Educator Insights: A Journal of Teaching Theory and Practice
Volume 01, Issue 12, December 2025
brightmindpublishing.com
ISSN (E): 3061-6964

STRENGTHENING STUDENTS' THEORETICAL KNOWLEDGE AND DEVELOPING PRACTICAL COMPETENCIES THROUGH EXPERIMENTATION

Shokir Xudoynazarovich Berdiyev
Lecturer at the Department of Physics,
Chirchik State Pedagogical University

Abstract

Physics is a discipline in which theory and practice are inseparably linked. Most physical laws, principles, and formulas are derived from experiments; therefore, experimentation plays an essential role in deepening students' theoretical understanding and strengthening their practical competencies. This article analyzes how classroom experiments facilitate the comprehension of abstract concepts, support the formation of research skills, develop analytical and problem-solving competencies, and enhance students' ability to connect theory with real-life phenomena. The paper further examines methodological approaches to organizing experimental activities, including demonstration experiments and open-inquiry laboratory work, highlighting their advantages and pedagogical implications. The study concludes that experimental learning environments significantly improve students' conceptual understanding, scientific thinking, and readiness for practical application of knowledge.

Keywords: Physics education, experiment, conceptual understanding, laboratory work, inquiry-based learning, scientific thinking, practical competence.

Introduction

УКРЕПЛЕНИЕ ТЕОРЕТИЧЕСКИХ ЗНАНИЙ УЧАЩИХСЯ И ФОРМИРОВАНИЕ ПРАКТИЧЕСКИХ КОМПЕТЕНЦИЙ ЧЕРЕЗ ЭКСПЕРИМЕНТ

Бердиев Шокир Худойназарович
Преподаватель кафедры физики, Чирчикского государственного педагогического университета

Educator Insights: A Journal of Teaching Theory and Practice
Volume 01, Issue 12, December 2025
brightmindpublishing.com
ISSN (E): 3061-6964

Аннотация:
Физика это дисциплина, в которой теория и практика неразрывно связаны. Большинство физических законов и формул были получены в результате экспериментов, поэтому использование эксперимента играет ключевую роль в углублении теоретических знаний учащихся и формировании их практических компетенций. В статье анализируется влияние школьных экспериментов на понимание абстрактных понятий, развитие исследовательских навыков, аналитического и проблемного мышления, а также способность учащихся связывать теорию с реальными жизненными явлениями. Рассматриваются методические подходы к организации экспериментальной деятельности, включая демонстрационные опыты и открытые лабораторные работы. Делается вывод, что экспериментальное обучение существенно повышает уровень понимания, научного мышления и готовность применять знания на практике.

Ключевые слова: физическое образование, эксперимент, концептуальное понимание, лабораторные работы, исследовательское обучение, научное мышление, практические компетенции

INTRODUCTION

Physics is one of the fundamental sciences that connects theory with practice through observation, measurement, and experimentation. Nearly all physical laws were discovered, verified, and refined through experiments; thus, the roots of theoretical physics lie in empirical investigation. For this reason, experimentation is considered one of the most effective pedagogical tools for helping students understand theoretical concepts through real, observable examples.

Studies show that almost all students (approximately 91–100%) believe that experiments significantly facilitate their comprehension of theoretical material. A well-designed experiment visualizes abstract formulas, turning theoretical constructs into tangible processes. This makes physics a discipline in which each principle can be demonstrated clearly and logically.

This article explores the pedagogical significance of experiments in physics education, the role of laboratory work in strengthening theoretical knowledge, and the ways experiments contribute to the development of practical, analytical, and research competencies.

Educator Insights: A Journal of Teaching Theory and Practice
Volume 01, Issue 12, December 2025
brightmindpublishing.com
ISSN (E): 3061-6964

METHODS

This paper employs:

Analytical review of physics education research, including results from PERC (Physics Education Research Conference), IOP teaching guidelines, and European pedagogical studies.

Comparative analysis of demonstration experiments and student-led laboratory activities.

Interpretation of empirical findings from modern inquiry-based science education.

Pedagogical reasoning based on classroom practice, observational data, and expert commentary (e.g., P. Logman, Leiden University).

The method focuses on synthesizing research findings with practical instructional strategies to assess the effectiveness of experiments in enhancing both theoretical understanding and practical competence.

RESULTS

1. Experiments facilitate deeper conceptual understanding

Students exposed only to theoretical explanations often struggle to visualize physical phenomena. Experimental activities "bring theory to life," enabling learners to observe, measure, and directly manipulate physical variables. For example, assembling a simple electrical circuit helps students understand Ohm's law more thoroughly than reading a formula alone.

Experiments reinforce memory retention:

"I heard – I forgot, I saw – I remembered, I did – I understood."

2. Laboratory work develops essential practical and scientific competencies

Through experimentation, students learn to:

Observe and record small changes in physical systems,

Analyze data and identify causal relationships,

Form hypotheses and test them,

Compare predicted and actual results,

Solve technical and conceptual problems during the experimental process.

Such competencies reflect genuine scientific practice and prepare students for independent inquiry.

Educator Insights: A Journal of Teaching Theory and Practice
Volume 01, Issue 12, December 2025
brightmindpublishing.com
ISSN (E): 3061-6964

3. Experiments connect theory with real-life contexts

Everyday observations such as bicycle gear ratios, mirror reflections, or the behavior of liquids under sound waves provide powerful examples that link formulas to reality. When students recognize the relevance of physics in daily life, their motivation increases significantly.

4. Methodological approaches influence learning outcomes

Two primary forms of experimentation were analyzed:

a. Demonstration experiments

Efficient, safe, and suitable when equipment is limited.

Enable clear presentation of key principles.

b. Student-led laboratory work (including open inquiry)

Promotes autonomy, creativity, and higher-order thinking.

Allows students to design procedures, pose questions, and interpret results independently.

Encourages experimentation beyond "cookbook" instructions.

Research shows that open-inquiry laboratories lead to higher engagement and deeper conceptual understanding.

DISCUSSION

The findings reveal that theoretical instruction alone yields limited outcomes; students may memorize formulas without fully grasping their meaning. Experiments compensate for this gap by providing hands-on experiences that foster inquiry, reflection, and scientific reasoning. Open laboratory formats where students design and conduct their own investigations are especially effective in developing research competence.

P. Logman notes that theoretical models rarely match real experiments perfectly, as factors such as friction or measurement error always influence outcomes. Observing such discrepancies deepens students' conceptual insight and strengthens their analytical skills.

Thus, experimental learning environments cultivate not only subject knowledge but also creativity, independence, and critical thinking competencies essential for future scientific or technical careers.

Educator Insights: A Journal of Teaching Theory and Practice
Volume 01, Issue 12, December 2025
brightmindpublishing.com
ISSN (E): 3061-6964

CONCLUSION

Experimental instruction is indispensable in physics education. While theoretical lessons provide foundational knowledge, only through experimentation can students truly understand, internalize, and apply physical principles. Experiments reinforce theoretical learning, develop practical and analytical competencies, stimulate scientific curiosity, and prepare learners for real-world problem solving. The study concludes that physics teaching without experimentation is incomplete akin to constructing a pool without water. Only when theoretical knowledge is enriched with experimental practice can genuine understanding and competence emerge.

REFERENCES

1. Iskandarov A.Y., Kuchkarov M.A., Shernazarov I.E. “Formation of students’ research, practical and scientific literacy through experimental activities.” Innovation: The Journal of Social Sciences and Researches, 2023, No. 5, pp. 59-67.
2. Toshmurodov, B. X., Yo‘ldoshev, M. O‘. Umumiy o‘rta ta’limda fizika laboratoriya mashg‘ulotlarini tashkil etish metodikasi. - Toshkent: O‘qituvchi, 2019. - 184 b.
3. Qodirov, O. R. Fizika darslarida nazariy bilimlarni mustahkamlashda tajriba va kuzatuvlarning roli. - Qarshi: Nasaf, 2021. -142 b.
4. Rasulov, Sh. B., To‘xtasinov, A. N. Fizika ta’limida amaliy mashg‘ulotlar va eksperimental metodlar: o‘quv-metodik qo‘llanma. - Toshkent: Innovatsion Ziyo, 2020. - 128 b.