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GEOMETRY EDUCATION IN KOREA

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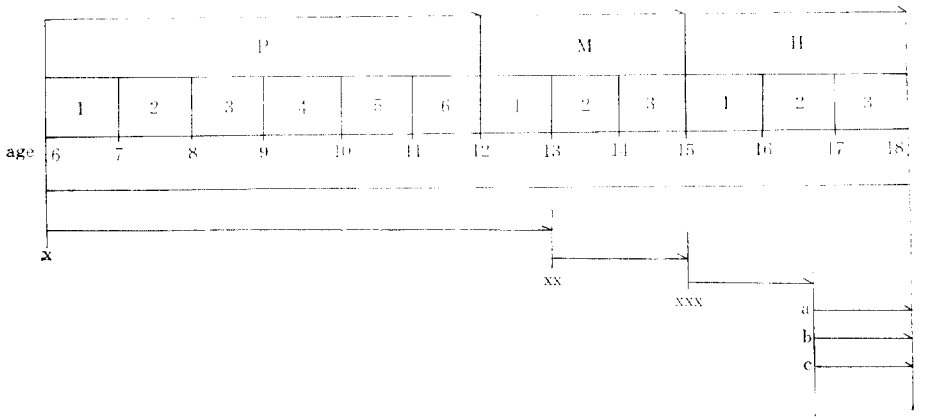
Introduction

I shall not touch on everything that could be included under this heading. What I shall do is as follows: select three aspects of the teaching of geometry in Korea, and then report the present situations and future prospects of the teaching of geometry in Korea as regards these aspects alone.

1. Pupils' mental development in geometry education

Theoretically we can identify five levels in the pubils' mental development in geometry: 1) The pupil recognizes a shape as a whole, 2) The pupil analyses figures, 3) The pupil understands inter relationship between figures, 4) The pupil understands the significance of deduction, 5) The pupil makes abstract deduction (By O' Daffer et al., 1976).



X informal geometry
XX semi-formal plane geometry
XXX simple analytic plane geometry
a literary course (no geometry at all)
b science course (semi-deductive solid geometry, concept of three dim. Vector through intuition, elementary analytic solid geometry, trigonometric ft. 's, Gaussian plane and matrix)
c vocational course (picks up any parts from a or b)

The levels 1), 2), and 3) may be called the informal geometry and belong to the education in primary school and middle school; 4) and 5) may be called the deductive geometry and belong to the education in high school.

The present curriculum of geometry in Korea follows this theory even though it is not strictly consistent with this theory. It may be illustrated as follows:

2. The transition from informal geometry to deductive geometry

Intuition should be the most essential factor throughout the education of geometry. Before and after the transition from informal geometry to formal geometry intuition continues to be essential for the students. Geometry without intuition is like a banquet without the principal guest. Teaching the "PROOF" marks the turning point of the transition. But the border line of this transition cannot be clearly drawn. The transition should be done gradually. In order to find the necessity of deductive thinking in geometry, students must be sufficiently equipped with understanding, ability and attitude for the Euclidean space through informal geometry. Students must be familiar with the properties of figures gained through intuition.

In the deductive geometry one demands axioms in the beginning. But one must be very careful in introducing axioms. Many systems of axioms equivalent to Hilbert's system of axioms exist and have been discovered, and may be discovered hereafter. We don't know exactly which system of axioms would be the best for Korean schools if and when we adopt axioms for deductive geometry at school. However one thing is certain so far: Hilbert's system, as it is, is not suitable for the educational use at school.

Teaching of "PROOF" is important, therefore its presentation in the curriculum must be very careful. If we try to present everything on PROOF at the same time it is impossible for students to follow. In Korea we teach PROOF in the second year of middle school. I have found through my experiments that if we fail to make pupils discover the necessity of PROOF, then pupils will fail to challenge the deductive thinking in geometry. Teachers must be on the alert when they begin to teach "PROOF". At the stage of transition from inductive approach to deductive approach to geometry, the essential thing for students is to recognize the significance of PROOF, and, such things as classification of types of PROOF are not of the first importance.

3. Changing societies and geometry education in Korea

a) Korean history and geometry

Korean art history of five thousand years proves that our ancestors enjoyed seeing the objects of the visible world around them, discovering beauty from it and expressing the beauty they found in them as art. It is important in the education of geometry in Korea to remember that Korean people since old time found pleasure in seeing the objects of the visible world because there was beauty in them. Without the sense of pleasure in seeing the objects of the visible world geometry could not be learned with pleasure.

But our ancestors could not connect logical thinking to the objects they saw. This is the reason why deductive geometry did not exist in Korea until the introduction of

Euclid's Elements two centuries ago. This was not the shortcoming of our country only: except for the ancient Greek people no nation in the history of the world has found deductive geometry in connecting object space and rational logic.

We think, however, that our ancestors did have informal geometry; ancient architecture, sculptures and industrial art objects show the existence and excellency of informal and experimental geometry in Korea: the eaves and the ridges of the roof of some old Buddhist temples or some famous old pavilions have catenary shapes, beautiful and artificial geometric curve.

An art historian says that this application of the geometric catenary to architecture is originated in Korea. The architects in the old days are reported to have used rope to form this curve in architecture. We know well in modern geometry and mechanics that an extended rope fixed at both ends forms a curve catenary, our ancestors discovered this curve through their experience. We think that this attitude of our ancestors, challenging the object space to beautify it, although on the level of informal geometry, should be acknowledged in the geometry education in Korea.

Non-existence of deductive geometry until the introduction of western civilzation near the end of Yi-dynasty caused considerable limitations in our past culture. We must seriously examine whether these limitations have been overcome or are being overcome by our geometry education in Korea today. At historical sites in Korea one finds, in general, square, hexagonal or octagonal pavilions or towers; but there is no pentagonal pavilions or towers. I feel this is due to the lack of the knowledge on the part of our ancestors of the construction of the regular pentagon before the introduction of Euclid's Elements. In the paintings of and before the Yi-dynasty we find that the law of perspective representation is violated.

It is a big difference to the fact that in the West the famous artist Leonardo da Vinci of the fifteenth century was also a geometrician.

But what we should overcome in the geometry education of Korea are not only such superficial weak points but also more fundamental ones. Familiarity with and pleasure in axiomatic and logical thinking fostered by the education of geometry will create an enlightened and scientific new generation in Korea.

b) Land and geometry education of Korea

The area of South Korea is about 100 thousand square km. The population is now over 40 millions.

One quarter of this population lives in Seoul. A large persentage of the Korean population is an urban population. Only a half century ago the majority of the whole population of Korea was a farming population. The problem of urban shift is not a problem of specialists only.

To utilize the narrow space the most effectively and the most beautifully is the urgent problem in Korea. What can the education of geometry in Korea do on this subject? We know that what the students learn in the mathematics education is not necessarily to be applied directly to everyday. However the urgent problem of narrow space in Korea cannot be neglected in the school geometry. The followings are a few of examples of what could be included in the geometry curriculum:

(i) A model of urban planning.

Here is a model of an old city in a form of square with an area of 1 km^2. It is divided into 25 blocks of the same area, each of which is a square. Each block is surrounded by sections of mainroads running east-west and north-south. The block at the center is a green zone.

Here is a model of new city in a form of circle with an area of 1km^2. It is divided into 25 blocks of the same area, each of which is surrounded by sections of main roads. The block at the center is a green zone. Now pupils are required to compare on the view point of geometry the city lives of two cities.

(ii) Shadow and sense of direction.

In residential districts in the city the shadow of one high building can cause trouble to others. A shadow is a projection in geometrical term.

The method of projection is only taught for some boys as a skill in the Korean middle school and unfortunately it is not included in the curriculum of geometry now. We must pay attention to the shadow in geometry education, as it leads to the study of projection and the concept of projection is important for the development of the concept of space.

A shadow against the sunshine changes its shape, length and direction as time and season change.

In the crowded streets of the modern city, most people live without having any sense of direction. This loss of sense of direction of modern citizens warns us that in the education of geometry concept of space in general must be stressed.

c) New living patterns of the Korean people and education of geometry.

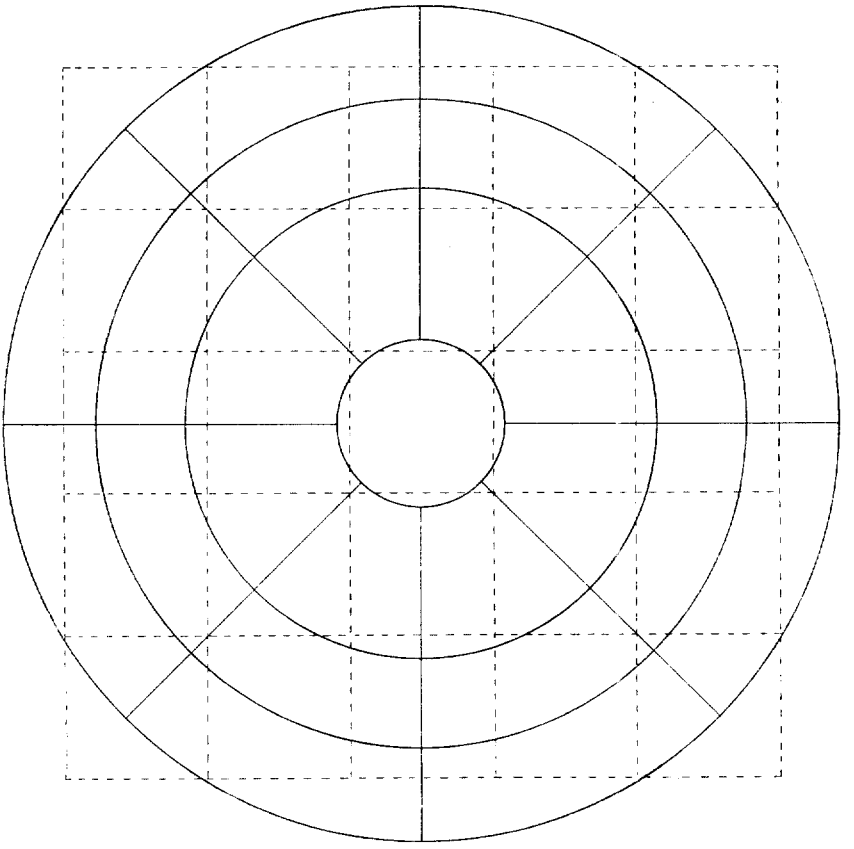
(i) Our living environment is not static. Space is to be grasped dynamically. Here are some examples: Prof. Seymour Papert of M.I.T. reported at ICME Ⅳ in 1980 that Turtle geometry using LOGO language of computer is recommendable for geometry education in kidergarten. In the Turtle geometry movement of points on the screen is essential.

Prof. Nesher of Haifa University reports that in the beginning of geometry education in elementary shools, she teaches transformation of figures.

Transformation of figures(and transformation of space itself) is composed of dilatation and displacement. Displacement is composed of symmetrization, translation and rotation.

Dilatation is composed of enlargement and contraction. In Korean curriculum, tranformation appears when we teach simple analytic geometry at highschool; and we only deal with translation and symmetrization there. Unfortunately "rotation" is reserved for some other occasions. In the future curriculum development we must keep in mind that "transformation" is not merely a part of the technique of handling the space but also the foundation of the concept of space.

(ii) The shocking accident of the crash of the passenger airplane of the Korean Airline on September 2. reminds us that our pupils and students who are future citizens of the space age must be familiarized with the concept of terrestrial and celestial space mainly through the education of geometry.



An example of urban planning:
dotted lines: main roads in an old city
concentric circles and radiants: main roads in a modern city.

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