TechnoLEARN: An International Journal of Educational Technology
TechnoLEARN: **13**(02): 81-88, December 2023
DOI: 10.30954/2231-4105.02.2023.3
Peer Reviewed Journal

A Study of Science Processes of Students Differing with Respect to Achievement

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Received: 15 Oct., 2023 **Revised:** 24 Nov., 2023 **Accepted:** 03 Dec., 2023

ABSTRACT

Learning science is crucial for the transformation of the country as a developed nation. It must engage students in activities that require higher-order thinking skills. The present study attempts to find out whether Students differing with respect to achievement differ in their science processes. Sample consisted of 209 students of class VIII studying in Prayagraj. 'Test of Science Processes' constructed by the researcher and 'Science Achievement Test' constructed by Kalplata Pandey were used to collect the data. One way analysis of variance was used for the analysis of data. It was found that students with high or above average achievement in science have better science processes than those having average or below average achievement in science; students differing with respect to achievement in science do not differ on ability to exclude variables, draw inferences, and design experiments; students having high or above average achievement in science have better ability to interpret data than those having below average achievement in science; high achieving students exhibit greater ability to identify supporting data than other students.

Keywords: Activities, achievement, thinking skills, Prayagraj, Science Achievement Test

Learning science is crucial for the transformation of the country as a developed nation. It must engage students in activities that require higher-order thinking skills (Saido *et al.* 2018). Scientific literacy must focus on the two domains- content knowledge and science process skills. The content knowledge includes facts, principles, laws, concepts, explanations, and

How to cite this article: Misra, K.S. (2023). A Study of Science Processes of Students Differing with Respect to Achievement. *TechnoLearn: An International Journal of Educational Technology,* **13**(02): 81-88.

Source of Support: None; **Conflict of Interest:** None

theories to be understood and remembered whereas the Science processes include skills and techniques of scientific methods which are used to discover scientific knowledge (Af'idayani *et al.* 2018). Both are essential. Science Process Skills are based on scientific inquiry. They are the acts performed by scientists. They include observing, inferring, measuring, communicating, classifying, predicting, using time space relations, using numbers, controlling variables, defining operationally, formulating hypotheses, formulating models, interpreting data and experimenting etc. Their use while learning science helps students in understanding of concepts procedure of scientific method, recall of science content knowledge and use of process skills while undertaking investigations in and outside the classrooms. Their use also promotes positive attitudes toward science among students. Their avoidance develops low interest in science activities and is detrimental to the development of higher mental abilities. Science process skills cannot be separated in practice from the conceptual understanding that is involved in learning and applying science (Irwanto & Prodjosantoso, 2019). Jufrida *et al.* (2019) thinks that students experience difficulty in science courses due to a lack of understanding of the methods of science i.e. science processes. These skills facilitate learning ability used to understand and learn scientific knowledge (Susantia *et al.* 2018) and help in developing learning skills necessary for the 21st century (Turiman *et al.* 2012). They can promote learning ways of reaching knowledge and learning with understanding. They can also help students connect prior understandings to new concepts and expand understanding of scientific phenomena (Harlen, 1999). NEP (2020) has emphasized inquiry based, experiential and discovery-based learning. This can facilitate students' later placement in high level science courses.

REVIEW OF RELATED STUDIES

Marek (1981) found moderate correlation between content achievement in biology and achievement in inquiry skills with reference to formulating problems, formulating hypotheses, designing experiments, interpreting data.

Bhargava (1983) found a moderate relationship of academic achievement in physics with three processes namely – observing, measuring and drawing inferences and low level of correlation with two processes – making prediction and making and testing hypotheses.

Padilla, Okey and Gerrad (1984) found that instruction in science process skills such as identifying and controlling variables, formulating hypotheses and experimenting are beneficial for overall science achievement.

Mabie and Baker (1996) found that students with ability to define a problem, construct hypotheses, design experiment and interpret data are highly correlated with academic achievement. Preece and Brotherton (1997) found that teaching science process skills had positive and persistent effect on science achievement.

Aktamis and Ergin (2008) found that exposing students to science process skills enhances students' achievement and scientific creativities.

Raj and Devi (2014) reported a very low positive correlation between science process skills and achievement in science of high school students.

Ekon and Eni (2015) reported that junior secondary school. Students who acquired the science processes showed better academic performance.

Delen and Kesercioglu (2012) found positive relationship between academic achievement and science process skills – observing, data interpreting, predicting, classifying, formulating hypotheses and defining operationally.

Supasorn and Waengchin (2014) found that use of scientific investigation learning activities enhances students' learning achievement of chemical reactions and integrated science process skills.

Chaurasia (2015) investigated the relationship between science processes and concept-attainment in science. Sample consisted of 600 students of class IX of U.P. Board schools of Allahabad city. For data collection 'Test of Science Processes' developed by K.S. Misra was used for measuring science processes. 'Concept-attainment Test in Science' developed by the researcher was used to measure concept-attainment. It was found that concept-attainment in science and its three dimensions are positively related to two science processes namely - designing experiments and identifying supporting data.

Hasanah (2018) studied the effect of science process skills-based learning in facilitating the achievement of student learning outcomes in the topic of carbohydrate metabolism. The research design used was pre-experimental one group pretest-posttest design. Trials were conducted on 30 students. The result of the research showed that the science process-oriented learning process can improve the students' understanding.

Kamarudin, Wahida and Ahrari (2022) examined the effect of the level of understanding of basic and integrated science process skills (SPS) on student science achievement. 73 students studying in the Science Foundation Studies Program were included in the sample. It was found that level of understanding of basic science processes was satisfactory whereas integrated science process skill was poor; a moderate correlation was found between basic and integrated science process skills; a weak positive correlation was found between basic SPS and science achievement; there was an insignificant correlation between integrated SPS and science achievement; level of understanding of SPS among both females and males was fair but not different.

These studies indicate that students differing with regard to achievement may differ in science processes.

OBJECTIVES OF THE STUDY

The objective of the study is to find out whether 'Students differing in achievement in science differ on science processes.'

RESEARCH HYPOTHESIS

It was hypothesized that 'Students differing in achievement in science differ on science processes'.

PROCEDURE OF THE STUDY

Sample: Sample consists of 209 students of class VIII studying in Prayagraj.

Tools used: 'Test of Science Processes' constructed by the researcher and 'Science Achievement Test' constructed by Kalplata Pandey were used to collect the data.

Statistical techniques used: Analysis of the data was done by using one way analysis of variance. Students were grouped into four categories- superior, above average, average and below average on the basis of percentage of scores on the Science Achievement Test. The ranges of score-percentages for the four groups were above 60, 50 to 60, 45 to 50, and below 45 respectively. Students of the four groups were compared on overall science process and its component abilities by using F-ratios. Post-hoc comparisons were made by using multiple range test.

RESULTS AND DISCUSSION

Table 1: Summary of ANOVA showing differences in science processes of students differing with respect to achievement

Source	df	Sum of squares	Mean square	F-ratio
Between groups	3	722.9420	240.9807	7.2357**
Within groups	205	6827.4025	33.3044	
TOTAL	208	7550.3445		

Table 2: Results of multiple range test for differences in science processes of students differing in achievement

Gr. No.	Group based on achievement	N	Mean score	Standard deviation	Groups showing significant differences
1	High	18	24.00	5.7905	2 > 4
2	Above average	77	21.6623	6.4982	2 > 3
3	Average	62	19.4516	5.1587	1 > 4
4	Below average	52	17.9423	5.2856	1 > 3

Table 1 shows that students differing with respect to achievement differ in their science processes (F = 7.2357, df = 3, 205, p < .01). Table 2 shows that mean science processes scores of students with high, above average, average, and below average achievement in science are 24.00, 21.6623, 19.4516 and 17.9423 respectively. Paired comparisons using multiple range test revealed existence of four significant differences. Students with high achievement in science had greater science process ability than students with average and below average achievement in science. Students with above average achievement in science had greater science process ability than students with average and below average achievement in science.

Table 3: Summary of ANOVA showing differences in ability to draw inference among students differing with respect to achievement in science

Source	Df	Sum of squares	Mean square	F-ratio
Between groups	3	4.7201	1.5734	0.4107
Within groups	205	785.2894	3.8307	
TOTAL	208	790.0096		

Table 4: Summary of ANOVA showing differences in 'Exclusion of variables ability' among students differing with respect to achievement in science

Source	Df	Sum of squares	Mean square	F-ratio
Between groups	3	31.8015	10.6005	1.5045
Within groups	205	1444.3899	7.0458	
TOTAL	208	1476.1914		

Table 5: Summary of ANOVA showing differences in 'Ability to design experiments' among students differing with respect to achievement in science

Source	Df	Sum of squares	Mean square	F-ratio
Between groups	3	14.1186	4.7062	.6789
Within groups	205	1421.0202	6.9318	
TOTAL	208	1435.1388		

Table 3 shows that students differing with respect to achievement differ in their ability to draw inferences (F = 0.4107, df = 3, 205, p > .05). Table 4 shows that students differing with respect to achievement differ in their ability for exclusion of variables (F = 1.5045, df = 3, 205, p >.05). Table 5 shows that students differing with respect to achievement differ in their ability to design experiments (F = 0.6789, df = 3, 205, p > .05).

Table 6: Summary of ANOVA showing differences in 'Ability to interpret data' among students differing with respect to achievement in science

Source	df	Sum of squares	Mean square	F-ratio
Between groups	3	126.7687	42.2562	6.5194**
Within groups	205	1328.7337	6.4816	
TOTAL	208	1455.5024		

** *significant at .01 level.*

Table 7: Results of multiple range test for differences in 'Ability to interpret data' among students differing with respect to achievement in science

Gr. No.	Group based on achievement	N	Mean score	Standard deviation	Groups showing significant differences
1	High	18	5.0000	2.5205	1 > 4
2	Above average	77	5.2208	2.4528	2 > 4
3	Average	62	3.8710	2.7370	2 > 3
4	Below average	52	3.4038	2.4516	

Table 6 shows that students differing with respect to achievement differ in their ability to interpret data (F = 5. 6.5194, df = 3, 205, $p < .01$). Table 7 shows that mean scores on this ability for students with high, above average, average and below average achievement in science are 5.0, 5.2208, 3.8710 and 3.4038 respectively. Paired comparisons using multiple range test revealed existence of three significant differences. Students with high achievement in science had greater ability to interpret data than students with below average achievement in science. Students with above average achievement in science had greater ability to interpret data than students with average or below average achievement in science.

Table 8: Summary of ANOVA showing differences in 'Ability to identify supporting data' among students differing with respect to achievement in science

Source	Df	Sum of squares	Mean square	F-ratio
Between groups	3	62.7844	20.9281	5.3653**
Within groups	205	799.6366	3.9007	
TOTAL	208	862.4211		

** *significant at .01 level.*

Table 9: Results of multiple range test for differences in 'Ability to identify supporting data' among students differing with respect to achievement in science

Gr. No.	Group based on achievement	N	Mean score	Standard deviation	Groups showing significant differences
1	High	18	4.5000	2.1213	1 > 2
2	Above average	77	3.0260	2.1087	1 > 4
3	Average	62	2.9032	1.9976	1 > 3
4	Below average	52	2.3462	1.6673	

Table 8 shows that students differing with respect to achievement differ in their ability to identify supporting data (F = 5.3653, df = 3, 205, p<.01). Table 9 shows that mean scores on this ability for students with high, above average, average, and below average achievement in science are 4.5, 3.026, 2.9032 and 2.3462 respectively. Paired comparisons using multiple range test revealed existence of three significant differences. Students with high achievement in science had greater ability to identify supporting data than students with above average, average and below average achievement in science.

Results of the analysis of data have revealed that students with high or above average achievement in science have better science processes than those having average or below average achievement in science; students differing with respect to achievement in science do not differ on ability to exclude variables, draw inferences, and design experiments; students having high or above average achievement in science have better ability to interpret data than those having below average achievement in science; high achieving students exhibit greater ability to identify supporting data than other students. This indicates that achievement in science is related to overall science process and two science process abilities namely- ability to interpret data and ability to identify supporting data whereas abilities like- exclusion of variables, ability to draw inferences and ability to design experiments may not be influenced by the levels of science achievement.

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