Email:

conference@houghtonstreetreview.com

Website:

www.houghtonstreetreview.com/index.php/conference

© 2026 International Online Conference on Multidisciplinary Academic Research. All Rights Reserved.

Editor-in-Chief:

Dr. Ewelum Johnson Nnadi

Managing Editors:

1.Harold Jan R. Terano

2.Dr. Mandakini Singla

3.Massoud Kaykhaii







INCREASING EDUCATIONAL EFFICIENCY THROUGH THE USE OF MODELING IN PHYSICS LESSONS

Jonibekova Sevara Dilmurod qizi
Andijan State University, the teacher
e-mail: Sevara92@gmail.com,
tel.: +99897-473-23-54
https://doi.org/10.5281/zenodo.23768856

Abstract. The work considers the modeling of physical processes using the graphical capabilities of the Visual Basic programming language on the example of the motion of an object thrown at an angle to the horizon. A new expression is obtained that allows you to determine the angle of launch of the object when the initial velocity of the object and the coordinates of the target are given, with and without air resistance. A program has been created in Visual Basic to model the considered process. A distinctive feature of the program is that the user can quickly independently execute it, observe, compare and draw conclusions. This program can be used in independent learning and physics teaching processes.

Key words. throwing angle, initial speed, coordinates, resistance force, height, range, flight time, target, modeling, program, Visual Basic.

INTRODUCTION

The development of education in the twenty-first century is characterized by the rapid introduction of digital technologies, the continuous improvement of teaching methods, and the emergence of innovative instructional approaches, educational resources, and learning materials. These transformations have created new opportunities for improving the quality of education and organizing the learning process in accordance with the changing requirements of modern society. Contemporary education is expected to provide students with a comprehensive understanding of scientific and cultural achievements, ranging from classical literature and music to the fundamental principles of modern physics, space exploration, bionics, microelectronics, and mathematical modeling. Consequently, one of the major responsibilities of higher education institutions is to establish an educational environment that integrates fundamental theoretical knowledge with innovative methods of instruction.

Maintaining students' interest in learning requires the systematic renewal of teaching approaches, the introduction of interactive educational resources, and the organization of activities that encourage active participation in the learning process. The application of modern pedagogical technologies should therefore be directed toward developing students' intellectual independence, scientific curiosity, creative abilities, and capacity for critical thinking [1, 2]. Problem-based learning occupies an important position among contemporary pedagogical approaches. Its application enables students to participate actively in intellectual and creative activities rather than relying exclusively on the mechanical memorization of educational material. When properly organized, problem-based learning encourages students to acquire a substantial proportion of the required knowledge during classroom activities, thereby

Email:

conference@houghtonstreetreview.com

Website:

www.houghtonstreetreview.com/index.php/conference

© 2026 International Online Conference on Multidisciplinary Academic Research. All Rights Reserved.

Editor-in-Chief:

Dr. Ewelum Johnson Nnadi

Managing Editors:

1.Harold Jan R. Terano

2.Dr. Mandakini Singla

3.Massoud Kaykhaii







making independent preparation more purposeful and productive. In physics education, problem-based learning is particularly important for developing students' cognitive competencies, strengthening their motivation, and promoting the acquisition of practical problem-solving skills. This approach encourages learners to identify scientific problems, formulate hypotheses, seek appropriate solutions, and independently evaluate the results obtained.

The distinctive characteristics of problem-based learning create favorable conditions for the development of creativity, the reduction of passive participation during lessons, and the improvement of students' understanding of physical concepts. Furthermore, this approach supports differentiated instruction by providing opportunities for students to master the required educational content while progressing toward more advanced levels of knowledge and competence [3, 4]. The teaching of physics involves several methodological challenges arising from the specific nature of the discipline. These challenges are associated with the need to represent physical phenomena accurately, demonstrate experimental processes, interpret laboratory results, perform mathematical calculations, and develop students' understanding of physical processes occurring at microscopic and macroscopic scales.

In this context, the effective organization of physics education requires addressing a number of significant methodological difficulties.

First, traditional teaching materials based primarily on printed texts, static illustrations, and mathematical descriptions cannot always adequately represent dynamic physical processes. This limitation becomes particularly evident when studying phenomena involving extremely high velocities, very short time intervals, microscopic dimensions, or large-scale physical systems.

Second, certain physical experiments cannot be performed under ordinary laboratory conditions because of technical, financial, or safety-related restrictions. As a result, their explanation is frequently limited to verbal descriptions, which may be insufficient for developing an accurate understanding of the phenomena under investigation.

Third, the demonstration of some physical processes requires sophisticated experimental equipment, highly accurate measuring instruments, and specialized technical facilities. The absence of such resources can restrict students' opportunities to observe and analyze relevant physical phenomena.

Fourth, the organization of demonstration experiments and laboratory activities may be constrained by insufficient methodological guidance, limited instructional time, inadequate laboratory facilities, and difficulties associated with the practical implementation of experimental procedures.

Fifth, the mathematical complexity of certain topics and physical problems may exceed students' existing mathematical preparation. This situation creates additional difficulties in understanding the physical meaning of mathematical expressions and interpreting the results of calculations.

The integration of computer modeling and information technologies into physics education offers practical opportunities to address these challenges. Computer simulations can reproduce physical processes in a dynamic form, provide graphical representations of mathematical relationships, and allow students to investigate the influence of various parameters on the behavior of physical systems. The present study examines the application of modern information technologies to solving and

Email:

conference@houghtonstreetreview.com

Website:

www.houghtonstreetreview.com/index.php/conference

© 2026 International Online Conference on Multidisciplinary Academic Research. All Rights Reserved.

Editor-in-Chief:

Dr. Ewelum Johnson Nnadi

Managing Editors:

1.Harold Jan R. Terano

2.Dr. Mandakini Singla

3.Massoud Kaykhaii







analyzing problems involving the motion of a projectile launched at an angle to the horizontal. Particular attention is given to the use of a specially developed computer program for visualizing projectile trajectories, investigating the effects of initial conditions, and comparing the motion of a projectile with and without air resistance.

MAIN BODY

The solution of many problems in physics requires the application of advanced mathematical methods, including the solution of transcendental and differential equations, graphical analysis of functions, and evaluation of definite integrals. In numerous practical situations, obtaining an exact analytical solution is difficult or impossible, making numerical methods essential for investigating the behavior of physical systems. The use of computer technologies considerably simplifies the implementation of numerical calculations and creates opportunities for the visualization of physical phenomena. By combining mathematical models with graphical and animated representations, students can examine physical processes more thoroughly and establish relationships between theoretical principles and observable results.

To facilitate the computer-based solution of such problems, the author developed a specialized software application designed to investigate projectile motion under different physical conditions. The program is provided as an executable file with the *.exe extension and is characterized by its relatively small size and straightforward operation. Its interface allows users to perform the required calculations and observe the corresponding physical processes without writing additional program code.

An important feature of the developed software is its ability to support the interactive investigation of projectile motion. Users can enter initial parameters, perform calculations, visualize trajectories, modify the input data, compare the resulting motion patterns, and draw conclusions based on the obtained results. The software is intended primarily for studying the motion of a projectile launched at an angle to the horizontal, both in the absence and in the presence of air resistance.

It provides opportunities to observe the motion through animation, investigate the influence of launch parameters, and determine a suitable projection angle when the initial velocity and target coordinates are specified, provided that the target can be reached under the assumed physical conditions. The program also enables users to visualize whether the modeled projectile reaches a specified target, thereby connecting mathematical calculations with an intuitive representation of the physical process. These characteristics make the software potentially useful for classroom demonstrations, independent learning, virtual experiments, and problem-based instructional activities.

Projectile motion is one of the fundamental topics of classical mechanics and provides a suitable example of the relationship between theoretical analysis, mathematical modeling, and computer simulation. When a body is projected at an initial velocity (v_0) and an angle (\alpha) relative to the horizontal, its subsequent motion is determined by gravitational acceleration and, depending on the physical model, the resistance of the surrounding medium. In the idealized case where air resistance is neglected, the horizontal and vertical components of the initial velocity are expressed as follows:

Email:

conference@houghtonstreetreview.com

Website:

www.houghtonstreetreview.com/index.php/conference

© 2026 International Online Conference on Multidisciplinary Academic Research. All Rights Reserved.

Editor-in-Chief:

Dr. Ewelum Johnson Nnadi

Managing Editors:

1.Harold Jan R. Terano

2.Dr. Mandakini Singla

3.Massoud Kaykhaii







$$v_{0x}=v_0\cos\alpha,$$

$$v_{0y}=v_0\sin\alpha.$$

Assuming that the projectile is launched from the coordinate origin and that the positive vertical axis is directed upward, the equations describing its position at time (t) are

$$x(t)=v_0\cos\alpha\cdot t,$$

$$y(t)=v_0\sin\alpha\cdot t-\frac{gt^2}{2},$$

where (g) represents the acceleration due to gravity.

Eliminating time from these equations gives the trajectory equation:

$$y=x\tan\alpha-\frac{gx^2}{2v_0^2\cos^2\alpha}.$$

This expression demonstrates that the trajectory of a projectile moving under the influence of gravity alone is parabolic.

If the projectile lands at the same vertical level from which it was launched, the horizontal range is determined by

$$R=\frac{v_0^2\sin 2\alpha}{g}.$$

Under these ideal conditions, the maximum horizontal range is achieved at a launch angle of (45^\circ).

The developed computer program makes it possible to visualize these relationships and examine how changes in initial velocity, projection angle, and gravitational acceleration affect the projectile's motion. When air resistance is taken into account, the mathematical description becomes more complex because the resistive force depends on the selected physical model and the projectile's velocity. For example, if aerodynamic drag is assumed to be proportional to the square of the projectile's speed, the equations of motion may be written as

$$m\frac{dv_x}{dt}=-kvv_x,$$

$$m\frac{dv_y}{dt}=-mg-kvv_y,$$

where (m) is the mass of the projectile, (k) is the aerodynamic resistance coefficient in the adopted model, and

$$v=\sqrt{v_x^2+v_y^2}$$

Email:

conference@houghtonstreetreview.com

Website:

www.houghtonstreetreview.com/index.php/conference

© 2026 International Online Conference on Multidisciplinary Academic Research. All Rights Reserved.

Editor-in-Chief:

Dr. Ewelum Johnson Nnadi

Managing Editors:

1.Harold Jan R. Terano

2.Dr. Mandakini Singla

3.Massoud Kaykhaii







is the magnitude of the instantaneous velocity.

In this case, the equations generally require numerical integration, making computer-based methods particularly valuable. The comparison of trajectories obtained with and without air resistance allows students to identify differences between idealized and more realistic mathematical descriptions of projectile motion. Such comparisons are important for developing an understanding of the assumptions underlying physical models and the limitations of their practical application.

The educational significance of the developed program lies in its ability to combine mathematical calculations, visual representations, and interactive experimentation within a single learning environment. During the investigation of projectile motion, students can independently specify the initial velocity, projection angle, and other parameters required by the computational model. The program then calculates the projectile's trajectory and presents the results in a graphical or animated form.

The ability to modify input parameters and immediately observe the corresponding changes enables students to explore the relationships between physical quantities and develop a deeper understanding of the governing principles. Particular educational value is associated with the possibility of comparing different physical scenarios. For example, students can investigate how projectile trajectories change when the initial velocity increases, the projection angle varies, or air resistance is introduced into the model.

The investigation of target-hitting problems also provides opportunities for developing analytical reasoning and practical problem-solving skills. When the coordinates of a target and the initial velocity are known, students can examine possible projection angles and evaluate whether the projectile can reach the specified position. The relationship between mathematical predictions and computer-generated trajectories allows learners to verify calculations and critically evaluate the results of the modeled experiment. In addition, the use of computer animation facilitates the explanation of concepts that may be difficult to understand through mathematical expressions or static illustrations alone.

Consequently, the software can serve as a supplementary instructional tool for integrating theoretical mechanics, numerical analysis, and interactive learning activities. Computer technologies can be applied at different stages of the educational process, including the introduction of new material, consolidation of theoretical knowledge, revision of previously studied topics, independent practice, and assessment of learning outcomes. During the presentation of new material, computer simulations can help instructors demonstrate physical phenomena and explain relationships that are difficult to illustrate using conventional teaching methods.

At the stage of knowledge consolidation, interactive models allow students to apply theoretical principles to practical situations, modify experimental conditions, and compare the results with mathematical predictions. During independent learning, educational software can function as a computational instrument, a virtual laboratory environment, and an interactive resource for self-directed investigation. Computer-based technologies can also support formative assessment by allowing students to verify their solutions, identify errors, and develop more effective strategies for solving physical problems. The educational functions of computer technologies are therefore diverse. Depending on the instructional objectives, digital systems may operate as

Email:

conference@houghtonstreetreview.com

Website:

www.houghtonstreetreview.com/index.php/conference

© 2026 International Online Conference on Multidisciplinary Academic Research. All Rights Reserved.

Editor-in-Chief:

Dr. Ewelum Johnson Nnadi

Managing Editors:

1.Harold Jan R. Terano

2.Dr. Mandakini Singla

3.Massoud Kaykhaii







sources of information, computational tools, objects of study, virtual experimental environments, or instruments supporting collaborative learning. The integration of computer models into physics lessons can contribute to improving instructional clarity, expanding opportunities for practical investigation, and increasing students' engagement with the subject.

Interactive simulations are particularly valuable when they encourage students to move beyond passive observation and participate in the formulation of questions, analysis of physical relationships, and interpretation of experimental results. Nevertheless, the effectiveness of computer-based learning depends on the quality of the software, the methodological organization of educational activities, and the extent to which digital resources are integrated with fundamental physical concepts. Computer simulation should therefore complement rather than replace theoretical reasoning, mathematical analysis, and real laboratory experiments.

The application of computer modeling in physics education offers several important pedagogical advantages.

First, it improves the visualization of physical phenomena by allowing students to observe processes that cannot be easily demonstrated under ordinary laboratory conditions.

Second, computer simulations facilitate the investigation of relationships between physical quantities and provide opportunities for conducting repeated experiments under different initial conditions.

Third, the interactive nature of digital modeling supports the development of students' independence, analytical thinking, and research-oriented learning skills.

Fourth, the use of educational software may reduce the time required for routine calculations, allowing greater attention to be directed toward the interpretation of physical results.

Fifth, computer-based learning environments offer additional opportunities for differentiated instruction and the organization of individualized assignments.

Furthermore, digital educational resources may assist instructors in preparing demonstrations, organizing problem-solving activities, and presenting complex topics in a more accessible form. However, computer modeling also has certain limitations that should be considered when designing the educational process. The results of a computer simulation depend on the accuracy of the underlying mathematical model, the assumptions used, and the numerical methods implemented in the software An inaccurate or oversimplified model may lead students to incorrect conclusions if its limitations are not adequately explained.

In addition, excessive reliance on computer-generated results may reduce students' motivation to perform independent calculations and critically examine the physical meaning of obtained solutions. For this reason, the pedagogical use of computational models should be accompanied by theoretical analysis, comparison with analytical solutions where possible, and discussion of the physical assumptions underlying the simulation. The successful integration of computer technologies also requires appropriate technical resources and sufficient digital and methodological competence on the part of instructors. Thus, computer modeling should be regarded as an effective supplementary component of physics education whose educational value depends on its scientifically justified and pedagogically appropriate application.

CONCLUSION

Email:

conference@houghtonstreetreview.com

Website:

www.houghtonstreetreview.com/index.php/conference

© 2026 International Online Conference on Multidisciplinary Academic Research. All Rights Reserved.

Editor-in-Chief:

Dr. Ewelum Johnson Nnadi

Managing Editors:

1.Harold Jan R. Terano

2.Dr. Mandakini Singla

3.Massoud Kaykhaii







The analysis of computer modeling and innovative educational technologies in physics instruction leads to the following conclusions.

First, the introduction of modern information technologies into physics education creates additional opportunities for improving the visualization of physical processes, strengthening the connection between theoretical knowledge and practical applications, and developing students' independent research skills.

Second, problem-based learning combined with computer simulation provides an effective methodological framework for encouraging active participation, critical thinking, and creative approaches to solving physical problems. Such integration allows students to investigate physical phenomena through observation, mathematical analysis, and computational experimentation.

Third, the application of specialized computer software to the study of projectile motion facilitates the analysis of the relationships between initial velocity, projection angle, trajectory, and other physical parameters. The possibility of comparing motion with and without air resistance contributes to a more comprehensive understanding of the role of mathematical assumptions in describing physical phenomena.

Fourth, the computer program developed by the author offers opportunities for conducting interactive experiments, visualizing projectile trajectories, and investigating target-hitting problems under specified initial conditions. Its use can support the integration of computational methods and physical interpretation within the educational process.

Fifth, the application of computer technologies at different stages of instruction can improve the organization of educational activities, facilitate independent learning, and expand the methodological possibilities available to physics instructors. At the same time, the effectiveness of these technologies depends on their appropriate integration into the curriculum and the professional competence of the teaching staff.

Sixth, computer modeling should not be regarded as a complete substitute for traditional experimental methods. The most appropriate educational approach involves combining theoretical explanations, analytical calculations, laboratory experiments, and numerical simulations in a coherent instructional framework.

In conclusion, the integration of computer modeling and modern educational technologies into the teaching of projectile motion represents a promising approach to improving physics education. The systematic use of interactive computational tools can contribute to the development of students' scientific reasoning, mathematical competence, and understanding of physical laws, while creating favorable conditions for more engaging and research-oriented learning experiences.

1. Майер Р. В. Компьютерное моделирование физических явлений. Глазов:ГГПИ; 2009. 112 с. ISBN 978-5-93008-115-2.
2. Суханова М. Д., Крутова И. А., Стефанова Г. П. Моделирование физических явлений с помощью программных пакетов. Школа будущего. 2021; 5:148-161.
3. Бугаенко Г. А., Маланин В. В., Яковлев В. И. Механика: учебник для вузов. 2-е изд., испр. и доп. М.: Юрайт; 2023. 368 с. ISBN 978-5-534-02640-5.
4. Nosirov M., Ismoilov U., Jonibekova S. Simulation of physical processes based on visual basic medium. E3S Web of Conferences, 508, 04017 (2024) https://doi.org/10.1051/ e3sconf /202450804017 508, GreenEnergy 2023.