Exploring Science Process Skills of undergraduate students and its Relationship with student's academic achievements

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Abstract

This study aimed to investigate science process skills of undergraduate students and their correlation with academic achievement. A cross-sectional survey and Correlational research design were employed. Population of the survey conducted was all undergraduate students at university of Malakand Pakistan. Data was collected from 177 stratified selected students of both genders of seven departments. The questionnaire was validated by subject matter export, comprised twelve items related to science process skills. Reliability analysis was performed using cronbach,s alpha yielded of coefficient of -.19, suggesting inadequate internal consistency. Software utilized for data analysis included statistical package for social science employing Pearson correlation. Result reveled that there was a strong correlation of 0.665 observed between science process skills and students' academic achievements. Schools and teachers should focus on improving students' science process skills to enhance overall academic performance. Incorporate more hands-on experiments, problem-solving activities, and critical thinking exercises in science classes. Provide targeted support and resources for students who struggle with science skills to help them improve. Recognize that strengthening science process skills is crucial for improving students' success across their studies.

Keywords: Science process skills, cadmic achievements, correlation research, SPSS analysis

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1. Introduction

The importance of teaching science has never been greater. As the world moves into a new stage of scientific and technical development brought about by the fourth industrial revolution, education must change to meet the demands of the modern world, claim (Thunberg et al., 2022). Due to the quick developments in biotechnology, environmental sciences, and artificial intelligence, students must learn how to think scientifically and use what they learn to address new global issues (Rahman et al., 2021). In this regard, scientific instruction must prioritize the development of scientific Process Skills (SPSs), which give students the capacity to research, evaluate, and make judgments based on evidence, in addition to theoretical knowledge (Zain et al., 2022).

In order to interact effectively with scientific concepts and procedures, students must acquire both SPSs and subject knowledge. Scientific literacy is crucial in a society that is changing quickly due to technological breakthroughs. To promote inquiry-based learning and enhance students' capacity to evaluate and resolve difficult issues, these abilities which include observing, categorizing, inferring, forecasting, experimenting, and evaluating data are essential (Irwanto & Prodjosantoso, 2019; Karamustafaoğlu, 2021). According to modern educational frameworks, scientific literacy encompasses more than just factual memory; it also includes the capacity to critically interact with and apply scientific information in real-world situations (Ibrahim et al., 2022). This emphasizes how crucial it is to create SPSs in order to provide students the critical thinking and investigative skills necessary for both academic achievement and real-world problem-solving (Mutlu & Doğan, 2020).

This research work states that scientific education should incorporate activities that require students to use higher-order thinking abilities. There are two main types of scientific knowledge: content knowledge and science process abilities. It is expected of students to understand and remember the laws, facts, ideas, explanations, and concepts that comprise content knowledge. According to (Af'idayani et al., 2018), scientific knowledge is found using scientific methodological skills and methodologies. According to Uğur et al. (2020), students' ability to understand and apply scientific concepts depends on their ability to fully understand both areas. To put it another way, students' proficiency with SPSs has a direct impact on their capacity to learn and use scientific knowledge. Students who can use SPSs are able to practice critical thinking, hypothesis testing, and scientific data interpretation all of which are essential for scientific inquiry and problem-solving (Mutlu & Doğan, 2020). Because of its ability to foster scientific thinking and problem-solving skills, SPS development has been a major emphasis of science education (Çelik, 2022). With the use of scientific process skills, students may create testable hypotheses, conduct experiments, critically evaluate findings, and investigate phenomena methodically. Additionally, by incorporating SPSs into the classroom, students can move from being passive learners to active contributors to the creation of information, fostering a greater comprehension of scientific ideas. Inquiry-based and problem-solving methods that support SPSs have been associated with increased student motivation and engagement, two factors that are critical for academic performanc. These abilities are also essential for everyday decision-making, problem-solving in the workplace, and civic engagement outside of the science classroom. Students that cultivate strong SPSs exhibit enhanced critical thinking, increased curiosity, and better academic performance, according to (Juhji and Nuangchalerm, 2020). Additionally, mastery of SPSs has been found to be essential for career advancement in STEM domains and workforce preparedness in a global economy that values scientific and technological competence more and more (Turan et al., 2023). Academic accomplishment and SPSs are related, which emphasizes how crucial it is to incorporate process skills into scientific courses at all educational levels. Numerous research has investigated the relationship between students' achievement and their acquisition of SPSs (Derilo, 2019). (Tilakaratne and Ekanayake, 2017) looked at the relationship between SPSs from lower secondary to senior secondary school and students' formal thinking abilities. They found that SPSs and cognitive ability were significantly correlated. Nonetheless, research shows that many undergraduate students lack a

thorough understanding of basic SPSs, even though SPSs are emphasized in scientific instruction at all levels, including primary, secondary, and postsecondary education (Irwanto & Prodjosantoso, 2019). The persistent dependence on conventional lecture-based instruction, which restricts opportunities for experiential learning and scientific inquiry, is a significant contributing element to this shortfall (Aydogdu, 2020). Teachers can help students close the gap between theory and practice by implementing active learning techniques such case studies, project-based learning, and experimental design (Rahman et al., 2021). Students that possess science process skills are also more equipped for future scientific pursuits, such as research and professions in STEM disciplines (science, technology, engineering, and mathematics) (Kirimi et al., 2017; Fakayode et al., 2020). These abilities complement the learning objectives of the twenty-first century, which place a strong emphasis on inquiry, problem-solving, and experiential learning. According to a study by Susantia et al. (2018), students who actively participated in experiments and research projects showed increased interest and engagement, which improved their ability to remember scientific ideas. This emphasizes how science courses must include inquiry-based and practical activities in order to improve students' SPSs. Recent research indicates that by offering immersive learning environments that replicate actual scientific investigations, interactive digital technologies like virtual laboratories and augmented reality simulations can greatly improve the acquisition of SPSs (Halim et al., 2020).

Although the significance of SPSs is acknowledged, a number of obstacles prevent undergraduate students from effectively developing them. Having mostly depended on rote memorization and passive learning techniques in their previous schooling, many students arrive at university with little exposure to practical scientific inquiry (Irwanto & Prodjosantoso, 2019). Further impeding students' capacity to learn and apply SPSs successfully include rigid curricula, a dearth of well-equipped laboratories, and a lack of training for teachers in inquiry-based instruction (Aydogdu, 2020). A diversified strategy including curricular changes, teacher preparation programs, and more chances for hands-on learning is needed to address these issues. Funding for faculty training, curricular adjustments that support evidence-based methods to scientific inquiry, and infrastructure development must be given top priority by policymakers and educational institutions (Turan et al., 2023). It is essential to comprehend the connection between SPSs and academic performance in order to develop efficient teaching methods and enhance learning outcomes. Investigating the degree to which undergraduate students have SPSs and the relationship between these abilities and academic achievement is the goal of the current study. To improve students' scientific literacy and general achievement in science-related fields, educators might create focused interventions by detecting gaps in SPS acquisition. Institutions can employ creative teaching strategies that increase SPS development and help students' professional competencies and analytical reasoning over the long run by filling these gaps (Ibrahim et al., 2022).

1.1. Statement of the problem

Science process skills, including observation, data collection, hypothesis formulation, and classification, are fundamental for fostering critical thinking and problem-solving abilities among learners. At the secondary school level, the acquisition of these skills plays a pivotal role in promoting conceptual understanding and enhancing academic achievement. Despite their recognized importance, many students in Pakistan continue to face difficulties in applying these skills effectively, which hampers their overall learning outcomes. Given the crucial role of science education in national development, it is essential to examine the extent to which secondary school students possess these skills and how they relate to their academic performance. Therefore, this study seeks to explore the basic science process skills of secondary-level students and to investigate their relationship with students' academic achievements.

1.2. Objective

To find out the relationship of science process skills with student's academic achievements.

1.3. Hypothesis

There is no significance relationship between science process skills with student's academic achievements.

1.4. Significance of the study

The present study holds significance for a wide range of stakeholders in the educational process. For school principals, the findings will provide insights into the importance of strengthening science process skills at the secondary level and guide evidence-based decisions for curriculum design and teacher training. Parents will benefit from a deeper understanding of how these skills contribute to their children's academic success, enabling them to provide more effective support at home. For the wider community, the study emphasizes the role of science education in fostering problem-solving abilities and preparing students to contribute meaningfully to national development. Most importantly, for students, the research highlights the relationship between science process skills and academic achievement, encouraging them to engage more actively in scientific inquiry and learning. Collectively, the study contributes to the ongoing discourse on improving the quality of science education in Pakistan, thereby addressing both academic and societal needs.

2. Review of Related Literature

2.1 Conceptualizing Science Process Skills (SPS)

Science Process Skills (SPS) are critical cognitive skills that enable students to solve problems and conduct scientific research. Basic SPS (such as observing, classifying, measuring, predicting, and communicating) and integrated SPS (such as controlling variables, interpreting data, generating hypotheses, and performing experiments) are the two major categories into which these talents fall (Aktamis & Ergin, 2008). Proficiency in SPS cultivates scientific reasoning, creativity, and critical thinking all of which are essential for success in college and beyond.

2.2 SPS and Academic Achievement

Student achievement and SPS have a well-established link. Research indicates that increased scientific success scores are correlated with higher SPS proficiency. Students with higher SPS, for instance, did noticeably better on standardized scientific assessments, according to research conducted in Turkey (Aydin & Kesercioglu, 2017). In a similar vein, (Oloyede and Adeoye, 2012) found that secondary pupils in Nigeria who had a high level of SPS competency performed better in chemistry and biology.

The ability of undergraduate students to use scientific reasoning in both classroom and real-world applications has a significant impact on their academic performance. According to (Derilo, 2019), SPS improves academic achievement generally by fostering transferable abilities like analytical reasoning in addition to improving performance in science courses. (Subasi, 2022) confirmed that university-level students' GPA scores and SPS mastery were positively correlated.

2.3 Instructional Approaches that Enhance SPS

- **Inquiry-Based Learning**: Research continuously demonstrates that inquiry-based learning is an effective strategy for fostering SPS. In contrast to lecture-based training, Majeed (2023) showed that employing the 5E instructional methodology (Engage, Explore, Explain, Elaborate, Evaluate) greatly increased students' SPS. Similarly, (Mutlu, 2020) discovered that pre-service science teachers' SPS increased and their conceptual knowledge deepened in inquiry-driven courses.
- **Problem-Based Learning (PBL):** PBL improves critical thinking and SPS by encouraging students to collaborate to solve real-world scientific challenges. According to a research by Hmelo-Silver,z2017), PBL students showed greater SPS proficiency and performed better on problem-solving activities than their counterparts.

- **Lab and Hands-on Activities**: Students can apply SPS in real-world settings through practical exercises. Students who engaged in guided laboratory activities demonstrated noticeably greater SPS development than those who received standard theory-based training, according to a study conducted in Nigeria (Opara & Oguzor, 2016). According to (Sukardi et al., 2020), chemistry students in Indonesia who received laboratory-based SPS education performed better on tests of achievement and skill.
- **Project-Based and Collaborative Learning**: By promoting creativity, teamwork, and independent inquiry, project-based approaches have been demonstrated to improve both SPS and accomplishment. According to research by (Abungu, Okere, and Wachanga, 2014), students who were exposed to project-based and cooperative learning methods performed better in physics than those who received standard instruction.
- **Technology-Integrated Learning:** Interactive technology, virtual labs, and digital simulations have become useful resources for improving SPS. (Chang et al., 2016), for example, showed that computer-assisted inquiry greatly enhanced university students' science achievement and SPS acquisition.

2.4 SPS, Scientific Literacy, and Cognitive Skills

A key element of success in contemporary education is scientific literacy, which is directly influenced by science process skills. (Yumusak, 2020) discovered that SPS-trained undergraduates demonstrated improved skills in data interpretation, scientific argument construction, and evidence-based decision-making. Additionally, SPS is directly linked to higher-order thinking abilities including creativity, logical reasoning, and problem-solving, all of which support scholastic success (Hardianti & Kuswanto, 2017).

Additionally, studies in physics education have demonstrated that SPS training facilitates students' cross-disciplinary learning. Learners may effectively acquire SPS and apply them in mathematics, biology, and engineering contexts with the help of peer-supported tactics including cooperative problem solving and reflective discussions (Docktor & Mestre, 2014).

2.5 International and Regional Perspectives

Across different educational systems, the importance of SPS in shaping achievement has been highlighted:

- In **Malaysia**, (Karsli & Sahin, 2009) reported that process skill-oriented teaching significantly enhanced students' chemistry performance.
- In **Kenya**, integrating SPS into mathematics instruction led to higher achievement scores in geometry and algebra (Mbugua & Muthoni, 2017).
- In **Pakistan**, recent studies emphasize the importance of embedding SPS in undergraduate curricula to prepare students for research and innovation-driven academic environments (Majeed, 2023).

3. Research Methodology

This study mainly focuses on Exploring science process skills of undergraduate students and its relationships with student's achievements. This chapter mainly shows the design of the research, instrumentation, data collection and data analysis. It shows the overall procedure used by the researcher for the research.

- **Nature of Research:** The present study employed a survey design and utilized a correlational research approach.
- **Population:** Population of the study was consisted of all undergraduate students currently enrolled at University of Malakand which is approximately 7966**.**

- **Targeted Population:** A stratified random approach was employed to select participants. The sampling frame consisted of seven departments, categorized into three academic disciplines: pure sciences (3 departments), social sciences (2 departments) and arts (2 departments).
- **Sampling Technique:** With the help of raosoft online calculator a 25 sample of students from each department was selected, resulting in a representative sample.
- **Research instrument:** Data were collected by already developed questionnaire with the permission of the author (Appendix A) after passing it from content validity and plait testing in our own culture. For the reliability purpose of chronbach alpha was find out. Questionnaire was validated from subject experts.
- **Data collection:** Data were collected by administering the science skills sale on undergraduate students of university of Malakand. They were from pure science social science and arts personally. They were given enough time for filling the scale. They were clarified for any ambiguity in the scale**.**

4. Data analysis & Findings

4.1. Data Analysis

Data were analyzed by using SPSs Pearson was used to find out the correlation between science process skills and academic achievement.

H_{01}. There is no co-relation between science process skills and their academic achievements.

Table 1. Correlations

		ScPro	AA
ScPro	Pearson Correlation	1	.665**
	Sig. (2-tailed)		.000
	N	177	177
AA	Pearson Correlation	.665**	1
	Sig. (2-tailed)	.000	
	N	177	177

****. Correlation is significant at the 0.01 level (2-tailed).**

The table shows a positive relationship between science process skills and academic achievements. The Pearson correlation coefficient is 0.665, meaning that as student's science process skills improve their academic performance also tends to improve. The p-value is 0.000, which means these relationships statistically significant.

4.2. Findings

The results demonstrate a beneficial relationship between students' academic performance and their proficiency with the science process. This implies that pupils who perform better in scientific classes are probably going to receive higher grades. Based on an investigation of 177 pupils, the findings are statistically significant, indicating that the association is genuine and not the product of chance. Simply said, students who are more proficient in science typically perform better academically.

5. Discussion

The study's conclusions showed a strong correlation between students' academic achievement and their mastery of SPS. This implies that students typically attain better academic results when they become more proficient in areas like observation, classification, data collecting, interpretation, and hypothesis formation. These findings highlight that developing the cognitive and analytical skills necessary for success in a variety of topic areas is just as important to science education as imparting content knowledge.

The current results are in line with previous research. In their meta-analysis, (Dolapçıoğlu and Subaşı, 2022) found that SPS has a moderate but significant effect on students' academic performance, supporting the notion that learning outcomes are directly supported by scientific reasoning. Similar findings were made by (Ochuba, 2015), who highlighted that process-oriented learning enhances students' ability to solve problems and maintain their intellectual independence by finding a strong association between process skills and science achievement among secondary school students. Similar to the tendency seen in this study,(Kasinathan, 2023) also noted that children who are proficient in SPS typically have superior overall academic performance.

This beneficial association may be explained by the fact that SPS fosters logical reasoning and critical thinking, two abilities that are applicable outside of scientific classrooms. Students who are adept in making deductions or evaluating experimental data, for example, are also better equipped to approach mathematical issues methodically or decipher data in the social sciences. Instead of being a collection of abilities limited to science courses, this cross-disciplinary influence emphasizes SPS as the cornerstone of comprehensive academic development.

The literature also makes clear that active, inquiry-based teaching methods are the most effective way to develop SPS. Research has demonstrated that project-based learning, laboratory exercises, and practical experiments all considerably raise SPS while also raising student accomplishment (Aydin & Yilmaz, 2010; Mutlu, 2020). This suggests that teaching methods that prioritize hands-on activities and inquiry-based learning are superior to conventional rote-based instruction in terms of enhancing process skills and academic results.

The results also have ramifications for teacher preparation programs and curriculum development. Curricula should purposefully include chances for pupils to practice and hone these skills at various grade levels if science process proficiency is associated with academic success. Inquiry-based teaching methods that promote investigation, logic, and problem-solving must also be taught in teacher education programs. SPS-focused instruction could offer a means to improve general academic achievement and science performance in settings like Pakistan, where classroom instruction is frequently content-driven.

Lastly, the findings emphasize how critical assessment reforms are. Recall of facts is frequently given priority in current exams, which hinders the advancement of scientific research. It may be possible to improve the alignment between teaching, learning, and student performance by moving toward assessments that measure process skills like planning experiments, interpreting data, or drawing logical conclusions.

6. Conclusion

The results show a significant and favorable correlation between students' academic achievement and their science process skills. Pupils with greater scientific proficiency typically perform better academically. Using a sample of 177 students, the research demonstrates that this association is statistically significant, proving its dependability and excluding chance. All things considered; the findings imply that raising pupils' proficiency in the scientific method can help them succeed academically.

7. Recommendations and Future Research

7.1. Recommendation

- Schools and teachers should focus on improving students' science process skills to enhance overall academic performance.
- Incorporate more hands-on experiments, problem-solving activities, and critical thinking exercises in science classes.

- Provide targeted support and resources for students who struggle with science skills to help them improve.
- Recognize that strengthening science process skills is crucial for improving students' success across their studies.

7.2. Future Research

This study was confined to undergraduate students of the University of Malakand and employed a quantitative research design. Therefore, future research may address these limitations by extending the investigation to other universities in Pakistan to allow for broader generalizability. Additionally, similar research could be undertaken at the graduate level within the same university to examine potential variations across academic levels. Employing qualitative or mixed-method approaches in future studies may also provide deeper insights into the phenomenon under investigation.

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