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NATURAL SCIENCE LESSONS USING CLIL TECHNOLOGY

Shoira Chariyevna Djalilova
Lecturer, Chirchik State Pedagogical University

Abstract

This article examines the pedagogical potential of natural science lessons organized through Content and Language Integrated Learning technology in contemporary school education. The relevance of the topic is determined by the growing need to improve subject competence and foreign language communication skills simultaneously within an integrated educational environment. CLIL technology enables students to master natural science concepts, laws, and phenomena through a foreign language, thereby creating conditions for meaningful learning, academic language development, and the formation of interdisciplinary thinking. The paper analyzes the didactic foundations of CLIL in natural science education, including the integration of content, communication, cognition, and culture. Special attention is given to lesson design, language scaffolding, visual support, interactive strategies, and task-based learning methods that help students understand scientific material while developing subject-specific vocabulary and communicative competence. The article argues that CLIL-based natural science instruction enhances learner motivation, encourages active participation, and strengthens the connection between theoretical knowledge and practical observation. It also contributes to the development of critical thinking, inquiry skills, and the ability to explain natural processes in a foreign language. The study emphasizes that the effectiveness of CLIL depends on careful methodological planning, age-appropriate linguistic adaptation, and the professional readiness of teachers to combine subject teaching with language instruction. The findings support the view that CLIL technology serves as an innovative educational approach that improves the quality of natural science teaching and promotes the comprehensive intellectual development of learners in pedagogical practice.

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Keywords: CLIL technology, natural science lessons, integrated learning, subject-language instruction, communicative competence, scientific vocabulary, interdisciplinary approach, teaching methodology, cognitive development, classroom interaction.

Introduction

УРОКИ ЕСТЕСТВОЗНАНИЯ С ПРИМЕНЕНИЕМ ТЕХНОЛОГИИ CLIL

Джалилова Шоира Чариевна
Преподаватель Чирчикский государственный
педагогический университет

Аннотация

В данной статье рассматривается педагогический потенциал уроков естествознания, организованных с применением технологии интегрированного обучения предмету и языку в современной образовательной практике. Актуальность темы обусловлена необходимостью одновременного развития предметных знаний и иноязычных коммуникативных умений обучающихся в условиях обновляющейся системы образования. Технология CLIL позволяет усваивать естественнонаучные понятия, законы и явления через иностранный язык, создавая условия для осмысленного обучения, развития академической речи и формирования междисциплинарного мышления. В статье анализируются дидактические основы CLIL в преподавании естествознания, включая интеграцию содержания, коммуникации, мышления и культуры. Особое внимание уделяется проектированию урока, языковой поддержке, визуализации учебного материала, интерактивным стратегиям и методам обучения на основе заданий, которые способствуют пониманию научной информации и развитию предметной лексики. Обосновывается, что уроки естествознания, построенные на основе CLIL, усиливают учебную

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мотивацию, стимулируют активное участие учащихся и обеспечивают более прочную связь между теоретическими знаниями и практическим наблюдением. Кроме того, такой подход способствует развитию критического мышления, исследовательских умений и способности объяснять природные процессы на иностранном языке. Подчеркивается, что результативность CLIL зависит от продуманного методического проектирования, возрастной адаптации языкового материала и профессиональной готовности педагога совмещать предметное и языковое обучение. Сделан вывод о том, что технология CLIL выступает эффективным инновационным подходом, повышающим качество преподавания естествознания и обеспечивающим всестороннее интеллектуальное развитие обучающихся.

Ключевые слова: технология CLIL, уроки естествознания, интегрированное обучение, предметно-языковое преподавание, коммуникативная компетенция, научная лексика, междисциплинарный подход, методика обучения, когнитивное развитие, учебное взаимодействие.

Introduction

The modernization of school education requires the search for pedagogical approaches that are capable of combining deep subject learning with the development of communication skills, critical thinking, and learner independence. In this context, Content and Language Integrated Learning has become one of the most promising educational technologies in contemporary pedagogy. CLIL is understood as an instructional approach in which a subject is taught through a foreign language, and both the content and the language are acquired simultaneously. This technology has gained significant attention in different educational systems because it responds to the demand for multilingual competence, academic flexibility, and interdisciplinary integration. In pedagogical universities, where future teachers are trained to work under innovative educational standards, the study of CLIL methodology is especially

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relevant, since it helps prepare specialists who can organize meaningful and student-centered instruction.

Natural science lessons provide a particularly productive environment for the use of CLIL technology. The content of natural science includes direct observation of the world, explanation of natural phenomena, study of living and non-living systems, and interpretation of relationships between humans and nature. These elements make science education closely connected to real-life experience, visual materials, experimentation, and inquiry-based learning. When such content is delivered through a foreign language, students do not merely memorize isolated words or grammar structures. Instead, they use language as a functional tool for understanding facts, discussing observations, describing processes, comparing objects, forming hypotheses, and presenting conclusions. As a result, the educational process becomes more meaningful, contextualized, and cognitively engaging.

The implementation of CLIL in natural science instruction is also important because the scientific domain naturally contains concepts that can be demonstrated through experiments, images, charts, models, and classroom interaction. These resources reduce language barriers and help learners understand complex material through contextual support. For example, when students study plants, weather, ecosystems, water circulation, or properties of matter in English, they are exposed to both subject knowledge and scientific language patterns. They gradually learn to identify, classify, describe, explain, and interpret. Such activities support the development of academic vocabulary and foster confidence in using a foreign language for real educational purposes. Therefore, CLIL in science is not simply a language exercise added to subject teaching, but an integrated pedagogical system in which language and cognition support one another.

Another reason for the growing interest in CLIL is its effect on motivation. Traditional forms of foreign language instruction often isolate grammar and vocabulary from practical contexts, which may reduce students' engagement. By contrast, CLIL gives language immediate value because it becomes a means of discovering new information. In science lessons, learners are often naturally

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curious about animals, weather, plants, the human body, energy, and environmental issues. When this curiosity is connected with language learning, students become more active participants in the lesson. They ask questions, observe, discuss, solve problems, and collaborate with peers. This active mode of learning creates favorable conditions for sustainable knowledge acquisition and deeper educational involvement.

At the same time, the successful use of CLIL in natural science lessons requires careful pedagogical design. The teacher must balance scientific accuracy with linguistic accessibility. This means selecting age-appropriate terminology, simplifying or scaffolding language without distorting scientific meaning, and organizing tasks that support both comprehension and expression. The teacher also needs to use visual aids, demonstrations, group activities, and structured classroom talk to help students interact with content in a foreign language. For this reason, CLIL is not a spontaneous method but a structured pedagogical technology requiring methodological competence, curriculum adaptation, and reflective teaching practice.

In the educational context of pedagogical training, the study of CLIL-based natural science teaching is highly valuable because it models a modern vision of the lesson as an integrated, interactive, and competence-oriented learning space. It reflects the broader educational shift from reproductive learning to active construction of knowledge. It also aligns with the need to prepare future teachers who are able to use innovative instructional technologies in multilingual and interdisciplinary classrooms. Thus, natural science lessons using CLIL technology represent not only an effective method of combining content and language, but also a powerful resource for improving teaching quality, expanding educational opportunities, and strengthening the intellectual and communicative development of learners.

Methods

The methodological basis of this study is grounded in an integrative pedagogical approach combining content-oriented instruction, communicative language teaching, and learner-centered science education. The research focuses on the

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design and implementation of natural science lessons using CLIL technology in the context of modern educational practice. The methodological framework is based on the understanding that effective science instruction through a foreign language requires the coordinated development of subject knowledge, language competence, cognitive activity, and intercultural awareness. In this regard, the study applies the widely recognized CLIL structure built around four interrelated components: content, communication, cognition, and culture. These components were used as the principal criteria for lesson planning, activity selection, and evaluation of instructional effectiveness.

The content component was organized around key natural science topics typically studied at school level, such as living organisms, the environment, weather phenomena, water, plants, animals, and the human body. These topics were selected because they are concrete, visually accessible, and closely connected to students' everyday experience. The language component included the introduction of essential vocabulary, grammatical constructions, and functional phrases required for describing, comparing, classifying, explaining, and presenting scientific observations. The cognitive component focused on the development of analytical and problem-solving skills through observation, hypothesis formation, experimentation, data interpretation, and oral or written explanation. The cultural component was incorporated through discussion of environmental awareness, responsible attitudes toward nature, and global perspectives on scientific knowledge and ecological issues.

Several complementary research methods were employed to ensure a systematic investigation of the pedagogical possibilities of CLIL in natural science lessons. First, a theoretical analysis of pedagogical, methodological, and didactic literature on integrated learning, science education, and bilingual instruction was conducted. This made it possible to identify the conceptual foundations of CLIL and determine the methodological principles most relevant to natural science teaching. Second, a descriptive method was applied to characterize the structure of CLIL-based lessons and the instructional strategies used by teachers in practice. Third, elements of pedagogical observation were included to analyze

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classroom interaction, student participation, language use, and the level of engagement during science lessons organized through CLIL principles.

The practical organization of the lessons followed a staged instructional model. At the initial stage, the teacher introduced the topic using visual prompts, real objects, short videos, pictures, or experiments to activate prior knowledge and create a meaningful context. At the second stage, core vocabulary and language structures were presented through scaffolding techniques such as word banks, sentence frames, labeling activities, matching tasks, and guided questioning. At the third stage, students engaged in content-focused tasks, including pair discussions, classification of objects, completion of observation charts, reading short scientific texts, and describing simple experiments. At the final stage, learners demonstrated understanding through oral presentations, written summaries, diagrams, concept maps, or reflective responses.

Special methodological attention was given to scaffolding strategies. These included simplified teacher speech, repeated key terms, visual reinforcement, cooperative learning, and gradual transition from supported responses to more independent production. The learning process was organized in a way that minimized fear of language errors and encouraged active participation. The emphasis was placed not on perfect linguistic form, but on meaningful use of language as a medium for scientific understanding. Such a methodological model made it possible to create a balanced learning environment in which scientific content remained central while foreign language acquisition developed naturally through purposeful classroom activity.

Results

The implementation of CLIL technology in natural science lessons demonstrated a range of positive pedagogical outcomes related to subject understanding, language development, learner motivation, and classroom interaction. The analysis of lesson organization and student participation showed that integrated instruction created a more active and meaningful educational environment than traditional subject teaching or isolated foreign language practice. One of the most significant results was the improvement in students' ability to understand

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natural science concepts through contextualized language exposure. Because scientific content was presented with the support of visual materials, demonstrations, structured teacher guidance, and interactive activities, learners were able to grasp new information even when their foreign language proficiency was still developing. This suggests that CLIL can make scientific knowledge accessible without reducing the intellectual value of the subject.

Another important result concerns the development of subject-specific language competence. During the lessons, students gradually acquired essential scientific vocabulary and functional language patterns needed to describe objects, explain processes, compare phenomena, and formulate simple conclusions. Their speech became more purposeful because language was used not for abstract drills but for communication within a real academic context. For example, learners used foreign language expressions to name parts of plants, describe the properties of water, explain the life cycle of organisms, and discuss changes in weather conditions. The integrated nature of these tasks increased retention of vocabulary and improved students' readiness to use foreign language structures in a meaningful and cognitively engaging way. As a result, language learning became connected with intellectual activity rather than mechanical memorization.

The results also indicate a noticeable increase in learning motivation. Natural science topics usually generate curiosity because they are closely related to the surrounding world and the students' own observations. When these topics were taught through CLIL, the lesson gained an additional dimension of novelty and challenge. Students showed greater interest in participating in experiments, interpreting pictures and diagrams, asking questions, and sharing ideas. The use of a foreign language in subject learning did not create only difficulty; it also stimulated attention and emotional involvement. Learners perceived the lessons as more dynamic and modern, especially when the teacher used collaborative tasks, games, short scientific videos, and practical demonstrations. This motivational effect is especially valuable in contemporary education, where sustained engagement is a key condition for deeper learning.

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A further result was the development of cognitive and communicative skills simultaneously. CLIL-based natural science lessons encouraged students not only to remember scientific facts but also to think, analyze, and explain. Through classification tasks, observation charts, guided comparisons, and cause-and-effect discussions, students learned to organize information logically and express their reasoning through simple academic language. Even when their sentences remained linguistically limited, they were able to demonstrate genuine cognitive activity. This confirms that foreign language learning within science education can support the growth of higher-order thinking skills if the lesson is methodically designed and appropriately scaffolded. Students were more likely to engage in prediction, interpretation, and explanation when language was presented as a tool for inquiry.

The classroom atmosphere also changed in a productive direction. Lessons using CLIL technology tended to promote cooperation, peer support, and interactive communication. Students worked together more frequently, helped one another understand new terms, and became more confident in expressing ideas. Teacher-student interaction was more dialogic and less reproductive, which supported a learner-centered model of education. Errors were treated as part of the learning process, and this reduced anxiety while encouraging experimentation with language. Such an environment is particularly important for the formation of communicative competence and educational independence.

In general, the results demonstrate that natural science lessons using CLIL technology contribute to the integrated development of learners. They strengthen scientific understanding, expand foreign language abilities, improve motivation, and support the formation of analytical and communicative skills. These outcomes confirm the pedagogical effectiveness of CLIL as a modern instructional technology capable of enriching both subject education and language education within a unified teaching framework.

Discussion

The results obtained from the analysis of natural science lessons using CLIL technology confirm that integrated subject-language instruction has substantial

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pedagogical value in modern education. The discussion of these findings shows that CLIL is not simply an additional teaching technique or a linguistic variation of traditional science lessons. It functions as a complex educational model that transforms the logic of the lesson itself. In this model, language becomes a cognitive instrument for learning content, while scientific content provides a meaningful and authentic framework for communication. Such reciprocity between language and subject matter creates conditions for deeper understanding, greater learner involvement, and more sustainable knowledge acquisition.

One of the central issues requiring discussion is the educational significance of contextualized learning. In conventional foreign language teaching, students often encounter vocabulary and grammar in artificial situations detached from real intellectual tasks. In contrast, CLIL-based science lessons place language inside the process of inquiry, explanation, classification, and observation. This significantly increases the semantic load of linguistic units and makes learning more functional. Students do not learn isolated words merely to reproduce them later. They use language to identify natural objects, explain scientific relationships, discuss environmental changes, and express conclusions. Therefore, language ceases to be a separate academic target and becomes a practical tool of cognition. This shift is methodologically important because it aligns with contemporary competence-based education, in which the ability to use knowledge is valued more than the simple possession of information.

The findings also suggest that CLIL creates favorable conditions for interdisciplinary integration. Natural science itself is a field that combines empirical observation, conceptual understanding, environmental awareness, and applied reasoning. When a foreign language is integrated into this domain, the lesson becomes a platform for simultaneous development of several competencies. Students improve scientific literacy, expand vocabulary, strengthen communication skills, and develop logical thinking through a single instructional process. Such interdisciplinary synthesis is one of the strongest arguments in favor of CLIL, especially within pedagogical education, where future teachers are expected to implement flexible and innovative teaching

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approaches. From this perspective, natural science lessons using CLIL serve not only as a model of classroom methodology but also as an example of broader educational modernization.

At the same time, the discussion must also address the methodological difficulties associated with this approach. The effectiveness of CLIL cannot be assumed automatically. It depends on several pedagogical conditions. One of the most important is the teacher's readiness to work in an integrated instructional format. A teacher implementing CLIL must understand both the scientific content and the linguistic demands of the lesson. This requires the ability to select vocabulary carefully, adapt explanations, use scaffolding techniques, and organize interaction in a way that supports understanding without oversimplifying the content. If the linguistic complexity is too high, students may become confused and disengaged. If the scientific material is reduced excessively for the sake of language accessibility, the educational value of the subject may decline. Therefore, methodological balance is the core requirement of successful CLIL practice.

Another issue concerns differentiation and learner diversity. Not all students enter the lesson with the same level of language proficiency, cognitive readiness, or confidence in communication. As a result, CLIL lessons require flexible instructional design, varied tasks, and differentiated support. Visual aids, structured speaking frames, collaborative activities, and gradual movement from supported to independent expression are not optional details but essential pedagogical tools. The findings indicate that when such support is provided, students can successfully engage with subject content even at modest language levels. This has important implications for inclusive and learner-centered education, showing that integrated learning can be accessible if proper methodology is applied.

The discussion also highlights the motivational dimension of CLIL. Students are often more engaged when they see a real purpose for language use. In natural science lessons, the foreign language is directly connected with discovering new facts, conducting observations, and discussing phenomena from everyday life. This purposefulness creates stronger internal motivation than repetitive

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language drills. Moreover, the novelty of working across two domains at once often increases attention and classroom energy. However, motivation should not be considered a spontaneous effect. It must be sustained through meaningful tasks, clear instructions, supportive feedback, and carefully structured lesson progression.

In pedagogical terms, the use of CLIL in natural science lessons reflects a wider transformation of education toward integration, competence development, and active learning. The findings demonstrate that this approach can enrich the educational process by bringing together cognition, communication, and practical understanding of the world. At the same time, its successful implementation requires professional training, methodological literacy, and thoughtful adaptation to specific classroom conditions. Therefore, CLIL should be regarded not as a temporary innovation, but as a strategically significant educational technology with strong potential for improving the quality of natural science teaching and the broader preparation of future educators.

Conclusion

Natural science lessons organized through CLIL technology represent an effective pedagogical model that responds to the contemporary need for integrated, competence-oriented, and learner-centered education. The analysis presented in this article demonstrates that the combination of subject learning and foreign language development creates favorable conditions for meaningful knowledge acquisition, stronger communication skills, and deeper cognitive involvement. In the context of natural science education, this integration is especially productive because the subject itself is closely connected with observation, experimentation, real-life phenomena, and inquiry-based learning. These characteristics make natural science highly suitable for CLIL implementation, as scientific content can be supported through visual, practical, and interactive forms of instruction while simultaneously expanding students' academic language resources.

The study confirms that CLIL technology contributes to several important educational outcomes. First, it increases the accessibility and meaningfulness of

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scientific knowledge by placing learning in a contextualized communicative environment. Students do not approach scientific concepts as isolated facts to be memorized, but as ideas to be understood, described, compared, and explained through language. This improves both conceptual comprehension and the ability to use language functionally in academic situations. Second, CLIL supports the development of scientific vocabulary, oral expression, and basic academic discourse, which strengthens learners' confidence and readiness to participate in subject-related communication. Third, the approach promotes motivation because it links language learning with discovery, experimentation, and real-world relevance, thereby making the lesson more engaging and intellectually stimulating.

An equally important conclusion is that CLIL-based natural science instruction encourages the simultaneous development of cognitive and communicative competencies. Students are not only exposed to new lexical units and grammatical structures, but also involved in analysis, classification, observation, reasoning, and presentation. This proves that language learning can become a medium of higher-order thinking when classroom tasks are properly structured. The educational value of CLIL lies precisely in this integration: language supports cognition, while cognition gives language real purpose. Such an approach aligns with modern pedagogical priorities that emphasize active learning, interdisciplinary thinking, problem solving, and the practical application of knowledge in meaningful contexts.

At the same time, the successful application of CLIL in natural science lessons depends on certain methodological and organizational conditions. Effective implementation requires careful lesson planning, age-appropriate adaptation of content and language, the use of scaffolding techniques, and the creation of a supportive classroom atmosphere in which students are not afraid to experiment with language while learning subject material. The teacher plays a decisive role in balancing scientific accuracy with linguistic accessibility. Therefore, professional training and methodological preparedness are essential prerequisites for the full realization of CLIL potential in educational practice. This is particularly significant for pedagogical universities, where future

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teachers must be prepared to work in innovative instructional environments and to design lessons that integrate multiple dimensions of learning.

In general, CLIL technology can be regarded as a strategically important direction in the improvement of natural science teaching. It broadens the didactic possibilities of the lesson, enhances interdisciplinary links, and supports the comprehensive intellectual development of learners. By combining scientific content with language-mediated interaction, CLIL transforms the lesson into a dynamic educational space where knowledge is actively constructed rather than passively received. For this reason, natural science lessons using CLIL technology should be considered a valuable resource for modern pedagogy and an effective instrument for improving the quality of education, strengthening communicative competence, and preparing learners for participation in a multilingual and knowledge-based world.

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