



Conceptual Difficulties of Primary School Students in Learning the General Science: A Sequential Explanatory Mixed Method Research Design

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Abstract

The present research aimed to explore the challenges that primary school students encounter in comprehending general science concepts. The principal objectives included identifying these conceptual challenges, scrutinizing the factors responsible for these difficulties, and proposing strategies to mitigate them. Employing a Sequential Explanatory Mixed Methods research design, the study focused on fifth-grade primary students in Kahrur Pacca city, Pakistan, encompassing 22 government primary schools selected through cluster random sampling. A purposive sample of 286 fifth-grade students was chosen for the study. To assess the conceptual challenges in general science, a specialized test instrument named the Test for Conceptual Difficulties in Science (TCDS) was developed and validated by senior science teachers. Reliability was assessed through a pilot test using the test-retest method, yielding a Cronbach's alpha coefficient of 0.759, indicating good internal consistency. Additionally, semi-structured interviews were conducted with nine teachers selected based on TCDS results. Findings revealed that 58% of the concept-based items in general science posed difficulties for primary school students. Several factors contributing to these conceptual challenges were identified, including insufficient prior knowledge, a lack of teaching aids, language misunderstandings, inadequate physical infrastructure, and limited parental involvement in their children's education. Based on these findings, it is recommended that teachers undergo refresher courses and training to enhance their ability to design art and drawing activities, ultimately aiding in addressing these conceptual challenges effectively.

Keywords: *General science, conceptual difficulties, Sequential explanatory mix-method education, Primary school*



Introduction

Science involves a methodical exploration of how the physical, social, and natural worlds function, achieved through observation and experimentation. It is pivotal for innovation, global competitiveness, and human progress. The world must continue to push the boundaries of scientific understanding, whether it's discovering novel cancer treatments, exploring distant galaxies, or any other scientific pursuit (Shafer, 2015). Shafer emphasizes that science education should not merely revolve around memorizing theories, formulas, and terminology; it should be a training ground for problem-solving and collaboration. Practical engagement and hands-on activities are essential to fostering a deep comprehension of science.

STEM (Science, Technology, Engineering, and Mathematics) is widely acknowledged as the linchpin of the future, and the responsibility for nurturing young minds in these fields often falls on primary teachers. Given children's inherent curiosity about the natural world, primary school science education holds immense significance for their development (Kersting, M., Steier, R., & Venville, 2021).

Science education at the primary level is vital for introducing foundational scientific concepts to all learners, preparing them for potential careers in science (Driel & Abell, 2010). The term "Science Education" encompasses the teaching and learning of science subjects at all educational levels. However, primary-level science education presents unique challenges in various countries, which cannot be resolved solely through conventional teaching methods. Ensuring a strong grasp of the science concepts students encounter in primary school necessitates a comprehensive approach (Lamanauskas, 2007). Furthermore, students' difficulties in understanding scientific concepts have become a significant concern for educators (Ozmen, 2004). These conceptual challenges may vary based on factors such as gender, age, culture, religion, and geographic location (Tavani, C. M., & Losh, 2003).

Primary education is universally a backbone of education of all nations in the world. It provides a frame-work for students, generation and beyond to anchor the specification of other levels of education. Primary education aims to educate the children aged 6 up to 11 or plus as primary education is the key to success or failure of the whole system. Pakistani science education suffers from a number of weaknesses. Inappropriate science curriculum, the introduction of non-integrated science curriculum, and random changes in science curriculum at various levels are



just a few of the deficiencies. As a result, there is no smooth transition from one level to the next. Science became one of three courses in the field of Social, Environmental, and Scientific Education in the Primary School Curriculum in 1999 (SESE). While the 1971 curriculum for senior students did touch upon Elementary Science to some extent, it is essential to note that the 1999 curriculum represents a significant enhancement in several aspects. Conceptual challenges in science concepts had grown frequent among children in Pakistan's government primary schools. Poor teaching methods, insufficient laboratories, a lack of science background, a language barrier, students' passive involvement, and other factors may have contributed to this situation. Students have difficulty in understanding the abstract natured science concepts, according to research, and many scholars conducted research in advanced countries to identify their conceptual difficulties and find possible solutions. (Nakhleh, 1992; Ogude, 1994; Ozkaya, 2002; Garnett & Treagust, 1992). It has been observed that General Science is taught with the help of different languages in our schools. In elite class population, the General Science is being taught in English medium, and in normal class schools are teaching General Science in Urdu medium. Several researches explored that English medium students were found to do much more badly than their mother tongue In general; students struggled with tasks assessing their grasp of theoretical concepts, their ability to distinguish between scientific terminology, and their capacity to apply scientific knowledge in practical contexts. Teachers faced significant challenges related to pronunciation, comprehending complex words, grasping scientific terminology, and requiring corrections in dictation. According to Nomlomo (2007), it is crucial for both learners and teachers to use the same language during the teaching and learning process to ensure mutual understanding. Additionally, Nomlomo concluded that students experienced emotional, cognitive, and academic difficulties due to receiving education in a foreign language, specifically English. Conceptual understanding refers to ways of contravention down misconceptions. Significant learning in science frequently requires learners to go through a method of conceptual modification. It means learners must be familiar with the disparity of their own theories and logical concepts and must make scientific concepts. Conceptual alteration involves Meta cognitive understanding where students have to distinguish their way of judgment in order to make suitable relation between their personal thoughts and scientific concepts. Students have to supervise and assess their existing understanding of assured concepts in order to make a significant link between previous and fresh knowledge. Teachers' attitude towards



learners; is derisory due to traditional methodology, medium of instruction in second language and uninspiring way of teaching which disheartened the students and kill curiosity. All the stakeholders show dissatisfaction with regard to content, teaching methodologies and for lack of resources to teach general science effectively (Shaheen & Kang, 2020). Science education affects the society, like culture, spirituality, cleanliness, attitude, and relations. Society members become responsible and take an active part in society building. Moreover, Rehman (2004) also investigated the problems facing science students of secondary schools, and found that they are only overburdened with many subjects. They have no career counseling at school or home. (Shaheen and Kang 2020). Furthermore, Akram, Surif, and Ali (2014) evaluated secondary school students' conceptual difficulties in understanding the fundamental features of the concepts of electrochemistry, such as redox reactions, electrolytic cells, and galvanic. Furthermore, the factors that contribute to secondary school pupils' conceptual difficulties in electrochemistry were explored. Using a purposively selected sample of 144 students from the IX class and a mixed method research methodology, this study found that 67 percent of the concept-based problems designed in electrochemistry were difficult for secondary school students to understand. A lack of information, a lack of instructional tools, and a misunderstanding of the language all contributed to conceptual difficulties in comprehension. The early studies have investigated the conceptual difficulties in science subjects; including electrochemistry, photosynthesis, and acid-base (Akram, Surif, & Ali, 2014; Bayrak, 2013; Woldeamanuel, Abate, & Berhane, 2020) and lacking behind the subject of general science. This study extends this stream of literature by exploring primary school students' conceptual difficulties in general science.

Significance of the study

In Pakistan, there is practically no activity in primary science. This research will aid teachers in determining the causes of students' conceptual difficulties in scientific learning. Administrators, such as EDOs, Dy. DEOs, AEOs, and Headmasters, as well as policymakers, will benefit from this research. This study was conducted to assist teachers in identifying pupils' weaknesses in the scientific curriculum. This study may be useful to researchers in determining the conceptual basis of science concepts. This research will be useful in identifying misconceptions about



scientific issues. This study will also serve as guidance for teachers in order to lessen the conceptual issues that students face when learning general science (Okpala, 2007).

Research Objectives

1. To find out the conceptual difficulties of primary school students in learning the general science.
2. To analyze the reasons behind the conceptual difficulties of primary school students in learning the general science.
3. To suggest the factors helpful to overcome the conceptual difficulties of primary school students in learning the general science.

Literature Review

A sociocultural and historical creation, science has the capacity to benefit all of humanity. Science knowledge is necessary since we live in a scientific age (Mathews, 2000). Science can eventually save the world and provide solutions to the difficulties it has caused, despite the fact that it has caused many illnesses and problems (Rowland, 2008). However, a nation with a strong foundation in science education may readily grow its natural resources and people capital. The secret to economic and social progress is a carefully thought-out science education program (Cobern, 1998). In Pakistan, Science is combined with other subjects (Chemistry, physics and Biology) and taught as general science in classes from first to eighth.

The term "science" comes from the Latin word "scientia," which means "knowledge" or "understanding." Prior to modern times, it was not connected to any experimental or practical expertise. Instead than being an empirical study, it was more philosophical in nature. Science eventually lost its original connotation, evolved to be connected with empirical research, and verified information. "Science is a body of objective and concrete facts, established through empirical investigation and mathematical techniques and expressed quantitatively (Ross, 1990)." Science is the reasoned investigation of natural occurrences (i.e., those that are physical and biological) that may be accounted for or connected with causative variables while staying within the bounds of natural causality. In essence, scientific research is restricted to the study of natural events that have natural causes. Finally, scientific knowledge needs Science belongs to the group



of most complex intellectual endeavors are difficult to accurately summarize in a sentence or two; while quick definitions may be helpful to experts, they seldom provide a whole picture (Shamos, 1995). In his list of definitions, he included statements like "Science is just what scientists do," "Science is a body of useful and practical knowledge about the universe," "Science is a method of inquiry," "Science is the search for order in nature," "Science is the search for first principles," and "Science is a discipline with the objective to understand, explain, and predict about natural phenomena."

The proper idea is that science is all of these things and far more because what is missing from such straightforward formulations is what makes science what it is: the pursuit of verifiable facts. This could contain information and facts that can be tested, validated, and attained again. It is, in a nutshell, tested knowledge.

A scientist is described as a "depersonalized and idealized seeker after truth, painstakingly pushing back the curtains that obscure objective reality, and abstracting order from the flux, an order which is directly reveal able to him through a distinctive scientific method"" (Cawthron & Roswell, 1978).

Scientific pedagogy and content are both aspects of the area of scientific education. Through this, science education also connects to the social side of society .Science education address social crises, environmental issues, and economic requirements (Hodson, 1998). Some may see it as the recruitment and training of future scientists. An effective scientific education programme aids in a nation's social and economic growth. It gives the students the essential scientific information that might aid them in solving the majority of socioeconomic and environmental issues. Students who study science get the essential scientific abilities for the profession as well as a solid and comprehensive knowledge foundation in the fields of agriculture, environmental problems and challenges, nutrition, and food (Mohanty 2004).

Ediger (1999) listed three goals for scientific instruction. The first goal relates to the cognitive area, which includes understanding of theories, concepts, and generalizations. The second is using the science information that has been acquired to address issues that kids face on a daily basis. The formation of a good attitude towards oneself, the science curriculum, and society is last but certainly not least. The second goal, though, has received less attention. This is evident



from the fact that pupils cannot be forced to address common issues by using school or college science. Additionally, science education hasn't succeeded in fostering in pupils a favourable attitude towards themselves, the scientific method, and society. One of the other goals of scientific education, according to Osborne (2000), is to pique people's curiosity about the world around them. The pupils must understand the fundamental scientific ideas and their relation to the modern technological environment. In the meantime, the students must comprehend the problems associated with the advancement of science in order to offer suggestions for improving society.

Research Methodology

A Sequential Explanatory Mixed method research design was adopted to achieve the objectives of the current study. The population of this study was consisted on fifth class primary student. Twenty-two (22) government primary schools selected by using the cluster random sampling technique within kahror pacca city of Pakistan. Then 286 primary students of fifth class purposively selected as sample of this study. Conceptual difficulties of primary school students in general science investigated by developing a special test instrument tagged as test designed to measure the conceptual difficulties in science (TCDS). The questionnaire test was closed ended and it's consisted of thirty-one (31) MCQ's The science book of 5th class consists of 8 chapters in which chapter 1-2 are from biology while 3-4 are from chemistry and chapter 5-8 are from physics. The researcher has selected some specific topics from Punjab text book by the help of senior science teachers. A pilot test established to find its reliability by test - re-test method. The Cronbach alpha coefficient also calculated to measure the internal consistency of instrument through SPSS IMB 22 and its value was 0. 759. The researcher checked the diagnostic test by the help of a senior science teacher and found conceptual weakness in students. The qualitative data was collected in the second stage by using the Semi-structured, open-ended interviews. And the teachers were interviewed regarding conceptual difficulties faced by students as well as by teacher. During school hours, participants' teachers were interviewed. For data analysis, the researcher employed a grounded theory technique, interviewing Nine (9) government primary school instructors by using purposive sampling technique. The recorded interviews were summarized and transcribed using the thematic approach.

Analysis of the Data



The aimed of this study was to investigate the conceptual difficulties of primary school students” in learning the science subject. The researcher analyzed the difficulties of quantitative data within table. In the TCDS, there is a criteria standard for measuring item difficulty. If the percentage of correctly answered items is less than 40%, it is assumed that the students are having difficulty in understanding the topic (Obomanu, 2012). If more than 40% of students properly answered the item, it is assumed that the students did not have any difficulties understanding the material.

Table 1
Classification of living things and Microorganisms

Sr. #	Topic	Correct answers from students		Incorrect answers from students		Difficulty perception
		F	%	F	%	
1.	Classification of plants	108	37.8	178	62.2	High
2.	Worms	162	56.5	124	43.5	Low
3.	Vertebrates	154	53.9	132	46.1	Low
4.	Making Food	41	14.4	245	85.6	High
5.	Virus diseases	106	37.0	180	63.0	High
6.	Causes of Infection	105	36.6	181	63.3	High

Table 1 showed that the concepts of classification plants, food , virus diseases and causes of infections were difficult for the students but they can easily described the concepts of worms and vertebrates .However when it was asked from the teachers that why the students do not understand the classification of plants ,making food , virus, and diseases? Then many of interviewees replied that these topics demands practical demonstration, and a teacher should show the actual parts of flowers and plants but unfortunately there are no ample grounds or gardens in schools. Even interviewee replied “*The government schools’ teachers do not perform practical of science subject due to shortage of time, labs, equipment and resources. Due to Lack of confidence our students does not asked questions*”.



Table 2
Environmental Pollution

Sr. No	Topic	Correct answers from students		Incorrect answers from students		Difficulty perception
		F	%	F	%	
1.	Kinds of pollution	102	35.6	184	64.4	High
2.	non-biodegradable materials	192	67.0	94	33.0	Low
3.	Effects of pollution	49	17.0	237	83.0	High
4.	Disadvantages of pollution	106	37.0	180	63.0	High

It is described by the table no1.2 that the level of conceptual difficulty about the topic of non-biodegradable material was low but students have difficulty in understanding the topics of Kinds, effects and disadvantages of pollution. .However when it was interviewed from the teachers that why the students have difficulty in describing these concepts then most of the interviewees replied that students do not understand kinds of pollution. Because these concepts are briefly described in the book. Interviewee [1,6] argued *“Most students have misconception in kinds of pollution. As the teacher do not practically demonstrate with objects easily available like matchbox, dirty water and trash.”*

Table 3
Matter and changes in its states

Sr. No	Topic	Correct answers from students		Incorrect answers from students		Difficulty perception
		F	%	F	%	
1.	Solids	226	79.0	60	21.0	Low
2.	Melting	169	59.0	117	41.0	Low
3.	Freezing	206	72.0	80	28.0	Low
4.	Gases	166	58.0	120	42.0	Low

It is described by table no 3 that primary students have low conceptual difficulties about the topics of matter and changes in its states. However, most teachers replied that *“as concepts of melting, freezing and gases are easier to understand because they observe these processes in their daily lives”*.



Table 4
Force and Machines

Sr. No	Topic	Correct answers from students		Incorrect answers from students		Difficulty perception
		F	%	F	%	
1.	Friction	112	39.0	174	61.0	High
2.	Gravitational Force	190	66.5	96	33.5	Low
3.	kind of lever	82	28.7	204	71.3	High
4.	Methods of Reduce Friction	186	65.0	100	35.0	Low
5.	Advantages of Friction	97	34.0	189	66.0	High

It is described by the table 4 that the students' conceptual difficulties about the topics of gravitational force and method of reduced friction were low but they have difficulty in understanding the topics of friction, kind of lever and advantages of friction. However when it was interviewed from the teachers that why the students have difficulty in describing these concepts then most of the interviewees replied "*In government schools, mostly an arts teachers teach the science subject due to shortage of science teacher in school*". Even interviewee no [6,3] replied "*she herself does not have enough command on the subject and cannot explain these topics of friction that's why students remain confused. They need practical and physical presence of the object to understand.*"

Table 5
Electricity, Magnetism and Light

Sr. No	Topic	Correct answers from students		Incorrect answers from students		Difficulty perception
		F	%	f	%	
1.	Translucent objects	75	26.2	211	73.8	High
2.	Shadow Formation	180	63.0	106	37.0	Low
3.	Lightning	77	27.0	209	73.0	High
4.	Opposite charge	110	38.5	176	61.5	High
5.	Fuse and Its uses	112	39.0	174	61.0	High
6.	Electromagnets	94	33.9	192	67.1	High

It is described by the table 5 that the students' conceptual difficulties about the topics of shadow formation was low but they have difficulty in understanding the topics of Translucent objects, Lightning, Opposite charge, Fuse and Its uses and Electromagnets. However, when it was interviewed from the teachers that why the students have difficulty in describing these concepts than majority of teachers replied that "**in** government school the teachers are forced to cover syllabus rather creating a meaningful environment in class. Teacher cannot present the topic

practically.” However, interviewee no. [5,7,1] replied that “*lack of resources is the reason that constrained the students’ understandings*”.

Exploration of Reasons Behind conceptual difficulties

Qualitative data explored the reasons behind the conceptual difficulties of students.

The primary challenges primarily stem from insufficient physical infrastructure and the absence of adequate learning resources, such as proper whiteboards, a library of textbooks, and other essential teaching materials. Government primary school buildings typically comprise just two or three rooms connected by a corridor. This arrangement leads to issues with students'

comprehension and attentiveness during lectures because two classes share a single room. Consequently, teachers find it challenging to provide undivided attention to



their teaching. Furthermore, the lack of well-equipped science laboratories is a prevalent issue in Pakistan's primary schools, and there is also a notable absence of dedicated rooms for this purpose.

Mostly teachers said that some basic scientific apparatus (like spirit lamp, thermometer, and magnets) must be present in primary schools. But unfortunately a very few teachers replied that there is no need of science lab in primary schools.





Improper teaching methods are another reason that hinders students' understandings. There are two scenarios behind improper teaching methods. Firstly, the subject of science at primary level is taught by arts teachers *due to shortage of science teachers in school* and they do not have command on science subject and its methodology. *That's why students remain confused*. Students require the practical and physical presence of objects to enhance their understanding.

Lack of interest and confidence in primary students generate conceptual difficulties among students as in rural area students are ignored by the family and do not let their emotions out of breath. so this compressed environment led snatched their self-confidence and they hesitate to ask questions after the lesson being taught. This thing made them frustrated and confused in teaching learning process, parents are mostly illiterate and belong to labor class or field work. They do not know the importance of education. They do not spend enough time with their kids. They hardly fill their basic need of food except education. They do not help them in doing homework or learning lesson. So the students remain weak in studies as homework consolidates class work.

Another important reason was Pressure of PEC examination on the teachers. When researchers asked about PEC examination from primary teachers. Majority teachers explain that they have to face severe problems in PEC examination. They have to cover syllabus before time and cannot use proper teaching method. Teachers have to prepare students for exams. As PEC papers are conceptual and mostly students cannot attempt papers properly so they fail. Presently, a teacher is pressurized by MEA, AEO all the time. They demand 100% student's attendance, diaries, lesson plan, teacher's observation, assessment, class observation, assessment 100% LND. That's why they cannot perform properly.

Communication skills are an important element to convey the concepts to students. Lack of communication skill in the primary students is one of important reasons that forces conceptual difficulties among students. Mostly primary students cannot communicate with their teachers because of lack of vocabulary and confidence. In short, we can say communication plays vital role in teaching and learning via, written communication or oral communication.

Listening skills are the backbone of teaching learning process. Due to shortage of rooms teacher cannot communicate with every student. Secondly some teachers have good vocal strength but some lazy bluffers and distraction creators confused their lecture during science period. Thirdly some



teachers try to engage students in activities but students take them easy and keep on talking all the time because of low voice of teachers. That's why they do not understand the topic properly.

Government schools don't have play grounds for sports. As sports gave them physical fitness and mental freshness. It increases students' moral values and stamina also. Lack of playgrounds effect the students learning process.

Conclusions and Recommendation

It was concluded on the basis of findings that most difficult concepts in the subjects of science at primary school were classification and characteristics of plants, microorganisms, virus disease, kinds of pollution, causes of friction, kinds of lever, Translucent and non-translucent objects, static charges, Opposite charges, characteristics of flowering plants, infection, cause of environmental pollution, disadvantages of pollution, advantages of friction, Fuse and Its uses, uses of electromagnets. while the concepts Characteristics of birds, Vertebrates, biodegradable and non-biodegradable material, Characteristics of Matter (solid, liquid and gas), process of matter changes from one state to another state, effects of temperature on the matter, Characteristics of matter particles, Gravitational Force, opaque objects, fish, method of reduce friction, earth, invertebrate were not found difficult for the primary students. The research explored the reasons "lack of physical infrastructure, Lack of science lab, Improper teaching methods, Lack of confidence in primary students, family background of students and teachers. Lack of learning resources (white-boards, textbook library). According to Umoh (2006), it is necessary to provide learners with basic and general science knowledge through teaching them how to use and function scientific instruments so those are familiar with such initial introductory for example they go to high levels. Poor lesson planning, training of science teacher, time management, lack of communication skill in the primary students. Teachers have very different conception of what science is. In a study by [Fitzgerald and Smith \(2016\)](#) a group of teachers were asked 'What is science? Than they concluded that many primary teachers haven't received extra training in teaching science, leading to low confidence in teaching, and less effective science lessons. Ammar (2015) stated that the medium of instruction is a biggest problem for teaching science subject. Pressure of PEC examination on the teachers is also one of the important reasons.



There are some following recommendations based on findings.

1. The English language learning is the major barrier in learning the conceptual subjects. English language courses should be arranged for teachers as well as for students at government level.
2. Students must be taught certain topics with the help of practical experiments.
3. Students at primary level can understand science well if they practically observe the scientific apparatus or equipment e.g., microscope, magnet, fulcrum, etc. (even their photograph can be shown to give a better concept.
4. Regular teacher training workshops should be arranged for improving the representation and personalities of teachers in terms of speaking, body languages and thoughts.
5. Regular tests, proper testing mechanism and punctuality of tests must also be observed for enhancing the confidence among the students.
6. Audio Visual Aids concerning Science should be provided in all primary schools.
7. The concepts should be taught in retaining way that the student could retain the basic concepts in all study levels
8. Monthly and yearly test session should be started for the preparation of board examination at the end of the academic year.

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