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MICROLEARNING: AN EXPERIMENTAL INVESTIGATION ON ACADEMIC PERFORMANCE AND LEVELS OF CONCEPT ACHIEVEMENT IN SCIENCE

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Abstract

Microlearning has been integrated into the modern concept of teaching in the current educational process as a new approach to teaching content in brief, focused and interesting learning units. The issues that arise in teaching science in elementary school are related to the low concentration of students, low engagement and motivation in learning. The purpose of the current study was to see if there is any impact of microlearning on students' learning performance and their motivation in science learning. Non-equivalent control group design was used for this study. The subjects of the present study were the pupils of 7th grade girls in a public elementary school of Lahore (Punjab, Pakistan). The experimental group was provided with microlearning practices in classroom whereas the students in the control group received instruction through pre-existing practices. The 'Academic Achievement Test' designed by researchers was used to collect data for the experiment. The intervention lasted for a period of 10 weeks. Results were statistically analyzed to draw conclusion that microlearning proved significantly effective not only in developing the levels of cognitive outcomes but also the academic performance in science subject indicating the fact that microlearning also helps in retention of the concepts.

INTRODUCTION

The early years in students' lives in the area of science education is one of the factors that can stimulate student's curiosity, reasoning and understanding of the surrounding world. Children begin to ask questions and think about the nature of events at this stage of development and develop attitudes that may affect their future learning. The initial learning of science could encourage learners to continue on a related science course which can even influence their career options. Although it is vital, research has been conducted on the declining interest of pupils

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and their performance in science (Jong, 2020; Mohammed et al., 2024).

Students' learning and achievement in Science is not just achieved in assessment. Good outcomes in science are based on students' understanding of scientific facts, the application of this knowledge to real world situations, problem-solving and thinking skills. Current educational strategies are more concerned with enabling meaningful learning rather than rote learning. Indeed, the findings of several studies indicate that students who are involved in 'learning by doing' and making their own meanings, out class others (Cheng et al., 2020; Yin et al., 2020).

Microlearning has been seen as a phenomenon in the world because of its many benefits. Firstly, microlearning is a unique learning tool because it has a flexible nature, learner-centered approach, and is digital-friendly. Microlearning allows for personalized learning experiences and to address the need for brief content as described by Buchem and Hamelmann (2020). As illustrated in the above countries, microlearning has been effectively used in education and the workplace in countries like United States, European countries like Germany, Finland and Singapore (Hug, 2019). Microlearning is also in practice in developing countries as well. This approach has been successful in the digital learning projects in Indonesia, Malaysia and India, where students can easily access materials for learning. As noted by Tibaná-Herrera et al. (2020), microlearning helps to address the digital divide because learning content is short and does not need a high bandwidth and can be delivered through a mobile phone. Furthermore, this approach of learning was employed in Malaysia to enhance students' scientific literacy, motivation and grades (Alhassan, 2020).

Microlearning is a learning strategy in which objectives of learning are achieved by transfer of information or knowledge in the form of small chunks. This allows the learner to receive information in small steps, aiding attention, memory and comprehension. Some research conducted before has demonstrated that the flexibility and convenience of microlearning will enhance learners' engagement, motivation, and learning outcomes (Hlazunova et al., 2024; Yin et al., 2020).

Microlearning is being recommended by international bodies such as UNESCO and World Bank as a recent strategy to promote learning that is adaptable and lifelong. Modern studies advocate that instruction designed around short and manageable units to help learners more to access knowledge and enhance 21st century skills (UNESCO, 2023).

Statement of the Problem

There are numerous challenges in learning science at elementary level in Pakistan. Traditional approach used to deliver science lessons is causing problems for most Grade VII students in learning science as it turns the learning process abstract and boring (Hussain, 2012; Ullah & Ali, 2021). Consequently, science learning is not perceived interesting by learners and does not motivate them, due to which the learning outcomes in science subjects are not achieved optimally. The traditional instructional method can be a single teaching method that only uses the teacher's lecture and may be insufficient to arouse the attention and involvement of learners (Aini et al., 2020). There are studies that suggest the positive effect of microlearning on students' conceptual achievement in higher education (Giurgiu, 2017; Hesse et al., 2019) but there is little evidence of using microlearning at elementary level,

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particularly in learning science for elementary school students. This study reveals the effect of microlearning on elementary school students' academic performance and levels of cognitive outcomes in science.

RESEARCH OBJECTIVES

Following were the research objectives of the current study:

- To determine the effect of microlearning on academic performance of elementary school students in science subject.
- To find the effect of microlearning on elementary school students' concept achievement at knowledge level in science subject.
- To find the effect of microlearning on elementary school students' concept achievement at comprehension level in science subject.

LITERATURE REVIEW

Microlearning is an innovative learning approach lately very popular due to its flexibility, efficiency and learner-centered approach. Theo Hug is the creator of the term "microlearning". Hug (2005, 2006) defines microlearning as an instructional approach that employs small, discrete elements of content and learning outcomes that are achieved relatively quickly. Hug (2019) states that one of the best definitions for microlearning is that it is a learning material in the small chunks, easy to understand parts and focused one concept at a time. If you want to find out how to create microlearning, you need this definition because it highlights two key factors: small learning units and focus one concept at a time. Furthermore, Hug (2019) highlights the notion that microlearning can't be limited to a specific type of technology. On contrary, the process described is very flexible and can be adapted for various contexts, enabling microlearning to be used in various teaching methods.

Microlearning differs from traditional learning by delivering complex content in small chunks versus absorbing a longer presentation of content in a lecture. This is because microlearning has the ability to address the cognitive load (Mayer, 2014; Sweller, 2019). Recent studies have been supportive of microlearning by having higher achievement and engagement as compared to traditional learning strategies (Jainuri, 2025).

Although microlearning has recently found its way into the past 10 years, the concept of microlearning has been decades old in previous learning theory. The theories of mastery learning developed by Bloom (1968), and programmed instruction developed by Skinner (1954), as well as the theory of school learning developed by Carroll (1963), were all based on the systematic and progressive approach to learning. All above mentioned concepts are directly linked with the current trends in microlearning. The application of microlearning has, however, broadened the possibilities of technology and online system (Aliasa & Razak, 2024; Bruck et al., 2018).

There is plenty of research on the effectiveness of microlearning that can be used as support in the implementation of learning in the classroom. There is a lot of research that can be used as support in implementing microlearning in the classroom, based on the relevant learning theories. For example, the Cognitive Theory related to information processing suggests that capacity of working memory is insufficient for students to assimilate a certain amount of information. When it comes to microlearning, the information is delivered in smaller chunks, which means that extraneous cognitive load is reduced (Sweller, 1988, 2019). Microlearning is also effective in learning due to 'Spaced Practice Theory' which

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states that distributed learning leads to retention (Kornell, 2018).

These theories have been further supported by empirical evidence. In using the blended learning model with the microlearning approach, for example, Ho et al. (2025) concluded that students' preparation for lesson was improved due to the pre-class video lessons given.

Jainuri et al. (2025) have summarized literature on the topic of the impact of microlearning on higher education student retention and learning outcomes from 2020 to 2025 and found that the impact is positive. A further systematic review of research articles published from 2023 to 2025 revealed a dramatic uptick in the amount of research related to microlearning during that time, particularly in the areas of higher education, healthcare, and vocational training (Adrian et al., 2025).

Microlearning benefits students not only academically, but also in terms of their satisfaction and motivation. Based on several research studies, the learner satisfaction findings are very high as microlearning provides a more flexible and relevant content that meets the learning needs of the learners (learner satisfaction 2024 study). Moreover, Zhao and Wahid (2025), advocated in their study that instructional models based on microlearning like flipped classroom improve learning.

Research on informal learning supports that Microlearning has significant positive effect in informal learning contexts. This learning method enables instructional support anytime and anywhere to enhance self-directed and lifelong learning. It can still be integrated into the formal curriculum when planned in a systematic way, carefully sequenced in curriculum and assessment approaches (Bruck et al., 2018). In the latest study results (Isibika et al., 2025), it has been proven that microlearning improves knowledge transfer and adaptability skills in the workplace.

Science Education at Elementary School Level

Science education at Elementary level is important in developing learners' skills in science because students attain scientific literacy as a result of the scientific education received in the classroom. Science literacy also involves the ability to interpret information presented to them in science i.e., to reason and evaluate information, to use scientific knowledge, to explain or solve real-world problems, and to provide explanations about natural phenomena based on scientific evidence.

At elementary level of education, learning begins to interact with the environment. Students are introduced to the basics of life process, living and non-living things, energy, earth and environment. At this stage of science education, learners develop important thinking skills, such as observing and making inquiries. According to Duschl et al. (2018), elementary level science education is extremely significant in providing science education foundations for further study at a higher level.

It has been found through research that those students who gain a solid knowledge base about science during the early stages of their lives tend to pursue studies in the fields of science at higher levels, even selecting science-oriented jobs. In contrast, students who struggle to learn science and/or lose interest in science in elementary school are not likely to do well in science over their lifetime (National Research Council, 2019). Hence, it becomes extremely crucial to deliver an effective science education to the students during their elementary years.

Teaching of science in elementary schools in Pakistan is given according to the objectives given

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in the Single National Curriculum (SNC) which aims to give equal education to all children of the country. There is a large variety of topics related to sciences included in the SNC, ranging from grades 1 to 8. These include organisms, plants and animals, matter and energy, Earth and space, and a range of scientific processes like observations, experimentation and problem-solving (Ministry of Federal Education and Professional Training [MoFEPT], 2020).

The SNC 2020's first principle is inquiry-based learning, meaning that students will be taught science by asking questions and conducting experiments. Other priorities are the development of skills for scientific enquiry and the use of scientific knowledge in everyday situations.

However, these principles should be adhered to, a large amount of research shows that this is not the case in practice. Many studies have shown that the teaching of science at elementary level is not satisfactory. That is, traditional approaches in science education, such as reading books and memorizing definitions and facts given by teachers, are still being followed in science education in Pakistan (Khalid, 2021, Rana & Bhutta, 2020). Moreover, when teachers are observed in classrooms, it is found that in many schools, the focus of most teachers is on filling in the syllabus rather than imparting a deep knowledge of a subject matter (Khalid, 2021). In such an instance, children are compelled to memorize information and answers without conducting any experiments or discussions.

The disparities between what pupils are expected to learn in the curriculum and what actually happens has a negative impact on the learning outcomes achieved by pupils. National and international assessments, for example, show that the overall level of achievement of Pakistani students is poorer than desired for science learning in the elementary grades. Theoretical knowledge is not being properly applied, and children are not showing good command of basic science concepts and skills as mentioned in ASER Pakistan (2022).

The outcomes of this research prove that the methods and approaches in science teaching at elementary level need to be improved. In the present times there is a great need for innovative approaches to science teaching, grounded in the latest research, to assure high-quality science instruction at the elementary level. This can be facilitated through instructional approaches such as microlearning, inquiry-based learning and technology facilitated instruction.

Students' scientific knowledge, skills and attitudes are greatly developed through the learning of science at elementary level. Pakistan has ample opportunities to acquire scientific knowledge in the curriculum but still there are some challenges regarding its implementation in curriculum.

Research is founded upon Cognitive Learning Theory (Bruner, 1966; Mayer, 2001; Piaget, 1973; Sweller, 1988) that asserts that learning takes place due to the processes of organizing and manipulating information within the brain. The Cognitive Theory states that learning is enhanced if instructional design matches the way the brain processes the information.

In the current research, the term microlearning is used to describe an education approach that is based on cognitive theories. The science subjects have been broken down into small pieces of information and presented in a series of focused lessons, giving students the chance to efficiently manipulate information in their brain rather overload it or enhance memorization.

The Cognitive Theory focuses on the mental processes occurring in the learning process, such as thinking, comprehending, remembering, and

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problem-solving. In line with Jean Piaget (1973), learning takes place when learners construct knowledge from their previous experiences or schemas (the framework of knowledge). Similarly, Jerome Bruner (1966) said that learning occurs when learners find and structure knowledge in some meaningful fashion. In cognitive theory, the learning process is seen as an internal and mental process. The learners are active in the process of learning.

Although microlearning has been gaining more attention as an innovative approach to learning, there are some gaps found in the current scientific literature.

First, even though today microlearning has received more attention and numerous theoretical and descriptive papers have been published on this topic in recent years, there has been limited effort to examine its real impact on students' learning performance experimentally. There are many conceptual and descriptive studies on microlearning that are difficult to establish the link between microlearning practice and its effectiveness in terms of better academic outcomes (Hug, 2017; Shail, 2019). This indicates a need for more systematic experiments in this direction.

Second, most of the literature about microlearning is targeted towards the corporate and higher education sectors and the use of microlearning in elementary schools has yet to be explored in detail. Children's cognitive abilities and attention span vary considerably from that of adults; therefore, results from adults are not necessarily representative of the results in the context of elementary education (Buchem & Hamelmann, 2010; Mayer, 2021).

Besides that, there is a clear lack of literature on microlearning, and the one that specifically addresses science education. Although extensive research has been conducted in the field of microlearning in digital learning environments in general, further research is needed on how microlearning can be applied to scientific concepts. For science learning to be successful, students need to have knowledge, engage in critical thinking, and process information, which can react differently to microlearning compared to other subjects (Mayer, 2021; National Research Council, 2012).

The second gap in literature is the lack of motivational elements and academic accomplishments. In research, attention is usually focused on the cognition aspects of learning and motivational aspects are overlooked, which are very important in promoting academic performance. According to STP, motivation plays a significant role in improving students' performance and involvement. The relationship between motivational factors and microlearning has, however, been less explored (Ryan & Deci, 2020; Schunk, 2020).

Lack of research on implementation of microlearning in developing countries specially in the context of Pakistan is the last but not the least gap. Most research on microlearning has taken place in technologically advanced settings with access to all the many facilities.

Furthermore, the research so far has been lacking in evidence for the use of microlearning in a face-to-face class setting. Although many researchers are interested in the implementation of the concept of microlearning in digital platforms, the way it is used in the classroom as an adjunct is not analyzed (Giurgiu, 2017).

Lastly, there is a lack of long-term studies to explore how microlearning affects students in the long run in terms of student achievement and motivation. Existing literature consists overwhelmingly of studies focusing on short-term

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effects and no studies examine the long-term effects of implementing microlearning techniques.

Research Design

This study was conducted using non-equivalent control group design (quasi-experimental design). The use of the research design was justified for its effectiveness in determining the effect of the interventions by comparing the performance of the experimental and control group.

Population and Sample

Study was conducted in a public girls school of District Lahore, where there was enough strength of the students to comply with research design. Class 7th was selected to represent the elementary level students. From the four groups (sections) of 7th class, two sections were randomly selected, constituting the sample of the study. These sections were then randomly assigned as control and experimental groups. It was ensured prior to the study that students' division in section is not due to difference in ability. Number of students in both groups was almost equal, 39 in experimental and 38 in control group respectively. Thus, overall sample of the study constituted 77 elementary girls of public sector school.

Research Instrument

1. Achievement Test: The test comprised of 28 multiple choice items was constructed from the textbook contents covered during intervention. Initially a larger pool of items was prepared to be reviewed and analyzed by 2 science subject specialists, 2 elementary science teachers and 2 experts from science teacher education background. The experts examined the correspondence of the test items and the contents covered in the science textbook selected for intervention. The validation of construction of test items in terms of the rules for writing the multiple-choice items was carried out by a science teacher educators with item writing experiences. Level of Items was also validated by these experts. Test thus, was validated in terms of science content grade compliance, science concept accuracy, compliance of item writing rules and levels of cognitive outcomes. All questions were to be awarded equal number of marks, as 1 for correct and 0 for incorrect response. A pool of 42 items was thus finalized by the experts. This draft was used for item difficulty and discrimination analysis and administered as a pilot test on 40 class 7th students, other than the sample of the study. 28 items having equal number of Knowledge and Comprehension Items with appropriate item analysis indices were finally included in the test. Items with item difficulty range 0.4 – 0.6 and discrimination index: 0.2 – 0.8, were placed in the final test.

2. Comparison of Academic performance for the effect of Microlearning was based on the difference between 1st term school exam and 2nd term school exam for Science Subject. Since intervention was conducted between these exams, scores of 1st term served as pretest and 2nd term were taken as posttest measure.

2. Intervention (Microlearning Implementation)

Intervention period spanned over a period of 10 weeks, where experimental group was exposed to microlearning techniques. Intervention package was prepared in advance complying to the academic calendar of the school. Content of Science textbooks was reproduced for students in form of

- colored infographics
- small chunks of information, with highlighted key words

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- concept maps,
- completion items followed by instruction
- feedback Form
- Short videos

Textbook was used as resource book. Contents, where functions and processes were involved, special videos were shown to students in groups, followed by a short quiz. It was ensured that students should be provided with immediate feedback where possible. Follow up session on students' tasks was a mandatory feature of intervention.

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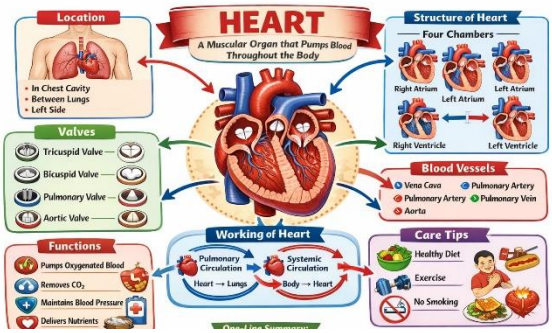
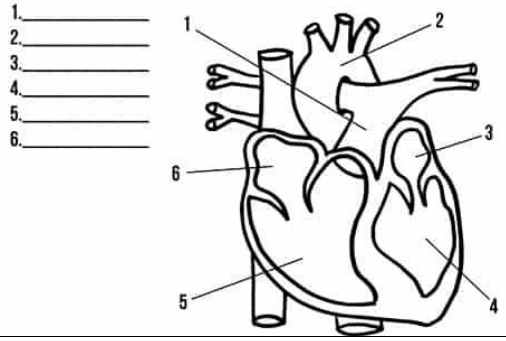
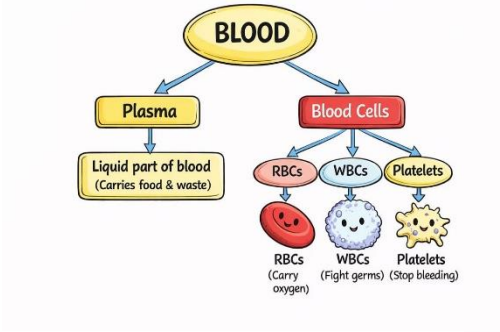
Few of the intervention samples are given here

Introduction of Concept	Assessment
1. Heart 	
2. Blood  **Blood** Complete the table to show the different features of the main 4 components of blood Component / Picture / Description / Function Red Blood Cell — Disc shaped cell with a dimple in — Carries oxygen White Blood Cell — Irregular shaped cell with a nucleus — Forms the immune response by engulfing pathogens & making antibodies Platelets — Disc shaped cell fragments — Stick together to form a clot Plasma — Straw coloured liquid — Carries dissolved nutrients	**Blood** Complete the table to show the different features of the main 4 components of blood Component / Picture / Description / Function
3. Rusting 	Identify the Objects s which may rust and why?

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RESULTS

The appropriate statistical tests were used to analyze the quantitative data collected and to test the research hypothesis. The goal was to find out how microlearning affects elementary school pupils' academic performance and motivation to learn science. Below is a description of the process of looking at the data collected.

Comparison of Control and Experimental Groups on Mean Scores of Different Areas of Achievement Test.

Group		Academic Performance		Knowledge Level Items		Comprehension Level Items	
		Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Ctrl	N=38						
	Mean	23.700	25.433	7.772	8.123	6.479	7.581
	SD	4.890	25.578	3.13	3.009	3.212	3.0111
Exp	N=39						
	Mean	24.667	28.667	7.839	10.81	6.430	10.260
	SD	5.05505	3.46095	3.294	3.230	11.71	12.211
	Mean Diff	.9667	3.133	2	4.260	2.343	4.541
	t- value	1.259	3.447	.831	11.410	6.321	11.435
	p-value	p=.213	p=<.001*	p=.406	p<.001*	p=.0896	p<.001
	Effect size		0.903		0.893		0.890

Table presents the comparison of the control and experimental groups on the academic performance, knowledge-level items, and comprehension-level items at the pre-test and post-test stages.

The results indicate that there was no statistically significant difference between the control and experimental groups on the overall measures of pre-test scores, suggesting that both groups were equivalent before the intervention. However, after the intervention, the experimental group obtained a significantly higher post-test mean score than the control group, with a statistically significant difference, indicating that the microlearning intervention had a substantial positive effect on students' academic achievement.

For the knowledge-level items, no significant difference was found between the two groups in the pre-test. However, the experimental group achieved significantly higher post-test scores than the control group. Regarding the comprehension-level items, the pre-test scores also showed no significant difference between the two groups, indicating comparable initial performance. In contrast, the post-test results revealed a statistically significant difference in favor of the experimental group.

Overall, the findings demonstrate that microlearning intervention significantly improved students' academic achievement, particularly in both knowledge and comprehension levels, compared with the traditional teaching approach.

CONCLUSION

Results of the study are found consistent with the literature on impact of Microlearning on academic

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gains. From the results, it may be concluded that students who received instruction through Microlearning didn't only perform better on identified units included in intervention but also their performance in school exams was significantly better than their counterparts. This implies that Microlearning not only have has a significant effect on enhancing achievement and performance in science but also students may continue to use microlearning based strategies even if they are out of intervention period. This may also be concluded that Microlearning is helpful n concept retention, an important measure of academic achievement.

Likewise better performance of students in experimental group reveals that Microlearning significantly helps in recall of scientific facts and terms. They may reproduce the content in significantly better way.

Elementary school students' performance was also measured on comprehension level of conceptual achievement in science subjects. Students who received instruction through microlearning demonstrated better level of conceptual understanding at Comprehension level.

The study concludes that Science being an important subject at elementary level should be made easier and interesting through application of Microlearning strategies in classroom.

sssss Conclusively, microlearning has great potential to enhance science education in the elementary level. It can assist in ensuring that students perform well academically as well as motivating them to learn science. Thus, teachers and learning institutions need to apply microlearning as an alternative teaching method for teaching science in elementary school classes.

RECOMMENDATIONS

1. Science teachers should implement microlearning as an instructional strategy in their science classroom because the researchers found that this approach is effective to boost students' science achievement and motivation to learn science.
2. Teachers should divide up complex science lessons into short, focused and meaningful units for students to learn which will make it easier, more engaging and less stressful for students.
3.Future researchers are recommended to conduct similar studies on microlearning at different grade levels (primary, secondary, and higher secondary) to explore its effectiveness across age groups.
4. Further research may be conducted in different subjects such as Mathematics, English, and Social Studies to examine whether microlearning has similar effects on academic achievement and motivation.
5. It is recommended that future studies compare microlearning with other modern teaching strategies such as blended learning, flipped classroom, and e learning to identify the most effective instructional approach.
6. Researchers are encouraged to conduct longitudinal studies to examine the long-term impact of microlearning on students' academic performance and motivation.
7.. Further studies may also explore the role of microlearning in developing higher order thinking skills such as critical thinking, problem solving, and creativity among students.

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