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Effects of Experimental Activities on Students' Learning in Life and Earth Sciences: A Quasi-Experimental Study in Moroccan Secondary Education

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Abstract

This study aimed to evaluate the impact of experimental activities on students' learning in Life and Earth Sciences (LES). Conducted within a secondary school context, the research involved a sample of 100 students, divided into 20 groups of 5 learners each, who participated in an experimental activity related to the study of soil. A quantitative descriptive approach was adopted based on a pre-test, an experimental intervention, a post-test, and a satisfaction questionnaire.

The results revealed a substantial improvement in students' understanding of the targeted concepts, with the average score increasing from 49.39% in the pre-test to 86.70% in the post-test, representing a gain of 37.31 percentage points. Furthermore, most students reported that the experimental activity facilitated their understanding of the lesson, enhanced their motivation, and promoted active participation. The findings also showed that 97.5% of the learners considered the activity useful or very useful, while an equally high percentage expressed positive levels of motivation during the experiment.

These results highlight the pedagogical value of experimental activities in facilitating scientific learning, strengthening student engagement, and developing essential scientific skills such as observation, analysis, and interpretation. The study supports the integration of inquiry-based and hands-on learning approaches in Life and Earth Sciences teaching. Despite certain limitations related to the sample size and the absence of a control group, the findings emphasize the importance of experimental work as an effective teaching strategy for improving the quality of science education.

Keywords: Life and Earth Sciences, experimental activities, learning, student motivation, inquiry-based learning, scientific skills, secondary education.

1. Introduction

Science education plays a crucial role in developing students' scientific literacy, critical thinking, and problem-solving skills. In Life and Earth Sciences (LES), practical activities are essential because they enable learners to construct scientific knowledge through observation, experimentation, and inquiry rather than passive memorization.

Constructivist and sociocultural theories emphasize that meaningful learning occurs through active engagement and collaboration (Piaget & Inhelder, 1972; Vygotsky, 1978). These principles underpin Inquiry-Based Science Education

(IBSE), which encourages students to investigate scientific questions through evidence-based reasoning (European Commission, 2007). Previous studies have consistently demonstrated the educational benefits of inquiry-based learning. Meta-analyses by Minner et al. (2010) and Furtak et al. (2012) reported positive effects on students' conceptual understanding and academic achievement, while Freeman et al. (2014) showed that active learning significantly improves student performance in STEM disciplines.

In Morocco, the secondary school curriculum promotes competency-based learning and the integration of practical investigations into Life and Earth Sciences. However, the implementation of experimental activities remains limited by constraints such as insufficient laboratory resources, limited instructional time, and large class sizes. Consequently, further empirical evidence is needed to evaluate the effectiveness of inquiry-based experimental learning within the Moroccan educational context.

The present study aimed to investigate the impact of an inquiry-based experimental activity on students' learning of soil science in secondary education. Specifically, it examined changes in students' academic achievement, motivation, and perceptions of the educational value of experimental learning.

2. Materials and methods

2.1 Study Design and Participants

This study employed a quasi-experimental one-group pretest-posttest design to evaluate the educational impact of an inquiry-based experimental activity on students' learning in Life and Earth Sciences (LES). The research was conducted during the 2025–2026 academic year in a Moroccan public secondary school as part of teacher professional training at the Regional Center for Education and Training Professions (RCETP).

The study involved 100 students enrolled in the Common Core Science program. Participants were selected from one intact classroom using a convenience sampling approach commonly adopted in classroom-based educational research. To promote collaboration and active participation, students were organized into twenty groups of five learners during the experimental activity.

2.2 Educational Intervention

The intervention consisted of an inquiry-based practical activity focusing on the study of soil composition. Students investigated natural soil samples through observation, manipulation, comparison, and interpretation of experimental evidence. Working collaboratively under the teacher's supervision, they identified soil constituents, discussed their observations, and formulated scientific explanations based on the collected evidence.

The instructional sequence followed the main phases of inquiry-based science education, including problem identification, observation, hypothesis formulation, experimentation, interpretation of results, and collective discussion. Throughout the intervention, the teacher assumed the role of facilitator, guiding students through the inquiry process while encouraging active participation, collaborative learning, and evidence-based reasoning.

2.3 Data Collection Instruments

Data were collected using three complementary instruments. First, a pretest was administered before the intervention to evaluate students' prior knowledge of soil science concepts. The same assessment was used as a posttest immediately after the experimental activity to measure learning achievement.

Following the intervention, students completed a structured questionnaire designed to assess their perceptions of the experimental activity, including motivation, classroom engagement, perceived usefulness, and ease of understanding.

2.4 Data Analysis

Data were analyzed using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA). Descriptive statistics, including means, frequencies, and percentages, were calculated to summarize students' academic performance and responses to the questionnaire.

Learning gains were determined by comparing mean pretest and posttest scores. Although descriptive statistics were appropriate for the objectives of the present classroom-based study, future research should incorporate inferential statistical analyses, such as paired-samples *t*-tests, effect size estimates (*Cohen's d*), and 95% confidence intervals, to provide more robust evidence regarding the effectiveness of inquiry-based experimental instruction.

2.5 Ethical Considerations

The study was conducted in accordance with the ethical principles governing educational research. Participation took place within regular classroom activities and involved no physical or psychological risk to students. All collected data were anonymized prior to analysis, and participants were informed that the information would be used exclusively for

research purposes without affecting their academic assessment.

3. Results and Discussion

3.1 Effect of Inquiry-Based Experimental Activities on Students' Academic Achievement

The comparison between students' pretest and posttest scores revealed a marked improvement in learning achievement following the implementation of the inquiry-based experimental activity. As illustrated in **Figure 1**, the mean achievement score increased from 49.39% in the pretest to 86.70% in the posttest, representing an absolute learning gain of 37.31 percentage points.

The substantial improvement observed in students' achievement suggests that inquiry-based experimental instruction effectively enhanced conceptual understanding of soil science. The practical activity encouraged students to actively engage in scientific inquiry by observing soil samples, manipulating materials, discussing experimental observations, and constructing evidence-based explanations. Such experiences are known to facilitate conceptual change by linking theoretical knowledge with authentic scientific practice.

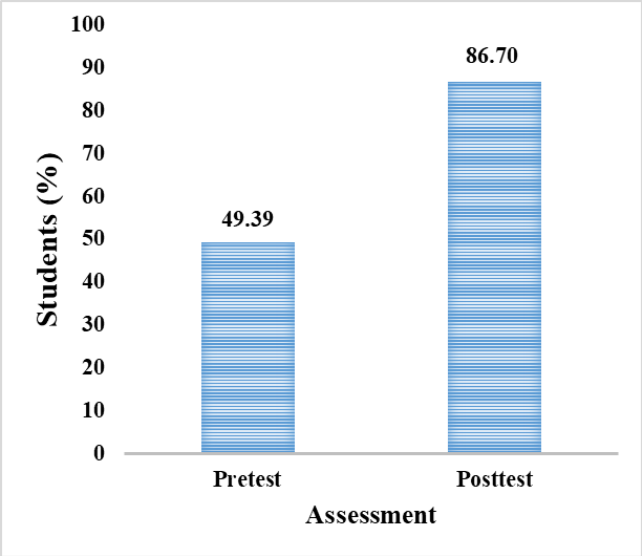

Figure 1: Mean achievement scores in the pretest and posttest.

These findings are consistent with the research synthesis conducted by Minner et al. (2010), who concluded that inquiry-based science instruction positively influences students' conceptual understanding when learners are actively involved in the investigative process. Likewise, the meta-analysis by Furtak et al. (2012) demonstrated that inquiry-oriented instruction produces significant improvements in science achievement by promoting active knowledge construction. Similar conclusions were reported by Lazonder & Harmsen, (2016), who emphasized that appropriately guided inquiry-based learning enhances both conceptual understanding and scientific reasoning.

From a theoretical perspective, the observed learning gains support the constructivist framework proposed by Piaget & Inhelder, (1972), which considers learning as an active process of knowledge construction through interaction with the environment. They also align with Vygotsky, (1978) sociocultural theory, according to which collaborative learning and guided inquiry promote higher-order cognitive development. The present findings therefore reinforce the view that experimental activities facilitate meaningful learning by enabling students to construct scientific concepts through direct experience rather than passive reception of information.

3.2 Effect of Experimental Activities on Students' Motivation and Classroom Engagement

Students reported very high levels of motivation during the experimental activity. As presented in Figure 2**,** 52.5% of participants described themselves as highly motivated, 45.0% reported being motivated, whereas only 2.5% expressed low motivation.

The high level of motivation observed in this study highlights the capacity of inquiry-based practical activities to create engaging learning environments. Unlike traditional lecture-based instruction, experimental learning requires students to manipulate scientific materials, formulate explanations, collaborate with peers, and actively participate in the learning process. Such learner-centered experiences increase students' sense of autonomy, curiosity, and ownership of learning.

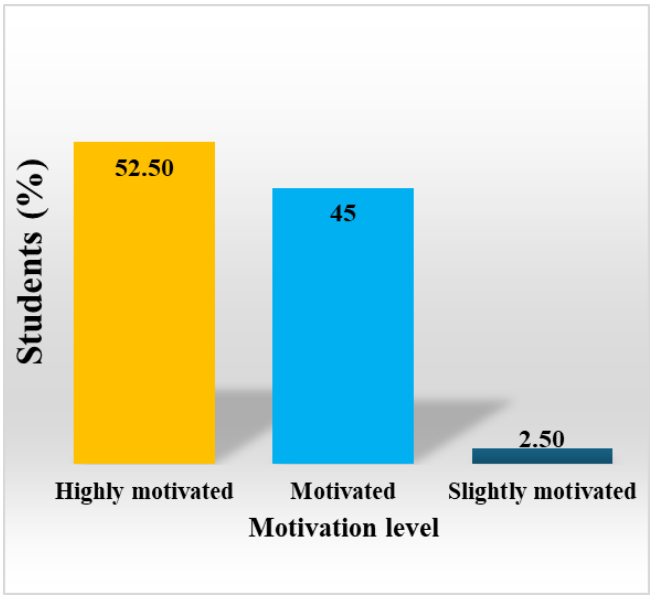

Figure 2: Students' motivation during the inquiry-based experimental activity.

These findings are consistent with the principles of active learning, originally described by Bonwell & Eison (1991), who argued that students learn more effectively when they actively participate in meaningful educational activities. More compelling empirical evidence was provided by Freeman et al. (2014), whose meta-analysis involving 225 studies demonstrated that active learning significantly improves academic performance while reducing failure rates in STEM disciplines. Similarly, National Research Council (2000) emphasized that scientific inquiry promotes motivation by encouraging students to ask questions, investigate phenomena, and develop evidence-based explanations.

The positive motivational outcomes observed in the present study may partly explain the substantial improvement in students' academic achievement. Educational research consistently shows that motivated learners invest greater cognitive effort, persist longer in challenging tasks, and adopt deeper learning strategies, ultimately leading to higher academic performance.

3.3 Students' Perceptions of the Educational Value of Experimental Learning

Students expressed overwhelmingly positive perceptions regarding the educational effectiveness of the inquiry-based experimental activity. As shown in Figure 3, 50.0% of participants reported that the activity made the lesson much easier to understand, whereas 42.5% considered it easier. Only 7.5% indicated that the experimental activity did not substantially change their level of understanding.

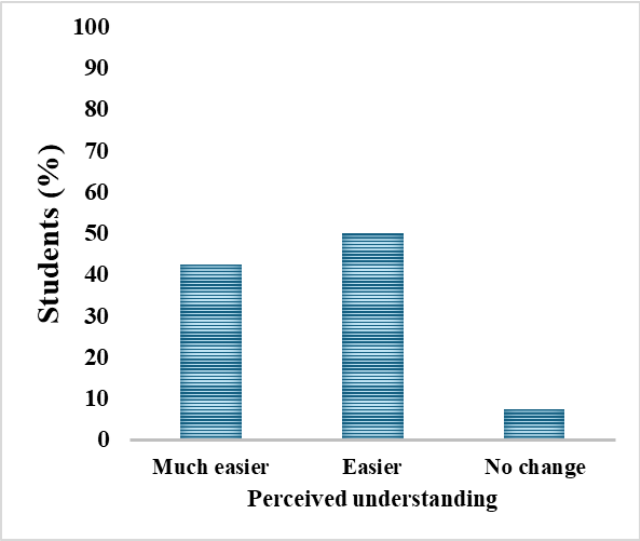

Figure 3: Perceived effect of the experimental activity on lesson understanding.

These findings suggest that practical experimentation facilitated students' conceptual understanding by enabling them to directly observe scientific phenomena and establish meaningful connections between theoretical concepts and empirical evidence. Experimental activities therefore appear to reduce the cognitive distance between abstract scientific ideas and observable reality, thereby promoting deeper conceptual learning.

Students also compared inquiry-based experimental instruction with conventional theoretical teaching (**Figure 4**). Approximately 67.5% reported that experimentation provided a better understanding of the lesson, while 20.0% perceived no difference between the two instructional approaches. Only 12.5% considered traditional theoretical instruction to be more effective.

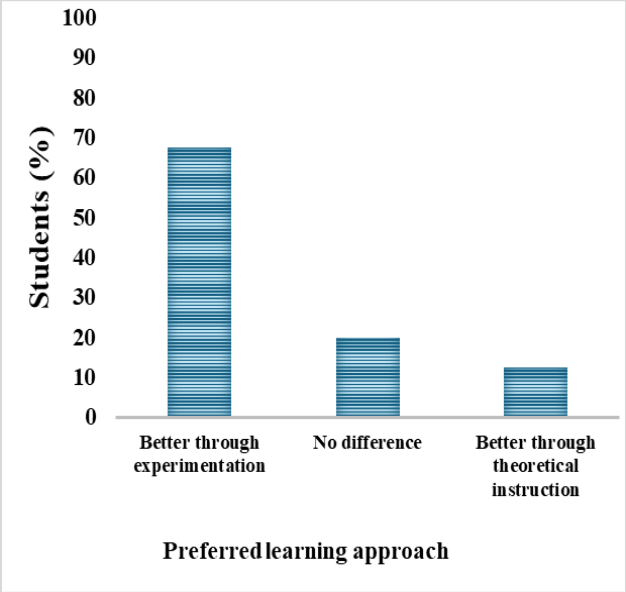

Figure 4: Students' preferred instructional approach.

These perceptions reinforce the educational value of inquiry-based science education and support international recommendations advocating greater integration of practical investigations into science curricula. According to the European Commission, (2007) Inquiry-Based Science Education (IBSE) promotes scientific literacy by engaging students in authentic investigative processes that stimulate curiosity, reasoning, and critical thinking. Similarly, Coquidé, (2000) emphasized that experimentation enables learners to transform empirical observations into scientifically structured knowledge through reflective cognitive processes.

The positive perceptions reported in the present study are also consistent with findings by Freeman et al. (2014) and Lazonder & Harmsen, (2016), who demonstrated that active and inquiry-based learning environments improve students' engagement, conceptual understanding, and long-term retention of scientific knowledge. Collectively, these studies support the interpretation that the benefits observed in the present investigation extend beyond immediate academic performance and contribute to the development of transferable scientific competencies.

Overall, the convergence between improved academic achievement, high levels of motivation, and positive student perceptions provides robust evidence supporting the educational effectiveness of inquiry-based experimental activities in Life and Earth Sciences. Nevertheless, these findings should be interpreted cautiously because the study was conducted with a relatively small convenience sample from a single educational institution and did not include a control group. Moreover, the analysis relied primarily on descriptive statistics. Future research should therefore employ larger samples, randomized or controlled experimental designs, and inferential statistical analyses to strengthen the robustness and generalizability of the findings.

Conclusion

This study investigated the impact of inquiry-based experimental activities on students' learning in Life and Earth Sciences within the context of Moroccan secondary education. The findings indicate that integrating practical experimentation into classroom instruction improved students' conceptual understanding of soil science, enhanced their motivation, and promoted active engagement throughout the learning process. Overall, the findings highlight the educational value of inquiry-based experimental learning as an effective strategy for improving science education.

Beyond enhancing academic achievement, experimental activities encouraged students to observe, investigate, collaborate, and construct scientific knowledge through direct experience, thereby fostering scientific literacy and critical thinking skills. Although the study was limited by its relatively small sample size, the absence of a control group, and the use of descriptive statistical analyses, the findings provide encouraging evidence supporting the integration of inquiry-based practical activities into secondary science curricula. Future research should include larger and more diverse samples, adopt more rigorous experimental designs, and incorporate inferential statistical analyses to strengthen the robustness and generalizability of the findings.

References

- Bonwell, C. C., & Eison, J. A. (1991). Active learning: Creating excitement in the classroom (ASHE-ERIC Higher Education Report No. 1). George Washington University.

- Coquidé, M. (2000). L'expérimentation en classe de sciences. Aster, 31, 9–30.

- European Commission. (2007). Science education now : A renewed pedagogy for the future of Europe. Office for Official Publications of the European Communities. https://op.europa.eu/en/publication-detail/-/publication/f5b39e7d-bc85-4da3-8003-85007b5b1b73

- Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and

mathematics. Proceedings of the National Academy of Sciences, 111(23), 8410-8415. https://doi.org/10.1073/pnas.1319030111

- Furtak, E. M., Seidel, T., Iverson, H., & Briggs, D. C. (2012). Experimental and Quasi-Experimental Studies of Inquiry-Based Science Teaching : A Meta-Analysis. Review of Educational Research, 82(3), 300-329. https://doi.org/10.3102/0034654312457206

- Lazonder, A. W., & Harmsen, R. (2016). Meta-Analysis of Inquiry-Based Learning : Effects of Guidance. Review of Educational Research, 86(3), 681-718. https://doi.org/10.3102/0034654315627366

- Minner, D. D., Levy, A. J., & Century, J. (2010). Inquiry-based science instruction—what is it and does it matter? Results from a research synthesis years 1984 to 2002. Journal of Research in Science Teaching, 47(4), 474-496. https://doi.org/10.1002/tea.20347

- National Research Council. (2000). Inquiry and the National Science Education Standards: A Guide for Teaching and Learning. National Academies Press. https://doi.org/10.17226/9596

- Piaget, J., & Inhelder, B. (1972). The psychology of the child. Basic Books.

- Vygotskij, L. S., & Cole, M. (1981). Mind in society : The development of higher psychological processes (Nachdr.). Harvard Univ. Press.