ELEMENTS OF SYBER COLLEGE

GEOMETRY FOR ELEMENTARY SCHOOL TEACHERS

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The paper presented here is a collaborative work of two specialists: professor of mathematics Dr. Tatyana Flesher and professor of computer graphics and multimedia Mr. Leonid Knizhnik. This is an attempt to turn mathematical educational process to (as we call it) natural-historical way with wide usage of modern technology.

The natural developmental path of mathematics is to start with the conceptual practical necessity of certain calculations and then search for formal solution methods. However, teaching mathematics proceeds in the opposite manner: the didactic theoretical aspect of the subject is introduced first and only afterwards are there (perhaps) presented the practical applications. This approach to teaching mathematics is utterly acceptable for those who are already familiar with the subject. But it is questionable whether this approach is much of any real use to beginners.

Psychologists have found that when little children learn something about the real world, their learning processes are strikingly similar to those of humankind in its early stages development. In both cases, tactile perceptions are the primary basis for recognition of forms. Once a particular form has been grasped and made familiar, a name will be given it later according to the sensation it evokes.

Traditional textbooks in mathematics lead from the **abstract** to the **concrete,** a process that presets a certain **transition phase** (a kind of "learning" gap) to students. Indeed, students frequently find that even though they have little or no familiarity or experience with a given mathematical topic, they must be able to grasp the abstract concept, generalize it, and then apply it to actual problems. This is the traditional method of organizing and presenting mathematics instruction. But, in general, it only yields good results when the learner already possesses a well-developed ability to abstract form and

structure or when the learner has what might be called a natural talent or capability for abstraction. If learners can successfully get past this transition phase, they develop confidence and interest in the subject. If, however, the transition phase cannot be gotten past in a reasonable amount of time and with a reasonable amount of effort, learners experience a sense of frustration and failure; and, as a result, tend to reject any later work with the subject. Thus, for these students, mathematics is likely to forever be *terra incognita.*

The natural path of learning mathematics, the path that leads from experience to abstraction (and not the reverse), eliminates the above-mentioned learning gap. It also creates conditions for differently prepared students to learn in a less stressful way, and, most importantly, it enables students to rid themselves of their phobias regarding mathematics and their unwillingness to learn it. With this view of how mathematics can best (and most profitably) be taught to younger children, we developed the idea of creating a line of textbooks for College students majoring in elementary education and for elementary school children. The main idea that underlies this line of texts, is that it should present mathematics and mathematics instruction in a way that is consistent with the natural learning paradigm whereby learning will proceed from practical considerations to formulas, abstractions, and generalizations. Geometry is ideally suited for this.

Children are surrounded by geometric objects – buildings, fruits, vegetables, dishes, furniture, and so on. And, starting from early childhood, they become more and more aware of the geometric distinction between various objects that they experience from day to day. These, and other, three-dimensional objects therefore provide the most

natural conceptual framework for teaching geometry to young children. In this paradigm, students start with familiar three-dimensional objects and then progress to the less intuitive plane (two-dimensional) figures. Only after gross (that is, the global) figures have been studied will the students proceed to study the abstract constituent elements of geometric figures such as points, segments, angles, etc.

Spatial perceptions and the natural feeling for distinctive forms that young children possess permits a strong but easy connection to be made between the learners' natural intuitive knowledge and their logic based knowledge of elementary geometry. In this course, the geometric figures are the focus. They are the main building blocks for entire program. It is this clarity of focus on the figures themselves (and not an vague abstractions of them) that permit students to study geometry using only their spatial perceptions and experience. Also, it is easy way of "concrete" geometric figures that youngsters gain a familiarity with and appreciation of geometry as a precise but complicated logical system in which apparently disparate things are interconnected and follow a few basic laws. Once the geometric figure has been related as the cornerstone of the study, then, as the result of the process of cognition, the students can move forward even as they steadily increase their knowledge of other, new, essential characteristics of figures. Thus, geometric figures not only provide the actual content of course but they also bind content and structure together so as to form an integrated system for exploring elementary geometry. This essential unity of content and structure is complemented by consistent use of visuals that will allow students to grasp the subtle beauty and clarity of elementary geometry.

The overall structure of the books follows the well-known psychological stages of cognitive development that are (i) The transition form three- dimensioned perception to two-dimensional perception, (ii) The transition from concrete objects and concrete forms to symbolic ones, and, finally, (iii) The transition from egocentrically-oriented system to a more objective one.

As students work through these books, they will encounter experiments that require observation, concrete operational tasks, and mental experiments. As a result, the information that student acquire from working with concrete objects, models, pictures and mechanical drawings is being constantly re-coded and expanded.

Young learners are introduced to the world of formal solid geometric figures by means of the real world objects that children encounter each day. The books lead students to the perception of pure geometric figures without imposing information on them but by allowing them to discover it and extract it. Assignments and exercises in the form of amusing informal experiments help students to determine and learn the basic features of geometric figures as well as the associated terminology. In this way, the students' knowledge is thus truly acquired and not imposed. Assignments include building with "blocks" of different shapes, making "toys", and reading fairy tales that present a geometric point of view. More serious and challenging problems include comparative analyses of similarly shaped geometric forms.

The smoothness of the transition from solid to plane figures is one of the most outstanding features of the course. The need to learn about plane figures arises natural from a practical point of view. Thus, for example, a shoe boxes and soda cans are made, and tracing the plane faces of solids help students to identify basic plane figures.

Drafting solid structures and experimenting with nets allow them to establish a connection between solids and planar figures. Games using tangrams and origami help them to learn about the properties of the figures and to draw conclusions about them based on observation. Students also learn how to write algorithms that will generate given geometric figures. They then use the computer software LOGO to write a program that will create figures. This procedure allows students to make a smooth transition from concrete objects to geometric abstractions such as segments, angles, triangles, etc.

Several final chapters of the text are more traditional in content. Here, the treatment for children presents polygons, their measurement and construction, their basic properties, and the associated terminology. On the other hand, the treatment for future teachers, titled "Geometry for Elementary School Teachers" presents an introduction to logical systems and the nature of mathematical proofs and arguments as these topics pertain to introductory geometry. In terms of content, all the basic topics of plane geometry are covered. There is also included an introduction to non-Euclidean geometries. In light of what has been discussed earlier, the progressive expansion of the children's understanding of geometric figures and their nature makes abstract figures more real. This serves to heighten the interest of the children so that there is less likelihood that they bored of frustrated at being required to study something that they might otherwise see as incomprehensible and useless. Both books are equipped with interactive CD-ROMs, made according to the main thesis: "experience goes first" which will increase their overall attractiveness as tools for learning geometry.

The following will share our experience of development of the educational multimedia and minimal logical and technical requirements for the successful supplement of our books with interactive means.

Automation of educational process is complex problem.

Developers of the computerized educational systems, usually employ heavy weight programming languages such as C, C++ or MS Visual Basic. As a result of the different skill requirements, the production of good educational software needs two different specialists for creation a computerized course. One will be needed for the lecture series and another for it's digital reflection, professor and programmer. Faculties, in most cases are deep but not wide specialists and they are not familiar with programming languages.

Recently released multimedia managers like Macromedia Director 7 or Authorware 5 could be a solution, but their user interfaces are still quite difficult to adopt. Macromedia Director in addition, has it's own proprietary background language called LINGO, which is difficult to learn.

Our idea was to link the professor with an easy to use multimedia management software application let us to choose the highly regarded software, PowerPoint 2000, for the creation and upgrading of our educational CD-ROMs.

This choice brought us a number of benefits:

- Simplicity of the user interface
- Affordable inexpensive software

- Easy learning for faculties who even never met computers
- Compatibility with other components of MS Office 2000 such as MS Word 2000, MS Excel 2000, MS Access 2000
- Strong orientation of the named software to the Internet HTML format
- Ability to acquire different vector based and bitmaps graphic file types
- Possibility to place movies and sound multimedia files. PowerPoint 2000 can utilize multimedia files with different types of compression
- Opportunity to make custom interactivity with built-in means and simplified Visual Basic for Applications
- Flexibility for additional corrections and updating
- Possibility of using OLE (Active-X) technology to implement fractions generated with partially compatible software applications
- Portability with Pack-n-Go option, allows the creation of compressed files and capability to run them on a computer that does not have parental software installed

The necessity of third party software usage depends on the particular theme of presentation. Our preferences and recommendations are as follows:

- **Adobe Photoshop** (current version 5.5) for photo retouching and sizing of static images, which must be saved as JPEG type to reduce file size on media

- **Corel Draw** (current version 9) for creation of vector based images, which could be inserted into Power Point via Copy/Paste procedure. It also could be saved as a Windows metafile (WMF) format which is native for vector images in MS Office,
- Corel Photo Paint can be used to edit computerized movies, which can then be saved with adjustable frame time rate and compression. Photo Paint is also very useful in multi-frame images re-sampling and retouching,
- **Corel Texture**, can be used to create fractal textures for backgrounds that PowerPoint does not contain in it's source
- **Asymetrix 3DFX** (current version 2.0) and **Asymetrix 3D Web Design** are extremely useful in creation of virtual reality of 3-dimentional geometry and rendering life-like movie clips with sound. This software allows the embeddings of vectorized 3-D objects inside of Power Point. Objects will be represented as wireframe or solid body. OLE technology makes it possible to rotate and move embedded images and to scrutinize them from all sides. This lightweight 3D animator let us not only create different geometric 3D objects and apply various surface rapture but also implement custom background, light and path for motion. Final product of 3DFX is AVI movie file, which can be recompressed with Ulead Video Studio or even Corel Photo Paint.

- As soon as PowerPoint 2000 accepted animated GIF file format, we used **Ulead GIF Animator**, which makes it possible to create very small animation files with deep adjustable compression.

- We also used **Visio Pro 2000** because it's huge object library and compatibility with PowerPoint.

Making a teacher presence in the visual form is very important for vitalization of materials. Our choice in this prospective was to make short video clips with teacher appearance and then to record audio narration with teacher voice. This means required Video Capture Board to be installed on the computer with corresponding software.

Recommended video capture board type depend of video source, which could be the analog camcorder or VCR or even digital (DV) camcorder. In a case of capturing the analog video clips we have got the best results with **Dazzle Multimedia "Szazzy"** video capture board. This hardware part gave the best quality of captured images and video clips with the highest level of MPEG compression. Accompanied software allows regulating also a bit rate for the output files, which is important for further streaming video via NET. This software – hardware complex is also affordable for price range $300 and included video editor from Ulead, while common editing software such as Adobe Premier 5 still need special plug-ins to accept MPEG format. More professional instruments immediately put you in a dramatically higher range of prices.

If the DV camcorder system was used to make a video clips it also possible to utilize present Snazzy card for capturing movies in MPEG format, because DV camcorders usually has analog output. But the best results can be achieved with FireWire high-speed interface board known as IEE-1394a.

We used inexpensive hardware board named PYRO DV from ADS TECHNOLOGIES (Part NoAPI-1394-PCI), which capable to organize 3 IEE-1394a

ports on the computer. Mentioned hardware piece has complimented software: **Ulead DV Video Studio3**, which allows you not only transfer DV video from camera to computer, but record clips back to DV cassette without further degrading while controlling your camcorder modes from the computer.

DV movie clips gives higher resolution up 550 x 360 pixels, while regular - MPEG only 360 x 240. DV clips have a conventional level of compression - 5, which make them impossible to be utilized in the NET video streaming.

In a purpose of reducing a size of these clips they must be recompressed in corresponding software like Ulead Video Editor (current version 5). We recommend a specific setting for DV-clips recompressing in Ulead Video Editor: while setting of making movie set up as AVI type, chose MPEG-4 High Speed Video Compression.

- **Ulead Video Studio** (current version 5.0). Named video editor featured with capability: to edit MPEG compressed video files, to recompress and resize video files with different file format, to edit video file cutting some fragments, to apply transition effects, etc.
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PowerPoint 2000 featured with significant number of customizable vector animation effects, which was very useful for demonstration of mathematical object behavior, including animated rapture for quasi-3D skeletons, self drawing lines, etc. For the most complex vector based animation, such as twining (object moves along curved trajectory between two points) we are planning to incorporate such vector-based software as

Macromedia Flash (current version-4) which compatibility with PowerPoint could be increased after installation of the appropriate plug-in.

In certain cases we were experienced with necessity to merge sequence of frames created manually (as a drawing) with movie, which was already done with another application. The most comfortable environment we find with using Corel Photo Paint that can perfectly adopt related application's product via OLE.

As soon as all components are collected on the media (we thankfully used Iomega Jazz drive) the next important stage will be - an adjustment of the timing and transition delays according narration and natural " boring barrier" which cold be recognized by demonstration of the materials for target auditorium.

And last stage of the process is a creation of the CD-ROM record with using Pack-N-Go option of PowerPoint 2000 and recordable or rewritable CD drive. With named compression utility presentation could be executed on the computer, which even does not have PowerPoint installed on it, because viewer can be packed with presentation body itself.

Richly filled with animation, sounds, vectorized effects and complex background 12-minute (47 slides) presentation, supplied with links and repetitions captured approximately of 60 Mb of CD space. Calculate that entire disk, filled with related materials could bring about 2 ours of interactive visual materials.

Unfortunately some important for educational process features are not present in PowerPoint such as twinning (moving object between two point with curved trajectory) and multiple choice examination templates. To solve this problem we are planning to migrate to new software named Micromedium Trainer (current version 5). Despite this is

more expensive application, but it especially designed to satisfy educational needs. Our choice based on particular features of Trainer 5 such as full compatibility with MS PowerPoint and hierarchical design of examination templates (such as multiple in multiple choice with database and weight for each question).

Micromrdium already prepared new release – Trainer 6, which will be more adaptive to Web broadcasting.