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INTEGRATION BASES OF SCIENCE EDUCATION IN SUSTAINABLE DEVELOPMENT PARAMETERS OF TYUMEN REGION

Galina Ivanovna Egorova (a)*, Olga Anatolievna Katkova (b), Natalia Gennadievna Ionina (c),
Bibinur Mutovna Chabarova (d), Ulia Anatolievna Boyarkina (e)
Demidova Olga Mikhailovna (f, g)
*Corresponding author

(a) Surgut State Pedagogical University, st. 50 years of the Komsomol, 10/2 Surgut RUSSIA, egorovagi@list.ru,
(b) Tyumen Regional State Institute for education development in regions, 73, Malygin str., Tyumen, Russia, o_a_katkova@mail.ru,
(c) Tyumen Regional State Institute for education development in regions, 73, Malygin str., Tyumen, Russia, nata.nina72@yandex.ru,
(d) Tyumen State University, 6, Volodarsky str., Tyumen, Russia, bchabarova@mail.ru,
(e) Tyumen Regional State Institute for education development in regions" 73, Malygin str., Tyumen, Russia, boyarkina_yuliya@mail.ru,
(f) National Research Tomsk State University, 36, Lenin Ave., Томск, Russia, berezovskaya-olechka@yandex.ru,
(g) National Research Tomsk polytechnic university, 30, Lenin Ave., Tomsk, Russia, berezovskaya-olechka@yandex.ru

Abstract

Integration bases of science education in the parameters of the region sustainable development are understood as certain regularities of improving any social system from politics to economy in the society. Science education is not an exception. A system work should be noted on developing integrated curricula, courses of studying sciences. Today pedagogical conceptions, approaches and methods in teaching are integrated. In contemporary conditions, when issues of the sustainable development of the world, country, and region are acute, it is important to take into account trends of the sustainable development in the society, region, in order to improve the quality of science education. At the same time, integrational bases of science education in the sustainable development of the region are weakly shown in the work of educational establishments. Understanding by the teachers and students basic trends of the sustainable development in the region is important from several positions. The main determinant of the article from the pedagogical point of view is constructing the system of science competence of the learner via studying basic trends of the sustainable development of the region as the media for life activity of the present and future, which determined the performance goals of the pedagogical model, teaching materials.

Keywords: Region, science education, integration, sustainable development

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1. Introduction

Globality and importance of integration bases of science education within sustainable development of the region cannot be estimated in one word. Key topical positions in science education provide quality living of social, and industrial systems. Here, scientific knowledge itself is a basis and a quality tool for studying the world. That is why; learners should know well the basic ideas, laws, and methods of science disciplines within the given hours.

Let us turn to several aspects of topicality of science education. Firstly, the importance of science knowledge, its primary role in person's development is shown. Secondly, a role of science knowledge in the development of industry, synthesizing new materials from raw natural resources to synthetic resin and medicine is great. Thirdly, new methods of synthesizing new matters are aimed at the progress of any state. Fourth, science education is a basis of all human activities, it creates safe environment for every person, develops the civilization. Despite a great importance of the scientific education, there are issues which must be solved. First of all, it is quality training of bachelors and specialists engineers for fields in a thermal-power complex as an important condition of the sustainable development in the region and the Russian Federation (Aganbegyan, 2018). The bases for science education are given at school.

It is important to note a negative attitude and scientific illiteracy in the modern school expressed by the statements: "I don't understand this discipline", "It is not important for me", "I don't need it", "I will not take the Unified State Exam in this discipline". Many students are not prepared for the activity required in the regional industry. The primary task for the teachers of the region is to show the role of the science in the learners' system of knowledge about the world and to show its importance for fuel power industry in the state (Aleksashina, 2009). In solving the second task teachers should make learners understand that science knowledge is important for dialectic relations between the concepts "man-matter", "matter – material – practical activity".

Understanding a scientific world view provides developing materialistic understanding of the environment, the scientific view of the world, culture of the scientific thinking and behavior, which is both important for life activity of a learner and for the sustainable development of the region. Scientific education from school develops further in the university and fills with a certain content all the fundamental ideas about the world: structure, system properties of any type, the form and the transmission mode of the energy, nano-, micro-, mega- particles (atom, molecule, crystals, universe and so on), discretization and continuity, evolution and genesis, matter and substance. The important aspect of the scientific education both at school and at university is the account of socio-cultural, socio-industrial infrastructure of the region area where a learner lives. The applied component of the scientific education is important to determine a profile and further employment of learners (Aleksashina, 2009).

Thus, on the one hand, integration processes comply with all spheres of the region's sustainable development strategy (Bogomolov, 2015). On the other hand, receiving scientific knowledge provides creating new technologies, means, enhancing the process of the sustainable development in the region. This regularity discloses the many-sided regional world, which develops the conceptual type of the rational thinking (Ladenko, 1993).

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2. Problem Statement

Integration bases of science education within the region's sustainable development have been widely discussed in the science literature. Category-conceptual field of the concept "integration" has been determined and proved (Tunnikov, 1988). We will deal with three aspects of the concept, shown in the dialectic dependence "system – process – result". The universal nature of the concept is proved by the fact that integration is in all spheres of life, in animate and inanimate nature, in cognition, in methods of cognition and up-bringing. The science education is penetrated with integration bases. From this perspective let's note conceptions based on the ideas of integration, providing methodological grounds for basic modules of the pedagogical model and teaching complex based on the trends of the region's sustainable development (Chapaev, 2019).

Basing on the conceptual ideas of the pedagogical integration, instructional aspects, let's put the accent on the integrity of the science educational media as a complex of interactions, providing the ideas of the sustainable development of the region into life activity, and set of conditions, preparing a subject to a social activity (Bezrukova, 1991). Scientific educational environment integrates scientific achievements of different fields (chemistry, physics, geography, ecology, biology) and implements them in practical activity. In our research scientific educational environment allows including basic trends of the region's sustainable development, both subject content and practical activity of learners and teachers.

The second conceptual ground for us was the conception (Berulava, 1990), which discloses functionally important focuses of integration (conceptual role of the content, polytechnology, a developing role, versatility of the scientific knowledge). Conceptual ideas, accumulated pedagogical experience discloses the concept "integrative grounds" as an invariant component of the scientific education which is important for good implementation of the sustainable development of the region. Invariant characteristics of integration bases of scientific education allow determine possible ways of implementation the ideas of region's sustainable development: a) via consolidation of pedagogical modules to incorporate into the subject areas; b) determining an individual consolidated module in contents' regionalization with the incorporation of the ideas of the region sustainable development; c) development of teaching materials based on the ideas of the sustainable development of the region (Egorova, 2018).

All possible variants are acceptable as scientific education as an integrated field of knowledge perceives the world as the system of interconnections and interrelations. It is a certain multidimensional integrity working for a shared objective – creating single scientific worldview with aiming at the ideas of the sustainable development of the region and world**.**

3. Research Questions

Nowadays there are certain scientific preconditions necessary and sufficient for understanding by teachers and learners integration grounds of the science education in the parameters of the sustainable development of the region to solve the contradictions between:

- The objective need for the sustainable development in the region and insufficient account of the key propriety areas of the regional surrounding in the educational process;

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- Functional capabilities of scientific education for training learners in the issues of the region's sustainable development and degree of their adaptation to the conditions of the secondary school;
- Necessity to develop the pedagogical model "Integration of the scientific education and regional environment in the parameters of the sustainable development" and their absence in the educational practice.

These contradictions conditioned the set of the following tasks to achieve the aim. What are the basic trends for the region's sustainable development? What possibilities (content, means, forms, methods) of the scientific education with the account of the integration principle are necessary to study and understand the trends in region's sustainable development in the educational process of school, university in order to prepare learners to life activity in the regional community?

4. Purpose of the Study

The methodological grounds for the pedagogical model "Integration of the scientific education within the parameters of the region sustainable development" are the approaches (pragmatic, environmental, integrated), which allow viewing the problem in the context of the cornerstone principles as strategic guidelines (integration, regionalism, innovativeness) (Chapaev & Choshanov, 2017; Zagviazinsky, 2001;). Model construction and implementation have a traditional character. At the first stage the problem conceptual field has been studied (the concepts: region's sustainable development, integration grounds of the scientific education). In content-analysis the effective forms and methods of work have been determined; integration grounds of the scientific education have been disclosed for achieving a certain result (table 01).

Table 1. Integration grounds for the scientific education

Integration grounds for the SE	Essence and manifestation	Result
Subject-idea grounds	Developing full pictures on different areas of reality (social, natural, technological)	Knowledge-representations, knowledge-images
Complex of notions	Synthesis, analysis of notions, generality, extension of a notion	Development of complex (integrated) notions
Worldview	Integration of facts, theories, for creating a unified scientific worldview	Worldview judgements
Pragmatic	Activity integration (cognitive, scientific, practical)	Meta subject competences
Conceptual	Conceptual importance of understanding problems, cause-effect analysis	Conceptual thinking

At the second stage, the model "Integration of the scientific education within the parameters of the region sustainable development" was tested in secondary schools in the Tyumen region. The model included several modules with the account of trends in the sustainable development of the region. In the module of goal-setting important trends of the sustainable development of the Tyumen region were taken into account.

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The content module included the chosen trends of the region's sustainable development to improve the quality of the scientific competence (science knowledge, meta subject skills, and worldview judgments). The pragmatic module included studying integrated elective curricula, courses, with the account of innovative forms of lessons, reports, projects that allowed using different pedagogical methods. The model was implemented with the account of several stages of integration.

Scientific and humanitarian knowledge was integrated at the first stage, which proved the learners moral aspect of main trends of the region sustainable development, with studying general scientific cognition methods.

Integrated curricula with the account of meta subject notions have been created and tested at the second level, incorporated from variable and invariable subject content. Pragmatic nature of the scientific knowledge was taken into account at the third level. Integration leading parameters were created with the account of interaction of schools with enterprises and social surrounding.

The authors have developed teaching materials with the account of key trends of the sustainable development of the regional community. The content of the modules is implemented vertically and horizontally into the subject areas (table 02). The developed content modules are the base for theoretical and practical classes, laboratory classes, science-research work, and the syllabus of the integrated course.

Table 2. Sustainable development trends in the content of educational modules

Trends	The content of educational modules	Subject areas
	Module "Environmental parameters"	
Pure products consumption and loss	Soil. Water, Air.	Biology, geography, ecology, chemistry, physics
Flora and fauna	Lands, forests, plant and animal resources	
Natural resources, mineral raw material	Depletion of natural resources. Environmental contamination: air, water, soil	
Pollutants, dumping, accumulation in the environment	Gaseous, liquids, solids. Hazardous and radioactive wastes. Accumulation tendency.	
Biological diversity. Ozone layer. Anthropological natural disasters	Tempos of changes. Protected areas. Cycles of changes. Depletion of the ozone layer. Environmental discharge.	
	Module "Parameters of the economy and industry"	
Energy/output ratio. Material consumption	Energy. Materials. Parameters calculation	Physics, chemistry, technology, mathematics
Wastes utilisation. Recycling	Production wastes. Wastes utilization and recycling	Ecology, technology, Safety of Living, chemistry, biology
	Module "Health parameters"	
Sickness prevention. injuries	Smoking. Alcoholism. Drug addiction	Chemistry, biology, Safety of Living
	Module "Quality of life indicators"	

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Ecological products	Products quality. Food additives	Ecology, chemistry, biology
Cognitive and cultural needs	Activity, professional motive, interest	Bases of moral and esthetic culture
	Module "Social activity parameters"	
Participating in projects and conferences	Integrated projects, reports, presentations	Chemistry, physics, biology, ecology, geography

Let us have a look at the basic elements of the integrated course "Development of learners' science competence within the parameters of the sustainable development of the Tyumen region".

The first module "Common region characteristics" includes the following study elements (structure, geography, flora and fauna of the region, oil and gas processing cluster, resources, raw materials, industry). The second module "Legislative, legal documents for solving the problems of the region's sustainable development", includes the following study elements (global studies, knowledge sphere, documents of "UNESCO", "United Nations", Declaration of Rio-de-Janeiro, documents of Russian and regional importance). The third module "Common regularities of the sustainable development" includes the study elements (scientific ideas of scientists K.E. Tsiolkovsky, V.I. Vernandsky, components of the sustainable development, the concept of "knowledge sphere", "genesis of knowledge sphere", comparative analysis of the leading principles for the sustainable development of the state and region, new scientific trends "Green economy", "Green chemistry").

The fourth module "Natural management is a leading strategy of the region's sustainable development" is oriented at the study of such elements as: nature management, natural ecological crisis, natural resources, sustainability, "ecosystem of the region" concept, climate, causes of changes, the ozone layer, and acid rains, natural and anthropological disasters.

The fifth module "Sustainable development of the Tyumen region" includes study elements (economy, environment, natural resources, rational nature management, criteria and parameters of the sustainable development in the Tyumen region).

Understanding the concept "sustainable development" is impossible without information about integrated companies and business structures in the region, which contribute to the region's sustainable development parameters. The authors have determined more than 10 key industrial integrated oil and gas processing companies ("Surgutneftegas", "Sibur", "Antipinsk oil and gas processing plant" and others, which also make their contribution to the sustainable development of the region (fig. 1)

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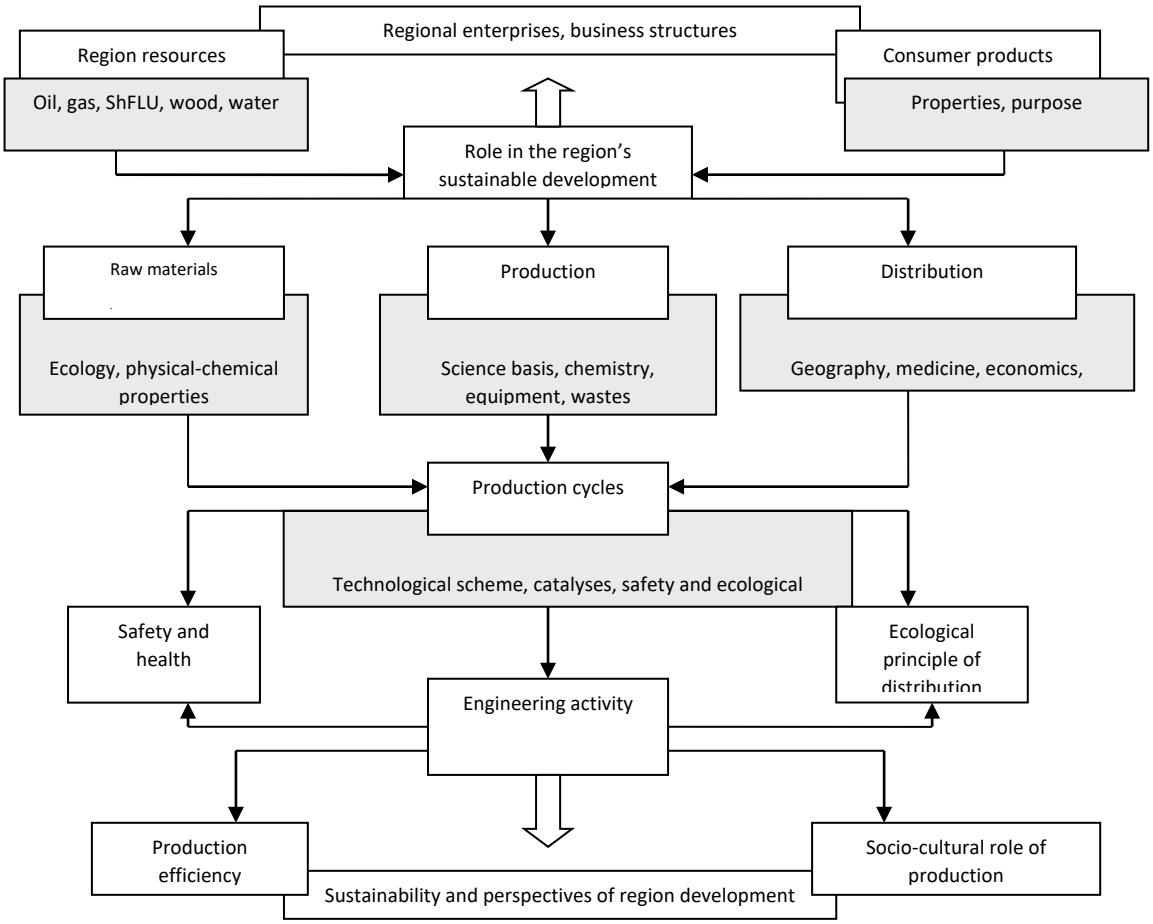

Figure 1. A map "A role of the production in the region's sustainable development"

Learners study history, raw materials, technology, products, wastes, and ways of environmental protection, which further influence the choice of profession. Talking about main production of the integrated company "Sibur" pay attention to more than 2000 goods; processing of more than a half of oil-associated gas and production of varied substances and products of organic and inorganic synthesis: propylene, polypropylene, polyethylene, different types of rubber resin, and many other petrochemicals. We also tell about ecological politics via advanced technology, resource-power saving, waste disposal, environmental protection measures.

Let's give examples of reports and synopsis done in different subject areas: "Innovative ideas of integrated companies and their role in the region development", "Chemistry, technology, ecology and polymers production", "Biochemical parameters of life quality", "Drugs, alcohol, nicotine, influence on the life systems", "Natural resources. Exhaustibility and renewability", "Product quality policy". Such information is beyond the scope of the curriculum, which widens science knowledge. Content modules with the account of the region's sustainable development allowed reconsidering the aims, content and theoretical grounds of the syllabi. The authors have developed a didactic map for studying an industrious object and its role in the region's sustainable development.

The study materials contain a complex of problems with the account of key trends in the sustainable development of the regional community (Velichkov & Zoteeva, 1991). Let us have a look at the problems.

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The problems of the first type (visualization problems) – mental pictures of the surrounding regional world, were done in mind, were built from objects disclosing their properties, distribution in nature, the role of the object in the sustainable development of the region, civilization, culture was shown. Example1. Imagine three science objects of the environment starting with "o" (ozone, water protection, and environment). Do the same with letter "e" (ecology, ecosystem, ecological principle). Disclose their functional meaning. Example 2. Imagine three objects of the region's sustainable development (strategy, raw material base, human health). Example 3. Imagine five objects at the micro level (electron, atom, molecule, substance, crystal) and five objects at the macro level (oil, water, wood, gas, and coal). Create mental pictures on their bases with the account of characteristics, properties, and composition, social, economic, science importance of the object for the sustainable development of the region.

The second type problems – clusterization method problems. Example 1. Find in D.I. Mendeleev's table a chemical element (No. 6, 7, 8….), close your eyes and imagine an atom model. Create a mental image of any chemical element and its role in the world. Example 2. Take a pen, a piece of paper, in the center write words "world", "noosphere", "principles of the sustainable development", "ecological crisis" and so on. Circle each word. Write down all thoughts, feelings, and science associations that this concept arises.

The third type problems – these are practical-problems of ecological, health saving character. Example 1. Can we synthesize ethanol from carbon, oxygen, and hydrogen at standard conditions? How is ethylic alcohol produced in industry? Give a positive and negative role of the ethylic alcohol in socio cultural space of the region it influences on human health. Example 2. Describe the factors influencing waste decomposition in water. Suggest a program of work on studying wastes behavior and water protection (when answering it is necessary to use knowledge in biology, chemistry, physics, geography). Example 3. At average annual race (15000 km) a car consumes (4350 kg of O_2) and exhausts (3250 kg CO_2), (530 kg of CO), (93 kg of carbons), (27 kg of nitric oxide). Analyze these data and make several tasks (a human consumes about 500 liters of oxygen per day).

The system of problem questions on the themes of the sustainable development in the region was especially interesting for the implementation of the integrated courses: "Green chemistry as an integrated science. Prospects for the development", "Famous scientists on the sustainable development of the civilization", "V. I. Vernandsky ideas on noosphere as a sphere of mind", "Principles of the sustainable development – necessity and reality of our time", "Regional bases for the sustainable development", "Globality ideas and nature management", "Ecology crisis and population health", "A comparative analysis of the climatic phenomena", "The Tyumen region in Russia's sustainable development". In order to solve efficiently the integrated science problems a solution constructor has been developed with such main trends as: studying, understanding, application, analysis, synthesis, and estimation of science information with the account of the trends in the region sustainable development.

5. Research Methods

The following theoretical and empirical methods were used to solve the problems: a questionnaire, a test analysis; conversations; science-pedagogical, philosophical problem understanding. Content-analysis

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allowed determining author's approaches to possibility of including the trends of the region sustainable development into the educational process. Mathematical statistic methods were also used in the work.

6. Findings

The implementation of the model was estimated quality and quantity criteria, allowing estimating the dynamic of science knowledge developing. By the quantity criterion, the learners demonstrated higher educational rating, high total amount of points, fixed cumulative system of portfolio, and number of participants in science-research projects based on the region's sustainable development. Quality analysis of the results was conducted by author's tests with the system of integral tasks on the sustainable development of the region. The total quality criterion was determined by three parameters (worldview judgments, meta subject skills, knowledge (ideas and images)), whose meaning allowed to judge about understanding and the trends of the sustainable development in the region.

The dynamics in quality parameters of science knowledge is in figure 02. The total growth of worldview judgments in the experimental group was 11 % (E); in the control group was 2 % (C). The growth parameters in meta subject skills increased by 2 times and was 24 % in the experimental group.

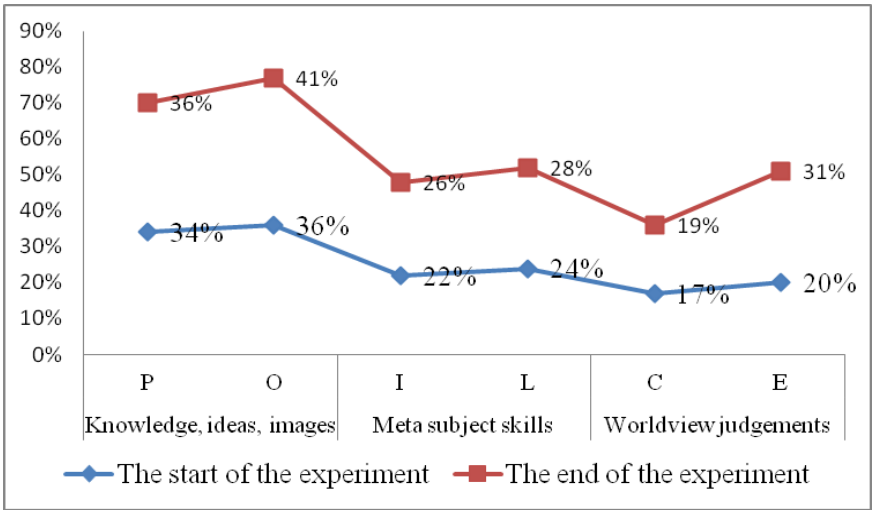

Figure 2. Dynamics of changes in science knowledge parameters

In implementing the pedagogical model, the quality results on utilization of trends of the region sustainable development were received via the project, science-research activity. The quantity of the participants in experimental groups in the regional projects with the trends of the sustainable development increased by 28 %. The results of implementing the pedagogical model prove the fact that high level of science knowledge increases learners' productivity.

7. Conclusion

The work discloses the meaning of integration bases of the science education within the parameters of the region's sustainable development, which are prior not only in improving the fields of human activity (economy, science, technology, ecology), but transforming contemporary knowledge into

scientificity and positive function in the future. Science education is one of the system factors in civilisation and region's sustainable development. Science education gives a full picture on the trends of the region's sustainable development in all spheres of the objective reality – social, natural, technical, cultural. The contradictions and topicality of the theme provided the development and implementation of the pedagogical model "Integration of science education and regional environment within the parameters of the sustainable development". A teaching complex was tested, created with the account of the key trends in the sustainable development of the region, incorporating the system of integrated problems (a problem – visualization, problems – clusters, problems – practices), and the curriculum "Developing of learners' science competence within the parameters of the sustainable development in the Tyumen region". The efficiency of the model was experimentally tested by quantity and quality parameters.

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