The Use of ACROTEX Library for Creating Electronic Educational Resources

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Keywords: Electronic educational resources, Tests, Acrotex package.

Abstract. The recent reforms in education have given rise to distant training due to the sharp increase in the percentage of time allowed for individual work. It causes the necessity of working out new teaching resources that would contribute to the revitalization of the students’ individual work. Until recently, the creation of electronic training tools has been viewed as creation of lecture materials or tests, given in PDF format. Since Adobe Acrobat Reader has been supporting integrated JavaScript [2], there is an opportunity to implement interactive content into the documents in PDF format.

At the moment we are working at the project of creating a series of interactive electronic educational resources in mathematics with the use of Acrotex package for the first year technical students. The package is written by a Professor of Mathematics in the Department of Mathematics and Computer Science at the University of Akron, D.P. Story, to integrate interactive content in the document made in PDF format. The package is installed in the system LaTeX. Due to the JavaScript support, the interactive engagement of a user is provided.

By now, the first teaching resource [1] in the framework of the project has been registered and tested in the work with the students.

Introduction

Nowadays one of the ways to enrich the educational process in the university is to upgrade the educational and methodical content and the related teaching methods and techniques. The problem of enriching teaching tools is becoming more important with the tendency to a broader use of the distant training. The time given to the face-to-face communication with a teacher is becoming more limited in correlation with the increase in time given to the individual work.

In the framework of the traditional full-time study a teacher provides the detailed work with the material at the lesson, but in distant training some teaching tools are needed to make the individual work of a student as effective as possible. That’s why the development of effective teaching tools with the interactive content is incredibly valuable. The article reviews the example of creating an electronic educational resource [8] for students studying math at a technical university.

Method

The electronic educational resource is to organize individual work of students when studying the topic [1]. It is intended for both the full-time and part-time students. Every section of the resource has the necessary volume of theoretical information (including definitions, theorems and illustrations), given in compliance with the educational program and State standards. The practical part provides a number of problem solving situations.

The main feature of the discussed resource is absence of on-line testing. When developing the topic tests the main emphasis was put not on the monitoring function of the text but on the training one. Their main educational purpose is to practice the skills of work with mathematical tests, mastering the main definitions, their properties and the algorithms of actions.

A teacher can choose the level and the type of assignments in compliance with the educational aim, program and the level of students’ knowledge. The proposed materials can be also used to
monitor the classroom work. For this purpose a computer classroom and the installed program Adobe Acrobat Reader DC of 2017 version should be provided.

The developed resource is created in PDF format. To make it interactive an acrotex package worked out by D.P. Story is used. The package is installed in the system LaTeX and when compiling the original .tex file it produces a .pdf file, which accesses to the built-in JavaScript support.

LaTeX language (e.g. [6],[3],[4],[5]) originally allowed converting its files in PDF format. However, it had a lack of means enabling JavaScript support. And in 1998, D. Story created an acrotex package, enabling to use various interactive elements (см. [7],[8]) in LaTeX-a documents.

The use of acrotex package required from us additional operations. As is always in the case of using packages in the system LaTeX, the acrotex package was made accessible in the preamble of the document.

\usepackage[pdftex,unicode=true]{exerquiz}

This command integrates the exerquiz package. The next step is the integration of the dljslib package to use JavaScript.

\usepackage[ImplMulti,limitArith]{dljslib}

Now the process of creating the interactive elements will be described. The illustrative examples are taken from the developed electronic resource [1]. It should be mentioned that every problem in the text starts with the button Start and finishes with the button Stop. Before the input of a reply to a problem it’s necessary to click the button Start, then to enter or cancel the necessary reply and finally click the button Stop.

A point is awarded automatically for every correct reply. If the solution of a problem implies a multiple choice, there is a point for every correct reply, and one or two points are removed if the reply is wrong.

Here is the description of setting an interactive element, illustrated in the figure 1.

\begin{quiz}{MatExec01}\label{test:actmatr01}
(Click <<Start>> answer the question, then click <<Stop>>.)
\begin{questions}
\item[1.] Two matrices are given $A=\begin{pmatrix} 3 & -2 \\ 1 & 4 \\ -3 & 5 \end{pmatrix}$ и $B=\begin{pmatrix} -3 & -2 \\ 2 & 1 \\ 5 & -7 \end{pmatrix}$. Find the matrix $C=2B-4A$.
\begin{equation*}
\def\pij#1{\setlength{\fboxrule}{0pt}\setlength{\fboxsep}{1bp} \fbox{\RespBoxMath{\rectW{16bp}\Q{1}\textSize{0}\{#1\}}{1}{.0001}{[0,1]}}} \begin{mathGrp}\PTs*{1}
C = \begin{pmatrix} -18 & 4 \\ 0 & -14 \\ 22 & -34 \end{pmatrix} \end{mathGrp} \CorrAnsButtonGrp{-18,4,0,-14,22,-34}
\end{equation*}
\end{questions}
\end{quiz}

\PointsField{currQuiz}
\eqButton{currQuiz}
\hspace{1cm}
\noindent Reply: \AnswerField{currQuiz} \hfill Check out \hyperref[solv:actmatr01]{solution}. 707
Let’s discuss the fragment in detail.

The commands \begin{quiz}{MatExec01} and \end{quiz} are obvious. They are the beginning and the end of the exercise. The special label «\{MatExec01\}» is required for the mechanism of checking.

The field «PointsField\currQuiz» is designed for the input of the results of checking the solution, after clicking the button Stop.

The construction «eqButton\currQuiz» creates the button «Correction» and provides its work.

The command «\item[1.]» numbers the exercises, and «\PTs{6} » sets the overall number of points for the test.

The command «\begin{mathGrp}» starts, and the command «\end{mathGrp} » finishes the set of commands with a multiple choice (they are scored up as a whole).

The command «\PTs*{1} » shows the number of points awarded for one correct answer. The instruction «\pij{-18} » sets the correct answer to insert into the cell (fig. 2, 3). The definition «\pij{-18} » identifies the macro.

The macro is used not to write a long command \RespBoxMath for all the cells of the input.

The construction «\CorrAnsButtonGrp{-18,4,0,-14,22,-34} » sets the correct answers that are shown in the correction mode, if the button Answer is clicked on (fig. 4).

The answers are inserted in the field «\AnswerField\currQuiz».

The command \RespBoxMath (and the allied commands \RespBoxTxt and others) is mainly responsible for checking the correctness of the input answers. Here is the syntax of the command \RespBoxMath. The command has 10 parameters: 6 optional (in brackets) and 4 mandatory parameters.

Finally, «\hyperref[solv:actmatr01] » sets the shift to the mode of checking out the solution. The label «\label{test:actmatr01» serves to return back from the page with the solution.

The resource provides a training option of the test in each topic. Taking the variant, a student can understand the scoring system. The training option contains solutions. If the task is completed incorrectly, a student has an opportunity to check out the solution and find out where there is a mistake. To check out the solution, it is necessary to click the relevant button Check out the solution.
1) Two matrices are given \( A = \begin{pmatrix} 3 & -2 \\ 1 & 4 \\ -3 & 5 \end{pmatrix} \) and \( B = \begin{pmatrix} -3 & -2 \\ 2 & 1 \\ 5 & -7 \end{pmatrix} \). Find the matrix \( C = 2B - 4A \).

Solution.

In order to multiply the matrix by a number \( \alpha \), each matrix element must be multiplied by a number \( \alpha \).

We have \( -4 \cdot A = \begin{pmatrix} -12 & 8 \\ -4 & -16 \\ 12 & -20 \end{pmatrix} \), \( 2 \cdot B = \begin{pmatrix} -6 & -4 \\ 4 & 2 \\ 10 & -14 \end{pmatrix} \).

In order to add two matrices, it is necessary to form a matrix of elements that are the sums of the corresponding elements of the matrix-summands.

\[
C = 2 \cdot B - 4 \cdot A = \begin{pmatrix} -6 & -4 \\ 4 & 2 \\ 10 & -14 \end{pmatrix} + \begin{pmatrix} -12 & 8 \\ -4 & -16 \\ 12 & -20 \end{pmatrix} = \begin{pmatrix} -18 & 4 \\ 0 & -14 \\ 22 & -34 \end{pmatrix}.
\]

In the proposed text materials the following tasks are given:

- the problems, where a numerical value should be calculated (the answer is a numeral, expressed as a final decimal fraction or a standard fraction; if a number, that is an answer, cannot be expressed as a final decimal fraction, it is written as a standard improper fraction \( \frac{a}{b} \));
- the problems, where a value of a literal expression should be calculated (the answer is a literal expression, expressed either in a standard way or clustered in relation to the variables, included in the expression);
- the problems with a choice of an only answer (among the given variants there is only one right) (fig.4);
- the problems with a multiple choice (among the given variants there are several right ones) (fig.3).

Start (Click «Start», answer the question, then click «Stop».)

6. Let the matrices \( A \) and \( B \) be square matrices of the same order. Choose the right words:

- 1). If \( A \cdot B \neq B \cdot A \), then \((A - B)^2 \neq A^2 - 2AB + B^2\).
- 2). If \( A \cdot B \neq B \cdot A \), then \((A - B)^2 = A^2 + 2AB + B^2\).
- 3). If \( A \cdot B = B \cdot A \), then \(B^2 - A^2 = (A + B)(B - A)\).
- 4). If \( A \cdot B \neq B \cdot A \), then \(A^2 - B^2 = (A - B)(A + B)\).
- 5). If \( A \cdot B \neq B \cdot A \), then \((A - B) + (A - B)B = (A - B)(A + B)\).
- 6). If \( A \cdot B = B \cdot A \), then \(A^2 - B^2 = A^2 + B^2\).
- 7). If \( A \cdot B = B \cdot A \), then \((A + B)^2 = A^2 + 2AB + B^2\).
- 8). If \( A \cdot B = B \cdot A \), then \((B - A)(B + A) = B^2 - A^2 + BA + AB\).

Stop — Score: 3 out of 3 — Correct

Check out the solution.

Start (Click «Start», answer the question, then click «Stop».)

2. Calculate the determinant of the second order: \( \begin{vmatrix} a - b & a + b \\ -a - b & b - a \end{vmatrix} \)

- \(a^2 + b^2\)
- \(a^2 - b^2 - 4ab\)
- \(4ab\)
- \((a - b)^2\)
- \(a^2 + b^2 + 4ab\)

Stop

Figure 2. After the shift by clicking the button Check out the solution.

Figure 3. A test with a multiple choice.

Figure 4. An example of a final test with one choice.
- the problems, in which the correct sequence of actions should be found out (the answer in such problems is presented as a correct set of numbers or letters, denoting a further answer or an action)
- the problems requiring to impute the missing elements.

Conclusion

The problems written and used in the tests have different levels of complexity. The simplest problems (problems with a choice of one correct answer) are used at the first stage of the topic study. The chance to guess the answer in the rest types of problems is as minimal as possible. To find out the right combination, if you rewrite a test, is impossible as the scoring system carries fines. The problems requiring the input of a literal expression presented either in a standard way or clustered in relation to the variables, included in the expression, can be attributed to the same level. At first a student should describe the path of the solution and then express a pattern of a literal expression input.

The most difficult problems are those requiring to impute the missing elements, the problems where the correct sequence of transformations should be found out and the problems requiring to match the proposed action with its algebraic model. In this case not only the final answer but also the correctness of the intermediate actions is scored.

The special feature of the presented tests is a chance for a student to see the result of the conducted work immediately and to correct the mistakes, reloading the file. Testing of the electronic educational resource shows the feasibility of the arotex package use when creating new electronic educational resources.

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