The development and application of VBA macros in the teaching of science and mathematics

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Abstract

The article examines the use of Visual Basic for Applications (VBA) macros in teaching sciences and mathematics, highlighting their potential for didactic visualization and automating computational processes. It outlines methodological approaches for integrating VBA into educational materials, which include transitioning from basic models of phenomena to creating interactive interfaces for conducting controlled educational experiments. Practical applications of VBA are provided to emphasise key elements of academic content, facilitate virtual experiments, and enhance the management of MS Office documents that were created using earlier software versions. The article also presents the results of a teacher training program that confirms the effectiveness of using VBA, even for individuals with no prior programming experience. In conclusion, VBA can serve as an effective tool for modernising traditional teaching materials, fostering the development of interactive educational resources, and improving the quality of the learning process. The article suggests areas for further research, particularly in evaluating the impact of VBA-enhanced content on the development of students' critical and algorithmic thinking skills, the development of mathematical modelling abilities, and the interpretation of results using valid mathematical methods.

Keywords

VBA macros, computational models, digital visualisation tools, automation of education, science education, mathematics education

1. Introduction

In modern education, a crucial task is to enhance the effectiveness of learning materials by using digital technology tools. One such tool is the Visual Basic for Applications (VBA) programming language, which is built into Microsoft Office packages. VBA enables you to create macros, which are programs that automate routine operations, build models, and perform complex calculations. The use of macros in science and mathematics enables the fast execution of mathematical calculations, the creation of dynamic graphs, the simulation of processes, and the conduct of virtual experiments.

Over the years of using Microsoft Office programmes, a wealth of materials related to the study of sciences and mathematics has been created. These documents were made in different versions of Microsoft Word, with objects from various software manufacturers imported into them. However, editing and formatting them is very difficult due to the lack of sufficient information for their modification using modern tools.

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The study aims to justify the use of VBA macros as a means of didactic visualization in the teaching of sciences and mathematics.

To achieve this goal, the following tasks have been set:

- To investigate the didactic and technical capabilities of VBA for automating the presentation of educational materials (for lectures or practical classes).
- To reveal the essence of the method of using VBA as a means of didactic visualisation.
- To provide examples of the use of macros in teaching science and mathematics.
- To analyse the advantages of using VBA in teaching science and mathematics, as well as to offer recommendations for integrating VBA macros into education.

2. Review of recent works

The Excel visual environment, with its built-in Visual Basic for Applications (VBA) language, has been used for over two decades as a didactic platform for modelling, automating calculations, and creating educational tools in various fields of knowledge. Its appeal is due to its low entry threshold, the availability of software for students, and the ability to quickly deploy interactive tasks and simulators without additional licensing costs. Early research [1] in engineering education shows that Excel macros can simultaneously reduce classroom time spent on complex topics and improve learning outcomes by visualizing algorithms and data analysis steps.

Studies [2] analyse the use of interactive spreadsheets with macros to explain fundamental statistical concepts, including the central limit theorem, confidence intervals, distribution fitting, and batch averaging methods. The work of Tsai and Wardell [2] demonstrates how VBA in the familiar Excel environment strengthens the connection between intuitive visualization and formal methods, and simplifies the creation of customised data sets for test assignments.

Research [3] concerns engineering analysis courses, where VBA acts as a "bridge" between the acquisition of numerical methods and basic programming practice: macros are used to implement interpolation, optimization, random number generation, queue modelling, FDTD schemes, etc. This allows methods and coding to be taught in parallel using a familiar interface.

The issue of web scraping, data extraction using Java applications and Visual Basic macros, was examined in studies [4]. Using a Virtual Laboratory Based on VBA Excel Study in Physics Education Students is devoted to studies [5]. Modernization of the educational process through the implementation of digital technologies in the competence of higher education teachers is the subject of the works [6, 7, 8, 9].

Thus, Excel with VBA is used as a convenient and accessible teaching platform that combines modelling, calculation automation, and the creation of interactive teaching tools in various fields of knowledge. At the same time, very little is known about the feasibility of using VBA to improve the quality of teaching science and mathematics. This feasibility stems from the need to use teaching materials that are outdated in format but relevant in content (lecture notes, problem-solving examples, tests, etc.), thereby making their use more modern. The essence of the issue is that teachers should be able to modify the appearance of documents for educational purposes while preserving the basic structure and properties of the objects contained within the document.

At the same time, this method should be as simple and understandable as possible for ordinary users who do not have specialized education in programming or experience working with VBA.

3. Research methods

The following research methods were used the analysis of scientific and pedagogical literature to justify the use of VBA macros as a means of didactic visualization in teaching science and mathematics, as well as to justify and develop a method of using VBA as a means of didactic visualization; diagnostic (project and interviews) to identify the level of readiness of teachers to use this method in practice.

The research was conducted at the Borys Grinchenko Kyiv Metropolitan University between March and September 2025. 12 lecturers of science and mathematics participated in the study, including 3 as experts.

4. Results of the research

4.1. The essence of the method of using VBA as a means of didactic visualization

The use of VBA macros in the educational process is based on a combination of the technical capabilities of the integrated Microsoft Office environment, the digitization of the educational process, and the theoretical foundations of pedagogy, computer science, and teaching methods in science and mathematics.

From a theoretical perspective, the introduction of VBA in teaching disciplines aligns with modern approaches to developing students' digital competence, fostering algorithmic thinking, and promoting interactive learning. Macros enable the implementation of the concept of active learning, as students not only consume ready-made information but are also involved in creating dynamic learning tools, which increases motivation and promotes deeper assimilation of the material. The theoretical basis also includes the idea of integrating automation tools into various educational disciplines, ensuring interdisciplinary connections and a practical focus on education [10, 11, 12].

The method of using VBA as a means of didactic visualization is based on the idea of changing the states of MS Office graphic objects implemented in a document, which significantly alters students' perception of the lecture content depending on the selected information fragment.

Let us reveal the purpose of introducing this method: using the simplest VBA tools, create an environment that allows, without interfering with the structure of a specific MS Office document, the integration of new objects of a representative purpose into it.

The idea behind the method is based on the technical principles of the VBA application. These principles are related to the capabilities of the programming language built into Microsoft Excel, Word, Access, and PowerPoint office software. Macros can contribute to:

- Automating routine computational and analytical operations.
- The creation of interactive training materials, test modules, and electronic simulators.
- The implementation of heuristic presentation of educational material using the technology of step-by-step selection of the most essential fragments in the proposed material [13, 14, 15, 16].

According to the principle of specific implementation of the method, all objects of the document are divided into two parts:

- Text fragments.
- Other objects whose properties we are unable to change.

A text fragment can change its color and intensity depending on whether it is in focus at a given moment. This is achieved by executing the corresponding VBA macro associated with this fragment. Other objects, usually graphic ones, come into focus or leave it by changing the transparency of the masks related to them after executing one of two or three VBA procedures.

Let us present the algorithm for implementing the method.

- We consider a file with useful didactic material to be demonstrated during the lesson.
- We examine the file structure for formatting and editing issues to determine the feasibility of using the proposed technology.
- We select key objects in the material and cover them with masks (based on geometric objects built into MS Office).

- A VBA procedure is attached to each mask to change the degree of transparency. Transparency control (for convenience) is displayed on the toolbar (in the command menu) with two or three buttons that adjust the degree of transparency (fully transparent, partially transparent, or without transparency). By turning a specific menu button on or off, the lecturer can adjust the intensity of the lighting for the fragment that should be in the audience's focus of attention.

An example of the fragment of algorithm implementation is shown in (figure 1, 2).

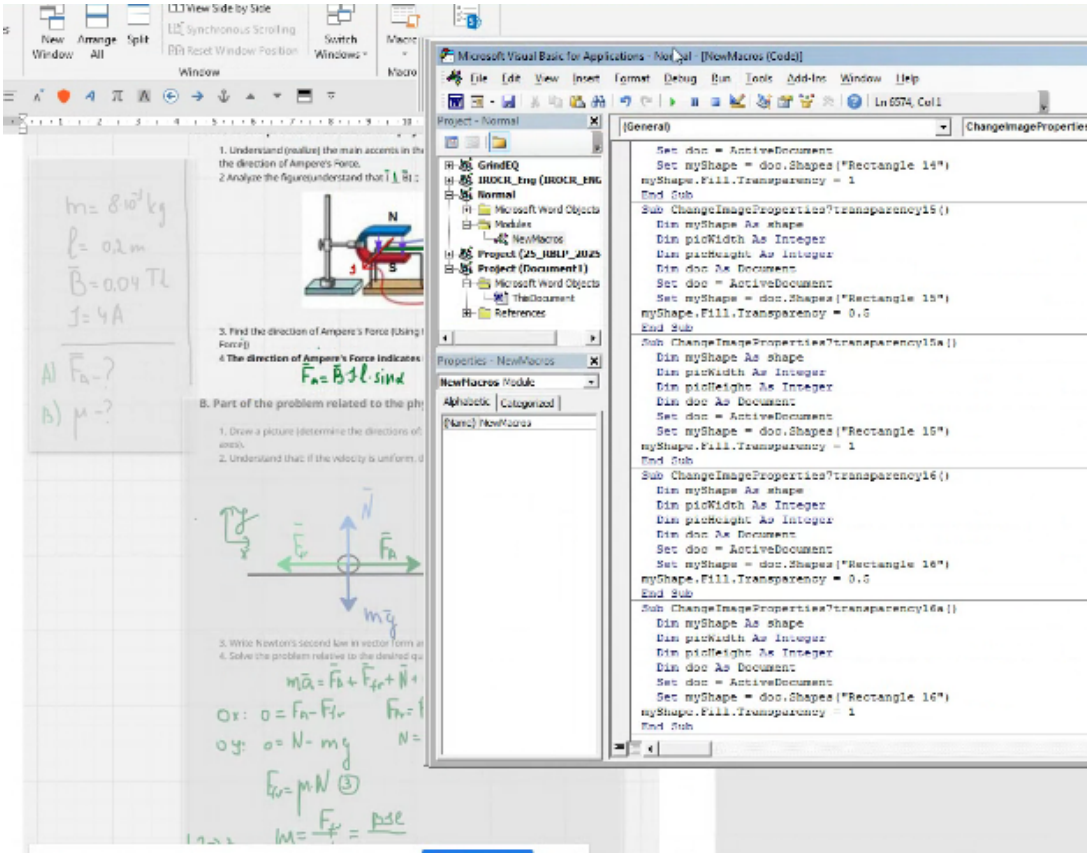

Figure 1: Creating a didactic visualisation tool in VBA (creating masks and procedures).

By turning a specific icon on/off, we can change the intensity of the lighting.

Thus, we have presented a method for quickly formatting MS Office documents to facilitate the convenient visualisation of educational material in situations where the origin of the files does not allow most standard formatting procedures to be performed. This method is designed for users who want to access educational material that is as convenient as possible for dynamic presentation, with maximum time savings, and without the need for complex programming procedures.

4.2. Examples of using VBA as a means of didactic visualisation

Example from the discipline "Differential Equations"

The original text looks like this (figure 3).

Let's take a closer look at this fragment. The basis of the document is text. The text contains images. Therefore, from the observer's point of view, there are two types of objects in the document: text and pictures. On the other hand, the system sees many more details that are invisible to the user. Let's look at the objects separately.

Text.

The first paragraph consists of black text, like all other parts of the document. For the system, black is defined by the RGB(0,0,0) color scheme. However, checking with MS Word in our case gives a slightly different result (figure 4).

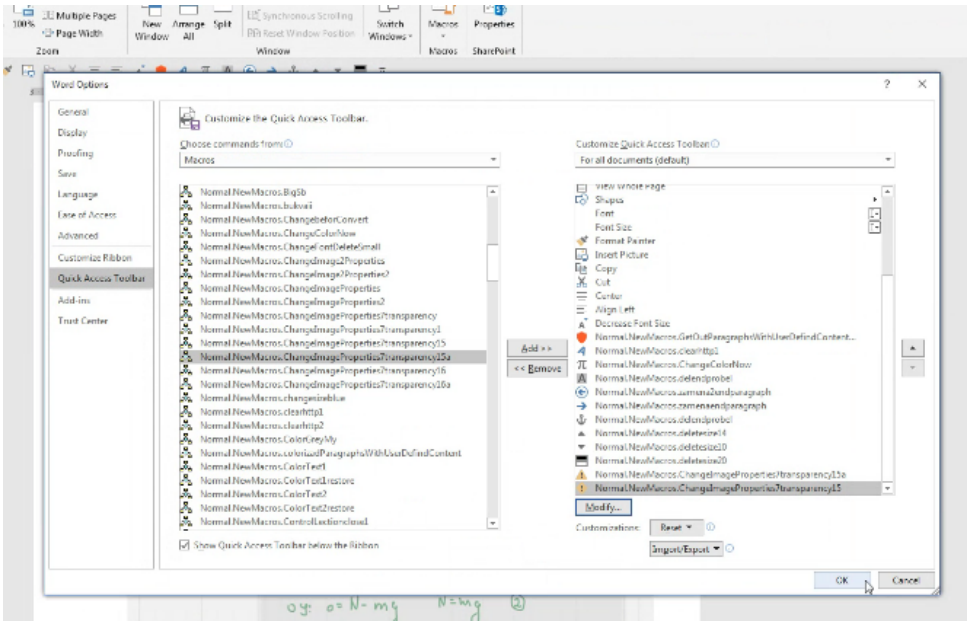

Figure 2: Creating a didactic visualisation tool in VBA (forming masks).

The systematic study of differential-algebraic equations (DAEs)

$$A(t)\frac{dx}{dt} = B(t)x + f(t),\ t \in [0;T], \qquad (1)$$

began in the second half of the past century. In particular, Campbell has proposed the notion of a standard canonical form of system (1) that was represented as

$$\begin{pmatrix} I_{n-s} & 0 \\ 0 & N_s(t) \end{pmatrix} \frac{dx}{dt} = \begin{pmatrix} M(t) & 0 \\ 0 & I_s \end{pmatrix} x + h(t), \qquad (2)$$

where I_s and I_{n-s} are identity matrices of orders s and $n - s$, respectively, and $N_s(t)$ is a nilpotent lower (or upper) triangular matrix [4]. Note that, when matrix $N_s(t)$ is additionally constant, system (2) is called the strong standard canonical form of system (1) [9, 20].

Figure 3: Example from the discipline “Differential Equations” (initial appearance of the material).

(Default) Times New Roman
10 pt
Font color: Custom
Color(RGB(1;0;0))

Figure 4: Example from the discipline “Differential Equations” (working with masks).

That is, for the system, these are two different colors. Thus, if we want to make changes to this particular fragment, which differs from all others in the property mentioned above (i.e., it is unique within the document), using VBA, the necessary actions will be addressed to the part of the text with these parameters only. By making such changes to the old document, we do not alter the geometry of objects of any type within the document itself, which in some cases is a critical requirement (such as the mutual arrangement of figures, formulas, paragraphs, etc.). This method of changing text is often referred to as a hidden control.

Given the uniqueness of the color scheme of the text in the first paragraph, let’s change the brightness of the text with a simple VBA procedure, making it visually less relevant to the observer (figure 5):

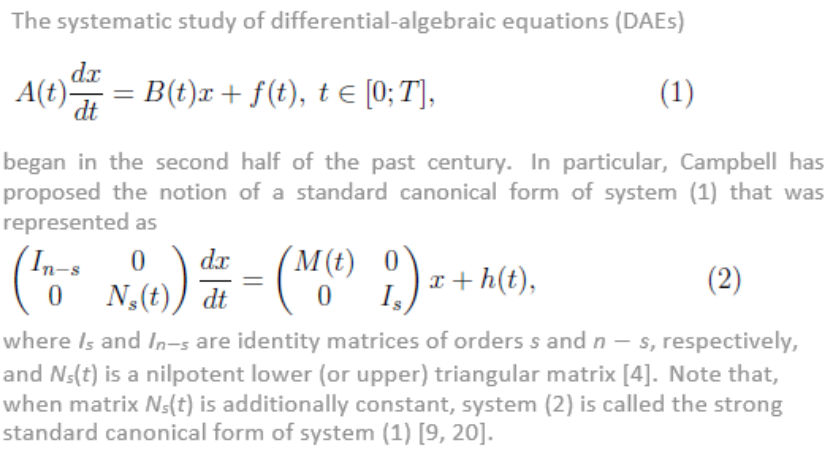

Figure 5: Example from the discipline "Mathematical Logic and Theory of Algorithms" (moderate transparency of secondary material).

This method shifts the audience's attention to a more visually distinct paragraph. The brightness of the text can be reduced or increased at the lecturer's discretion, for example (figure 6):

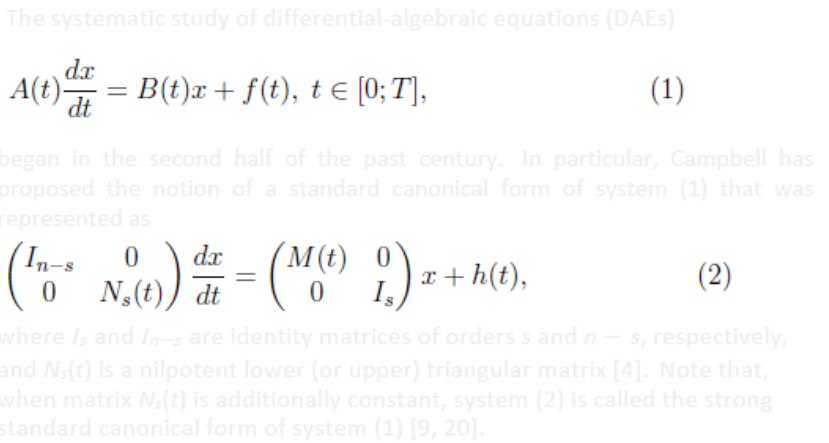

Figure 6: Example from the discipline "Mathematical Logic and Theory of Algorithms" (significant transparency of secondary material).

The fragment can be returned to its original state using a reverse VBA procedure. The second fragment of text also features a unique color scheme, as per our design: RGB(2,0,0). Using a similar VBA procedure, the fragment can acquire changed properties. The result is quite evident in (figure 7, 8). It should be noted that the text of mathematical (physical, chemical, etc.) content may contain formulas that the text editor perceives as external objects from the point of view of the text, as well as other formulas that are typed exclusively in text format. Therefore, the method suggested above can also be used for the latter fragments of a symbolic nature. The appearance of the object will acquire new visual properties (figure 9).

Let us consider the issue of meaningful images located in the document if their editing is not taken into account. Recalling the assumption made at the beginning of the article regarding limited information about the origin of objects in the document, we will not attempt to make direct changes to their structure, as this could distort not only the appearance of the object but also its behaviour in the document. In the case under consideration, the first image is a formula created in the MS Equation editor, which is available in different versions depending on when the specific document was created. The second image is a graphic file inserted into the document, which could be in any format, with corresponding consequences for its formatting using VBA.

Then there exist periodic nonsingular sufficiently smooth matrices $P(t, \varepsilon)$, $Q(t, \varepsilon)$ such that

$$P(t,\varepsilon)A(t,\varepsilon)Q(t,\varepsilon) = H(t,\varepsilon) \equiv diag\{N_q(t,\varepsilon), I_p(t,\varepsilon)\}, \quad (6)$$

$$P(t,\varepsilon)B(t,\varepsilon)Q(t,\varepsilon) = \Omega(t,\varepsilon) \equiv diag\{I_q(t,\varepsilon), W_p(t,\varepsilon)\}, \quad (7)$$

where $I_q(t, 0) = I_q$, $I_p(t, 0) = I_p$, I_q and I_p are the identity matrices of orders
q $(q = q_1 + q_2)$ and p $(p = p_1 + p_2)$, respectively;

$N_q(t, 0) = N_q \equiv diag\{N_{q_1}, N_{q_2}\}$, $W_p(t, 0) = diag\{W_{p_1}(t), W_{p_2}(t)\}$, $p = p_1+p_2$,

N_{q_i} is the square matrix of order q_i such that

$$N_{q_i} = \begin{pmatrix} 0 & 1 & 0 & \dots & 0 \\ 0 & 0 & 1 & \dots & 0 \\ \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & 0 & \dots & 1 \\ 0 & 0 & 0 & \dots & 0 \end{pmatrix}, \ i = 1, 2,$$

Figure 7: Modernization of teaching materials using VBA. Original appearance.

Then there exist periodic nonsingular sufficiently smooth matrices $P(t, \varepsilon)$, $Q(t, \varepsilon)$ such that

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q $(q = q_1 + q_2)$ and p $(p = p_1 + p_2)$, respectively;

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N_{q_i} is the square matrix of order q_i such that

$$N_{q_i} = \begin{pmatrix} 0 & 1 & 0 & \dots & 0 \\ 0 & 0 & 1 & \dots & 0 \\ \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & 0 & \dots & 1 \\ 0 & 0 & 0 & \dots & 0 \end{pmatrix}, \ i = 1, 2,$$

Figure 8: Modernization of teaching materials using VBA. Modernised appearance with moderate transparency applied.

All these considerations lead to the need to use the object masking method. Let's illustrate this with an example of an image that is a formula (figure 10).

Let's place a "shape" object, for example, in the form of a rectangle, so that it completely covers the formula image (figure 11).

From the observer's point of view, there is "nothing" in place of the formula. In fact, they see a white rectangle that "blends" with the document background and obscures the formula image. If we want to "reveal" the formula, we need to "remove" this rectangle. But next time, the problem will be to put it back in the same place. A more effective way is to change the "transparency" property of the rectangle, making this object transparent or semi-transparent. This will reveal the image of the formula to the observer.

Then there exist periodic nonsingular sufficiently smooth matrices $P(t, \varepsilon)$, $Q(t, \varepsilon)$ such that

$$P(t,\varepsilon)A(t,\varepsilon)Q(t,\varepsilon) = H(t,\varepsilon) \equiv diag\{N_q(t,\varepsilon), I_p(t,\varepsilon)\}, \quad (6)$$

$$P(t,\varepsilon)B(t,\varepsilon)Q(t,\varepsilon) = \Omega(t,\varepsilon) \equiv diag\{I_q(t,\varepsilon), W_p(t,\varepsilon)\}, \quad (7)$$

where $I_q(t, 0) = I_q$, $I_p(t, 0) = I_p$, I_q and I_p are the identity matrices of orders q ($q = q_1 + q_2$) and p ($p = p_1 + p_2$), respectively;

$N_q(t, 0) = N_q \equiv diag\{N_{q_1}, N_{q_2}\}$, $W_p(t, 0) = diag\{W_{p_1}(t), W_{p_2}(t)\}$, $p = p_1+p_2$,

N_{q_i} is the square matrix of order q_i such that

$$N_{q_i} = \begin{pmatrix} 0 & 1 & 0 & \dots & 0 \\ 0 & 0 & 1 & \dots & 0 \\ \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & 0 & \dots & 1 \\ 0 & 0 & 0 & \dots & 0 \end{pmatrix}, \ i = 1, 2,$$

Figure 9: Modernisation of teaching materials using VBA (moderate transparency with an emphasis on key formulas).

The systematic study of differential-algebraic equations (DAEs)

$$A(t)\frac{dx}{dt} = B(t)x + f(t), \ t \in [0; T], \quad (1)$$

began in the second half of the past century. In particular, Campbell has proposed the notion of a standard canonical form of system (1) that was represented as

Figure 10: Example of using the VBA visualisation tool: masking formulas (initial view).

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Figure 11: Example of using the VBA visualization tool: masking formulas (intermediate option, covering with a graphic object).

There is an even simpler option:

```
Sub ChangeImageProperties2()
Dim myShape As shape
Dim doc As Document
Set doc = ActiveDocument
Set myShape = doc.Shapes("Rectangle 3")
With myShape myShape.Visible = False
End With
End Sub
```

To close the formula, you need another procedure, which differs from the previous one by only one line: instead of myShape.Visible = False, you need to use myShape.Visible = True The outcomes of both procedures will appear as follows (figure 12, 13).

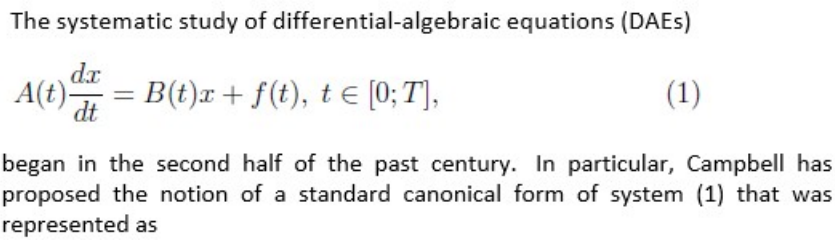

Figure 12: Modernization of teaching materials using VBA. Initial appearance.

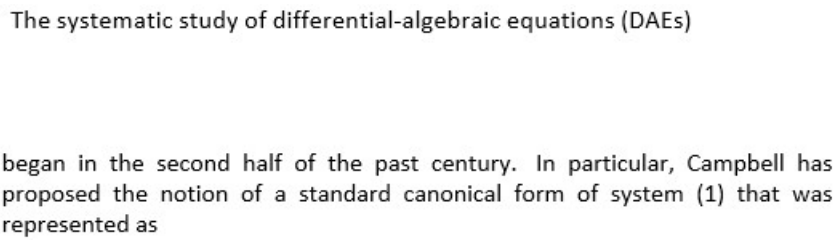

Figure 13: Modernization of teaching materials using VBA. Modernised appearance with complete data masking.

To make the rectangle semi-transparent, simply replace the command myShape.Visible = False in the macro with myShape.Fill.Transparency = 0.5, i.e. 50% transparency.

After performing both procedures of equal intensity – with text and image – we will get the following result:

The essence of the method is that we are not working with old objects of unknown origin and version, but with new ones to which VBA has direct and predictable access. Therefore, in the previously created images, we are only interested in their size and location in the document.

If necessary, they can be used together if you need to reduce the visibility of both the text and the accompanying images in a paragraph.

Let's reduce the intensity of the text and image of the formula in the first paragraph, while preserving the brightness of the second paragraph, using a procedure that calls the other two:

Sub HideAbzats1()
Application.Run MacroName:="ColorText1"
Application.Run MacroName:="ChangeImageProperties1"
End Sub

Using this approach for all fragments of the document, we can implement any number of combinations of formatting changes to its content parts.

Example from the subject "Physics"

Let us demonstrate the scaling capabilities of our technology using an example from physics material that contains large illustrations. We have a task from the Electricity and Magnetism section. In this task, the key points are highlighted in bold, and is provided (figure 14).

The task (with accents). A **horizontal conductor of mass** 8 g and length 20 cm lies on parallel rails in **a vertical magnetic field** with an induction of **40 mT**. A **current of 4 A** is passed through the conductor. Determine: a) **in which direction** the conductor **will start to move** if the circle is closed; b) the coefficient of friction between the conductor and the rails if it **moves uniformly**.

The command to execute it is located on the Quick Launch bar in the menu.

The example includes a large illustration made up of three sections: (1) part of the problem related to the physics topic "Electricity and Magnetism", (2) part of the problem related to the physics topic "Dynamics", and (3) the mathematical solution of a system of equations concerning the desired quantity.

The author intends to highlight each of these sections at specific moments during the presentation (figure 14).

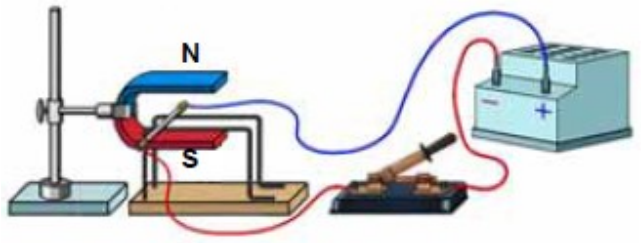

Figure 14: Example of a problem from the discipline of Physics (explanatory drawing for the issue).

Let's show how this is implemented in practice.

We will place three numbered objects of the "Rectangle" type so that they cover each fragment of the large image separately. We will attach three procedures to each of them: one makes the object transparent, the second makes it semi-transparent, and the third makes it opaque. Now, to visualize the method of bringing the selected fragment into focus, we will create two semi-transparent fragments and get the third one into focus (figure 15).

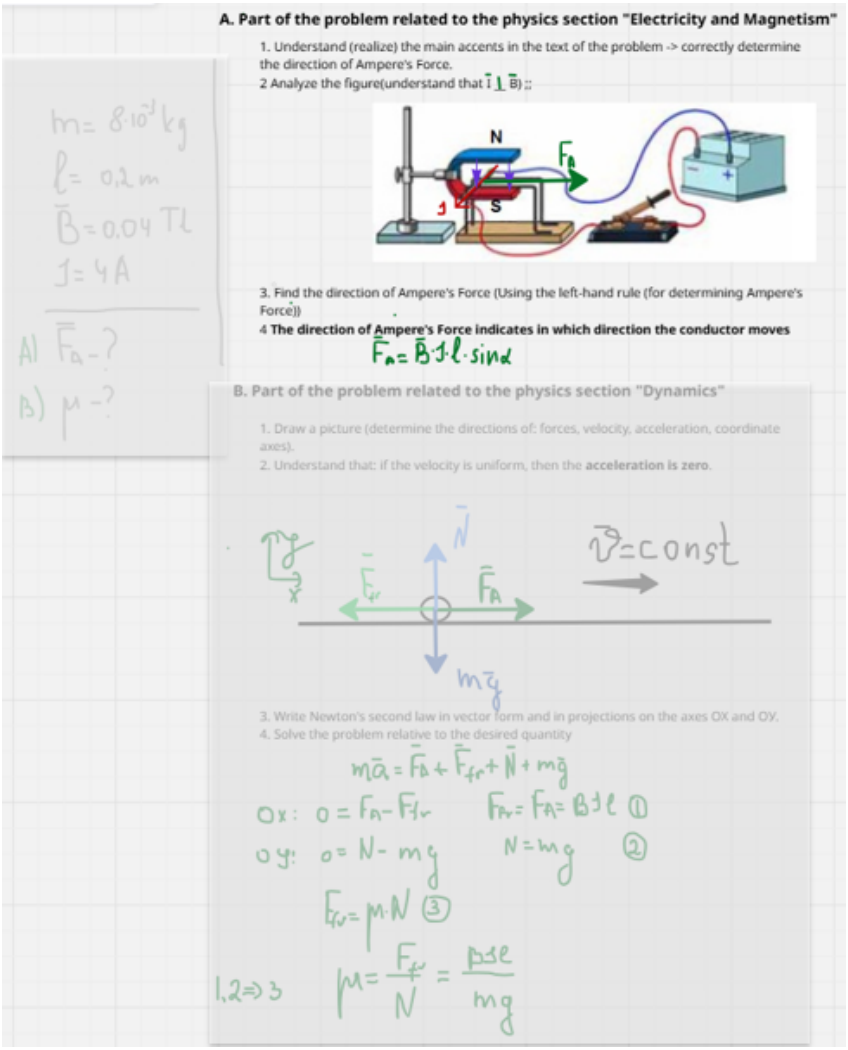

Figure 15: Modernization of teaching materials using VBA: Physics Modernised view with partial data masking (semi-transparency).

4.3. Research results

In March 2025, we surveyed teachers to gauge their experiences with using VBA macros in teaching science and mathematics. It was found that all nine teachers lacked the necessary knowledge and expertise. At the same time, identifying the possibilities of using VBA macros in the teaching process sparked the teachers' interest in further professional development in this area. As a result, we developed a professional development programme entitled "Development and use of VBA macros in teaching science and mathematics", which was implemented in March-April 2025. Duration of training: 30 hours (1 ECTS credit). Here is the course structure:

Module 1. Introduction to VBA (4 hours): The role of macros in modern education. The VBA interface in Word, Excel, and PowerPoint. Creating your first macro: automating a simple action.

Module 2. VBA basics (6 hours): Variables, operators, conditions, loops. Working with Microsoft Office objects. Debugging and testing code.

Module 3. VBA as a means of didactic visualization (6 hours): Methods for highlighting and hiding objects in educational documents. Using VBA to focus students' attention. Examples from mathematics, physics and chemistry.

Module 4. Automation of calculations and modelling (6 hours): Calculations in Excel using macros. Random number generation, statistical models. Virtual experiments and simulations.

Module 5. Integration of VBA into the educational process (4 hours): Development of educational materials with VBA. Examples of use in PowerPoint presentations. Tests and simulators on VBA.

Module 6. Practical project (4 hours): Developing your own teaching fragment using VBA. Presentation of results.

At the end of the course, teachers were asked to complete a creative project. To do this, they had to complete the following tasks:

1. Choose a topic from their discipline.

2. Develop a short teaching document, table or presentation containing: text explanations; formulas or images (diagrams, drawings, charts); didactic elements that require students' attention.

3. Use VBA to create interactivity, such as highlighting essential text fragments (changing color, brightness, or transparency), hiding/showing objects (images, formulas, or graphs), and automating calculations (e.g., calculating examples or physical quantities).

4. Format the document/file so that the teacher can easily demonstrate it in class.

Experts evaluated the implementation of each project according to the criteria (100 points in total):

1. Relevance to the topic and didactic goal (0–20 points.

2. Quality of the developed teaching material (0–20 points).

3. Use of VBA for didactic visualization (0–30 points).

4. Interactivity and ease of use (0–15 points).

5. Creative approach and originality (0–15 points).

It was found that all teachers received relatively high scores ranging from 73 to 92 points, which, according to experts, can be considered a positive learning outcome.

As a result of interviews with teachers, their opinions on the advantages of using VBA macros in the teaching process in terms of accessibility, quick feedback, clarity, and didactic integration were revealed.

"Working with VBA does not require in-depth programming knowledge, but it opens up the possibility of automating routine tasks." "I like that macros provide instant feedback. For example, when a student enters data, the programme immediately highlights errors or important points. This helps to focus attention on essential details and immediately see the results of the simulation." "Using VBA is a convenient way to introduce students to algorithmic thinking gradually. From simple macros, we can move on to creating our own functions and even small educational applications. This contributes not only to the assimilation of the subject, but also to the formation of digital skills."

As a result of our research, we have developed methodological recommendations for the use of VBA macros in teaching science and mathematics.

1. Project design: from model to educational tool.

It is advisable to start developing materials by building a basic model of a phenomenon (e.g., motion, heat transfer, or chemical reaction). This approach enables you to determine the logic of calculations and algorithmic relationships. The next step is to encapsulate parameters and visualizations in VBA forms, which creates a user-friendly interface for students and enables controlled educational experiments.

2. Using VBA as a supplement, not a replacement.

VBA as a means of didactic visualization should be considered as a tool for expanding traditional methods, not as a complete replacement for them. They are particularly valuable when preparing students to solve physics and mathematics problems or experiments based on classical didactic materials. It is advisable to combine VBA solutions with other digital resources, such as computer mathematics systems, virtual laboratories, interactive whiteboards, and online platforms, which ensures the integrity and multidimensionality of the learning process.

3. Using ready-made add-ons to get started.

At the initial stage, it is advisable to use proven add-on packages (e.g., GenAlEx, PSIC) that demonstrate standard analysis and visualization procedures while lowering the barrier to entry for teachers. This allows you to quickly integrate VBA into the learning process without needing to write your own macros immediately. Subsequently, as experience is gained, it is worthwhile to gradually move on to creating author macros and user functions tailored to specific educational goals.

5. Conclusions

The use of VBA macros is an effective tool for integrating digital technologies into the teaching of science and mathematics. An analysis of examples from these fields shows that VBA can facilitate didactic visualization, highlighting key points in the teaching materials. It allows for hidden control of various elements and ensures variability in the presentation of information without disrupting the document's structure.

The proposed method of didactic visualization is based on straightforward techniques for modifying the properties of objects such as text, images, and graphs. This approach ensures that students' attention is focused on key components of the teaching material. Consequently, lecturers can create interactive resources and adapt existing documents with minimal time and effort. In materials with excessive text and few professional symbols, the proposed method may not be suitable because the educational content lacks specific objects. However, with some adjustments, this method can be tailored for a variety of academic disciplines.

The implementation of a professional development program for educators has demonstrated that these lecturers can quickly acquire practical skills in using VBA. Lecturers with no prior programming experience were able to create their own interactive materials, which received positive feedback from experts.

We have developed methodological recommendations for using VBA macros in the teaching of science and mathematics. These include: starting with simple models and gradually increasing the complexity of tasks; using VBA as a supplement to traditional teaching methods rather than as a replacement; beginning with ready-made add-ons before developing custom macros; and providing professional development and creating support materials for lecturers.

Prospects for further research include assessing the impact of VBA-enhanced educational content on students' analytical and algorithmic thinking. It is imperative to study how the integration of such tools contributes to the formulation and testing of hypotheses, the improvement of mathematical modelling skills in science, and the accurate interpretation of results using valid mathematical methods and data analysis tools. According to the researchers, our method could be extended to objects in DOM models, provided that the method remains accessible to the end user.

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