

Using Information Technology in Training Equipment Preparation (E.g., Linear Algebra & Analytic Geometry Course)

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Current situation of using IT

For NUM:

- School of Mathematics & Computer Science, School of Economics and School of Information Technology have placed some lessons as electronic files on the server computer and internet
- School of Physics & Electronics implemented projects “Physics laboratory model” in 2004 [4] and “Interactive physics” in 2004-2006 [6]
- Teaching faculty’s computer and projector usage on lectures is not at satisfactory level and materials shown are limited to text files not using wide possibilities of IT.

For MUST:

- With goal to become an “E-University” they have placed 942 e-files on the open lesson database
- Implementation of projects such as Distance learning on a master degree, Development of the E-test for intermediate and term exams v 1.0 software, Appliance of interactive and multimedia technology for an e-learning [7].

Today’s rapid development in IT shows one of the problematic aspects in Education sector that there is need for introduction and development of computer based training program, creation of possibilities for self-learning and strengthening personal abilities.

Objective

We put an objective to solve this problem in the frame of Linear Algebra & Analytic Geometry Course and develop training equipment.

1. Lecture equipment
2. Equipment for seminars and self-learning
3. Use of mathematics system (MS) for learning activities support

Purpose

- The faculty should know role and possibilities of IT as a tool and choose appropriate teaching equipment and methodology.
- Therefore, at instance he should study software like Flash, Maple, and MathCad, and explore on how to use above mentioned software in creating e-learning with the help of Interactive Educational Software for e-Learning Math, e-learning authoring tool, Knowledge Presenter, TeachingMATE, LectureMAKER, etc.
- The faculty should be introduced to local and global multimedia e-learning, videos, web pages.

Content

Hereby, I present my attempt towards realization of defined goal by development of the following TE based on subject study and analysis.

1. **E-learning** with 8 subsections, prepared for the first part of LAAG course “Matrices and determinants” [1].
Content: Matrix, operations performed on matrices, multiplication of matrices, transpose, determinant, properties, expanding method, inverse of a matrix, rank, elementary row operations on matrices, basis minor.
2. **Interactive software** AG-1, aimed for problem solving during “Line in plane” [2] seminar and self study and strengthening theory knowledge. Equation general form, with slope, parametric of line in plane, graphic, move, rotate, explanation, line definition elements. Two and three lines general form equation, explanation of their compare lie tested easily using the rank concept for both coefficient matrix and augmented matrix, intersection point, graphic, move, rotate.
3. MS application development, used by faculty for improving students knowledge and abilities and evaluating activities, and preparing of assignments.
for Maple: animation graph of quadric curve and compare eccentricity; animation graph of quadric surface, to look at the traces in planes parallel to the three coordinate planes and whatever plane;
for MathCad: Find inverse of a matrix, find eigen values and eigen vector of a matrix, find conversion matrix from bases to bases.

1. E-learning

Any application program is equipped with Demo, Help, Sample and Resource center. This is a kind of an e-learning and contains graphical and interface classic solutions with easy support for name index, connections and search tools. The e-learning was made using Macromedia Flash program based on the above idea and has two main goals:

- Teacher must prepare his presentation understandable, live and interesting, facilitate board teaching, follow content’s sequence and do not leave any topic.
- It gives student chance to repeat the lecture and see it again at his own speed and resolves problem of study material.

Macromedia Flash Player 8

1.8. Эгэл хувиргалт (ЭХ) (5)

ЭХ1. Матрицын аль нэг мөрийг тэгээс ялгаатай тоонуудаар үржих $A \xrightarrow{\alpha S_i} B$

ЭХ2. Матрицын аль нэг мөр дээр өөр мөрийг тоогоор үржүүлж нэмэх $A \xrightarrow{S_i + \alpha S_j} B$

ЭХ3. Матрицын 2 мөрийн байрыг солих $A \xrightarrow{S_i \leftrightarrow S_j} B$

(2) Лемм: (b) Теорем 1: Теорем 2: (b)
 Теорем 3: (b) Мөрдлөгөө: Теорем 4: (b) Теорем 5: (b)

(4) $A \xrightarrow{S_i - S_j} A_1$

$$A_1 = \begin{pmatrix} a_{11} & a_{12} & a_{13} & \dots & a_{1n} \\ a_{21} & a_{22} & a_{23} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ a_{i1} & a_{i2} & a_{i3} & \dots & a_{in} \\ \dots & \dots & \dots & \dots & \dots \\ a_{j1} & a_{j2} & a_{j3} & \dots & a_{jn} \\ \dots & \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & a_{n3} & \dots & a_{nn} \end{pmatrix}$$

(1) Эхлэл Урвуу матрицыг олох Суурь минор

Матрицын баганын хувьд дээрх зүйл бүгд хучигтэй.

Working principle is similar to website.

- (1) Click mouse to subsection. In this picture we enter “Үдөёү” subsection
- (2) See formulation by clicking each definition, theorem, lemma, corollary, quality, etc.
- (3) See their solution (b), motion formulation (b), example (b) by clicking side buttons.
- (4) Complicated, long solutions of the theorem, solution of an example problem, description and formulations are shown on this space as short movies. E.g., solution of lemma in this picture.
- (5) Control movie with play, stop, forward and backward buttons.

2. Interactive software [9]

HTML page and Flash program that makes video give us chance to demonstrate and process sound, moving and shape information. Nowadays, Flash program is used widely in cartoon, PC game and e-learning making.

We have written this AG-1 program using ActionScript of Macromedia Flash for the development of TE that technology for transformation of knowledge and ideas. It can show inter relationship among three sections, such as:

1. Matrix, its rank
2. Linear equations system
3. Line on the plane and its relational graphics

With AG-1 program students have broad possibilities to strengthen their theory knowledge, easily solve problems, study other parameter changes arisen from the problem and decrease mechanical mistakes during calculation.

ШУЛУУНЫ ТЭГШИТГЭЛ

Өнцгийн коэф.: $y = 0.5x + 35$

Параметр: $\begin{cases} x = -10 + 2t \\ y = 30 + 1t \end{cases}$

Ерөнхий: $1x - 2y + 70 = 0$

Тайлбар: Ерөнхий шулууны тэгшитгэлийн А, В, С коэффициент нь тэгээс ялгаатай учир шулуун координатын системтэй ерөнхий байршилтай.

\vec{s} чигл.: $(2; 1)$ $(x_0; y_0) (-10; 30)$ өнцөг: 26.56

\vec{n} норм.: $(1; -2)$ $(x_1; y_1) (-8; 31)$ ө/коэф.: 0.5

3 ШУЛУУНЫ ХАРИЛЦАН БАЙРШИЛ

$\begin{cases} \ell_1: 0x + -1y + 20 = 0 \\ \ell_2: 2x + -1y + 105 = 0 \\ \ell_3: 0x + -1y + 0 = 0 \end{cases}$

$A = \begin{pmatrix} 0 & -1 & 20 \\ 2 & -1 & 105 \\ 0 & -1 & 0 \end{pmatrix}$ $B = \begin{pmatrix} 0 & -1 & 20 \\ 2 & -1 & 105 \\ 0 & -1 & 0 \end{pmatrix}$

$\delta_1 = \begin{vmatrix} 2 & -1 \\ 0 & -1 \end{vmatrix}$ $\delta_2 = \begin{vmatrix} 0 & -1 \\ 0 & -1 \end{vmatrix}$ $\delta_3 = \begin{vmatrix} 0 & -1 \\ 2 & -1 \end{vmatrix}$

2 нь параллель, 3 дахь нь тэдгээрийг огтлоно. Учир нь $\text{rang}(A)=2, \text{rang}(B)=3$, мөн $\delta_1 \neq 0, \delta_2 = 0, \delta_3 \neq 0$.

$\text{rang } A = 2$
 $\text{rang } B = 3$

$\vec{s}_1 (1; 0)$ $(x_1; y_1) (-3; 20)$ $\ell_2 \cap \ell_3 (-52; 0)$

$\vec{s}_2 (1; 2)$ $(x_2; y_2) (-50; 5)$ $\ell_1 \cap \ell_2$

$\vec{s}_3 (1; 0)$ $(x_3; y_3) (0; 0)$ $\ell_1 \cap \ell_3 (-42; 20)$

Data is entered on the white space and, accordingly, other parameters, description and line graphics will be changed. Lines can be moved and rotated by mouse.

3. Use of mathematic system in training

In order to train students, develop and evaluate their knowledge and abilities teacher has to give different data to problems, exercises and course works. It takes a lot of effort and time from the teacher. Sometimes it is unsuitable to give data with random variable. Because choosing initial data for “nice” end answer (whole number, easy fraction, with radical) is time consuming and complicated task [10], [11]. Computer mathematics system (system that combines up-to-date user interface, strong graphical tools and calculator of mathematical problem using number and analytic methods [5]) reduces above difficulties, including:

- Eliminate risk of calculating error occurrence from teacher
- Preparation of multiple exercises
- Opportunity to compute “nice” data.

Mathematic system enables rotating figure shape and body surface graphics and showing it from any side, and demonstrates in moving motion each parameter change. In this way it is better than Maple software. It is easy to use MathCad program in solving problems as it has button for entering mathematical formulas.

In the first example when coordinates of triangle three vertices are given it shows the case where side length, orthocenter, gravity center, circumscribed and inscribed circle centers coordinates are whole numbers.

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> with(geometry) : ABC гурвалжны оройн цэгүүд өгөгдсөн.
triangle(ABC, [point(A,116,0), point(B,-28,-144), point(C,-52,24)]),
AB, distance(A,B), AC, distance(A,C), BC, distance(B,C),
circumcircle(E1c, ABC, 'centername' = O), O, coordinates(O), Багтаасан тойргийн төв
centroid(M,ABC), coordinates(M), Хүндийн төв
orthocenter(H, ABC), coordinates(H), Ортолөв
incircle(inc,ABC,'centername'=J), J, coordinates(J); Багтаасан тойргийн төв
ABC, AB, √41472, AC, √28800, BC, √28800, E1c, O, [23, -51], M, [12, -40], H, [-10, -18], inc, J, [8, -36]
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In the next example after entering data (1), processing (2) and end (3) measurements are computed simultaneously. By this guideline each student gets different data to problem and processing (2) and end (3) result can be checked. Also (1) “nice” data, i.e. rooted, fractional data can be entered and solved.

Summary

The e-learning “Matrices and determinants” was demonstrated on the seminar and review course of SE-1b and ISE-1 of the SMCS. The lesson is constantly being improved after correcting error detected during lessons, adding required items, such as example problem and possibility for pausing motion movie. It is been observed that during e-learning students pay more attention and interest and their participation is increased.

Сүүрийн тал ба хажуу ирмэг харгалзан a, b байх зөв гурвалжин пирамидын өндөр ба багтаасан бөмбөрцгийн радиусыг олъё.

(1) $a := \sqrt{3}$ $b := \frac{3}{2}$

(2) $AA1 := \frac{\sqrt{3} \cdot a}{2}$ $AA1 \rightarrow \frac{3}{2} = 1.5$
 $AO1 := \frac{2}{3} \cdot AA1$ $AO1 \rightarrow 1 = 1$
 $Sabc := \frac{a}{2} \cdot AA1$ $Sabc \rightarrow \frac{3}{4} \cdot \sqrt{3}$

(3) өндөр $SO1 := \sqrt{b^2 - AO1^2}$ $SO1 \rightarrow \frac{1}{2} \cdot \sqrt{3} = 1.118$

(2) радиус $OA := \frac{AO1^2 + SO1^2}{2 \cdot SO1}$ $OA \rightarrow \frac{9}{20} \cdot \sqrt{3} = 1.006$
 $V := \frac{1}{3} \cdot Sabc \cdot SO1$ $V \rightarrow V = 1$ $Vsbco := \frac{2}{3} \cdot \frac{1}{3} \cdot V$ $Vsbco \rightarrow \frac{2}{9} \cdot V$
 $Sbcs := \sqrt{b^2 - \left(\frac{a}{2}\right)^2} \cdot \frac{a}{2}$ $Sbcs \rightarrow \frac{1}{4} \cdot \sqrt{6} \cdot \sqrt{3}$ $OL := \frac{3 \cdot Vsbco}{Sbcs}$ $OL \rightarrow \frac{4}{27} \cdot V \cdot \sqrt{6} \cdot \sqrt{3}$

(3) $OL1 := \frac{\frac{\sqrt{3} \cdot a}{9} \cdot \sqrt{b^2 - \left(\frac{\sqrt{3} \cdot a}{3}\right)^2}}{\sqrt{b^2 - \left(\frac{a}{2}\right)^2}}$ $OL1 \rightarrow \frac{1}{18} \cdot \sqrt{3} \cdot \sqrt{6}$

AG-1 program was distributed among several students of MIT-1 and below is their opinion about it.

- Easy to use and operate for anyone with basic computer knowledge
- Help is not good enough, data preciseness is complicated
- Student’s knowledge about line equation and mutual relationship theory and solving problems was improved after using the program

Above mentioned training equipment can be used individually or in combination with other tools.

Significance:

- To increase student interest and to support self learning.
- To include more information and to save time for studying and confirming subject
- To enable faculty to work with and evaluate each student
- To make model example for development of mathematics and other lessons training equipment
- To have possibility for changes, additions and improvements in training equipment

Notice:

- To improve instruction materials for e-learning and AG-1 program
- Mathematics formula entry into Flash program is complicated and requires more mechanical work
- Training equipment does not contain audio description. Therefore it cannot replace lesson and teacher. The audio was not included because of audio quality requirements [8].

Reference:

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