rectangular signs.


Octagonal signs.

Many different traffic signs are to be seen on the roads. They give advance information about road conditions ahead. Road markings also give orders, warning or guidance to drivers or cyclists. Learn the meaning of these signs and markings and look out for them when on the road. Then, you will not be surprised by a bend, a one-way street or a junction ahead. Good drivers are prepared.

Most of the traffic signs and road markings are illustrated in this article. Traffic signs shaped like a circle are instruction signs indicating "Do and Don't", and traffic signs shaped like a triangle are warning signs.

Colors of the traffic signs are also important. Red-white-black traffic signs are "Don't" signs; they prohibit drivers from performing something. Blue-white traffic signs are "Do" signs, instructing the drivers to perform something.

Some traffic signs have unusual shapes because the legislator wishes drivers and pedestrians to identify them not only from the direction which they are facing but also from any direction at the junction. These are the signs regulating the "give way" at the junction as follows:

a. The Traffic sign -"**Stop!"**is shaped like an **octagon** and it is the only one in this shape. The traffic sign is usually placed at a junction or a point where streets meet, instructing drivers to fully brake their vehicle, advancing only if the road is clear. Using Stop signs started in the United States at the beginning of the 20thcentury. These traffic signs were smaller than the ones used today and the word "stop" was written in color.
b. The traffic sign -"Give way" is one of the triangle-shaped signs. Like the "stop" sign, it too is displayed so that it can be identified from every direction at the junction. Hence, it is presented like an upside-down triangle. It is the only triangle-shaped sign displayed in this way. As mentioned, it can be identified also from its back side, without seeing what is drawn on it.

3.2 General questions relating to all traffic signs

a. Which geometric shapes serve as traffic signs?

[1] In the field, the geometric figure (mainly of triangles) is not always "pure geometric". The reason is that, on the production line (made of metal) of traffic signs, the triangle vertices are sometimes "rounded" (protecting the installers against injury). Hence, they do not comply with the formal definition of triangle. Nevertheless, they are presented and defined as triangles in the guidebook of the "Caution on the Roads" Council.

b. What characterizes the triangle-shaped traffic signs?
c. Why is the "Stop" sign different from other traffic signs and in what?
d. Two traffic signs: "Do not enter" and "Give way". Please indicate special features about the geometric figure of each.

Below are some questions for example relating to few traffic signs, with indication for more extensive geometric activities (it is important to mention that there are some international traffic signs as well every state/country has its own traffic signs).

3.3 Questions for Geometric activities

1. Traffic sign: "NO ENTRY"

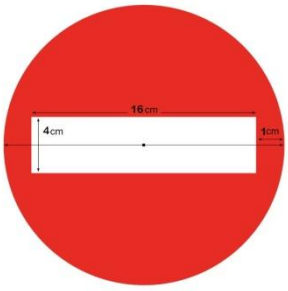


Illustration No. 1: Traffic sign – "NO ENTRY"

a. What geometric figures appear on the "No entry" traffic sign?
b. According to the dimensions indicated for you on the "No entry" traffic sign – what is the radius of the red circle?
c. What is the ratio between the area of the rectangle on the sign and the area of the entire circle?
d. Try estimating the dimensions of the "No entry" traffic sign placed in the street?
e. What is the mathematical relation (scale) between the traffic sign in the street and the one drawn on your activity sheet?
f.

2. Traffic sign: "GIVEWAYAHEAD"

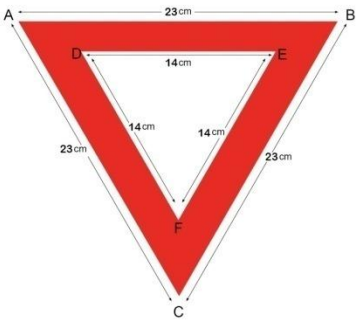


Illustration No. 2:Traffic sign –"GIVE WAY AHEAD"

a. What can you say about the shape of the traffic sign in illustration no.2 ?
b. Triangles ΔABC and ΔDEF are _____triangles.
c. The ratio of the perimeter -between triangle Δ ABC and triangle Δ DEF is: ___

d. The Area[2]Ratio between triangle Δ ABC and triangle Δ DEF is:_____

3. Traffic sign: "One way traffic"

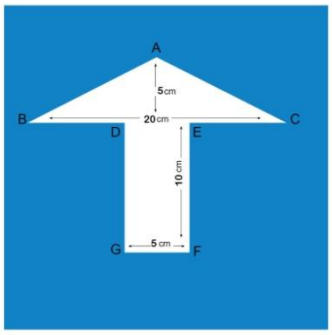


Illustration No. 3: Traffic sign-"ONE WAY TRAFFIC"

a. What geometric figures appear on the traffic sign "One way traffic"? What is the significance of this traffic sign?
b. The traffic sign "One way traffic" is a warning signal. According to the displayed dimensions, what is the area of the sign?
c. What is the **polygon** drawn in white in the traffic sign? Is it a regular polygon? Please explain your answer.
d. How many diagonals does the "white" polygon have? Please draw all the diagonals from vertices B and F.
e. What percentage of the area of the entire traffic sign is the area of the white polygon, if the side length of the square traffic sign is 28 cm?

4. Traffic sign: "STEEP HILL DOWNWARDS"

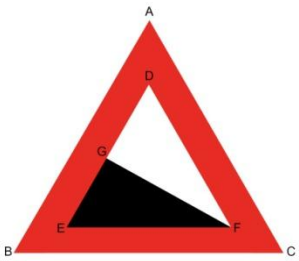


Illustration No. 4: Traffic sign- "Steep hill downwards "

a. How many triangles arein illustration no.4?
b. How many types of triangle are in the drawing?
c. What can you say about the segment GF? Please explain your determination.
d. Are angles A and D equal in size? Please explain.
e. What is the different between those two traffic signs in illustration no.5 ?

[2] An enrichment and enhancing exercise – this is an opportunity to teach (in high grades) Heron's formula for calculating the area of a triangle.

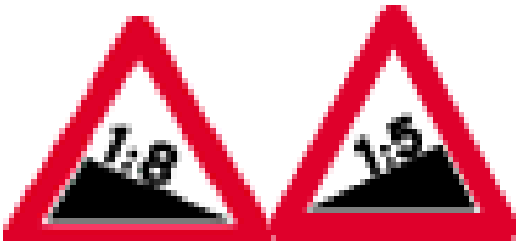


Illustration No. 5: Traffic sign- "Steep hill upwards ahead"

4. Research Process

The participants were divided into smaller groups of 2-4 pupils, and were asked to perform the following tasks:

1. Choose 3 of the "Traffic - signs "from the website "Road –traffic Signs, for driving learners".
2. Draw or photo the chosen traffic - signs.
3. Record accurately the meaning of the road signs and the category they are related to. (Directive signs, warning signs, etc.)
4. Pose two mathematical questions for each traffic sign.
5. Write down what did you learn from this activity.

4.1 Data Analysis

The data were processed by qualitative methods: Assertions were collected and categories were formulated in accordance with the professional literature (ETIC) and the phenomena under study (EMIC) and frequency of assertions were calculated according to the categories. Analysis of the content was validated by two independent experts in pre-service teacher education, according to a process of expert judgment (Görn, 1977; Creswell, 1998, 2003). They examined a random sample of categorizations on all three questionnaires: a 92% agreement was found

5. Findings

From the questions posed by the participants as mentioned above(in illustration no. 4), all questions were collected and analyzed.(40 questions). 90% of the questions were worded correctly, the rest of the questions were denied as a result of inaccurate wording, or lack of appropriate data that allow solution. Below are the topics of mathematics questions that were posed by the participants:

1. Calculation of area or perimeter of the traffic sign-45% of the total questions.
2. Symmetry of the traffic-sign- 25% of the total questions
3. Identify the geometric shape of the traffic- sign -15% of the total questions
4. Various other questions -15% of the total questions.

From the participants answers to the question: "What did you learn from this activity?" (in question no.5), a qualitative analysis was carried out. The answers were classified according to two criteria, wording related to mathematical meanings and wording not related to mathematical meanings. Some of the participants' answers include two criteria together.

Examples from wording **related to mathematical** meanings:

- "*We did not think that you can learn Geometry in this way".*

- *"I did not realized that traffic sign shape can be a polygon".*
- *"There is a very large difference, between the traffic- signs in the notebook and the traffic sign in the reality".*
- *"Never taught symmetry relating to traffic –signs".*
- *"When I ride the bus I immediately notice the geometrical shape of the traffic –signs".*

Wording **not related to mathematical** meanings:

- *"You can learn on math almost everywhere.*
- *"Traffic signs play an important role in our life".*
- *" Now when I travel in a car I immediately recognize the significance of traffic signs".*

6.Conclusions

The activities presented above provide a rich environment for the purpose of developing mathematical thinking, developing logical thinking skills, using intuitions and developing spatial orientation and acquaintance with the environment in our reality.

Those are but a few of the examples of numerous options of sharing activities at school between mathematics teachers and instructors of the "caution on the roads" subject.Learning in parallel those two subjects – significance of traffic signs and mathematics – will only enhance knowledge thereof. Perhaps in this way, as a country struggling to reduce road traffic accidents, we will even manage to save lives.

References

Creswell, J.W. (1998). *Qualitative inquiry and Research design; choosing among five traditions*. Thousands Oaks, CA: Sage Publication Ltd. ERIC ED500417

Creswell, J.W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: Sage Publication Ltd.

Görn, L. (1977). 'Expert judgment as evaluation data'.In: Levy, A. (Ed.), *Handbook of Curriculum Evaluation*, UNESCO.

Government of Hong Kong (2013). *Regulation of the Transport Department*. Available: http://www.td.gov.hk/en/road_safety/road_users_code/index/chapter_8_the_languagee_of the road/signs_giving_warning_/index.html

Ministry of Education (2003).*Managing Director Circular 2003 /5(a).* Retrieved online on 28.1.2012 from: http://cms.education.gov.il/EducationCMS/applications/mankal/arc//sc5ak5_2_10.htm [Hebrew]

Ministry of Education, Culture and Sports (2006).*Curriculum in mathematics for 1-6 grades in all population sectors.* Jerusalem: Pedagogical Secretariat, Department for Curricula Planning and Development. [Hebrew]

Ministry of Education (2012).*Managing Director Circular 2012/5.* Retrievedonline on 28.1.2012 from: http://cms.education.gov.il/EducationCMS/Applications/Mankal/EtsMedorim/5/5-2/HodaotVmeyda/H-2012-5-5-2-4.htm[Hebrew]

National Council of Teachers of Mathematics (NCTM). (2000) *Principles and Standards forSchool Mathematics.*□□Reston, VA: NCTM□

Patkin, D.&Levenberg,I. (2012). Geometry from the world around us. *Learning & Teaching mathematics*- A Journal of MESA , No.13 14-19

Van Hiele, P. M. (1987). *Van-Hiele Levels, A Method to Facilitate the Finding of Levels of Thinking in Geometry by Using the Levels in Arithmetic*. Paper Presented at the Conference on Learning and Teaching Geometry: Issues for Research and Practice. Syracuse University.

Van Hiele, P. M. (1999). Developing geometric thinking through activities that begin with play.*Teaching Children Mathematic*. 5(6), 310-316.