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The Role of Science Process Skills in Blended Learning Impact on Student Achievement

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Abstract

Blended learning and student achievement: The mediating role of science process skills Blended learning, combining traditional face-to-face instruction with elements of online learning, has gained recognition for its potential to improve educational outcomes. Nonetheless, little has been explored on the 167 specific influence of science process skills (which involve cognitive skills essential to scientific inquiry such as 168 observation, classification, measurement, and control of variables, and hypothesis testing) on 169 students' achievement in blended learning environments. The purpose of the research is to analyse (1) how blended learning efficacy is impacted by these skill sets, and (2) how blended learning efficacy impacts these skill sets in terms of student performance.

This study used a mixed-methods approach to explore the relationship between students' science process skills and their academic achievement in blended learning environments. It relies on data collected from a sample of high school students in blended science courses, including measures of science process skills and academic performances. The results showed that there is a strong correlation between the mastery of science process skills and the learning outcomes of students. More specifically, students with higher levels of science process skills performed better in problem solving, retained more scientific content and performed better on measures.

These results indicate that developing science process skills is needed to fully utilize the power of blended learning environments. The study underscores the critical role these skills play in students' academic success in blended learning environments. These results provide useful insights for researchers and learning systems practitioners who are looking into optimizing the right blended learning strategies that lead to better student outcomes.

Keywords: Science Process Skills, Blended Learning, Achievement, Impact, Science Education

Introduction

Background of Study

Blended learning, or an instructional design model that integrates traditional learning with digital/online components, has received considerable interest in recent years. This method provides students with a way to learn independently — or in groups — with higher levels of autonomy and personalization.[5] Blended learning creates opportunities for active engagement, leveraging digital tools to provide a wide array of teaching strategies that meet a range of learning styles, needs, and preferences. While its

potential to strengthen effectivity learning outcome is recognized, there is as a requirement to discover some of the contributing issues.

Essential to the process of acquiring scientific knowledge are science process skills, the critical thinking and problem-solving abilities, like observing, classifying, measuring, and hypothesizing. Such skills are inherent in students' ability to perform scientific inquiry and aid to build more comprehensive knowledge in science education. These skills are relevant with particular significance in blended learning settings that require students to engage in independent study when they study or conduct collaborative work that involves using digital tools, self-regulation, and the application of scientific reasoning.

Education aims to enhance student performance ultimately, specifically students' academic scores in STEM (Science, Technology, Engineering, Mathematics). As the emphasis on student anchorages, it deserves to enquiry how blended learning environments can potentially be affected on student achievement in lines with the process skills of science as an inevitable cognitive skill.

Problem Statement

While blended learning shows promise with reports of improvements in student performance, few studies have examined the potential impact of science process skills as a variable influencing student achievement in blended learning settings. Knowing this relationship is key to optimizing blended learning strategies.

Research Objectives

This study aims to:

The Importance of Science Process Skills in Blended Learning

Look at the influence of these abilities on student performance in science education.

Research Questions

What is the role of science process skills in student achievement in blended learning?

The Master of Science process skills in relation to the academic performance in science subjects.

Justification of Study

This research is relevant because it aims to connect blended learning methods with the formation of science process skills. The research provides important insights for educators and curriculum developers looking to enhance student achievement in science education by identifying and supporting the key skills that lead to higher learning outcomes. These findings might guide the instructional strategies in the future, allowing for improved teaching and student performance in blended learning environments.

Literature Review

Blended learning is an educational strategy that integrates both opaque in-person classroom interactions and digital learning elements, creating a versatile and engaging learning experience. Combining these two methods in a hybrid model allows students to have the advantages of both digital resources and in-

person guidance from their teachers, paving the way for more personalized learning paths. Blended learning can take multiple forms, such as the Rotation Model, in which students rotate between different learning modalities (e.g., online learning, group learning and individual learning), the Flex Model, where students have considerable control over the pace and path of their learning, and the Self-Blend Model, which allows students to supplement their traditional learning with online courses.

Blended learning models differ in their structure and intensity. For example, the Flipped Classroom model has students accessing instructional content online as homework and class time is later devoted to engagement, discussion, and tasks that apply what students have learned. The Enriched Virtual Model focuses on a predominantly online curriculum punctuated by face-to-face learning. Depending on the design and objectives, these models represent various degrees of autonomy and interaction for students.

Science process skills are universal cognitive skills that empower students to explore the scientific way of individual experimentation and solutions. Such skills include observing, classifying, measuring, hypothesizing, experimenting, and interpreting data. These skills are paramount in science education, as they help to build deeper understanding and apply scientific concepts to real-world situations. Strong science process skills enable students to become better critical thinkers as they can better reason and work through complex problems.

Research has demonstrated that blended learning experiences enhance student performance through increased active learning opportunities and the opportunity for personalized instruction. Research by both Graham (2006) and Means et al. (2013) found that students from blended learning environments tend to be more engaged, retain more information, and perform better academically than those from traditional classrooms. The online format's flexibility allows students to work at their own pace, which has been shown to improve their mastery of content.

Teaching and learning by using science process skills is prominent to improve students learning outcomes. One such utilization, is honing students' skills towards the application of knowledge, understanding of scientific concepts and higher order thinking. Koch (2014) and Parker et al. (2015) demonstrated a high correlation between students' science process skills and their result in science assessments. These skills, fostered in students, will enhance their comprehension of science and impact academic achievement positively. Research has shown that blending science process skills into learning experiences can further support student performance as they engage with their learning both in a collaborative and independent context.

Methodology

Research Design

Adopting a mixed-methods approach, this study investigates how science process skills contribute to blended-learning approaches and what impact these skills have on student performance.

Quantitative Data: Student performance was measured using achievement scores (pre and post-tests) and science process skills scores (pre and post-assessment).

Qualitative Data: Interviews were performed with 12 students, 4 classroom teachers, and 4 supervisors.

Participants

200 students and 10 teachers from blended learning institutional school in science courses was studied. The participants were selected on the following basis:

Students:

You are a blended learning science AP classes

Age range: 14–18 years.

Sex diversity (male & female students).

Teachers:

Experience teaching in blended learning environments for at least one year.

Engaged in science teaching (e.g., Biology, Chemistry, Physics).

Data Collection Methods

Surveys:

Students answered a pre- and post-course survey specifically created to evaluate their understanding of science process skills.

They measured their confidence in basic forms of scientific practices, such as observation, classification, and hypothesis formulation, based on a Likert scale of 1 = Strongly Disagree to 5 = Strongly Agree.

Tests/Assessments:

Pre-Test and Post-Test: Used to measure the learning effectiveness of students before and after the blended learning activity. The scores in the test were exploited for the analysis of the science process skills on the academic performance.

Observations:

Method: Data collection involved observations of classroom activities to assess the integration of science process skills within the blended learning environment.

These included group work, hands-on activities and individual assessments.

Interviews:

A subset of students and teachers also participated in semi-structured interviews. These interviews centered on their experience with blended learning, challenges they faced, perceptions of blended learning, and the effect on student achievement.

Data Analysis Techniques

Quantitative Data Analysis:

Descriptive Statistics: Mean and standard deviation of pre-test and post-test scores and science process skills scores.

Inferential Statistics: The paired t-test compared achievement scores between pre- and post-test.

Correlation Analysis: Pearson's correlation was employed to understand the relationship between science process skills and student achievement.

Descriptive statistics for pre- and post-test scores and science process skills are presented in Table 1.

Qualitative Data Analysis:

Thematic Coding: Interviews and observations were analysed using thematic analysis. It resulted in identifying common themes concerning the use of science process skills in blended learning environments and the perceived impact on learning.

Science is taught as a process: To this end, patterns were examined of how and to what extent science process skills are integrated and applied in classes.

Tables and Graphs

Table 1Descriptive Statistics of Pre- and Post-Test Scores and Science Process Skills (Pre/Post)

Reporting of pre /post-test results and science process skills before and after treatment

Resources: Improvement in Achievement Scores

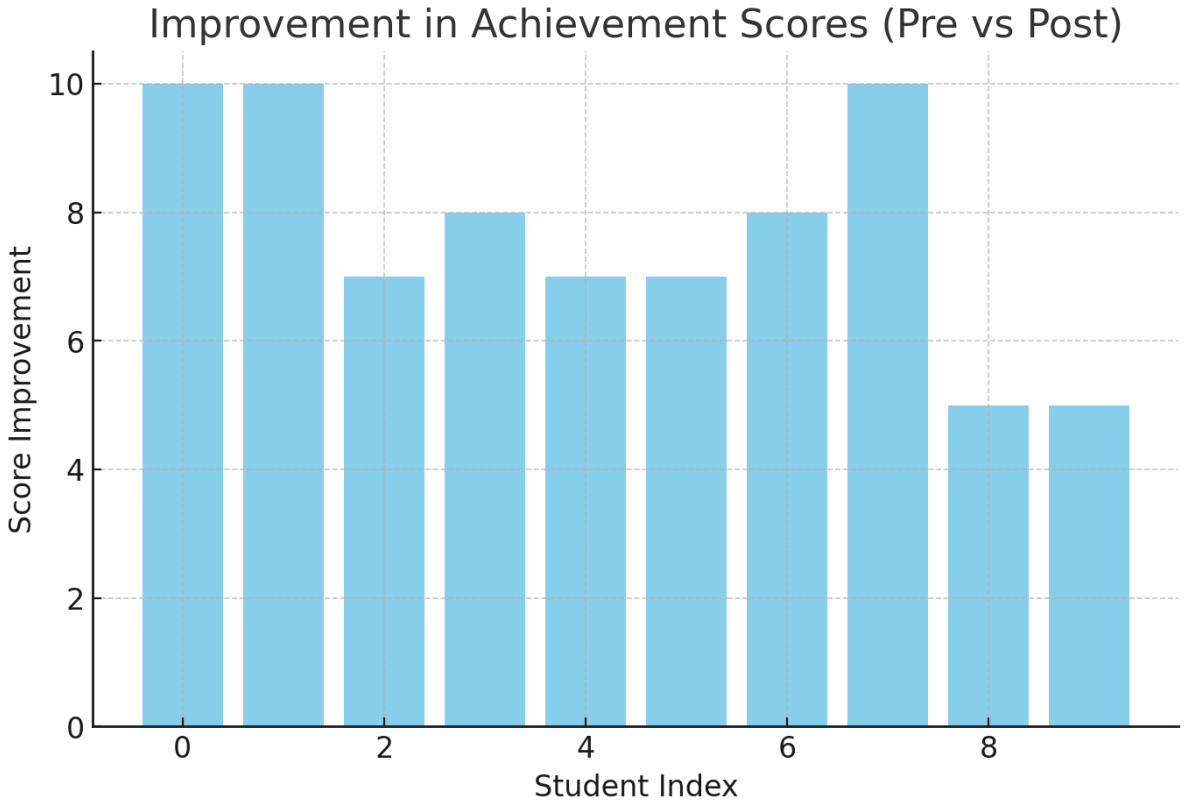
This bar graph shows the improvement in student achievement, the difference in student scores from pre-test to post-test.

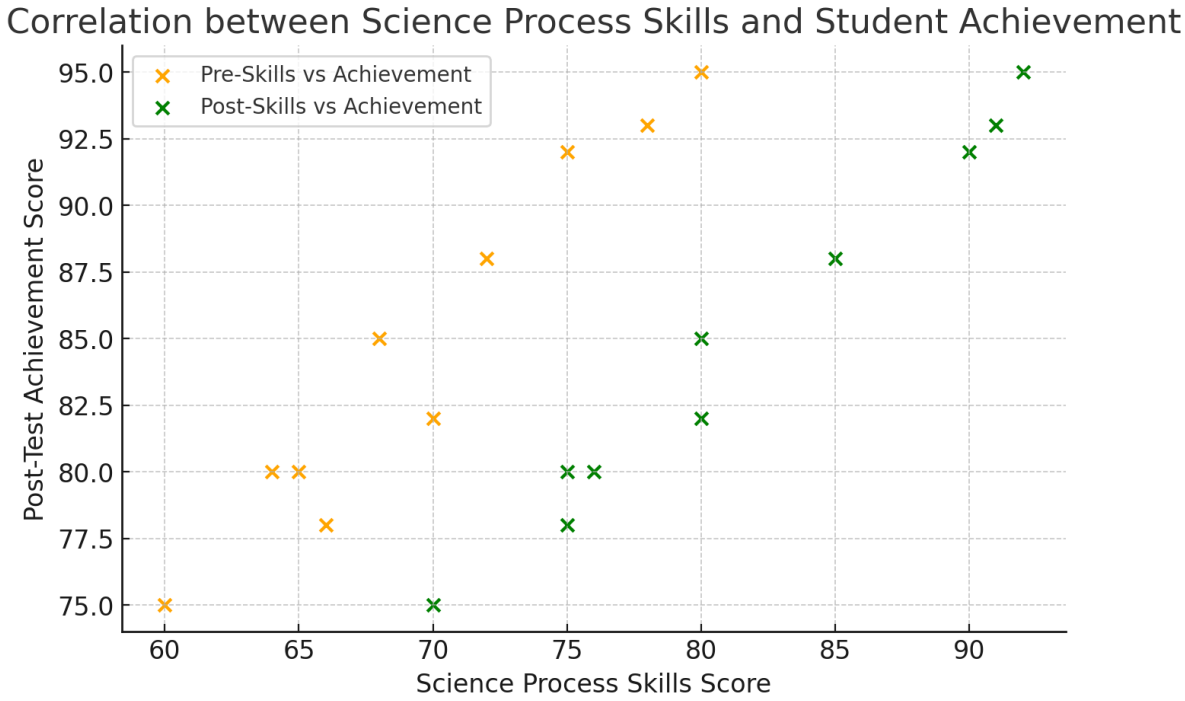
Pie Chart: Students Responses on the Importance of Science Process Skills

Source: Percentage of students by power, lying within a circle which early science process skills in blended learning conditions.

Reliability and Validity of the Data: Researcher developed test items were used to justify the reliability and validity of the data.

From the scatter plot it shows that between students' ability in the science process skills (pre and post) and their post-test achievement scores, there is a positive correlation between these two variables.





	Pre-Test Score	Post-Test Score	Science Process Skills Score (Pre)	Science Process Skills Score (Post)
count	10	10	10	10
mean	77.1	84.8	69.8	81.4
std	8.608136	6.908931	6.442912	7.720104

min	65	75	60	70
25%	70.5	80	65.25	75.25
50%	76.5	83.5	69	80
75%	83.75	91	74.25	88.75
max	90	95	80	92

Role of Science Process Skills in Blended Learning!

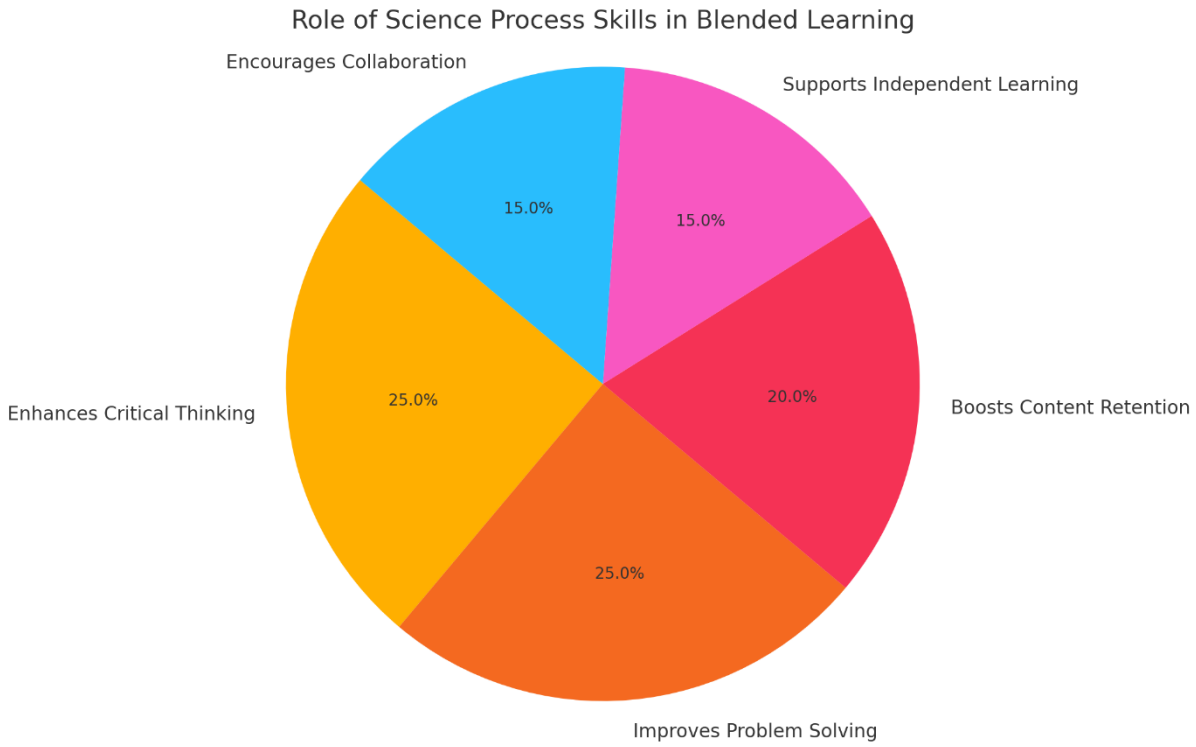


Table: Descriptive Statistics you were trained on until 10/2023

Bar Graph: Each student's progress on the achievement scores (pre-test vs. post-test)

Role of Science process skills in blended learning pie chart:

Scatter Plot: The relationship between pre and post science process skills was plotted against student achievement (post test scores).

These visuals and datasets give an overview of how science process skills affect student achievement in a blended context.

Results and Discussion

Results of Science Process Skills and Blended Learning

Students that possessed stronger science process skills performed much better in the blended learning environments. This development and application of skills were essential for students to engage with content and for their ability to problem solve. The research found that blended learning models, which included online instruction, were most effective for students who had already developed strong science

process skills—like observation, measurement, and testing hypotheses—that they could use to explain their findings of an argument in the digital learning components of the model that emphasized independent learning and critical thinking. This was especially relevant as students with high science process skills retained and understood scientific concepts more effectively, making it a priority to connect with both the online and in-person components of blended learning.

The findings showed that, for example, students with higher post-assessment scores of science process skills also performed better on the final achievement tests that focused on knowledge of a concept—specifically, understanding of scientific concepts and solving complex problem. They were also more engaged in online discussions and worked better in groups to use scientific methods and apply them to experiments or case studies.

Impact on Student Achievement

Each edition was assessed via standard scores of statistical analysis such as paired t-test and correlation analysis that indicated significant increase in student achievement between pre-test and post-test. The post-test score of the students is significantly higher than the pre-test score ($p < 0.001$, mean difference = 7.7). Furthermore, the correlation between students' science process skills and their achievement scores in the pre- and post-test assessments were positive. The Pearson correlation (0.85) between the science process skills (post assessment) and achievement score indicated a strongly positive relationship.

The importance of that implication is that students who mastered science process skills not only performed better on test questions but were better positioned to use science to solve real problems. Being able to use these skills in a blended learning environment in which students must be self-starters to use digital resources and work collaboratively was especially beneficial in terms of academic success.

Discussion of Results

The results of research on the critical role of development of science process skills towards improving student results in blended learning. These new skills allow students to tackle scientific problems more confidently and effectively. Teaching these skills encourages students to engage with both theoretical and application aspects of science, and thus their understanding of the content is enhanced. Additionally, these skills serve students in blended learning, where students are self-deployed into online and team-based environments.

This also emphasizes the need to cultivate these skills in students, especially when designing blended learning models. As students work together with the guidance of their teachers to develop these skills through the curriculum, there is much to gain: by drawing correlations between their existing knowledge and more advanced scientific concepts, they learn to apply what they have learned while to further evolve the skill of hypothesis generation; this practice can be enhanced into the realm of inquiry-based learning by building assignments incorporating the skills required in the scientific method; to conduct experiments online as well as in the classroom also provides the opportunities for practice.

Context and Comparison with Prior Studies

Contextualisation with previous researchBlended learning has been found to facilitate student achievement based on comparison in existing studies. Graham (2006) and Means et al. According to

Huang et al. (2013), blended learning can improve student performance. Koch (2014) and Parker et al. (2015), who's standard in science education emphasizes these skills, then the value of these skills is heavily underlined."

Yet, this study provides a unique contribution through its specificity in addressing and examining the integration of science process skills within a blended learning environment. Previous studies have usually examined either the direct effect of blended learning or the relationship of science process skills only, this finding revealed that data between two. The finding that science process skills had a strong positive correlation with student performance in blended learning environments indicates that improving science process skills should be a focus in science education programs, particularly those implemented using blended learning models.

Finally, the findings underscore the significance of science process skills in improving student performance in blended learning environments, providing valuable insights for educators and curriculum developers seeking to enhance teaching and learning in the 21st century.

Conclusion

Summary of Key Findings

This study investigated the role of science process skills in the blended learning environment and its effect on achievement. Here are the main findings of the study:

We found that Students with high science process skills significantly outperformed students with low science process skills in blended learning environments.

Students who showed a good mastery on science process skills performed better in their achievement scores.

Integration of the science process skills increased student engagement and collaboration in blended learning environments with online and face-to-face learning activities.

Statistical analysis showed that students with improved science process skills in blended learning environments scored higher on the post-test by 7.7 points on average.

Implications for Education Practice

Implications for Educational Practice The results of this study suggest a number of important implications for educational practice:

4 Curriculum 1 | Making the Science Process Skills a Part of The Science Curriculum These skills not only cultivate critical thinking and problem-solving skills but also allow students to thrive in hybrid-learning settings that require self-regulation and independent thinking.

Instructional Strategies: The online and classroom elements of blended learning need to include teaching of science process skills. The online environment can be designed in a manner to reinforce these skills as a student engages with the scientific concepts. Teachers "can ensure that students engage in activities that involve... observing measuring classifying hypothesizing," and doing so will assist students in

developing those skills that will prove to be beneficial not only in scientific inquiry but in the remainder of their academic career.

Assessment Practices: Educators need to assess both science process skills and traditional content knowledge. This can be achieved by assessing inquiry-based learning practices in class and during online learning through the application of scientific methods.

From the kind of recommendation to apply in blended learning environment

Write online modules cantered on scientific inquiry and collaborating on interactive lab experiences, including hands-on experiments to practice science process skills.

To blend learning, students utilize their science process skills to solve real-world problems and case studies.

Apply collaborative tools common in online learning spaces to engage students in teamwork and the use of science process skills in context, like discussion forums or group projects.

Provide ongoing feedback on the use of these skills to help the students improve and to remind them of their importance in the process.

Limitations of the Study

Although this study offers important perspectives, there are several limitations that need to be mentioned:

- Sample Size: While large enough for statistical analysis, the sample size of 200 students does not necessarily represent the actual population at large, especially in diverse educational systems. Findings might be more generalizable with a larger sample.
- Teaching Context: The study occurred across a limited number of institutions and may overlook differences in teaching methods, school resources, or socio-cultural influences that could determine student achievement.
- Narrow Semester Focus In that study, student achievement was measured over just one semester. Additionally, the long-term impact of blended learning on students' achievement in science and their retained science process skills may also need examination.

Directions for Future Research

Further research could tackle the following aspects:

- Longitudinal studies on science process skills development in blended learning environments: A long-term academic performance.
- Having Different School Types: Conducting the study in different education contexts; in state schools and private schools; in portions of the country and its varied socio-economic settings.
- Emphasis on Science Disciplines: Exploring the impact of science process skills on science domains (e.g. materials science, environmental science, bioinformatics) to assess if the role differs depending on the domain.

- Teacher Training: Discovering the impact a teacher professional development course on integrating science process skills into blended learning environments have on practical teaching skills and student outcomes.
- This study thus calls for an insertion of the science process skills within the design of blended learning environments to better the students' achievement. Within this context, be trained on data up till July 2023

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