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# EFFECTIVENESS OF CLIL METHODOLOGY IN BIOLOGY EDUCATION

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**ANNOTATION.** This article examines the effectiveness of the Content and Language Integrated Learning (CLIL) methodology in secondary and higher biology education. It highlights how CLIL improves students' subject knowledge, increases foreign language proficiency, enhances critical thinking, and strengthens motivation. The study concludes that CLIL provides meaningful learning through authentic communication, inquiry-based tasks, and interdisciplinary integration.
**Keywords:** CLIL (Content and Language Integrated Learning), bilingual education, integrated curriculum, biology education, scientific literacy, academic language, inquiry-based learning, scaffolding, cognitive development, multilingual competence, pedagogical strategies
**АННОТАЦИЯ.** В статье рассматривается эффективность методики предметно-языкового интегрированного обучения (CLIL) в преподавании биологии в средней и высшей школе. Показано, что CLIL улучшает предметные знания учащихся, повышает уровень владения иностранным языком, развивает критическое мышление и повышает мотивацию. Исследование подтверждает, что CLIL обеспечивает осмысленное обучение через аутентичную коммуникацию, исследовательские задания и междисциплинарную интеграцию.
**Русские ключевые слова:** CLIL (интегрированное обучение предмету и языку), двуязычное образование, интегрированная учебная программа, биологическое образование, научная грамотность, академический язык, исследовательское обучение, скаффолдинг (пошаговая поддержка), когнитивное развитие, многоязычная компетентность, педагогические стратегии

## INTRODUCTION

In modern education systems, increasing the quality of learning and ensuring students' active involvement are among the main objectives. One of the pedagogical approaches that effectively addresses these needs is the **Content and Language Integrated Learning (CLIL)** methodology. CLIL simultaneously focuses on teaching subject content while improving learners' foreign language skills.

Biology, as an experimental and observation-based science, is especially suitable for CLIL integration. Biological concepts, processes, and laboratory analyses provide natural opportunities for communication, reading comprehension, and the use of academic vocabulary in a foreign language. Therefore, studying the effectiveness of CLIL in biology education is both timely and relevant.

## LITERATURE REVIEW

CLIL is based on the 4C Framework (Coyle, 2007):
**Content** – mastery of subject knowledge
**Communication** – language as a tool for learning
**Cognition** – development of thinking and problem-solving skills

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**Culture** – understanding global and local perspectives
Biology lessons allow full implementation of these components through experiments, diagrams, models, scientific texts, and group discussions.
Research shows that students learning biology through CLIL:
better memorize key terms (cell, tissue, ecosystem, metabolism, etc.),
deepen understanding through bilingual explanations,
use scientific reasoning more confidently.
The dual-channel processing of information (content + language) increases retention.
CLIL significantly enhances:
academic vocabulary,
reading comprehension of scientific texts,
oral communication during experiments and discussions,
writing skills (lab reports, summaries, posters).
Learners use English as a real communication tool, not just in language exercises.
Motivation increases because:
lessons become interactive and meaningful,
students work with real scientific problems,
tasks require collaboration,
learning a foreign language occurs naturally.
Gamified tasks, projects, and laboratory simulations make the lessons more dynamic.

**Scaffolding.** Teachers provide:
glossaries,
visual aids (charts, diagrams),
sentence starters,
simplified instructions.
This helps students gradually master both language and content.

**Inquiry-based learning.** CLIL biology lessons include:
experimentation,
observation tasks,
hypothesis building,
data interpretation,
presentations.
Students learn how to think like young scientists.

**Assessment in CLIL.** Assessment focuses on:
subject knowledge (tests, quizzes),
language performance (accuracy, fluency),
group participation,
project presentations.
Rubrics help evaluate both content and language together.

**RESULTS AND DISCUSSION**

Researchers (Dalton-Puffer, 2011; Mehisto, 2012) report that CLIL students outperform non-CLIL peers in:
long-term retention of scientific terms,
problem-solving skills,

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communication abilities,
confidence in using academic English.
In Uzbek biology classrooms, pilot studies similarly show:
increased active participation,
better lab report writing,
improved pronunciation of scientific terminology,
deeper understanding of processes (photosynthesis, respiration, genetics).

**EXTENDED ACADEMIC CONTENT**

**1. Theoretical Foundations of CLIL**

**1.1. Origin and Development of CLIL**

Content and Language Integrated Learning (CLIL) emerged in Europe in the mid-1990s as part of the European Union's strategy to promote multilingualism, mobility, and educational modernization. David Marsh first introduced the term in 1994, emphasizing that learning content through an additional language accelerates cognitive, linguistic, and academic development simultaneously. Over the past three decades, CLIL has evolved into one of the most influential bilingual education models worldwide.

**1.2. Core Idea of CLIL**

Unlike traditional language teaching, which focuses mainly on grammar and vocabulary, CLIL involves teaching subject content—such as biology—**through a foreign language**, allowing language to serve as **a medium of instruction** rather than an isolated subject. This dual-focus approach develops:
subject knowledge
communicative competence
cognitive skills
cultural awareness

**1.3. The 4C Framework (Coyle, 2007)**

CLIL is built on four interrelated components:

**1. Content**

Students acquire subject knowledge related to biology, such as cell structure, genetics, ecosystems, evolution, and human physiology.

**2. Communication**

Language is used for learning and communicating scientific concepts, enabling students to develop academic vocabulary and functional language.

**3. Cognition**

Learners engage in higher-order thinking skills, including analyzing, synthesizing, applying, and evaluating biological information.

**4. Culture**

Students develop intercultural understanding and view science from global perspectives.

**1.4. Pedagogical Theories Supporting CLIL**

CLIL is grounded in several educational theories:

**Constructivism (Piaget, Vygotsky)**

Learners construct new knowledge through interaction, collaboration, and meaningful engagement.

**BICS & CALP (Cummins, 1981)**

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CLIL develops not only conversational English (BICS) but also academic language proficiency (CALP), which is essential for scientific learning.

**Dual Coding Theory (Paivio, 1991)**

The combination of visual information (diagrams, charts, images) and linguistic input strengthens memory retention—highly relevant for biology.

**Sociocultural Theory**

Language becomes a tool for social interaction and knowledge construction.

**1.5. Advantages of CLIL in Scientific Subjects**

Enhances both language and subject knowledge
Increases long-term memory retention
Improves reasoning skills
Supports international scientific communication
Encourages student autonomy and engagement

**2. Effectiveness of CLIL in Biology Education**

**2.1. Enhancement of Subject Knowledge**

Research shows that biology taught through CLIL leads to:
deeper conceptual understanding
better mastery of scientific terminology
improved ability to explain scientific processes
strengthened logical and analytical skills

CLIL learners often demonstrate superior performance in understanding complex topics such as photosynthesis, genetics, and ecological interactions.

**Mechanisms behind subject improvement**

**Dual input** (content + language) improves cognitive processing.
**Visual and textual integration** enhances comprehension.
**Collaborative learning** reinforces knowledge through interaction.

**2.2. Development of Language Proficiency**

CLIL significantly contributes to academic English skills:

**Vocabulary Development**

Students learn technical terms (e.g., nucleus, diffusion, biodiversity) in authentic contexts, ensuring deeper understanding.

**Reading Skills**

Scientific texts, lab instructions, graphs, and research summaries improve reading comprehension.

**Speaking Skills**

Group discussions, presentations, laboratory explanations, and scientific debates enhance fluency and accuracy.

**Writing Skills**

Lab reports, summaries, posters, and research reflections build academic writing competencies.

**Research Evidence**

Studies by Dalton-Puffer (2011), Mehisto (2012), and Lasagabaster (2017) show that CLIL students score higher in:
academic vocabulary
scientific text comprehension

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spoken fluency
task-based performance

**2.3. Increased Motivation and Classroom Engagement**

Biology CLIL lessons are highly engaging because they:
use experiments and hands-on activities
include real scientific problems
involve games, experiments, models, and multimedia
provide meaningful tasks with real-life relevance
As a result, students:
participate more actively
show higher levels of curiosity
demonstrate stronger academic confidence
express positive attitudes toward both biology and English

**2.4. Cognitive Development and Higher-Order Thinking**

CLIL biology requires students to:
analyze data from experiments
construct and test hypotheses
interpret diagrams, tables, and graphs
make scientific predictions
evaluate evidence and draw conclusions
This develops HOTS (Higher Order Thinking Skills), including:
critical thinking
problem-solving
conceptual reasoning

**2.5. Development of Global Competences**

Through CLIL, learners:
gain access to global scientific knowledge
understand international biological terminology
become prepared for international exams, olympiads, and research opportunities
This makes them competitive in modern scientific and academic environments.

**3. Strategies for Implementing CLIL in Biology Lessons**

**3.1. Scaffolding Techniques**

Scaffolding is essential for supporting both language and content learning.

**Language Scaffolding**

glossaries of key biological terms
sentence starters for scientific explanations
grammar support frames
model texts (lab reports, descriptions)
academic discourse phrases

**Content Scaffolding**

diagrams, charts, timelines
labeled models and illustrations
graphic organizers (Venn diagram, KWL chart)
flowcharts of biological processes

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These supports gradually reduce as students become more independent.

**3.2. Inquiry-Based Learning**

Inquiry-based tasks strengthen both scientific skills and language proficiency.

Examples in biology:

microscope analysis of plant and animal cells
osmosis and diffusion experiments
modeling DNA structure
ecology fieldwork investigations
genetic probability simulations

Students formulate hypotheses, record data, describe observations, and present findings—in English.

**3.3. Visual and Multimedia Support**

Biology relies heavily on visual representation.

Useful tools:

labeled diagrams of cells and organs
animations of mitosis and meiosis
interactive models of ecosystems
infographics
charts and graphs for data interpretation

Visuals reduce language load and increase comprehension.

**3.4. Effective Lesson Planning for CLIL**

Each CLIL lesson must include:

**Content Objectives**

What biological concepts students should learn.

**Language Objectives**

Which linguistic skills and vocabulary they will use.

**Cognitive Objectives**

Which thinking processes they should develop.

**Learning Activities**

Hands-on tasks, experiments, group discussions, digital tools.

**Assessment Methods**

Aligned with both subject and language targets.

**3.5. Assessment in CLIL Biology**

Assessment includes two components:

**A. Language Assessment**

vocabulary accuracy
clarity and fluency
correct use of academic expressions
written coherence

**B. Content Assessment**

conceptual understanding
ability to explain biological processes
accuracy of lab reports
interpretation of graphs and scientific data

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Rubrics help maintain balance and transparency.

**3.6. Teaching Techniques in CLIL Biology**

Effective methods include:

**Jigsaw Reading** (students share different parts of a text)
**Think–Pair–Share** (critical thinking + communication)
**Project-Based Learning** (ecosystem models, genetic studies)
**Role-play** (e.g., "cell organelles debate")
**Flipped Classroom** (videos before class, practice during class)
**Cooperative Learning** (team experiments)
**Socratic questioning** (deep reflection)

**Conclusion.** The analysis demonstrates that CLIL is a highly effective methodology for teaching biology. It strengthens both subject mastery and language skills, promotes active learning, and prepares students for global scientific communication. Implementing CLIL in biology requires teacher training, material adaptation, and systematic assessment. Nonetheless, its benefits make it a valuable approach for modern education systems.

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