Integrated lesson in learning the phenomenon “diffusion”

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Abstract. The purpose of the article is to describe some of the changes in the nature and the function of the integrated methods in physics education for the establishment of scientific literacy. In the article is presented a good practice in the organization and the realization of a lesson - “The phenomenon diffusion”, with 16 years old Bulgarian students. We conducted a physical lesson implementing integrated methods with biology and chemistry knowledge. The lesson also uses interactive methods combined with ICT, which is a good prerequisite for the formation of basic key competences and natural-science literacy.

1. Introduction
The formation of scientific literacy is one of the main purposes in the learning of natural science, which is assumed by their unity with respect to the object of the study - nature in its diverse, scientific methods and approaches. Given this application to the integrated approach in the learning process in physics is a good opportunity for purposeful formation of scientific literacy.

Using integrated methods in teaching physical phenomena is widely applicable in various areas of school. Moreover, when it is taught by different subject teachers leads to a better understanding and reflection of the learning material. Here are specifically described some of the possibilities, opportunities for discourse, illustration and explanation of the phenomena “diffusion” from different points of view in the fields of biology and chemistry. By applying an integrated lesson in physics-education we will adapt the idea of unity and diversity of natural processes which is the main component of scientific outlook: "The integrated training which consists of a full and harmonious development of autonomous and creative personality – this being the goal of contemporary education" [1].

An integrated approach to teaching and learning physics phenomena differs from the traditional in several aspects. In the integrated approach we emphasize the following statements:

- General scientifically understanding of the phenomena;
- Various pedagogical methods;
- Scientific literacy on the three subjects - biology, chemistry and physics;
- Critical thinking and creativity.

Teaching physics in the 21st century is a real challenge for each teacher. Nowadays, technology plays a vital role in the life of young people. This requires changes in the students’ education. Multimedia, virtual classrooms, and cloud technologies are just a part of contemporary education. Furthermore, we can apply a moderate balance between the textbook and the computer in order to transform the compulsory teaching materials to be more enjoyable and easier to understand by the students. Integration (integrative activity) is a process that involves merging, synthesizing, hierarchizing, and system-forming [6].
2. Integrated methods

2.1. Integration

According to Ahuja, an integrated approach to teaching and learning offers an approach that is different from the traditional approach:

- Relational understanding rather than just instrumental understanding;
- Exploring patterns and relationships rather than just memorizing formulas;
- Effective and meaningful learning rather than just learning for test/exams;
- Cooperative learning rather than just individualistic learning [5].

One of the methods to form critical thinking, creativity, team-working and most of all, science literacy is the integrated approach. At the same time, computer technologies that have a proven advantage are already in classrooms, such as educational tools, virtual classroom and applications for various scientific activities. Certainly ICTs take precedence in modern education, so it is good to combine the integrated approach and computer technology in the formation of students' literacy.

Although digital integration is in the heart of 21st century learning, it is not enough to simply "add" to existing teaching methods. There must be a clear and accurate strategy for their use for learning activities. In recent years, students have shown advances in the use of information technology, suggesting that they will be much more open to opportunities related to technology applications.

"The first and basic principle in integrated learning is "learning to know" [2]. Some of the main objectives of the lesson are:

- Forming scientific literacy in students;
- Enhancing the interest of students and their willingness to perform homework when they have the freedom to choose the experiments;
- Active learning through a changed role of the student in conducting a physical experiment for easier and in depth learning of the knowledge and skills underlined in the curriculum;
- Stimulating students to creative and inventive thinking;
- Presenting the opportunities for innovative learning through the use of ICT by students in conducting a physical experiment and its presenting.

The purpose of this report is to present some possibilities for integrating the curriculum content in natural science subjects. We specifically address content elements and ideas that are relevant to the components of scientific literacy. This goal was established by the idea to explore the possibilities of forming scientific literacy in the school course of the Bulgarian school. As such, the authors see integrated lessons between the subjects – biology, chemistry and physics. In recent decades, integrative processes in science and social practice have increasingly influenced the trends of the educational process. Scientists in the field of pedagogical sciences are increasingly looking for ways to realize this trend.

Integration has different considerations, but we accept that it is a "problem-oriented cognitive activity" [3]. Integration can be recognized at both the cross-curricular and internal subject and psychological levels. Furthermore, it can be seen as a specific way of formulating scientific literacy in order to support and better understand the phenomena of reality and to adapt the skills and competencies that make students full and complete persons.

"The integrated training which consists of a full and harmonious development of autonomous and creative personality – this being the goal of contemporary education – targets the stages of education encompassing all the dimensions of the human being." [1] According to Andreev [2], there are three basic principles in integrated learning. The first is called "learning to know" and it does not observe a significant difference from any other subject activity. We need to take into account the fact that integrated activity involves training that is based on practical activity; it forms critical thinking and promotes student’s individuality. The second basic principle is "learning to act". Action is at the heart of life. For this reason, the knowledge from school should be useful. Here it is emphasized that "necessary" knowledge will be required for the development of a person through active learning, rather than simply memorizing formulas and laws. Andreev formulates the third principle as "learning to exist". In this principle, knowledge and activity are combined. The emphasis here is on the quality of life: that
a well-educated and lettered person should achieve a higher quality of life. This can only be accomplished if the student obtaining knowledge has acquired qualities such as critical thinking, autonomy, and not merely quantitative.

2.2. Scientific literacy
Here are four major components when it comes to fostering scientific literacy. [4]:
- Basic scientific concepts, ideas and concepts that have a worldview meaning;
- Knowledge related to the path of scientific knowledge (planning, conducting and analyzing an experiment, setting and testing a hypothesis, presenting results, working with models, etc.);
- Essence of science in the ways of forming scientific thinking;
- Knowledge related to knowing the role of science, its nature and the relationships between science, technology and society.

Each of these components is naturally formed in the students through the purposeful study of physics and astronomy, as well as the other natural sciences.

The world is recognizable and this is most clearly revealed through the natural sciences. The comprehension of phenomena and processes can be done by understanding the scientific truth and revealing the mysteries of nature only through knowledge. The nature of science is such that knowledge is not seen as a tool but is thought of as valuable of itself. The purpose of scientific knowledge is scientific knowledge itself.

3. Experiment
The topic of the lesson is "Diffusion" and can be prepared and delivered by science teachers.

Another component of scientific literacy is related to knowledge about the role of science and its relationship with technology and society. Teachers should discuss the positives and negatives of technical applications and scientific breakthroughs, develop teamwork skills, and build understanding of some of the environmental implications of physical discovery. Thus, they engage in the development of active citizenship among students and become acquainted with basic ethical principles. Studying natural science offers opportunities to teach knowledge related to students' health culture, to establish correct behavior in laboratory conditions and to observe safety techniques. Students can become familiar with the collective nature of science and the importance of adhering to ethical and moral standards in its making. According to Roth and Barton "the scientific ideas the youths learned were important and not only did understanding scientific ideas play a role in success of their gardening practices, but also these ideas were part of the standards for learning in schools.” [7]

We set out to deliver an integrated lesson in physics, biology and chemistry. At the end of the lesson, we tried to summarize the students' views of a different lesson that covered a broad aspect of natural science. The lesson is intended for students studying physics in grade 8. These students have provocative thinking, and are interested in facts and myths related to the creation of the world and the natural laws governing the universe. The activity is part of the curriculum.

The students have to make presentations for the phenomena of diffusion. Each teacher works with a small group of students. They create projects including different points of views of learning the phenomena, to connect the scientific activity with a certain subject. The class is a section of teams with different tasks. Students need to gather the necessary information and distinguish between scientifically proven truths and "myths", to examine physical phenomena and laws, and to present themselves in a comprehensible way. Students are encouraged to use originality and creative thinking when presenting the phenomena. Realistic estimation of the difficulties caused by different media, since they are related to the principles of thermodynamics. Students are given one week to gather the information they need to present to the class. They were told that they should work in a team and focus primarily on information and facts from credible sources, which would then be cited by them. They were also advised that much information does not always lead to success. Each one is given 10 minutes to present and defend their thesis with arguments, using multimedia presentations, photo materials and posters. Students actively participate, discuss the phenomena and use scientific terminology. Tasks are divided into sub-tasks -
each has his or her own duty, which helps the team to explain and describe the thesis better. The objective evaluation of the capabilities of each team member leads to the complete implementation and excellent presentation of their problem. Students participate in presentations, videos, photos, posters and brochures they have developed. They distinguish credible information from "old mythology," trying to provoke their classmates to think logically and to give themselves a real account of the natural laws and the inextricable link with our lives. Students have the freedom to express their personal opinions and to defend them in the way they consider most appropriate. It is this freedom that is their greatest motivator. The whole class is pleased to be involved in the tasks they have set out, in an effort to prove to each one that they have done the best.

3.1. Consequence of the experiment

![Figure 1: Did the use of ICT help you do your homework successfully?](image)

A large percentage of the students find the work with ICT so much interesting. The use of ICT has played a key role in its implementation - this indicates 88%.

![Figure 2: Some barriers when performing the tasks](image)

Figure 2 shows that 80% of the students would be willing to participate in other similar projects if they can use ICT. Most of the students answer that they never, seldom had confusion when using ICT. Half of the students admit that they need additional training for specific computer programs related to physics. They answer with sometimes to easily find information. Before using the above-mentioned methods, students expressed a negative attitude towards research with ICT. They could not see the importance of studying science and the fact that science arouses curiosity, enthusiasm and encourages thinking. After the lesson diffusion, their attitude toward science and research changed. Moreover, they are interested
in the scientific world and interaction between science and technology and express a positive attitude towards the study of science, using an integrated approach.

3.2. After the experiment
Based on a follow-up meeting with teachers of the school about survey results and colleagues from other schools, we propose to undertake this lesson in three additional Bulgarian schools, in order to augment findings from the survey and to inform the development of strategies to improve students’ knowledge and enhance interprofessional collaboration between teachers around the world. Different integrated lessons in learning physical phenomena will relate to the help of ICT.

4. Conclusion
The integrated lessons with the use of the ICT tools develop students’ ability to think logically and make learning interesting and exciting. It is also helping students to assimilate more easily the learning material, preparing experiments by themselves and presenting them in front of the class. Using integrated methods in school’s education help students understand the nature of the phenomenon "diffusion“ and also its applications more deeply. Students are convinced of the social importance of scientific knowledge. They understand the unity of nature, and the generality of scientific methods that are used in the various natural sciences. Students have better comprehension of the relationship between theory and practice.

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5. References
[1] Mușata Bocoș and Vasile Chiș, An Integrated Approach to Curricular Contents: Particular Features for Primary Schools, Cambridge Scholars Publishing, 2013
[2] Andreev M, Integrative tendency in education, Narodna prosveta, Sofia, 1986
[3] Андреев М. Интегративни тенденции в обучението, Народна просвета. (1986)
[4] Raykova Zh, Development Procedural Skills in Science Education – Constructivist Approach, University of Plovdiv, Bulgaria, Plovdiv, (2008)
[5] Ahuja, Om P., Jahangiri, Jay M., An Integrated Approach to Teaching and Learning College Mathematics, Journal of the Korea Society of Mathematical Education Series D: Research in Mathematical Education Vol. 7, No. 1, March 2003, 11–24
[6] Nikolov, P. (1985). Integralniyat podhod v pedagogicheskiya proces. Sofia: Narodna prosveta., (Оригинално заглавие: Николов, П. 1985. Интегралният подход в педагогическия процес. София: Издателство „Народна просвета”)
[7] Wolff-Michael Roth, Angela C. Barton 2004 pp.173, pp. 183, Rethinking Science Literacy