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IMPACT OF ACTIVITY-BASED TEACHING ON IMPROVING LEARNING: AN EMPIRICAL EXPLORATION IN SCIENCE SUBJECTS

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ABSTRACT

This study explored the effectiveness of activity-based teaching (ABT) to improve learning among grade 8 science students. Experimental research Single subject design ABA was selected to conduct the study. The population was all public schools in District Lodhran. Thirty-five grade 8 students from the current academic year (2023-24), were selected as the subject of the study seven general science concepts were designed for grade 8 students. In the initial phase, the curriculum content was outlined and a table of specifications was developed. Before the treatment, students' initial learning level was assessed through a pretest. To ensure validity, the study design gets reviewed by secondary school teachers, educators and educational experts. After sixteen weeks of treatment of ABT approach, post-tests were administered. The results of the study depicted that the activity-based intervention significantly impacted the students' learning. The study revealed that implementing activity-based teaching; significantly rally the student's skill to transform knowledge into solution of various daily situations.

Keywords: Activity based teaching (ABT), learning outcomes, science subjects.

INTRODUCTION

Activity-Based Teaching (ABT) is an up-and-coming teaching strategy that has attracted much attention in the realm of education. Active student engagement is stressed through the choices, collaboration and critical reasoning by the students. This is further supported by the fact that ABT is based on a sociocultural theory which encourages student's active engagement in such activities that allow them to shape their knowledge. (Piaget, 1962; Vygotsky, 1978). In particular, the conception of activity oriented teaching is derived from John Dewey's "learning by doing" theory which is based on both pragmatism and constructivism with particular emphasis on knowledge construction through experience.

The quote "I hear and I forget, I see and I remember, I do and I understand" is a well-known maxim that has frequently been used by individuals who study Kolb's learning styles and further explains the concept of doing always contributes to enhancement of learning. Learners become actors and learn through doing such activities as experiments, problem solving and exploration. (Mustapha et al., 2021). Given the opportunity to do activities that require interactivity, students can also create and invent new approaches to the problem (Pulling et al., 2021).

According to Hodges (2020), ABT enhances the ability of the students to think critically since they are required to assess information, examine facts and come up with a solution. Anwar (2019) adds that ABT improves students' performance and raises their engagement, leads them to motivation and develops a passion for learning that lasts a lifetime. In the same way, there is a more profound comprehension of the content as there is a use of skills learned in the class in practice which results in more effective learning (Alabadi, 2019). Because it focuses on real, active learning, ABT is pleasing for children. It makes use of both the head

and the hands so that children can imagine, create and work together. The more the senses are afoot, the more a person knows and remembers (Martella et al., 2020). This technique allows children to be active, imaginative and avid learners at all stages of their lives by interesting them and entertaining them in learning activities.

The use of ABT approaches is revolutionary as it transformed the most negligent and monotonous process of conventional learning into a highly engaging and multidisciplinary one teaching first-hand experience. What makes educators interested is how ABT can build up one's academic performance and what factors motivate these students. Science is ever evolving, every discipline progresses as new solutions to age-old questions are discovered and unacceptable boundaries to understanding are pushed back. Education, much like any other human activity, flourished thanks to such a noble human aspiration as the pursuit of knowledge (National Academies Press, 2011). The amazing ability to combine theory with practice in the scientific knowledge has brought forth remarkable innovations which have altered peoples understanding on various fields including particles, energy and even life itself and the planet (Wong, 2006). The engagement in ABT is clearly a reversal in the normal or traditional teaching methods which usually wore out the children and overemphasized the details on the topics covered. It makes it possible for the learner to direct his or her education which encourages active deliberation, critical reasoning and dedication towards learning along their schedule (Bazarian, 2021).

The significance of science extends far beyond mere intellectual enrichment. It acts as the engine of progress, driving advancements that improve our lives in countless ways. From the development of vaccines and antibiotics that have conquered diseases and prolonged lifespans (Brown, 2005), to the creation of communication technologies that connect us across continents, science has revolutionized our world. Modern agriculture, transportation and energy infrastructure, all owe their existence to the tireless efforts of scientists and engineers (UNESCO, 2017). Just as a flower needs sunlight to bloom, a student's positive attitude towards science is essential for their growth and development. Interest sparks curiosity, which, in turn, fuels deeper learning. This deeper understanding can lead to academic success and open doors to exciting career opportunities in the fascinating field of science (Karen, 2013).

Science cultivates critical thinking and problem-solving, fostering informed decision-making and responsible citizenship (Dewey, 1910). Schroeder et al. (2007) review found limited research on elementary science education, especially inquiry-based learning. Even studies like Minner et al. (2010) faced methodological challenges. This lack of research hinders improving elementary science instruction. Terada (2021) conducted a study to investigate the effects of evidence-based learning activities on university students' knowledge acquisition, confidence and self-assessment. Activity-based learning enhances self-esteem and motivation by providing opportunities for independent and collaborative work (Arioder et al., 2020).

Bosch et al. (2023) found that evidence-based learning activities can improve university students' knowledge acquisition, confidence and self-assessment by providing opportunities to engage with authentic data and evidence. Curtis et al. (2013) point out that active engagement in practical scientific activities fosters positive attitudes and a sense of accomplishment. Activity-based teaching is a learner-centered approach that prioritizes student engagement. (Metin, 2020). Activity-based learning promotes creativity and personal development in addition to academics. (Camargo et al., 2020; Faikhamta, 2018; Chauca et al., 2021). Through the incorporation of practical work and experiments in the activities, this study sought to see whether it was possible to facilitate the students' comprehension of some scientific concepts, enhance their interest in the subject and encourage them to develop a positive attitude towards learning. This research was significant for appreciating the value of activity based teaching approaches in science education and the anticipated gains in students' performance.

Much like a garden nurtured by the right teachers, a student's love for science can also grow well. Field trips to various institutions, active participation of students in activities, boosting of skills and engaging students in the topic to be studied enhance science achievement and interest among students. This atmosphere is also supported by the parent's encouragement and enables the nurturing of the love for science (Osborne, 2003)

As such, ABT is an important approach to science instruction that involves hands-on activities and inquiry-based instruction. This is because through doing experiments and carrying out investigations students are able to properly understand some scientific concepts, be able to reason scientifically and develop positive disposition to science. This active learning method not only enhances the level of retention but the pleasant atmosphere also stimulates the students' willingness to learn. Research findings such as those by Kurniasih et al. (2021) on the persistence of learning effects in ABT learning also provide evidence on this claim. The ABT improves student-teacher relationship and enhances effective learning in its context (Berkowitz 2004). ABT can be used to solve problems that are encountered with traditional lectures such as students being passive and unmotivated. Exposing students to more of a responsive and student-centered teaching approach, ABT has the potential to ameliorate the students' performance in science significantly.

Statement of the problem

The growing phenomenon of student-centered learning in education called for new forms of teaching which at best would interest and facilitate understanding of science courses. In most cases where the lecture format was used, students were deprived of an active learning setting where they will apply the theoretical knowledge they have acquired. Earlier studies indicated that students usually encountered problems with their memory performance and looking at high order thinking skills in science. Active teaching strategies were used in a range of education environments for the purpose of promoting active engagement and the practical component. Early reviews indicated that such techniques might help the students both understand the scientific concepts and remember them longer. However, there was still paucity of sufficiently comprehensive literature review on the effectiveness of activity based learning in general and science subject in particular. Further, the question needed to be answered was how these instructional methods affected the students' academic performance, balance between student engagement and classroom management and students' experience in science learning.

Objectives of the Study

The objectives of the study were:-

1. To evaluate the effectiveness of activity-based teaching in achieving desired learning goals.
2. To identify the key components and characteristics of effective activity-based teaching in developing skill based learning in science students.
3. To provide practical guidelines and recommendations for educators to effectively implement and optimize activity-based teaching strategies.

Methodology

The current research employed a single-subject design to determine the impact of the activity based teaching on the learning outcomes of the students (Gay et al., 2012), where the unit of observation can be a single participant, a group of participants, or the entire unit. A total of thirty-five public school eighth-grade science students attended the study, all of whom were recruited based on their performance on the diagnostic test and were determined to require additional assistance. This study used an A-B-A single-subject design to determine the value of Activity-Based Teaching (ABT) in promoting the desired learning of science students. Although this approach has exceedingly few disadvantages, group-single-subject designs do have some disadvantages in relation to other more conventional forms of dominant group designs. This allows for more thorough analyses of the impact of an intervention on a single patient. Moreover, these are most appropriate when the epidemiology of the disease is such that the number of subjects to be recruited is very few or there are difficulties of recruitment. At last, single subject designs are more flexible with respect to the changing needs of the subjects and are therefore applicable to both clinical and experimental approaches (Kinugasa et al., 2004). Using an A-B-A withdrawal single-subject design, the researchers sought to understand the influence that the intervention had on the learning outcomes of the science students. In this situation, researchers conducted the studies on one or a number of individuals (including groups or classes) at recurrent intervals with the focus being on dependent variable(s)/behaviours. A comparison of behavioral changes between (A) 'Baseline,' (B) 'Treatment,' and (A) 'Return to Baseline' has been

used in order to measure the effectiveness of the treatment (Yao et al., 2013). This method has the following advantages; it may allow surveillance of behavior shifts in individuals, clusters of individuals or even whole populations.

The study followed such steps:

In this study, a single-subject design was applied; it encompassed three phases: baseline, treatment (ABT) and withdrawal. The baseline focused on learning what was learned initially, the treatment phase used ABT and the withdrawal phase evaluated learning gain post ABT removal. A-B-A Experimental Design. (Yao et al., 2013).

Baseline A	Treatment B	Baseline A
O-O-O	X-X-X	O-O-O

O = Observations

X = Treatment

Population

The population was all eighth-grade Science students of Public Schools of District Lodhran.

Subjects of the study

This study sought to examine the impact of ABT on learning outcomes in a group of 35 eighth-grade Science students in a public school. Single-subject research designs, as outlined in educational research methods (Gay et al., 2012), can involve individual participants, intact groups, or entire institutions. The students were selected based on their need for additional support, as determined by a diagnostic assessment.

Data Collection Instruments

The following instruments were used to fold data for the study.

Seven key concepts from the General Science textbook for eighth grade: Ecosystem, Environmental Problems and Solutions, Nervous System, Heredity, Cell Division, Biotechnology and the Periodic Table. The classroom buzzed with activity as learners delved into hands-on engagement, simply answering questions. Students actively participated in tasks and activities, building science projects, conducting science experiments, or debating scientific issues. These authentic tasks mirrored real-world challenges, making the learning experience both engaging and relevant. Whether analyzing data through video projects, collaborating on problem-solving quizzes, or fostering critical thinking through discussions, the focus was on active participation. The classroom had transformed into a dynamic space where knowledge wasn't just absorbed, it was experienced.

A total of twenty-two lesson plans were developed based on these concepts, incorporating activities, pre-tests and post-tests.

Pretest: This assessment was conducted before the treatment began. It established a baseline measurement of the participants' characteristics, knowledge, or behaviors. By understanding the initial state of the subject, researchers could assess the impact of the treatment.

Posttest: This assessment was administered after the treatment was completed. It measured the same variables as the pretest. By comparing the post-test measurements with the baseline, researchers could determine the changes or effects resulting from the treatment.

Face Validity and Content Validity

The test's alignment with the Grade 8 Science curriculum was ensured through comparison, expert review and face validity assessment.

Construct Validity

Subject matter experts ensured the test accurately assessed intended skills by removing irrelevant questions and focusing on desired scientific concepts.

Data Analysis

A single-subject design was used to analyse data collected from students through diagnostic tests and observations during seven experimental concepts. The study used a single-subject design to evaluate the effectiveness of ABT on eighth-grade general science learning outcomes, analysing pre and post-test data using ANOVA and t-tests.

Table 1: Level of Identification Learning in General Science

Level 1	Excellent
Level 2	Good
Level 3	Satisfactory
Level 4	Needs Improvement

Table 2: Assessing of students learning before treatment

Concepts	Frequency	Percentage
1. Ecosystems 2. Environmental Problems	0	0.0
3. Nervous System	05	14.3
4. Heredity 5. Cell Division	09	25.7
6. Biotechnology 7. Periodic Table	21	60.0

Table 2 reveals the students' pre-activity-based teaching understanding of the concepts. A majority of students (60%) were at level 4, indicating a need for improvement. While 25.7% demonstrated satisfactory performance, only 14.3% achieved a high level of comprehension. These findings suggest that the majority of students required targeted treatment to enhance their understanding of the concepts.

Table 3: Assessing the Effect of Activity-Based Teaching on the Concept of Ecosystem

Test	Mean	SD	df	t-value	Sig(2-tailed)
Pre-Test	3.142	1.548	34	-8.625	0.001
Post-Test	5.451	0.651			

Note: n=35, P=.005

Table 3 shows the results of paired t-test statistics about the effect of activity-based treatment on the student's learning in the concept of Ecosystem. The p-value (0.001) shows the significant effect of activity-based intervention. Data in the above table also shows the effectiveness of treatment in enhancing students learning.

Table 4: Assessing the Effect of Activity-Based Teaching on Environmental Problems

Test	Mean	SD	df	t-value	Sig(2-tailed)
Pre-Test	4.652	1.984	34	-10.016	0.003
Post-Test	7.891	1.165			

Table 4 shows the results of paired t-test statistics about the effect of activity-based treatment on the student's learning of the concept of Environmental Problems. The p-value (0.003) shows the significant effect of activity-based intervention. Data in the above table also shows the effectiveness of treatment in enhancing students learning.

Table 5: Assessing the Effect of Activity-Based Teaching on the Nervous System

Test	Mean	SD	df	t-value	Sig(2-tailed)
Pre-Test	4.087	1.463	34	-12.158	0.001
Post-Test	7.243	.7650			

Table 5 shows the results of paired t-test statistics about the effect of activity-based treatment on the student's learning of the concept of on Nervous System. The p-value (0.001) shows the significant effect of activity-based intervention. Data in the above table also shows the effectiveness of treatment in enhancing students learning.

Table 6: Assessing the effect of activity-based teaching on heredity

Test	Mean	SD	df	t-value	Sig(2-tailed)
Pre-Test	3.776	1.450	34	-7.840	0.002
Post-Test	6.275	.8670			

Table 6 shows the results of paired t-test statistics about the effect of activity-based treatment on the student's learning of the concept of Heredity. The p-value (0.002) shows the significant effect of activity-based intervention. Data in the above table also shows the effectiveness of treatment in enhancing students learning.

Table 7: Assessing the effect of activity-based teaching on cell division

Test	Mean	SD	df	t-value	Sig(2-tailed)
Pre-Test	3.135	1.568	34	-8.695	0.023
Post-Test	5.482	.753			

Table 7 shows the results of paired t-test statistics about the effect of activity-based treatment on the student's learning of the concept of Cell Division. The p-value (0.023) shows the significant effect of activity-based intervention. Data in the above table also shows the effectiveness of treatment in enhancing students learning.

Table 8: Assessing the effect of activity-based teaching on biotechnology

Test	Mean	SD	df	t-value	Sig(2-tailed)
Pre-Test	4.058	1.482	34	-12.158	0.001
Post-Test	7.430	.987			

Table 8 shows the results of paired t-test statistics about the effect of activity-based treatment on the students learning of the concept of Biotechnology. The p-value (0.001) shows the significant effect of activity-based intervention. Data in the above table also shows the effectiveness of treatment in enhancing students learning.

Table 9: Assessing the effect of activity-based teaching on periodic table

Test	Mean	SD	df	t-value	Sig(2-tailed)
Pre-Test	4.587	1.985	34	-10.576	0.002
Post-Test	7.891	1.264			

Table 9 shows the results of paired t-test statistics about the effect of activity-based treatment on the student's learning of the concept of on Periodic Table. The p-value (0.002) shows the significant effect of activity-based intervention. Data in the above table also shows the effectiveness of treatment in enhancing students learning.

Result

The findings from the pre-test revealed a significant need for improvement in students' understanding of various scientific concepts. Despite some showing satisfactory levels, many demonstrated insufficient comprehension, particularly in ecosystems, environmental problems and cell division. These results highlight the need for revised teaching methodologies and curricular materials to better address the educational needs of students in the Punjab region. Conversely, the post-test results following activity-based treatment indicate a significant enhancement in students' learning across all examined concepts. The consistent positive outcomes, evidenced by statistically significant differences in scores and partial eta square values, suggest that this instructional approach effectively engages students and facilitates deeper understanding. Activity-based learning not only improves knowledge but also fosters critical thinking and problem-solving skills, promoting a more engaging and effective learning environment.

Discussion

Many grade 8 science learners in the study experienced challenges in the comprehension of major topics/subjects including Ecosystems, Environmental Problems, Nervous System, Heredity, Cell Division, Biotechnology and the Periodic Table. Most students lacked comprehension and needed more help to improve

their understanding. Almost concerning comprehension of key concepts was present in the majority of grade 8 science students as more than half was rated too weak. Few students fully understood the concepts that were assessed. Nevertheless, all the objectives related to the students' learning had improved considerably due to the incorporation of activity-based teaching methods in the classrooms. This was evident by the presence of statistically significant differences in pre and post-test takers among students of all the subjects administered. The application of partial eta-squared values supported that the effectiveness of the activity-based measures was around the student factors and motivation. These offer a better understanding of the situational pedagogy and where students participated incorporating the premise of change. The findings update those that had been previously documented based on the broad view of human learning in education (Hattie, 2019: Freeman et al 2014).

It can be concluded from his results that other TA of physical education and activity based teaching of subjects should be included in class for higher growing improvement in learning psychology of children and also assuring effectiveness of science education through deep comprehension, thinking out of the box and solving related problems.

Recommendations

In accordance with the results of the study that analysed the efficacy of activity based learning on students' acquisition of certain science concepts, it would be appropriate to improve the states of education:

1. Lessons incorporate activity-based teaching methods into their subjects of teaching on different science topics. The levels of understanding of several concepts such as ecosystems, environmental problems, nervous system, heredity, cell division, biotechnology, periodic table, etc., which were achieved by students' application of knowledge, prove the availability and efficiency of these methods. Educators need to establish the right pedagogical methods that will help students not only to learn but to understand complex scientific concepts.
2. There is a major need for creation of professional development opportunities for science teachers concerning introduction of activity-based learning there into classrooms. Programs based studies create a standard structure incorporating design and implementation that engage the ability to actively participate by educators on practical, interactive approach within the learning scenarios of students in a classroom. Such approaches coupled with complementary strategies such as mutual collaboration and discussion among teachers to share success stories can enhance the effectiveness of the additional methods greatly.
3. A revision is required because educational institutions do not go beyond the traditional, subject-centered curricula in their science programs. This could entail the designing of specific learning modules which would make use of teaching learners through experimenting, group activities and applying the concepts of science in everyday life. Furthermore, evaluation methods should also reflect these methods of instruction by including evaluation of projects wherein knowledge acquired through active learning methodology is put into a working model.
4. Schools should make consistent efforts for seeking the involvement of the parents, the local people and activity-related organization for the purpose of activity-based learning. This can include field activities, visiting guest speakers or collaborating with organizations that are involved with science which add more resources and knowledge. Brokers of the community can bring certain aspects of the science curriculum extra and help motivate students by showing them the application of science concepts learnt in class.
5. It would be important to pursue other studies for the purpose of following the effects of activity based teaching on the learners' achievement for a longer period of time. Other studies may involve different participants with higher or lower levels and may have to work with new or different subjects to understand the thesis more widely. Implementing systematic evaluation practices will make it possible to adjust teaching techniques towards changing requirements and demands for the learners from the scientific arena.

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