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Analysis of some aspects of the implementation of the integrated course “Science” in the educational process of schools in Ukraine

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Abstract. The integrated course “Science” is being introduced into school curricula in Ukraine for the first time. The article analyzes the experience of implementing an integrated course “Science” in schools of Ukraine. The advantages and disadvantages of various curriculum projects of the integrated course “Science” are discussed. The analysis of the content of the project No 2 of the curriculum of the integrated course “Science” is made. Based on the results of two years of work on the implementation of the experimental integrated course “Science” in the profile school, the analysis of the main problems that arose during the implementation of this course and discusses possible ways to solve them.

1. Introduction

In August 2018, an all-Ukrainian level experiment “Development and implementation of educational and methodological support of the integrated course “Science” for 10-11 grades of general secondary education institutions” started in Ukraine. According to the Order of the Ministry of Education and Science of Ukraine No 863 dated 03.08.2018, the experiment is planned to be completed in October 2022 [5].

The introduction of such an integrated course was a logical continuation of the reform of profilized education in Ukrainian schools. Formally, this integrated course is analogous to the “Science” course taught in schools in the United States and Western Europe. The main purpose of the integrated course is to create in students a holistic scientific perception of the world, the development of curiosity and the ability to apply knowledge of the natural sciences in everyday life.

The integrated course “Science” is positioned as a course that combines the such disciplines: biology, physics, chemistry, astronomy, geography and ecology.

The process of integrated course “Science” learning can be carried out by a teacher of any of the disciplines of the natural cycle (physics, geography, chemistry or biology), or a pair of teachers of natural sciences discipline. Since 2019, special in-service teacher training courses have been launched, focused on preparing for the effective implementation of an integrated course in the teaching process in a profilized school.

From the fall of 2018, 141 schools in Ukraine were to take part in this experiment. There are 4 such schools in Kryvyi Rih, including a Kryvyi Rih Comprehensive School of I-III levels No 122 of the



Kryvyi Rih City Council in Dnipropetrovsk oblast (school No 122). In the 2019-2020 academic year, there are already 5 such schools in the city. Analysis of the structure and features of the integrated course “Science”, as well as generalization of experience in its implementation in the educational process of the school No 122 in Kryvyi Rih is the main purpose of writing this article.

2. Methods

In the competition of projects of curricula of the integrated course “Science”, the Ministry of Education and Science of Ukraine selected four projects, which were recommended for implementation in educational institutions. Each educational institution chose the appropriate project independently, focusing on material and human resources, learning abilities and preferences of pupils and so on.

None of the presented projects is not without flaws. Project No 3 [11] has a significant bias towards biology and the basics of health, project No 4 [3] is only formally integrated - the whole course is divided into separate modules, each of which teaches the material of one separate discipline of the natural cycle. According to the authors of the article, the most balanced and at the same time with a high degree of interdisciplinary integration were projects No 1 [2] and No 2 [13]. But the project No 1, in our opinion, was somewhat overloaded with a physical component. Such an analysis of the projects of the integrated course programs is not thorough, as the authors of the article did not aim at a deep comparison, especially since only one of the projects could be tested. However, the choice of a specific project for implementation was based on these considerations.

A characteristic feature of almost all curriculum projects is the great freedom of choice provided to teachers for their implementation: there is the possibility of rearranging the order of studying topics, changing the number of hours to study the topic, choosing and replacing topics of practical work etc.

In addition, a certain predominance of the physical component in projects No 1 and No 2 can be explained by the typical structure of the study of natural sciences at the standard level (see table 1). As we can see, the study of physics is almost half of the study time spent on the study of all natural disciplines.

Table 1. Fragment of the curriculum for grades 10-11 of general secondary education institutions (natural cycle disciplines studied at the standard level) [4].

Educational disciplines	Number of hours per week in classes	
	10 grade	11 grade
Biology and ecology	2	2
Geography	1.5	1
Physics and astronomy	3	4
Chemistry	1.5	2
Total	8	9

Due to the introduction of the integrated course “Science” it is possible to reduce the weekly workload of pupils, or slightly increase the amount of study time for the study of profilized educational disciplines. This, as the authors rightly noted [1], causes significant dissatisfaction of teachers of natural sciences and mathematics, who lose a certain part of the rate due to the introduction of an integrated course.

The implementation of the experimental course “Natural Sciences” on the Kryvyi Rih school No 122 in 2018-2019 took place with the consent of the parents of students and taking into account the opinion of the pupils themselves – almost all unanimously agreed to study the experimental course instead of individual disciplines of the natural cycle (as a result, two 10th grades were formed: 32 students in 2018 and 34 students in 2019). Most parents justified their decision by the need to pay more attention to specialized disciplines, most pupils – the reluctance to study one or more disciplines of the natural cycle.

The key advantage of implementing an integrated course “Science” is primarily certification of the prevalence of interests, inclinations and opinions of pupils who no longer have the desire and need to study theorized, detached from reality, not provided with a practical component of natural sciences that are not relevant to them [1].

However, this is a very important problem related to the further educational trajectory of pupils. At the beginning of the experiment in 2018, normative documents [8] clearly stated that the integrated course “Science” is studied by those students who do not plan to take an external independent evaluation in any of the natural disciplines (physics, chemistry, biology and geography). In essence, the integrated course “Science” is designed to study in the classes with philology, social sciences, sports and artistic and aesthetic profiles of education.

Later in 2019, normative documents mention that students who have studied the integrated course “Science” have the right to choose one of the subjects of the natural cycle for the state final certification in the form of external independent evaluation [9]. No one has forbidden students to choose an appropriate discipline for external independent evaluation before, but now this seems to confirm that the level of knowledge gained by students during the integrated course is sufficient to be able to choose one of the natural cycle subjects for external independent evaluation.

Thus, there is a problem of compliance of the programs of the integrated course “Science” with the programs of ordinary disciplines of the natural cycle, studied in senior classes at the standard level (i.e., are not profile and not related to the learning profile of pupils).

Table 2. The list of topics of programs of educational disciplines of a natural cycle for 10-11 classes (standard level) which are not reflected in the curriculum of the integrated course “Science” (project No 2).

Educational discipline	Topics of standard level disciplines that are not considered within the integrated course “Science” (project No 2)
Biology	General plan of cell structure. Surface apparatus. Core. Cytoplasm of cells
Physics	–
Chemistry	Theory of structure of organic compounds Hydrocarbons Diversity and relationships between classes of organic matter Chemical reactions
Astronomy Geography	Methods and tools of astronomical research) Asia (section) Oceania (section) America (section) Africa (section) Ukraine in the geopolitical dimension Topography Cartography Ukrainian state The population of Ukraine Political geography and geopolitics

A comparative analysis of the project No 2 [13] with the curricula of natural cycle disciplines studied at the standard level showed quite significant differences in the content and distribution of time to study the main topics of these courses. Briefly, the results of this comparison are shown in table 2.

Geography suffered the greatest losses in the process of integration. This is not surprising, because socio-economic geography is really impossible to integrate with natural sciences. But this poses a serious problem - a significant number of students studying the humanities profile of education to take an external independent evaluation choose geography. Therefore, for them such a gap in knowledge may be crucial. A very small part of this problem is solved by the integrated course “Civic Education”, but only a very small one.

Chemistry in the integrated course “Science” is also quite reduced compared to the standard level curriculum, much fewer reductions have occurred in biology. Physics and astronomy have also been reduced, but quite slightly - mainly at the level of individual semantic parts of topics.

Also, it should be noted very significant differences in the forms of work of students: in the integrated course “Science” preference is given to descriptive methods and project activities of students – almost no forms of work associated with accurate calculations, solving computational problems. This cannot be considered a disadvantage, because modern man, the consumer never uses in everyday life calculations, for example, according to Ohm's law or the Clapeyron-Mendeleev equation. However, simple calculations that may be needed in everyday life in the curriculum of the integrated course are provided. For example, the calculation of the maximum power of electrical appliances that can be connected to the network at the same time.

Most students have a humanitarian mindset, well-developed logical thinking, and the ability to make cause-and-effect relationships, but are reluctant to solve problems that in most cases are detached from everyday life and perceived as the need to calculate abstract quantities. At the same time, according to our personal observations, students loved to do practical work. Students studying the humanities, for whom chemistry is one of the most obscure sciences, lined up to perform their own chemical experiments. The same applied to experiments in physics and biology, practical work in geography. They may not always have interpreted the results of these experiments and their theoretical background quite correctly, they may not always have thinking and calculated correctly, but they may have memorized much more learning data than when watching instructional videos or reading a textbook.

At the beginning of the school year in the 10th grade a monitoring test of residual knowledge in natural sciences was conducted. The test was a mixture of tasks of various forms (including open) from the disciplines of the natural cycle on topics studied mainly in the 9th grade. Table 3 shows the test results as a percentage of the maximum possible number.

Table 3. Results of monitoring testing on natural sciences at the beginning of 10th grade.

Year	Percentage of scored test points				Overall
	in physics	in chemistry	in biology	in geography	
2018	42	31	34	45	38
2019	41	43	36	48	42

The results of these tests showed a low level of knowledge of students, especially in biology and chemistry. The highest level of knowledge was in geography – the most humanitarian among the natural sciences. It is possible that the level of knowledge of pupils in different natural sciences depended not only on their personal preferences and the specifics of the disciplines themselves, but also on the conditions of learning and cooperation with the teacher of the discipline.

The highest score among individual students was 63% in 2018 and 59% in 2019 (two students in the class at once).

At the beginning of the 11th grade (for students who passed the monitoring test in 2018), another test was conducted in the same form, but the tasks were based on what was studied in the 10th grade. The results were slightly higher – 47% of the total score and 74% of the test scores scored by the best student.

3. Discussions

The integration of the natural sciences into any of the curriculum projects does not look perfect at present. Of course, there are topics in which there is no possibility and meaning to integrate all natural sciences, so to a greater extent they reveal the content of only one or two sciences. However, the general principles of integration of natural sciences in most projects of the curriculum of the integrated course “Science” are well thought out and effective.

There is a clear contradiction between the level of planned practical work and the material resources level of schools: starting from the lack of a separate equipped science room, and ending with the need to have for some practical work modern educational equipment, which most schools simply do not have, because they chose a profile that does not require constant use of this equipment. Of course, most of the practical work can be done with the help of improvised means and applied experimentation, in part - through virtual laboratory work. Officials of the Ministry of Education and Science of Ukraine noted that there is no need for effective organization of this course in the use of modern, complex and expensive equipment [12]. But, in our opinion, to teach students who are not interested in natural sciences with the help of a textbook, improvised tools and educational videos - is to finally finish them interested in studying sciences, and therefore reduce the effectiveness of even such a simplified course to zero. Therefore, it may not be necessary to have complex and state-of-the-art devices (they are not always available in schools with science and mathematics profile classes), but to provide schools with the simplest equipment to conduct educational experiments in sufficient quantities is a strict necessity.

A great advantage of the integrated course is the simultaneous study of related topics from different disciplines on common examples. This not only forms a holistic view of the objects of the surrounding world, but also provides an opportunity to avoid inconsistencies in the programs of individual disciplines. For example, according to the biology curriculum for 10th grade [6], the study of the properties of proteins, lipids and carbohydrates and their role in cell life occurs in early 10th grade. And a detailed study of these substances from a chemical point of view (which is important for understanding what functions they can perform) occurs only in the second semester of 10th grade [7]. In an integrated course, such a study takes place simultaneously. There are many such examples.

The weekly workload of 4 hours, which significantly saved time for the study of specialized subjects, led to a certain lack of time for quality implementation of practical work and student projects, associated with a fairly high pace of learning topics. Similar topics within individual subjects of the natural cycle would be studied much more time with almost the same amount of information. Therefore, it is quite appropriate to review the amount of weekly workload when studying the integrated course “Science” in the direction of at least a slight increase.

The lack of high motivation to study the integrated course in most students, due to the fact that this course is not relevant to them (which is logical), and will not be assessed in the form of external independent evaluation. Most students see it as an introductory course that is not required for thorough study. We see a way out of the situation in a certain simplification of the content of the integrated course, increasing its focus on the applied aspects of the natural sciences, but at the same time introducing mandatory external independent evaluation from the course “Science”. Or a comprehensive final exam in disciplines that were not specialized. A graduate of a profilled school should not be equally well versed in all areas of human knowledge, but should still be a fully developed personality. Every modern person, regardless of whether he has a humanitarian or technical nature of thinking, must have a certain minimum of knowledge about the surrounding material world - that is, knowledge of the disciplines of the natural-mathematical cycle. Therefore, it seems logical to introduce such testing, especially since for many students, unfortunately, the best motivator is the fear of failed of external independent evaluation of knowledge in a particular discipline.

Given the impossibility of full integration of social and economic geography with natural sciences, it may be necessary to develop a separate course for students in grades 10-11 “Socio-economic geography” or an integrated course of social and economic geography with economics or law.

At the end of the experiment, if successful, it is important to understand the Ministry of Education and Science of Ukraine position on the school's integrated science course: it will be mandatory for profilled education, or schools will choose between this integrated course and the study of individual disciplines at the standard level. The second option is currently quite questionable, as it will lead to a significant difference in the ability of graduates to pass the external independent evaluation in disciplines of natural sciences.

It is quite difficult for teachers to adapt to the realities of the new discipline: starting from the lack of sufficient methodological materials and ending with the need to urgently engage in self-education - increasing the level of knowledge in those natural sciences that the teacher did not teach. In Ukraine, graduates of pedagogical universities usually receive two specialties for teaching. Of all the available combinations of specialties for teaching the integrated course “Science”, the most suitable are “biology + chemistry” and “geography + biology”. It should be noted that over the two years of the experiment, the teaching community has significantly improved the teaching methods of “Science”: on teachers' personal websites, on other educational resources (including thematic groups on social networks) appeared lesson compendiums and scripts, video collections, multimedia presentations etc.

Starting from 2016, the specialty 014.15 Secondary Education (Sciences) was introduced into the system of higher education of Ukraine. Several pedagogical universities in Ukraine have introduced a bachelor's degree program in this specialty and the first scientific achievements in the practice of training specialists in teaching an integrated course “Science” arose [10]. In our opinion, the beginning of training in higher education institutions should stimulate the development and improvement of teaching methods for the integrated course “Science”, and the modernization of the content of this integrated course.

4. Conclusions

The attempt to introduce an integrated course “Science” in profile learning in schools of Ukraine is an attempt to meet global trends in education. Such integrated courses should provide not deep, but holistic insights into the relevant sciences in pupils for whom it is not the profile of their learning.

The integration of different subjects in the course of “Science” is realized through the study of natural phenomena and processes in terms of several sciences. This approach is implemented in three projects of the curriculum of the integrated course “Science” out of four (projects No 1, 2 and 3). We consider this approach to be the most successful.

The content of the integrated course “Science” more satisfies the educational needs of students in the humanitarian profile, as such students are more willing to perform observations rather than measurements, descriptions of features and logical relationships, rather than calculations. The emphasis on the implementation of project work and the predominance of qualitative judgments over quantitative in the study of “Science” is quite justified, but to completely abandon the activities associated with the implementation of calculations in the learning process is inappropriate.

Motivation to study natural sciences in the humanities can be increased by emphasizing the practical significance of the acquired knowledge and the organization of a quality laboratory workshop in the classroom.

The content of the integrated course “Science” differs significantly from the content of individual disciplines of the natural cycle, which are studied in the profile school at the level of the standard. This is especially true of geography, chemistry and biology. While the choice of chemistry as a field for further study by humanities students is highly unlikely, biology and, in particular, geography are often seen by them as necessary for external independent evaluation. This raises the problem of different opportunities for graduates who have studied the integrated course “Science” and those who studied physics, chemistry, biology and geography separately at the standard level, in obtaining the necessary points for admission to higher education institution.

Among the students who completed two years of study this year under the project No 2 of the curriculum of the integrated course “Science”, a significant number chose geography or biology as disciplines for external independent evaluation of knowledge. It would be very interesting to compare their results with the average in the city and in Ukraine. Unfortunately, due to the COVID-19 pandemic and quarantine measures, the timing of the external independent evaluation has been changed and it is not possible to obtain and analyze these results at the time of writing.

Improving the methodology of teaching the integrated course “Science” is on the part of curriculum developers and teachers participating in the experiment, as well as teams of higher education institutions, which began training bachelors in the specialty 014.15 Secondary Education (Science).

References

- [1] Alyokhin M M and Alyokhina T M 2018 Integrated course “Science” as an alternative to science in the profile school: advantages and disadvantages *Technologies of teaching chemistry at school and ZVO* (Kryvyi Rih: KDPU) pp 60–5
- [2] Domina I, Zadoiany V and Kostyk S 2017 *Science. Integrated course. 10-11 grade* URL <https://mon.gov.ua/storage/app/media/zagalna%20serednya/programy-10-11-klas/2018-2019/prirodnichi-nauki-10-11-domina-zadoyannij-kostik.docx>
- [3] Ilchenko V, Bulava L, Hryniuk O, Huz K, Ilchenko O, Kovalenko V and Liashenko A 2017 *Science. 10-11 grade. Integrated course* URL <https://mon.gov.ua/storage/app/media/zagalna%20serednya/programy-10-11-klas/2018-2019/prirodnichi-nauki-10-11-avtorskij-kolektiv-pd-kerivnicztvom-ilchenko-vr.doc>
- [4] Ministry of Education and Science of Ukraine 2011 *Typical educational program of general secondary education institutions of the III degree* URL <https://mon.gov.ua/storage/app/media/zagalna%20serednya/typovi-programu-2-11/20180420-tipova-osvitnya-programa-10-11-standart-2011-nmo-408.docx>
- [5] Ministry of Education and Science of Ukraine 2018 *About carrying out of experiment of the all-Ukrainian level “Development and implementation of educational and methodical providing of the integrated course “Science” for 10-11 grades of educational institutions of general secondary education” for August, 2018 – October, 2022* URL <https://imzo.gov.ua/2018/08/06/nakaz-mon-vid-03-08-2018-863-pro-provedennya-eksperymentu-vseukrajinskoho-rivnya-rozroblennya-i-vprovadzhennya-navchalno-metodychnoho-zabezpechennya-intehrovanoho-kursu-pryrodnichi-nauky-dlya>
- [6] Ministry of Education and Science of Ukraine 2018 *Biology and Ecology Grades 10-11 (standard level)* URL <https://mon.gov.ua/storage/app/media/zagalna%20serednya/programy-10-11-klas/2018-2019/biologiya-i-ekologiya-10-11-kl-riven-standartu-obgovorennya2.doc>
- [7] Ministry of Education and Science of Ukraine 2018 *Chemistry Grades 10-11 (standard level)* URL <https://mon.gov.ua/storage/app/media/zagalna%20serednya/programy-10-11-klas/2018-2019/ximiya-10-11-riven-standartu.docx>
- [8] Ministry of Education and Science of Ukraine 2018 *Regarding the experimental implementation of the integrated course “Science”* URL <https://imzo.gov.ua/2018/08/23/lyst-mon-vid-20-08-2018-1-9-504-schodo-eksperymentalnoho-vprovadzhennya-intehrovanoho-kursu-pryrodnichi-nauky>
- [9] Ministry of Education and Science of Ukraine 2019 *Regarding the experimental implementation of the integrated course “Science”* URL <https://imzo.gov.ua/2019/07/05/lyst-mon-vid-02-07-2019-1-11-6006-shchodo-eksperymentalnoho-vprovadzhennya-intehrovanoho-kursu-pryrodnichi-nauky/>
- [10] Sadovyi M I 2018 Software of competencies of future specialists 014 “Medium Education (natural sciences)”: content and features of formation *Collection of scientific papers Kamianets-Podilskyi national Ivan Ohienko university. Pedagogical series* **24** 27–30 URL <https://doi.org/10.32626/2307-4507.2018-24.27-30>
- [11] Shabanov D and Kozlenko O 2017 *Science. The past, present and possible future of humanity*

- and the biosphere. Integrated course 10-11 grade* URL
<https://mon.gov.ua/storage/app/media/zagalna%20serednya/programy-10-11-klas/2018-2019/prirodnichi-nauki-10-11-shabanovkozlenko-minule-suchasne-majbutne-lyudstva-i-biosferi.docx>
- [12] Shvadchak N 2017 Pavlo Khobzei about integrated courses: “What should be mainstream has become an experiment and a test” *New Ukrainian School* URL
<https://nus.org.ua/articles/pavlo-hobzej-pro-integrovani-kursy-te-shho-malo-b-butny-mejnstrimom-stalo-eksperimentom-i-aprobatsiyeyu>
- [13] Zasiakina T, Buniak M, Bukhtiarov V, Kapirulina S, Kozlenko O, Niukalo T, Semenenko I, Sokol T, Shabanov D and Shahiieva R 2017 *Science. 10-11 grade. Integrated course* URL
<https://mon.gov.ua/storage/app/media/zagalna%20serednya/programy-10-11-klas/1prirodnichi-nauki-10-11-avtorskij-kolektiv-pid-kerivnicztvom-zasekinoyi-tm.doc>