Lesia Protsyshak
*Teacher of physics of the highest category of*
*Lviv Academic Gymnasium at the National University "Lviv Polytechnic"*

# VISUALIZATION OF TEACHING USING SYSTEM DYNAMICS IN PHYSICS CLASSES

**Formulation of the problem.** The presence of students' interest in learning and interest in physics contributes to raising the level and quality of knowledge and turns learning into an interesting and exciting process, rather than in a routine. One of the approaches to increasing interest and, as consequence, learning efficiency is the use of electronic learning tools.

The use of computer technology in the physics classroom enhances students' motivation for solving their tasks by means of novelty, active involvement in the learning process of all its participants, monitoring and evaluation of the results.

For the teacher, the software makes the presentation of the teaching material easier, particularly by visualizing it [1, p. 541].

The purpose of the article is the visual representation of graphs of physical quantities through the model "Acceleration" built in the program Stella Architect and its effective use in the educational process in physics.

**Presentation of the main material.** Visualization of educational information allows solving a number of pedagogical tasks: providing intensification of training, activating educational and cognitive activity, formation and development of critical and visual thinking, visual perception, figurative representation of knowledge and educational actions, transfer of knowledge and image recognition, improvement of visual literacy and visual culture [3, p. 75].

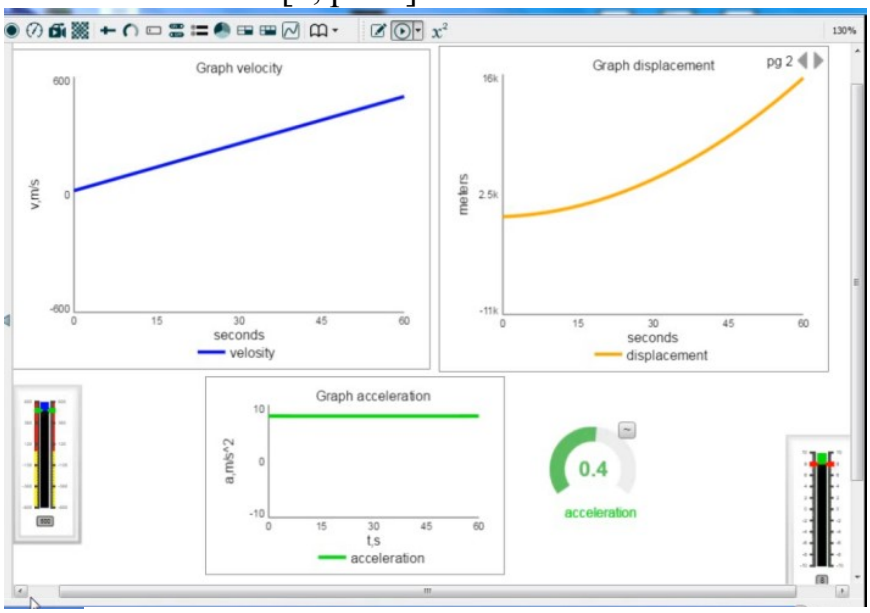


Figure 1. **Graphs of kinematic quantities of accelerated motion**

In physics, graphs of proportions between time and distance are used to show accelerated motion. There is no physical difference between it being shown on paper or in a special application.

If the student makes such a graph in Stella application, they do it step by step. At the same time, they study the physical quantities, check their units of measurement, and test the validity of the kinematic equation. And, after that, they analyze it by themselves. The application allows to change certain variables, which helps to see the changes in the model. When they face real challenges, they use knowledge they gained during this practice.

The model below, «Acceleration», was created with using system dynamics in the Stella Architect software.

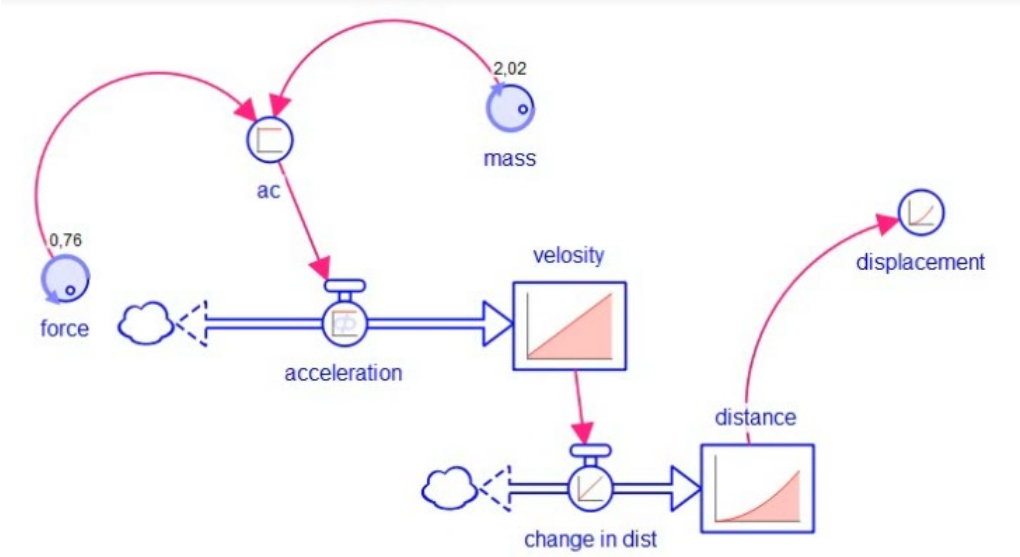


Figure 1. **Model of «Acceleration»**

System dynamics is a powerful methodology and technique of computer simulation for designating, understanding and discussing complex issues and problems. The system dynamics was created in the late 1950's by J. Forrester at the Massachusetts Institute of Technology (MIT).

System-dynamic model consists of a set of abstract elements that represent some characteristics of the simulated system.

However, the process of using models of system dynamics has it's drawbacks as well. One of them is sight stress during long-term use, as well as the complexity of creating hygienic conditions that meet standards, the threat of students losing a sense of boundary between the idealized physical model and the natural phenomenon. In the learning process, the teacher can use well-known and self-developed models, the process of creating which is long, troublesome and requires a teacher of certain skills and efforts.

**Conclusion.** So, the process of studying physics becomes more effective with the use of system dynamics. This occurs at the visual level, and also manifested in the simple understanding of physical processes through flows and stocks. In simplicity, truth always lies, and it helps to get good results in a lesson. In addition, the versatile presentation of system dynamics helps to achieve not only the educational goal, but also educational, which is an important moment in school.

The study of new stimulates activity and professional growth. Therefore, I consider the use of system dynamics in the educational process to be realistic, useful and productive.

### *References*


1. Baryshkin, A. G. and Reznik, N. A. (2003). Basic Parameters of Visualization of Educational Information [Electronic resource]. Informational and publishing house "Filin". – 616 p.
2. Computer Science. Computer Engineering. Computer Technology: Textbook for Students of Higher Educational Institutions / Ed. O. I. Pushkar – K.: Publishing Center "Academy", 2002. – 246 p.
3. Karshiev, X. (2016). Electronic means and methods of teaching to increase the efficiency of the educational process. *Young Scientist*. – №14. – P. 539–542.
4. Poiasok T. B. (2010). Elektronni zasoby navchannia: pedahohichnyi aspekt Pedahohichnyi protses: teoriia I praktyka. – N2. – S. 164–169.
5. Chernylevskyi, D. V. (2002). Dydaktycheskye tekhnolohyy v vysshei shkol. : ucheb. Posobye dlia vuzov.– M. : Yunyty-Dana. – 437s.
6. Методологія системної динаміки Дж. Форрестера. Режим доступу: http://studies.in.ua/mpd_seminar/1312-metodologya-sistemnoyi-dinamki-a.html.
7. Fisher, Diana M. «Lessons in Mathematics a dynamic approach».



Katheryna Savolchuk
*4th-year students, LNU*


## SYSTEM DYNAMIC APPROACH FOR ECONOMIC GROWTH INVESTIGATION

The models of economic growth investigate the mechanisms of influence that the rate of savings, the rate of growth labor resources and technological progress have on the standard of living of the population. Consider a simple model of economic growth that takes into account the behavior of households and firms. This model is described by a system of differential equations:

$$Y = F(K, AL) = K^{\alpha}(AL)^{1-\alpha} \qquad 0 < \alpha < 1$$

$$\dot{L}(t) = nL(t)$$
$$\dot{A}(t) = gA(t)$$
$$\dot{K}(t) = sY(t) - \delta K(t)$$

The production function focuses on three factors: K – capital, L – labor and A – knowledge or technological progress. The stock of capital depreciates over time at a constant rate $\delta$ . The fraction output devoted to investment, s. Labor and knowledge grow at constant rates n and g. Where s, $\delta$ , n and g are exogenous parameters.