

HANDS-ON, MINDS-ON AND HEARTS-ON ACTIVITIES IN HIGH SCHOOL SCIENCE TEACHING: A COMPARISON BETWEEN PUBLIC AND PRIVATE SCHOOLS IN NEPAL

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ABSTRACT

This study examined the comparison among cognitive (minds-on), affective (hearts-on) and psychomotor (hands-on) activities in science instructional practices among the public and private schools of Kathmandu valley. It is carried out on 60 science teachers; thirty from each public and private schools. It used the hierarchical linear modeling (HLM) analyses in which the students and teachers classroom activities were observed relating with emphasizing motivation to learn science, science instructional practices, field visits and excursions, linking science outside the classrooms, improvisation of instructional materials, group activities and science content delivery approach over a period of six months. It was found out that using the practical activities in teaching and learning science showed a high degree positive effect on students' achievement, use of teacher centered lecture method had a remarkably negative effect on the students' achievement in science subject. Public schools were significantly better in doing hands-on and hearts-on activities and are creating a warm and self-motivation to study and learn science comparing with private schools. Private schools were doing better in minds-on activities that is based on recitation of the content.

Keywords: Hands-on, minds-on, hearts-on activities, science performance

CONTEXT

This research study aimed to enhance the knowledge of how school science teachers in Nepal perceive and apply science teaching learning practices by applying hands-on (psychomotor domain), minds-on (cognitive domain) and hearts-on (affective domain) in public and private schools. This research aimed to explore the constructivist approach based on 5E learning cycle i.e., engage, explore, explain, elaborate and evaluate. It outlines how school science teachers applied the techniques of presenting the conceptual and comprehensive aspects of secondary level teaching and learning science. One of the area of this research was to analyze the science teachers' classroom activities were to compare public and private school teachers understanding of the embedded 5E model.

INTRODUCTION

Science is a body of knowledge, a way of investigation, and a way of thinking in the pursuit of an understanding of nature. It is difficult to say the exact definition of science. According to Conant (2008) science is an interconnected series of concept and conceptual schemas that have been development as a result of experimentation and observation (Mohan, 2007, p. 5). Science is accumulative and endless series of empirical observations which result in the information of concepts and theories (ibid). In the same way, the definition of science has given differently as science is scienteing (White, 2005), science is a way of investigation (Green, 1998), science is a certain way of looking at the world (Weinberg and Shabal, 2003), and science is an approach rather than content (Biesant & Biesant, 2005). Similarly, Soti (2005) said that science is the process of construction of knowledge by the observation and empirical evidences (p. 4). From these definitions science can be defined as an accumulated and established knowledge, which has been systematized and formulated with reference to the discovery of general truths or the operation of general laws; knowledge or the search for truth; comprehensive, profound, or philosophical knowledge. In this context, Lavoven (2009) said that without the applications of science, it would have been impossible for human to explore the other planets of the universe. Science teaching helps to underpinning the principles of science in the society (Ucar, 2011). It helps to develop scientific literacy among the people. Teaching science is depending upon the practical, experimental and improvisational activities. Scientifically literate people in this digital world is important for uplifting the overall dimensions of the today's world. According to (Goodrum, 2001), recent reform efforts in science education underline the importance of developing students' scientific thinking skills and scientific literacy.

In science teaching and learning, hands-on activities play a crucial role to understand the real meaning of scientific inquiry which plays a distinctive and pivotal role to increase awareness among the people (Hofstein, et. al. 2008). Activity based students' centered teaching and learning approaches help to uplift students' higher order cognitive skills like analyzing and creating. In this context, McNeill (2009) concluded in his research that students exposed to hands-on science instruction frequently get significantly higher scores in science than those students who experienced only minds-on activities in teaching learning activities. Blending hands-on, minds-on and hearts-on activities help to develop scientific awareness in the secondary level students.

Objectives: Major objectives of this study were to:

- analyse the condition of hands-on, minds-on and hearts-on activities while teaching science in public and private schools;
- explore the use of 5E approach of teaching by the school science teachers in Nepal.

METHODOLOGY

Qualitative and quantitative data were drawn from the Nepalese school science teachers of public and private institutions in 2016 that contained 60 science teachers who were selected through purposive sampling procedure from 10 schools across the Kathmandu valley. This sample consisted of 20 primary teachers, 20 lower secondary teachers and 20 secondary teachers. 30 male and 30 female teachers were purposively selected for the study. The number of science teacher per school in the public and private schools were 3.

Hierarchical linear modeling (HLM) was used in this study to explore the level of activities by school science teachers. According to Luyten, (2008), this method influence on educational outcomes with hierarchical linear modeling. One of the accurate and widely used statistical techniques is the hierarchical linear modeling that helps to analyze data that can deeply analyze the entire educational process. In this context, Willms (1999) argued that strength of hierarchical analysis is that it estimates statistics for each unit of a hierarchical structure using data from that unit while borrowing strength from the information available on all units.

The overall research design of this research was Quan-qual in which statistical tools were used to analyze quantitative data whereas qualitative data were analyzed by thematic approach. Meaning of the data text was derived from the thematic approach of analysis (Miller & Brewer, 2003, p.43).

Analysis and Interpretation of Data

Teaching learning strategies adopted by public and private school science teachers were analyzed on 5E model.

Among 30 science teachers, most of the them (24 out of 30 i.e.80%) in the public schools have adopted 5E modes of teaching using hands-on and minds-on activities blending with hearts-on activities that is they were arising interest in study and only a few science teachers (6 out of 30 i.e., 20%) were used only minds-on activities which is only based on recitation of the content of science. In E1 (engage phase), the performance of public school science teachers were very appropriate at the beginning of the class. They stimulate curiosity and released question based on inquiry approach and link the previous knowledge of students. Public school science teachers in the E2 (Explore phase) was very high. In the same way, in E3, E4 and E5 (Explain, Elaborate and Evaluate) phases, the performance was very high in terms of multimodal explanations. Integrate new approaches learning helps to provide the learning environment to the students to receive and make their own understanding. The details of it is given in the below table. Only few (9 out of 30 i.e., 30%) teachers were used hands-on and minds-on activities whereas (21 out of 30 i.e., 70%) science teachers in private schools were applied only narrative approach of teaching. They entirely based on cognitive approach of teaching and learning. The applied 5E model used to pursue this study is given below:

Public school teachers	E1 (Engage phase)	Performance
	Stimulating curiosity	Very high
	Set environment	High
	Inquiry arise by asking questions	Very high
	Linking students previous knowledge	Very high

In E1 (engage phase), public school science teachers were using very high performance by arising curiosity to learn, bridging the teaching topic with the previous knowledge of the students and so on.

Private school teachers	E1 (Engage phase)	Performance
	Stimulating curiosity	Low
	Set environment	Low
	Inquiry arise by asking questions	high
	Linking students previous knowledge	Low

In the E1 (engage phase), private school science teachers performance was low in-terms of bridging the knowledge of students, arising curiosity and setting environment to learn. Secondary level science teachers were teaching the topic liquid pressure in both the type of schools. Public school science teachers were motivating students by showing instructional materials such as empty water bottle, needle, beakers, water filled

vessel, syringe, pistons, etc. Students were divided into the group of 4-5 members and asking few questions related the teaching topic to bridge the previous knowledge of students. Teachers asked questions randomly to the students in the class. They arranged classroom setting from traditional to face to face seating arrangement.

Private school science teachers wrote the teaching topic on the white board and started to deliver to the lesson (definition, unit and the formula) of pressure without linking the previous knowledge of students. Most of these did not have the ideas of setting learning environment and arising curiosity of the students. Finally they dictate students to copy the notes.

Public school teachers	E2 (Explore phase)	Performance
	Provide experience of the teaching concept	Very high
	Addressing students' questions and testing relevant ideas	High
	Solving the related problems by investigating the ideas	Very high
Private school teachers	E2 (Explore phase)	Performance
	Provide experience of the teaching concept	moderate
	Inquire into students' questions and test their ideas	low
	Investigate and solve the related problems	High

In the E2 (explore phase), school science teachers from public schools in the Kathmandu valley were doing better than private school teachers. Private school science teachers were doing better to solve questions of the related problems and low in providing experience and know the ideas of students.

Science teachers at the public schools in Nepal have better performance in providing experience the major ideas of science ideas. Teacher help them by solving the queries and problems. Public school science teachers were exploring the concepts of science by engaging students in the well manner.

Public school teachers	E3 (Explain phase)	Performance
	Introduce conceptual ideas, interpret the evidence and construct explanations	Very high
	Construct evidence based multi-modal explanations	High
	Link and compare the explanations provided by students	Very high
	Explain the related but current scientific explanations	moderate
Private school teachers	E3 (Explain phase)	Performance
	Introduce conceptual ideas, interpret the evidence and construct explanations	Moderate
	Construct evidence based multi-modal explanations	Low
	Link and compare the explanations provided by students	Low
	Explain the related but current scientific explanations	Low

In E3 (Explain phase), science teachers dealt the conceptual ideas, construct evidences, linking the previous knowledge of students with the present ideas by public school science teachers were performing better than private school science teachers.

Dealing with the conceptual ideas, explaining multimodal concepts. Linking the ideas of science and discussing current scientific explanations are the key points followed by public school science performance of the above activities is very low in private school science teachers. They ignore the conceptual ideas, scientific explanations and did not linking the ideas.

Public school teachers	E4 (Elaborate phase)	Performance
	Applying new concepts and explanations	High
	Reconstruct and extend explanations	Low
	Integrating different approaches of teaching	High
Private school teachers	E4 (Elaborate phase)	Performance
	Applying new concepts and explanations	Low
	Reconstruct and extend explanations	Low
	Integrating different approaches of teaching	Low

In the same way, science teachers of public schools were performed very high comparing with that of private school science teachers in E4 (Elaborate phase). Extending explanations by inquiring students' previous ideas was seem better among public school science teachers. They blended lecture method with demonstrate and with discussion, collaborative learning method was the major approach of teaching. Science teachers at the public schools were using student centered approach of teaching. The performance of private school science teachers was totally based on teacher centered approach i.e., explanation by lecture method.

Public school teachers	E5 (Evaluate phase)	Performance
	Sharing opportunities for students to reflect students ideas for self-learning pace and to introduce it in new situation	High
	Modify the students' behavior (understanding, beliefs and skills)	High

Private school teachers	E5 (Evaluate phase)	Performance
	Provide an Opportunity to set up for students to provide and review the teaching and learning ideas and apply in new situation	Low
	Modify the students' behavior (understanding, beliefs and skills)	Moderate

In the final E5 phase, public school science teachers were performed far better than private school science teachers in terms of providing opportunities to review and reflect and modify the behavior of students. It shows us that public school science teachers were adopted 5E model of teaching and learning that helps students to understand scientific concepts.

Statistical analysis of hands-on, minds-on and hearts-on activities among the public and private school science teachers

In this section, students' activities were analyzed by the use of statistical analysis.

Table 1. t- test for the hands-on activities between the public and private school science teachers (N=60)

Science teachers	Sample size	Mean	S.D.	Variance	t-value	Remarks
Public schools	30	5.375	1.83	3.34	4.999	4.999>2.00
Private schools	30	12.28	1.954	3.82		

t_{0.05, 60}=2.00

significant at 0.05 levels

This statistical analysis reveals us that the mean of public and private school teachers are 5.375 & 12.28 respectively. The calculated standard deviation and variances were found to be 1.83 and 3.34 respectively for public school teachers. While the calculated standard deviation and variances were found to be 1.954 and 3.84 for the private school teachers. The calculated t-value was found to be 4.99 which is less than the tabulated value (t=2.00) at 0.05 level of significance using two tailed test with degree of freedom 64. This shows that

there is significant difference between public and private school science teachers' in-terms of doing hands-on, minds-on and hearts-on activities.

Table 2. t- test for the minds-on activities between the public and private school science teachers (N=60)

Science teachers	Sample size	Mean	Mean %	S.D.	Variance	t-value	Remarks
Public schools	30	12.28	49.12	1.95	3.82	4.1	4.1>2.00
Private schools	30	16.16	64.62	1.94	3.75		

t0.05, 60=2.00 significant at 0.05 level

It shows that the mean scores of public and private school teachers were 12.28 and 16.16 respectively. The mean percentages were 49.12 and 64.62 respectively. The calculated standard deviation and variance were found to be 1.95 and 3.82 for public school teachers. While the calculated standard deviation and variance was found to be 1.94 and 3.75 for private school teachers. The calculated t-value was found to be 4.1 which is greater than the tabulated value (t=2.00) at 0.05 level of significance using two tailed test with degree of freedom 60. This shows that there is significance difference between public school and private school teachers.

Table 3. t- test for the hearts-on activities between the public and private school science teachers (N=60)

Science teachers	Sample size	Mean	S.D.	Variance	t-value	remarks
Public schools	30	5.88	1.20	1.45	0.98	0.98<2.036
Private schools	30	5.06	2.11	4.46		

t0.05, 30=2.036 insignificant at 0.05 level

The data showed that the mean scores obtained in doing hearts-on activities of public school and private school teachers were 5.88 and 5.06 respectively. The calculated standard deviation and variance were found to be 1.20 and 1.45 for public school teachers and standard deviation and variances were found to be 2.11 and 4.46 for private school teachers. The calculated t- value was found to be 0.98 which is less than the tabulated value (t=2.036) at 0.05 level of significance using two tailed test with degree of freedom 30. This showed that there was no significant difference between public and private school teachers on hearts-on activities.

Table 4. t- test for the hands-on and minds-on activities between the public and private school science teachers (N=60)

Science teachers	Sample size	Mean	S.D.	Variance	t-value	Remarks
Private schools	30	5.88	1.20	1.45	13.465	13.465>2.036
Public schools	30	5.69	1.69	2.88		

t0.05, 30=2.036 significant at 0.05 levels

This analysis shows that the mean scores of private and public school teachers on hands-on and minds-on activities were 5.88 and 5.69 respectively. The calculated standard deviation and variance were found to be 1.20 and 1.45 for the private school teachers while the calculated standard deviation and variances were found to be 1.69 and 2.88 for public school teachers. The calculated t-value was found to be 0.16 which is less than the tabulated value (t=2.036) at 0.05 level of significance using two tailed test with degree of freedom 30. This shows that there was no significant difference between the public and private school science teachers on hands-on and minds-on activities.

Table 5. t- test for the hands-on, minds-on and hearts-on activities between the gender at public and private school science teachers (N=60)

Science teachers	Sample size	Mean	S.D.	Variance	t-value	Remarks
Male	30	5.69	1.49	2.23	3.221	3.221>2.036
Female	30	11.81	2.14	4.56		

t0.05, 30=2.036 significant at 0.05 levels

It shows that the mean scores of male and female teachers were 5.69 and 11.81 respectively. The calculated standard deviation and variance were found to be 1.49 and 2.23 for male teachers while the calculated standard deviation and variance was found to be 2.14 and 4.56 for female teachers. The calculated t-value was found to be 3.221 which is greater than the tabulated value ($t=2.036$) at 0.05 level of significance using two tailed test with degree of freedom 30.

This shows that there was significant difference between two mean scores on male and female teachers. Hence, the null hypothesis was rejected and alternative hypothesis was accepted. Male secondary school science teachers had better performance in doing activities than female science teachers.

CONCLUSION

The challenges faced by the mushrooming private schools in Nepal in terms of science teaching and learning is a great problem. The school system has to deal with poor teachers quality and increasing students and societal expectations, Nepal government has to make some sorts of arrangements to provide the teacher education system with an environment encouraging innovation and meeting the need of the schools. The major conclusion of this study is that science teachers at the public schools in Nepal have better performance in doing all sorts of activities that help to aware and increase inquiry oriented science learning in both the types of schools in Nepal. The overall performance of public school science teachers is significantly better than the performance of private school teachers. Furthermore, for very few science schools teachers at the public schools in Nepal produced innovative teaching and learning environments for the high quality science achievement. The overall impression public school science teachers is significantly high as compared with private school science teachers in their pedagogical practice towards innovative science practices such as inquiry-oriented science and use of the 5E learning cycle often takes in excess of a year.

Science instructional practices help to increase science achievement by relating cognitive (minds-on), affective (hearts-on) and psychomotor (hands-on) activities. In the hands-on learning pedagogical style, school science teachers were able to learn from experiments conducted either on the laboratory or during the excursions conducted by the school, showed the substantial positive effect on science achievement. Teachers who employed hands-on activities blending with minds-on and hearts-on activities in science lessons led to higher achievement in science than those who did not employ hands-on activities.

Analysis of minds-on activities of public and private school science teachers showed that calculated t-value (4.1) greater than the tabulated ($t= 2.03$) at 0.05 level of significance at degree of freedom 30. Public school science teachers were significantly better than teachers teaching at private schools. Minds-on activities were analyzed on the basis of motivation, explanation, teaching techniques, peer interactions, collaboration and recapitulation of the context delivery of the science teachers.

Analysis of the motivation of the students and to develop craze and motivation to study science both the public and private school science teachers show similar concern. Calculate t-value (0.98) is less than ($t=2.03$) at 0.05 level of significance. Furthermore, male science teachers were significantly better than female science teachers in doing hands-on, minds-on and hearts-on activities in relation to science teaching at the schools of Nepal.

Public school science teachers in Nepal have high performance of doing hands-on and hearts-on activities that have positive and influential effects on students' conceptual and understanding, their practical and intellectual skills, and their understanding of the nature of science. Hence, teachers can play a crucial role in helping students have productive experiences to promote the desired learning and their subsequent performance in science. Science learning cycle is a way of planning of science education and consistent with contemporary theories about how students learn.

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