Topological Philosophy School

DIGITAL BOZHURISHTE
BoJurist Consulting

Училище по Топологична Философия
„ДИГИТАЛНО БОЖУРИЩЕ“

24.1.2019 г.

The Topological Abduction of (Classroom) Europe:
European Topological Classroom for Primary School Education (ETCPSE)

Topology for children in primary school education - the main concern of the present project

**“Topology! The stratosphere of human thought!
In the twenty-fourth century it might possibly be of use to someone...”**

**— *The First Circle*,
A. Solzhenitsyn**

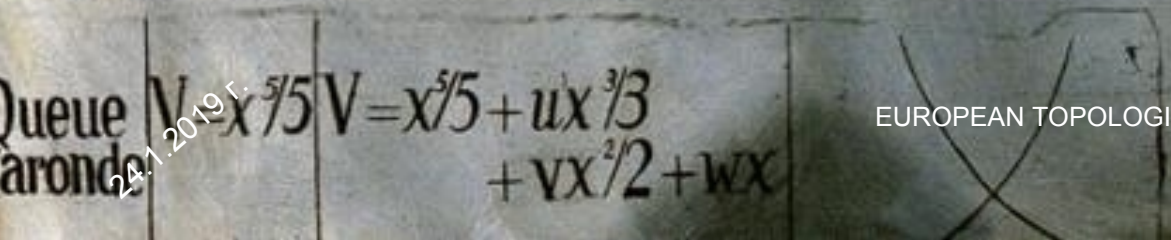
for Primary School Education (ETCPSE)

The Topological Abduction of (Classroom) Europe, to recall with one expression Erich Kästner's book *The Flying Classroom* and Salvador Dalí's painting *Topological Abduction of Europe: Homage to René Thom*, will be utilized by the use of

Quick response (QR) codes (that will transfer and deliver educational learning content and outcome in our topological classroom)

and

Augmented reality (AR) - a live direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data.



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Our project will unfold for the pupils and teachers the metaphor of Topology through the so called topological thinking as spatial creative thinking of place/space and place/space of thinking, as visualization of knowledge.

Following the etymology of word 'Topology' (Analysis Situs), from the Greek τόπος, "place", and λόγος,"study", our aim is to introduce for the pupils and teachers topology as conceptual tool for enhanced learning (in) situation with an emphasis (in true topological mode) not on the differences between the shape and figures of identity and identities (cultural identities) but on the relationships between.

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The dimensions of our topological project will be implemented within three learning areas related with topology (in general)

- **mathematics (geometry);**
- **language (narrative) and rhetoric;**
- **visual art.**

An implementation of innovative topological plays/games will connect these three subjects in manifold of homogeneous activities.

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Our objectives are to introduce to the pupils and teachers in primary school education new area of learning and communication – Topology and Topological Thinking, blending mathematics, language and visual art with new teaching and learning skills based on the digital technology, Quick response (QR) codes and Augmented reality (AR).

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Topology (Analysis Situs) from Greek τόπος, “place”, and λόγος,“study” is a branch of mathematics, the study of continuity and connectivity, formally defined as the study of qualitative properties of certain objects (topological spaces) that remain invariant under a certain kind of transformation (continuous map), especially those properties that are invariant under a certain kind of equivalence (homeomorphism).

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Topology includes the study of how items are arranged or mapped in a network. Rather than focusing on distances between these items, topology concentrates on the relation between the items. A commonly cited example of topology is a metro map; although it will not reliably tell you how far it is between stops; it will tell you how the metro lines connect them.

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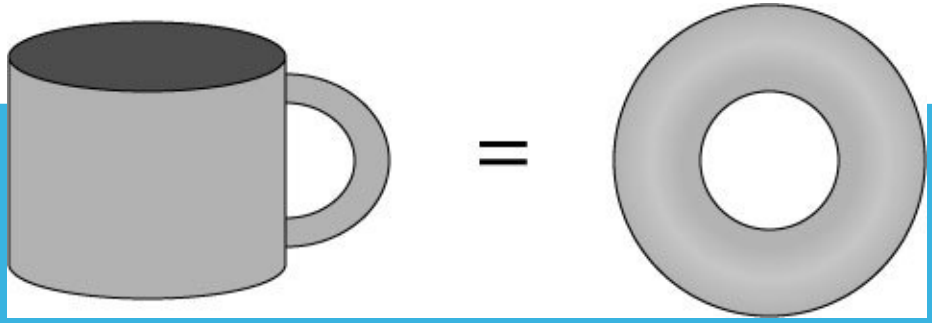
There is a traditional joke about a topologist
who cannot distinguish a coffee mug from a doughnut.
The identity of the torus disappears into the identity of the cup.
A sufficiently pliable doughnut could be reshaped to a coffee cup by creating a dimple and progressively enlarging it, while shrinking the hole into a handle.
This example illustrates topological notion of homeomorphism involving a continuous function with a continuous inverse.

a continuous deformation (homeomorphism) of a coffee cup into a doughnut (torus) and back.

Mug_and_Torus_morph.gif



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Every aspect of culture is subject to forces of change.
Topology can be useful for studying these changes because it can map all the links, relationships and transformations that occur between cultural elements.

The continuous deformations of objects in topology are deformations that involve stretching, but no tearing or gluing. With such transformation we can transform a spatial body such as a sheet of rubber in various ways which do not involve cutting or tearing. In topology there are no differences between the shapes or forms of the figures.
The triangle, square, circle, rectangle are all equivalent, because each figure is connected within the plane in the same way. Topology is concerned with the relationships between the figures not with their shape differences.

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Topology is not only a logical proposition
from the discipline of mathematical science,
but also a notion of rhetoric and language, with 'topos' – common place,
transgressing the four basic tropes of rhetoric:

- metaphor,
- metonymy,
- synecdoche,
- irony

with the emphasis on the metonymy of metonymy or 'metalepsis'
Toplogical Metalepsis is presented in visual art and visual narrative.
The meaning of 'Metalepsis'
is participation, sharing, transgressing and transforming the boundaries
('in-between').

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Historically Topology springs from the heart of Europe . . . the development of Topology is European Project.

The roots of topology can be traced back to Ancient Greek philosophy (Plato and Aristotle).

Topology originally initiated with Leonhard Euler's paper on *the Seven Bridges of Konigsberg* (1736), the study regarded as one of the first academic treatises in modern topology.

The term "topologie" was introduced first in 1847 by Johann Benedict Listing and the discipline was established in the modern science by Henri Poincare with the published in 1895 *Analysis Situs*.

Topology penetrated the psychology and neuroscience, starting from Kurt Lewin's *Principles of Topological Psychology* (1936) through the topological studies of Freud, and Jean Piaget's Genetic Epistemology with his "topological primacy thesis".

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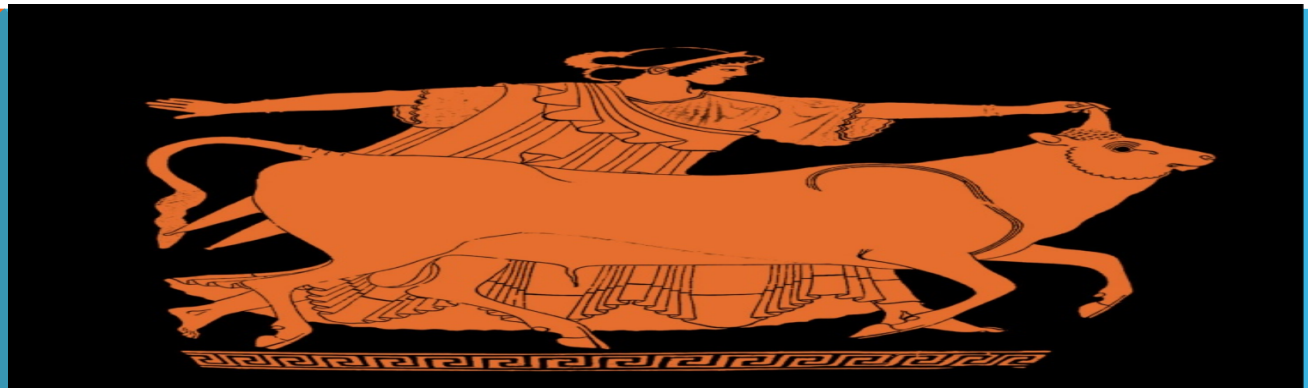
The common European ground could be found in the Greek ancient mythology, where Zeus, transformed as white bull, abducted Europe taking her to a new shore. Once arriving, he told her, *"Immortal, your name will be! The new part of the world, which accommodated you, will be called from now on: Europe!" And* 'Europe' as topos was born. Inspired by the work of the French mathematician, philosopher and linguistics, René Thom, who worked in topology and invented the 'catastrophe theory' which seeks to describe, in a way that is impossible using differential calculus, those situations in which gradually changing forces lead to so-called catastrophes, or abrupt changes, back in 1983, the artist Salvador Dalí, created the painting *Topological Abduction of Europe: Homage to René Thom.*



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René Thom was a French mathematician who worked in topology.

Topology is the branch of mathematics that studies shapes and symmetries of abstract geometric figures.

Thom's research culminated in his 1972 book Structural Stability and Morphogenesis in which he unveiled his catastrophe theory.

Thom concluded that in four-dimensional phenomena there are seven possible equilibrium, and thus, seven possible breaks in equilibrium, which Thom called elementary catastrophes.

Thom called these: fold, cusp (s-curve), swallow's tail, butterfly, hyperbolic umbilic, elliptic umbilic, and parabolic umbilic.1

In 1970, Thom presented sophisticated catastrophe theory model of language. He developed a visual representation of the verbs associated with spatio-temporal activity. This was, Thom would say 20 yars later, a "geometrization of thought and linguistic activity".

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The topologist René Thom in Topologie et linguistique (1970) proposed that the small number of elementary sentence types corresponds to the small number of topological structures underlying events in the exterior world, the so called Versal Unfolding...

Children in primary school can learn **catastrophe theory**

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The simple minimum: ``I am."

The *simple minimum* is exemplified by the minimum of the function $f(x) = x^2$. This minimum is *stable*: every small perturbation of $f(x) = x^2$ will have a minumum near $x=0$. There is no possibility of a system with this internal dynamics jumping from one state to another: it is always at the single critical point. Any one-dimensional section through any parameter space will be constant, or nearly constant, near $x=0$. The corresponding verb class is represented by ``**I am.**'':

Children in primary school can learn catastrophe theory

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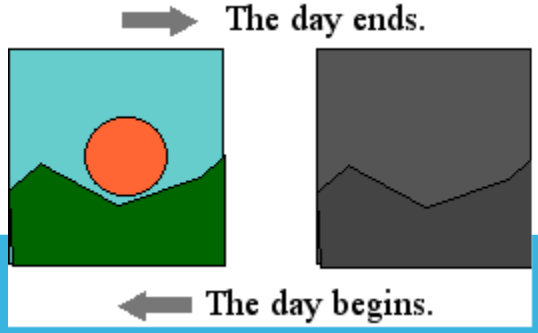
The fold: ``The day begins.''

The *fold* catastrophe is exemplified by the critical point of the function $f(x) = x^3$. This critical point is *unstable*: perturbing the function to $f(x) = x^3 + ax$ gives a function with a maximum and a minimum near zero if a is negative, no matter how small, and no critical point at all if a is positive. A typical one-dimensional section will follow the parameter a: the energy minumum that exists for $a < 0$ disappears as the section crosses $a = 0$. The corresponding verb class is represented by ``**The day ends.**'' if the section is traversed from negative $a$ to positive and ``**The day begins.**'' if it is traversed in the opposite direction.



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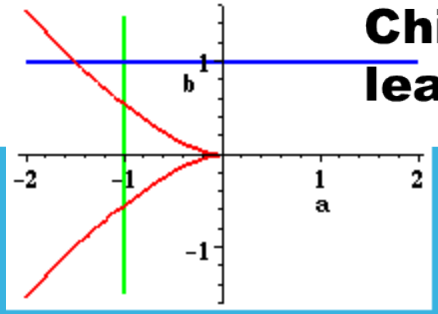
The cusp: ``The fish swallows the bug." etc.

The cusp catastrophe is exemplified by the minimum of the function f(x) = x4 at x = 0 . This critical point is unstable: perturbing the function to f(x) = x4 + ax2 gives a function with three critical points (two minima) near zero if a is negative, no matter how small. The minimum of f(x) = x4 has an additional instability: the perturbation to f(x) = x4 + ax2 + bx will have two minima near zero if b < (4/3)(-a3/6)1/2 and one otherwise. (For a mechanical instantiation of this catastrophe (The Catastrophe Machine)



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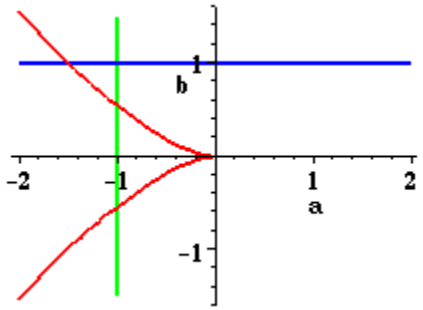

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The (a,b) parameter space for the cusp catastrophe. For parameter values (a,b) in the region between the red curves, the energy function f(x) = x4 + ax2 + bx has two minima. Otherwise it has one.

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Folllowing from right to left the one-dimensional section given by the blue line, one of the local minima disappears and is captured by the other. The verb class corresponding to this morphology is *capture*: **The fish swallows the bug.**

Following the blue section from left to right, a new local minimum appears beside the old one. The verb class corresponding to this morphology is *emission*: **The bird lays an egg.**

Children in primary school can learn catastrophe theory

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Following the green line in either direction, one local minimum is substituted by another. The verb class corresponding to this morphology is *transformation*: **The caterpillar becomes a butterfly.**

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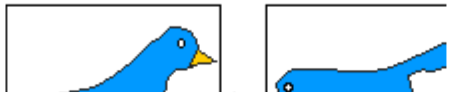
The swallowtail: ``The bird lays an egg, swallows it and dies."

The *swallowtail* catastrophe is exemplified by the inflection point of the function $f(x) = x^5$ at $x = 0$. This critical point is unstable: the most general perturbation requires three parameters: $f(x) = x^5 + ax^3 + bx^2 + cx$. The possible numbers of minima for a degree-five curve are zero, one and two, shown as the green-sided, blue-sided and pink-sided regions in this figure:



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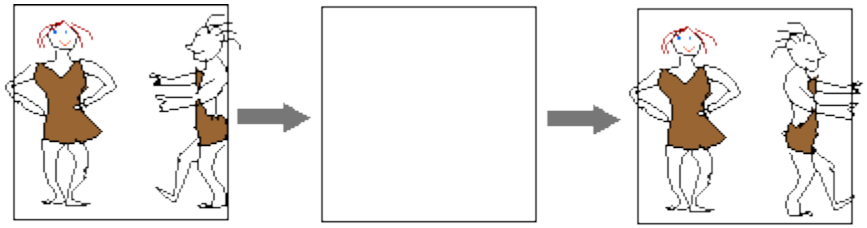
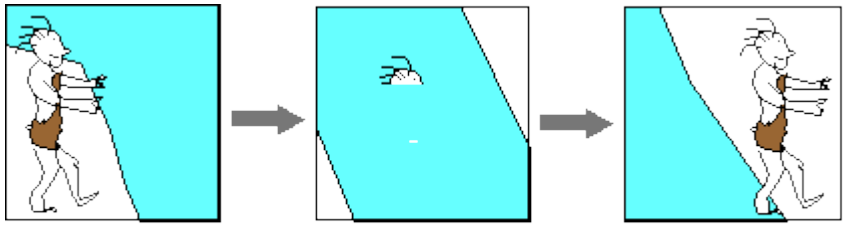


She repulses his advances.

Children in primary school can learn catastrophe theory



He crosses the river.

References

V. I. Arnol'd, Catastrophe Theory, Springer-Verlag, New York 1984

Beth Levin, English Verb Classes and Alternations: a Preliminary Investigation,University of Chicago Press, Chicago 1993

Steven Pinker, The Language Instinct, William Morrow & Co., New York 1994.The quote is on p. 232. Pinker attributes the trope to Noam Chomsky, but Ihave not been able to track it down in Chomsky's published works.

European Topological Classroom for Primary School Education (ETCPSE)

The contemporary situation in the European countries shows the cracks visualized by Dali in his masterwork Topological Abduction of Europe: Homage to René Thom.

Our children in primary school education shall learn which values unite us today in Europe, they shall be well prepared about the challenges of the near future, about what Rene Thom called in his "Structural stability and Morphogenesis - An Outline of a general theory of models" (1975) - 'the malignity of the human attractor'. The exact words of Thom are the solution that both person and society needs to resolve the challenges in the period of transition, the advise contained within the suggestion "We need to slow down: as the possible meaningful way, the malignity of human attractor."

Why Topology in primary school education?

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Research by Piaget and Inhelder (1956, 1960) suggest that early spatial conceptions are topological in nature.
These basic topological ideas are very general and inclusive, and so give an infant a very broad understanding of his/her spatial world that can be refined with more detailed and complex perceptions. These perceptions can be described through the features of various types of geometry. The observations gathered by Piaget and Inhelder led them to propose four stages of development in spatial thinking.

Why Topology in primary school education?

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The four basic topological concepts are as follows:

- **Proximity - the relative nearness of an object or event to any other object or event.**

- **Order - the sequence of objects or events (in time) according to size, colour or some other attribute. For example, if three toys are suspended in a line over a crib long enough for an infant to become familiar with them, he/she will notice if the sequence of the toys is changed.**

- **Separation - an object, event or 'space' coming between other objects or events. It also involves distinguishing between objects and parts of objects.**

- **Enclosure - an object or event surrounded by other objects or events, which involves the ideas of inside, outside and between.**

Pre-operational Stage 2-7 years

Children begin to represent spatial features through drawing and modelling. Their topological thinking is evident in their drawings. For example, in the drawing of a duck below, done by a five-year-old, the sky and the ground are represented as separate objects - there is no comprehension of the horizon. Both eyes are drawn on one side of the head because, to the child, the important feature is that they are inside (enclosed within) the head shape (McNally, p.29). As is typical around this age, the child does not yet possess the type of thinking that can be described by Projective Geometry, and which would allow him/her to imagine the other side of the duck.

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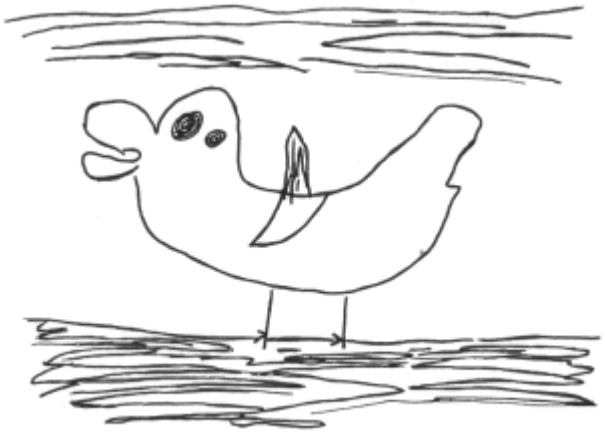
Pre-operational Stage 2-7 years



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Concrete Operational Stage 7-12 years

Gradually, between the ages of about 4 and 9 years, the child begins to perceive and represent objects from different points of view and incorporates ideas of perspective. The placement of features or objects in relation to each other and taking account of vertical and horizontal relationships becomes part of the child's way of viewing the world. These sorts of ideas can be classified as belonging to the type of geometry called Projective Geometry. In the drawing of 'Dogs playing soccer', done by a 7 year old, evidence of this type of thinking can be found. When asked why the dogs had only one eye she replied, "The other one's on the other side but we can't see it". When questioned about the numbers of legs drawn for each dog, she explained that the dogs on the left were running so we could see all their legs, but the dog on the right was standing still so two legs were hidden from view (the third appendage is a tail!).

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Concrete Operational Stage 7-12 years

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While Piaget and Inhelder suggest that the development of perception as described by the types of geometry are sequential (i.e. Topological, Projective, Euclidean), other researchers believe that all types of geometric thinking continue to develop over time and become increasingly integrated.

Piaget, J. and Inhelder, B. (1967). The Child's Conception of Space. New York: Norton.Piaget, J., Inhelder, B. and Szeminski, A. (1960).

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If geometry is the study of Connected, with the emphasis on the shape and size, Topology is the study of Connections and Relationships. We grapple with topology from the very beginning of our lives. Each of us has been solving topological problems every day of our lives, but may not know it because no one taught us the word and its meaning.

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Edward Kasner, American mathematician and grandfather of the five-year-old boy who named "The Googol", once said that he found it easier to teach *topology* to tots than to grownups, because they "haven't been brain-washed by geometry"!

Here are some *topological experiences of tots*:

- **In infancy and childhood, *trying to kick off blankets or covers***
- **Struggling to climb out of a playpen or a bed**
- **Trying to put arms into sleeves, or remove arms from sleeves; similarly with pant legs**
- **Trying to button buttons, or unbutton them**
- **Trying to tie or untie shoe laces - A vast field of *topology* is *knot theory*, of great importance in *molecular chemistry* and *particle physics***
- **Trying to open or shut drawers, or doors**
- **Opening or closing jars, cans, boxes, envelopes, etc.**
- **Crossing boundaries or rooms, yards, streets, etc.**

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The deepest core of the human imagination is topological. Human beings see, think and feel 'topologically'. The topological kind of seeing, thinking and feeling forms a sub-set of imaginative perception. Topological modes of seeing, thinking and feeling are one of the ways that we intuit relations that are described as homeomorphism. Topology is a source of meaning and the way in which the most profound thoughts about the world are generated. Topology is the medium of human creation. Topology allows us to melt distinct figures of forms, shapes, images and thought. (Murphy, P. (2014).

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Topology as a mathematical representation of continuity, is the study of constancy in change, the study of the intensive identity of change and not-change. Topology is the study of shapes and place(s) that change and yet through change remain continuous with each other. These shapes and spaces remain connected to each other without breach. Even though they look different, under the surface of appearance they maintain unbroken an identity with each other. (Murphy, P. (2014), Topeme: Truth. Topology. Cartography, Analogy., The Hydra Dialogues, May 22-23 2014,)

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Topology equates transformation and invariance, alteration and permanence, renovation and solidity, stability, longevity and immovability are indistinguishable from modification, adjustment and variation. (Murphy, P. (2014), Tropeme: Truth. Topology. Cartography, Analogy., The Hydra Dialogues, May 22 -23 2014,)

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John Willats assert that the “drawing systems are systems that map spatial relations between features of scene into corresponding relations on the picture surface”. (Willats, J. 1997). Within the known type of drawing systems in evolution of culture and art, the drawing system described as ‘primary geometrical’, such as the ‘perspective’; ‘oblique projection’ (commonly used in Hellenistic art, Mediavel art, Persian miniature painting and Chinese art); ‘otragonal projection’ (the basis for most Greek vase paintings, and now utilized in engineering and architectural drawings); ‘horizontal oblique projection’ (typical for naïve American landscape and icon painting); ‘vertical oblique projection’ (Indian painting, Cubist still life paintings), there are drawing systems can also be defined in terms of “secondary geometries”. (Willats, J. 1997).

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Our world is undergoing profound change due to the advanced research in topology and significant importance of topological thinking and topological meaning making. Topology itself is the science of the change. Topology is extremely applicable to the complex dynamics systems. The unique and modern treatment of topology today is employing a cross-disciplinary approach. Topology has been transformed from a theoretical field that highlights mathematical theory to a subject that plays a growing role in nearly all fields of scientific investigation.

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The term "topology of meaning" emerged at the proceedings of the "Einstein meets Magritte" Conference, Brussels, Belgium /1995/. The "topology of meaning" was introduced by R. Ian Flett and Donald H. McNeil in their paper "What's Wrong with this Picture? Towards a Systemological Philosophy of Science with Practice."

McNeil and Ian Flett utilized systemology to topologically visualize the dynamic intra-relationship of art and sciences, offering an unconventional systhemological illustrations as developments beyond the conventional scientific and artistic imagery. /Donald H. McNeil, "What's going on with the topology of recursion?"

- http://www.library.utoronto.ca/see/SEED/Vol4-1/McNeil.htm - Donald H. McNeil acknowledges that the allusions to the "topology of meaning" relate to the unpublished work by R. Ian Flett. /- Science and Art: The Red Book of `Einstein Meets Magritte': The Red Book Vol 2 (Einstein Meets Magritte: An Interdisciplinary Reflection on Science, Nature, Art, Human Action and Society), Kluwer, 1999/.

The "topology of meaning" is explored by Donald McNeil in a special issue of the S.E.E.D. Journal (Semiotics, Evolution, Energy, and Development) in 2004 focused on Essays on Recursion, Difference, Dialectics, Maps and Territories in Celebration of Gregory Bateson's centennial.

European Topological Classroom for Primary School Education (ETCPSE)

Presently

- **The Topology project is developed at Tate Modern in collaboration with NTNU Trondheim (Norwegian University of Science and Technology), Goldsmiths, University of London, Ohio State University, and the Centre for Freudian Analysis and Research, London.**

- **The Topologies of Social Change is an area of research within the ESRC Centre for Research on Socio-Cultural Change at The University of Manchester, UK, where the theme is introduced as "Topological approaches (that) seek to address the fluidity and elasticity of social life. We approach notions of stability and change through an appreciation of the spatial and material qualities of relations, looking specifically at the more affective, messy, and hybrid aspects of transformative practice."**

European Topological Classroom for Primary School Education (ETCPSE)

Presently

- **The International Center for Formal Ontology (ICFO), affiliated with the Warsaw University of Technology, Poland, announced the 5th International Ontological Workshop - Topological Philosophy (February 8 – 9, 2016).**

- **In 2014, The Hydra Dialogues, a strategic research initiative at the Royal Danish Academy of Fine Arts, School of Architecture, Architecture, with University of Copenhagen, and Roskilde University, under the thema of Space and Form, addresses issues of morphology, topology and artifice in today's built environment. Since 2004 Study Department 6, Royal Danish Academy of Fine Arts, School of Architecture under direction of Cort Ross Dinesen has researched issues of cartography, topology and architectural drawing in seminars and reoccurring summer schools on the Greek island of Hydra. The focus has been to consider contemporary topography developed as a topology for architecture in the contemporary built environment. Based on this ongoing research a new step has been taken in the form of The Hydra Dialogues: five dialogues at the School of Architecture, 2013-2014, culminating in May 2014 in an international conference with renowned scholars as keynotes. (Murphy P, 2014)**

European Topological Classroom for Primary School Education (ETCPSE)

- **A Topological Approach to Cultural Dynamics (ATACD) a project funded by EU Framework program (2007-2010), lead by Prof Celia Lury, Warwick, research network based on the mathematical theories of topology, involved 19 university as partners from fields as diverse as semiology, crtificial intelligence, sociology, philosophy and mathematical economics. (Lury C., Parisi L. and Terranova T., 2012)**

- **John WP Phillips, in his paper On Topology (2013), critically examines the recent arguments asserting a topological turn in culture, the range of topologically informed interventions in social and cultural theory, remarks that such contemporary fashionable notions of 'topological approaches' and 'becoming topological of culture' "demands a greater critical reflection than the notion of a 'topological turn' suggests."**

Phillips, John WP. (2013), On Topology, Theory, Culture and Society, 9/2013; 30(5):122-152: http://www.researchgate.net/profile/John_Phillips20/publications [accessed Mar 21, 2015].

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A New Topology of European Education Space

European Topological Classroom for Primary School Education (ETCPSE)

A New Topology of European Education Space

In addition, our project will explore in the mode of Topological Research the theme - A New Topology of European Education Space.

As Tobias Werler asserts in his two research papers - *Are there Common Places for Educational Research?* () and *Teaching on teachers teaching* ().

On teacher education's topology **() - "A topos should no be longer understood as an instrument of literature but as a method and tool for research. Here one may find the difference between ancient topic (Aristotle) and modern topological research. Topology as a concept of research may show constants and continuities. . . . The objective of topological research is to gain knowledge and the realization of a historically changed situation and its equivalent. . . . Topological research will observe the change of the content of the topos as well as the change of the semantics used. Therefore, the guiding principles have to be: (a) finding a topos on its place; and (b) lighting up the horizon of meanings. Thus, one may ask in addition what metaphors and symbols were used."**

European Topological Classroom for Primary School Education (ETCPSE)

A New Topology of European Education Space

…"Topological thinking wins objectivity when it confronts itself constantly with its problems. … topological research allows the differentiation of the individual and the typical. … topological research maps the topology of the discourse….A topology of European teacher education has to map traditions of teacher education and its systems."

Tobias Werler

European Topological Classroom for Primary School Education (ETCPSE)

A New Topology of European Education Space

“the teacher” could be understood as a topos. As a mold of thinking it will affect not only the professional teaching practitioner but also the teacher education student and teacher educators. It will help us to understand the double roll of teacher educators’ work in relation to General Didactics as content of teacher education, and to the concept of “the teacher” which they have to present as anchoring point for the self-image of future teachers as well as a person concerned about self-cultivation (Bildung).“

Tobias Werler

The Topological Abduction of (Classroom) Europe

European Topological Classroom for Primary School Education (ETCPSE)

The Topological Abduction of (Classroom) Europe

European Topological Classroom for Primary School Education (ETCPSE)

The objectives and activities of our project are to create a content - teaching/learning materials for the three areas related with topology:

- ***mathematics (geometry)***
- ***language (narrative) and rhetoric***
- ***visual art***

And to develop innovative *topological plays/games* that will connect these three subjects in homogeneous activities.

The Topological Abduction of (Classroom) Europe

European Topological Classroom for Primary School Education (ETCPSE)

The content - teaching/learning materials will be delivered through:

- **web site**
- **book (paperback)**

Quick response (QR) codes **(that will transfer and deliver educational learning content and outcome in our topological classroom) and**

Augmented reality (AR) **- a live direct or indirect view of a physical, real-world environment whose elements are *augmented* (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data.**

In addition, we aim to develop our pupils' digital skills, speaking and interpersonal skills by promoting topological cultural values and exchange of ideas and good practices.

A fear of failing?

mathematics

drawing

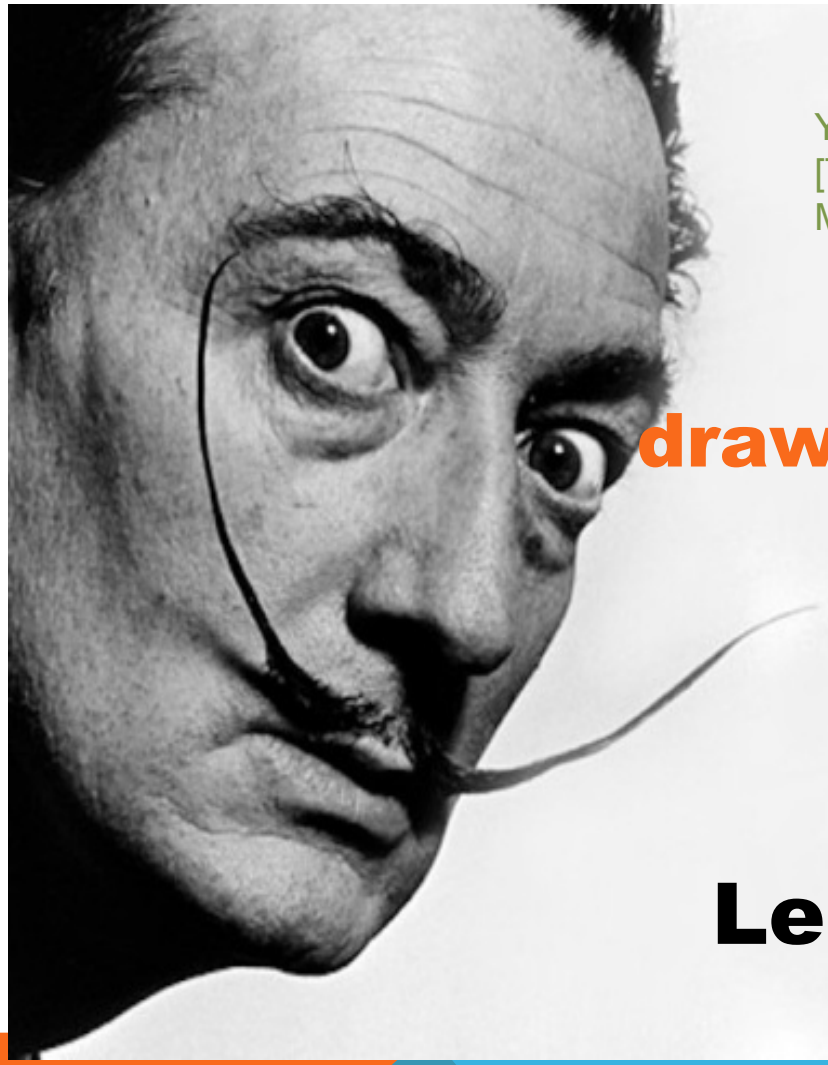
Anxiety

speaking

glossophobia

Learning Anxiety

Topology is Brave and Beautiful like the waves and sea. Its is like the mathematics of lava lamps and pottery wheels...It can make Courageous Children



You! hypocrite lecteur!--mon semblable,—mon frère!”
[TRANSLATION: Reader! You're a hypocrite! My fellow! My brother!]

T.S. Eliot's Wasteland

mathematics

drawing

“Do you know nothing?
Do you see nothing?
Do you remember nothing?”

Anxiety

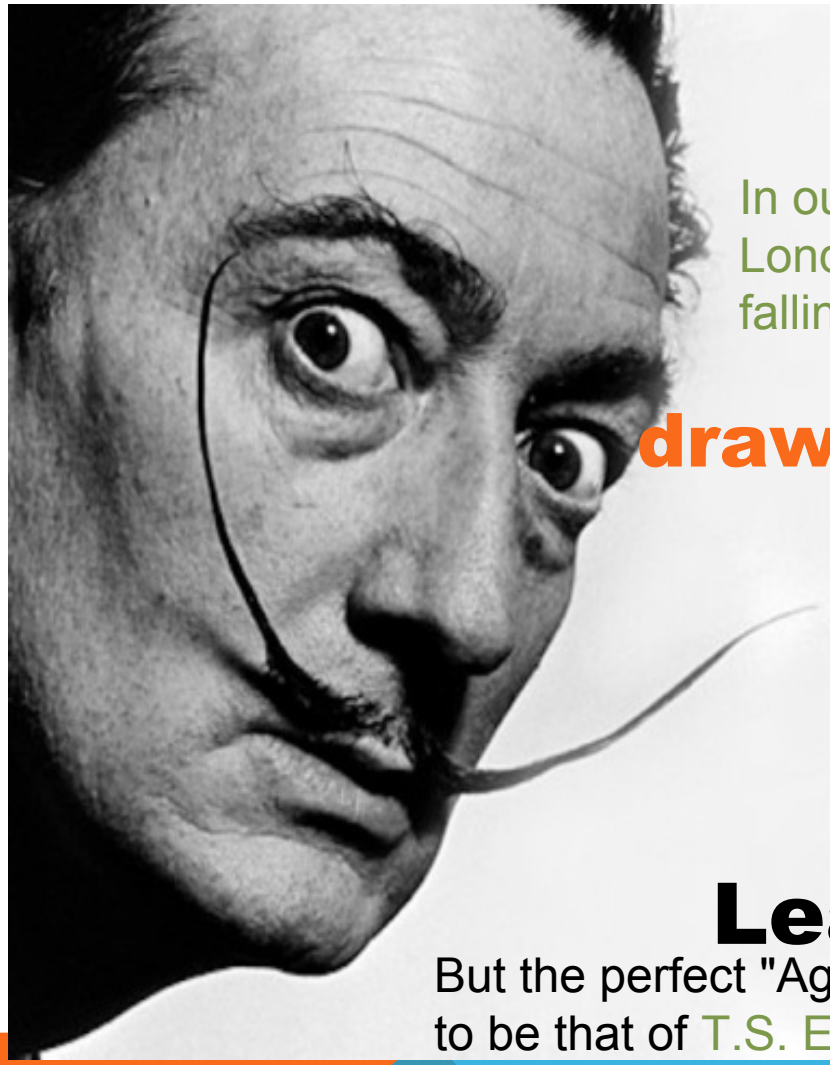
speaking

glossophobia

Learning Anxiety

Topology is Brave and Beautiful like the waves and sea. Its is like the mathematics of lava lamps and pottery wheels...It can make Courageous Children

A fear of failing?



In our empty rooms....
London Bridge is falling down falling down falling down

mathematics T.S. Eliot's Wasteland

drawing

Speak to me.
Why do you never speak?

Anxiety

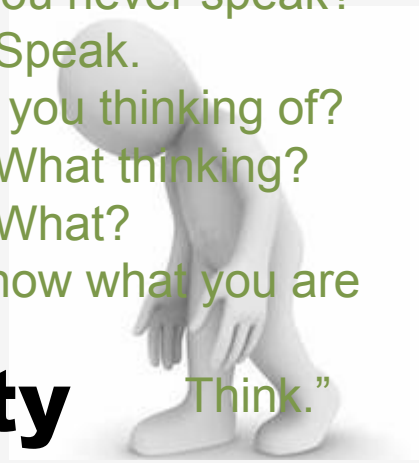
Speak.
What are you thinking of?

speaking

What thinking?
What?

glossophobia

I never know what you are thinking.

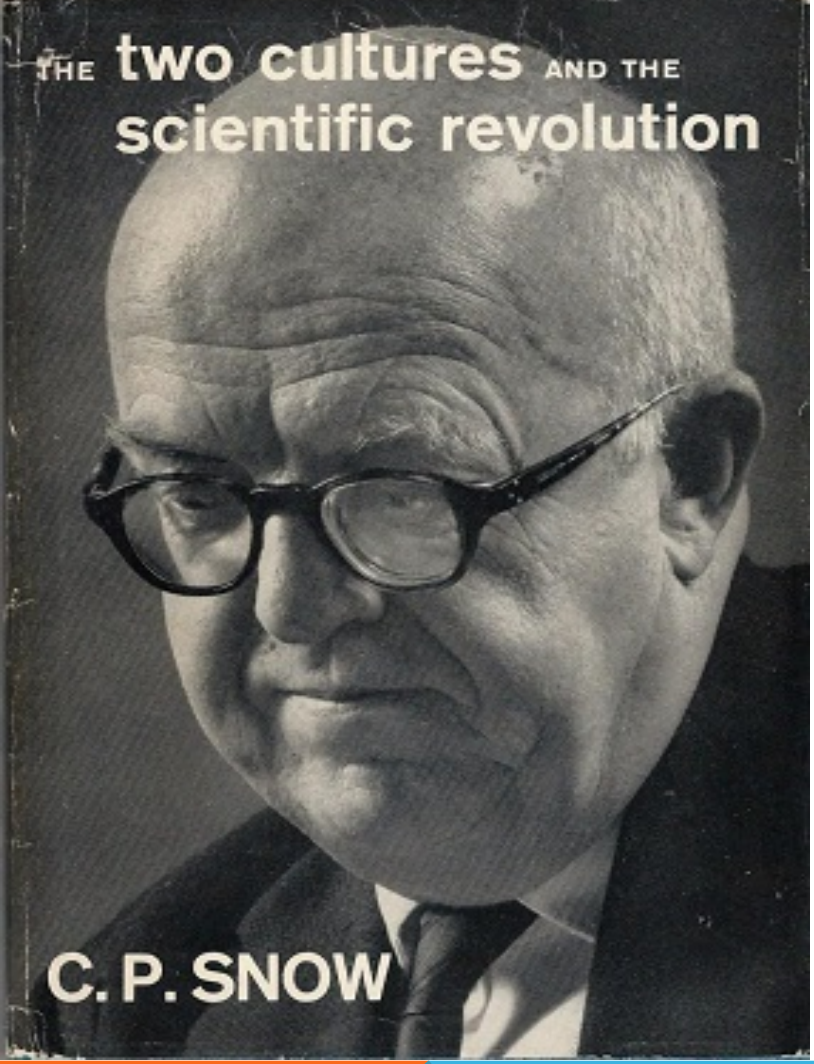


Think."

Learning Anxiety

But the perfect "Age of Anxiety" text seems to be that of T.S. Eliot's Wasteland.

Topology is Brave and Beautiful like the waves and sea. Its is like the mathematics of lava lamps and pottery wheels...It can make Courageous Children



Reconciling the 'two cultures'

"the intellectual life of the whole of western society" was split into the titular two cultures — namely the sciences and the humanities — and that this was a major hindrance to solving the world's problems.

Back in the '60s, the two cultures were in their separate camps and often one group had contempt for the other. The British scientist and novelist C.P. Snow called a version of this fight "two cultures" — art and science.

Abduction as the logic of surprise

The term “**abduction**” was coined by **Charles Sanders Peirce** (1839–1914) in his work on the logic of science. He introduced it to denote a type of non-deductive inference that was different from the already familiar inductive type. It is a common complaint that no coherent picture emerges from Peirce's writings on abduction.

The term “**abduction**” was coined by **Charles Sanders Peirce** (1839–1914) in his work on the logic of science. He introduced it to denote a type of non-deductive inference that was different from the already familiar inductive type. It is a common complaint that no coherent picture emerges from Peirce's writings on abduction.

Peirce made relevant contributions to deductive logic, but he was primarily interested in the logic of science, and more especially in what he called abduction (as opposed to deduction and induction), which is the process whereby hypotheses are generated in order to explain surprising facts. Indeed, Peirce considered abduction to be at the heart not only of scientific research, but of all ordinary human activities. For him abduction had its proper place in the context of discovery, the stage of inquiry in which we try to generate theories which may then later be assessed. For Pierce [a]bduction is the process of forming explanatory hypotheses. It is the only logical operation which introduces any new idea.

Application of Abduction are available in Artificial intelligence (fault diagnosis, belief revision, automated planning), Medicine (as a component of clinical evaluation and judgment), Intelligence analysis, Historical linguistics (abduction during language acquisition is often taken to be an essential part of processes of language change such as reanalysis and analogy), Anthropology.

Helmut Pape, author of the wonderful essay "Abduction and the Topology of Human Cognition", which is devoted to Charles Sanders Peirce, asserts that the term “Abduction” used by Peirce refer to a form of inference /alongside deduction and induction/ by which we treat a signifier as an instance of a rule from a familiar code, and then infer what it signifies by applying that rule.

In his essay Helmut Pape establish that "Peirce developed in his post-1894 writings a topological way of viewing logical relations between representations with categorically different logical status: topological connectivity provided for him a comprehensive model of a space in which the individual logical sequences, e.g. those started by an abduction, could be embedded." As it is directed by Helmut Pape, "for a study that treats Peirce's whole logic from the point of view of his topology, see Burch [1991].)". Robert W. Burch's work - "A Peircean Reduction Thesis: The Foundations of Topological Logic" is probably the most comprehencive study on Topological Peirce.

And here is Helmut Pape account on the development of the **Topological Peirce**:

"Only late in his life Peirce become aware of what peculiar meta-logical and topological properties an adequate account of hypothetical inference has to deal with and the decisive experience was his formulation of a logic-based evolutionary metaphysics from 1890-93. By 1898, when Peirce planned to give a lecture-series at Harvard on his evolutionary metaphysics, the title "The Consequences of Mathematics" or "The Logic of Events" reflects a change in the style of reasoning: To some extent the biological, evolutionary, physiological and psychological concepts of the 1891 version of his evolutionary metaphysics were either replaced or interpreted by logical and mathematical notions. In particular he applied and developed topological concepts - adapted from early topology by Benedict Listing [1862] - to the cosmological development of an ontological phase transition necessary to initiate cosmology evolution."

Erich Kästner's book *The Flying Classroom . . .*

The essential structure of a teacher-centered classroom has not changed for many centuries.

Neither has the behavior of students, some of whom in the image are shown to be sleeping, chatting, or generally distracted.

Everything is changing now, of course, with the advent of digital convergence and the ubiquitous information provided by the internet.

Iconic mathematics explores what Lee Shulman calls the pedagogical content knowledge of mathematics, that particular form of mathematics that is most germane to its learnability.

Erich Kästner's book *The Flying Classroom . . .*

- **What makes mathematics comprehensible to a novice?**
- **Which mathematical forms afford the fewest errors in understanding both structure and meaning?**
- **Which transformation rules and axioms are more error-prone?**
- **When should symbolic models of mathematical concepts be augmented with manipulatives?**
- **And in particular, when will we reconnect math to physical reality in order to enhance concept learning in mathematics classrooms?**

Answer: Topo-logiclal Classroom!
Why?

Symbols ask us to think. Icons ask us to look.

Erich Kästner's book *The Flying Classroom . . .*

- **"… numbers have neither substance, nor meaning, nor qualities. They are nothing but marks…[2]**
- **"…proof is a syntactic object consisting only of sentences arranged in a finite and inspectable array." [3]**
- **"…despite the obvious importance of visual images in human cognitive activities, visual representation remains a second-class citizen in both the theory and practice of mathematics." [4, p3]**

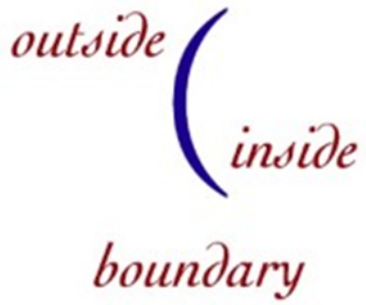
(David Hilbert, c. 1900)

Answer: Topo-logiclal Classroom!
Why?

Symbols ask us to think. Icons ask us to look.

Erich Kästner's book *The Flying Classroom . . .*

Iconic Principles



Iconic mathematics or/and Topology

Answer: Topo-logiclal Classroom!
Why?

Symbols ask us to think. Icons ask us to look.

Erich Kästner's book *The Flying Classroom . . .*

Iconic Principles

General Principles of Iconic Mathematics

1. **Mathematics is the experience of abstraction.**
2. **Experience is not a recording. Representation is not reality.**
3. **The void cannot be represented.**
4. **Space requires participation. To participate is to partition space, to construct a boundary.**
5. **Boundaries both separate and connect.**
6. **Boundaries identify an intentional construction.**
7. **Representation and meani**
8. **ng are different sides of the same boundary.**
8. **Our body is our interface.**

Answer: Topo-logiclal Classroom!
Why? Iconic mathematics or/and Topology

Symbols ask us to think. Icons ask us to look.

Topology for children in primary school education - the main concern of the present project

**“Topology! The stratosphere of human thought!
In the twenty-fourth century it might possibly be of use to someone…”**

**— *The First Circle*,
A. Solzhenitsyn**