CREATING AN INTERACTIVE SOFTWARE ENVIRONMENT FOR ACADEMIC LYCEUM STUDENTS

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Abstract. *This scientific thesis is devoted to the theoretical foundations, methodology, and practical aspects of creating an interactive software environment for academic lyceum students. The research analyzes the essence of interactive learning environments, the macro-mezo-micro level design model, and the role of virtual laboratories and simulation software in the educational process. Additionally, the didactic possibilities and effectiveness of implementing interactive software environments in academic lyceums are evaluated. The proposed approach serves to develop students' cognitive abilities, facilitate visual and practical mastery of subjects, and form independent research skills.*

Keywords: *academic lyceum, interactive software environment, virtual laboratory, simulation, digital educational resources, design model, macro-mezo-micro level.*

One of the most important tasks facing the modern education system is to provide students not only with theoretical knowledge but also with practical skills and competencies. Academic lyceums perform the function of rapidly developing the intellectual abilities of students who have completed general secondary education and preparing them for higher education . At this stage, students are required to master complex scientific concepts, apply them in practice, and develop independent research skills.

Interactive software environments — virtual laboratories, simulation software, animated models, and digital educational resources — enable the effective fulfillment of these tasks. Such environments create opportunities for students to conduct experiments in safe and convenient conditions, visually observe complex processes, and consolidate their knowledge .

The purpose of this thesis is to develop the theoretical and methodological foundations for creating an interactive software environment for academic lyceum students and to provide recommendations for its implementation. The research analyzes the types of interactive environments, their design principles, as well as the specific features of their application in academic lyceums.

An interactive software environment is a set of software tools that ensures two-way communication between the user (student) and the computer, activates the learning process, and facilitates the practical mastery of knowledge. For academic lyceum students, such an environment should possess the following characteristics :

- **Interactivity** — active interaction between the student and the program, with the system responding promptly to the student's actions;
- **Visualization** — representation of abstract concepts through graphic, animated, and 3D models;
- **Simulation** — modeling of real processes and the ability to conduct experiments in a computer environment;
- **Adaptability** — the ability to adapt to each student's level of knowledge and learning pace.

Interactive software environments used in academic lyceums can be classified into the following types :

1. Virtual Laboratories — platforms that simulate real laboratory conditions, enabling safe and cost-effective experiments. For example:

- *PhET Interactive Simulations* — interactive simulations for physics, chemistry, and biology ;
- *Labster* — a platform for advanced virtual laboratory experiments ;
- *ChemCollective* — virtual laboratories for chemistry .

2. Molecular Modeling Tools — software for visualizing chemical structures and molecules:

- *ChemDraw* — drawing molecules and chemical structures ;
- *Avogadro* — 3D molecular modeling ;
- *Molecular Workbench* — visualizing molecular motion and interactions .

3. AR/VR Technologies — educational environments based on augmented and virtual reality:

- *AR Chem* — studying molecular structures through augmented reality ;
- *VR Chemistry Lab* — conducting chemical experiments in virtual reality .

4. Digital Educational Resources — interactive textbooks, online tests, multimedia materials .

When designing an interactive software environment, it is important to distinguish three levels: macro, mezo, and micro levels :

Macro level — determines the organizational context, curriculum, overall goals, and requirements. At this level, the strategic tasks of the educational institution, student population, and available resources are analyzed. The skills to be developed in students are also identified.

Mezo level — the level of pedagogical and didactic modeling, where educational content, learning objectives, pedagogical strategies, and student tasks are defined. The conceptual interface design is also developed at this level. Specifically, it determines what tasks students will perform in the interactive environment and in what sequence they will engage with educational materials.

Micro level — the level of detailed user interface and interaction design, where the mechanisms of interaction between the student and the computer are developed. At this level, the detailed specification of screen design, navigation, animations, and interactive elements is prepared .

When creating an interactive software environment, it is recommended to use the methodology of prototyping and iterative development. This approach enables continuous improvement of the system through repeated cycles of design, development, and evaluation .

Experience shows that when designing interactive multimedia products, separating the design and production stages — completing all design decisions on paper or in script form before proceeding to technical development — yields effective results . Otherwise, correcting errors made during the prototyping phase can be costly and may lead to project failure .

Academic lyceum students (aged 15-17) are at a crucial stage of cognitive development, actively developing abstract thinking, logical analysis, and independent reasoning skills . Therefore, interactive software environments should meet the following requirements:

- Visual and interactive representation of abstract scientific concepts;
- Enabling students to conduct independent research;
- Engaging students as active subjects in solving complex problems.

Digital technologies should serve not only as presentation tools but also as means of transforming the student into an active subject. Animated models that "bring to life" processes such as molecular motion, electron emission rates, or photocurrent formation serve to develop visual perception of abstract concepts .

Interactive software environments create extensive opportunities for teaching various subjects in academic lyceums:

Exact Sciences (Mathematics, Physics) — tools such as GeoGebra and Desmos enable the construction of function graphs, 3D study of geometric shapes, and simulation of physical processes . Virtual models allow students to observe laws with their own eyes and analyze them .

Natural Sciences (Chemistry, Biology) — virtual laboratories enable safe experimentation, 3D study of molecular structures, and observation of chemical reactions . Through virtual laboratories, students' ability to apply theoretical knowledge in practice can be increased by up to 30% .

This scientific thesis has developed the theoretical and methodological foundations for creating an interactive software environment for academic lyceum students. The research findings allow for the following conclusions:

1. Interactive software environments — virtual laboratories, simulation software, AR/VR technologies, and digital educational resources — are effective tools for developing students' cognitive abilities, facilitating visual and practical mastery of subjects, and forming independent research skills in academic lyceums .
2. When designing interactive software environments, the macro-mezo-micro level model should be applied. This model allows for systematic coverage of all stages, from strategic planning to interface details .
3. In creating interactive software environments, using prototyping and iterative development methodologies, and separating design and production stages, yields effective results .
4. The age and cognitive characteristics of academic lyceum students (aged 15-17, active development of abstract thinking) require special attention when designing interactive environments. The software environment should serve to visualize abstract concepts, transform the student into an active subject, and encourage independent research .
5. When creating interactive software environments, it is necessary to rely on pedagogical (activity, visualization, sequencing, feedback) and technical (adaptability, intuitive interface, modular structure, multimedia) principles.

Future research should focus on empirical testing of the proposed model and principles, evaluating the effectiveness of interactive software environments in various academic lyceums, and exploring possibilities for integration with artificial intelligence technologies.

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