The PEARL Model in Science Education: A Qualitative Outcome for Interactive Learning

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Abstract

The PEARL model is an interactive demonstration of learning. This model was developed based on need analysis, intervention of the PEAR model, collected field information from interviews and FGDs of participants, and experiences of researchers. Five steps: predict, summon past knowledge, add basic life-related visuals, and apply logic. Participate in an interactive demonstration, reflect on ID results, and learn. Students forecast and hypothesize using prior knowledge. Previous knowledge facilitates collaboration. Scientific principles become more practical when applied to ordinary life. It clarifies complex concepts and how scientific knowledge influences students to involve in demonstrations. This stage improves theory, critical thinking, curiosity, and problem-solving. After the interactive presentation, students reflect on their learning. Students can evaluate their learning, uncover misconceptions, and connect theory and practice, promoting metacognition. ID reflection in the third step requires reviewing the complete learning experience. Students organize and improve by reviewing predictions, knowledge, and learning outcomes. The PEARL model improves student retention, critical thinking, and engagement. The PEARL model includes prediction, previous knowledge activation, real-life illustrations, interactive demonstrations, and reflection. Thus this model should be used this framework in science classes.

Keywords: *PEARL model, interactive learning, science education, student engagement, critical thinking, prior knowledge*

Introduction

Science education is crucial to providing students with the knowledge and skills they need to understand the world around them. Traditional instructional methods, on the other hand, frequently fail to engage pupils and generate more profound learning experiences ultimately. (Barkley & Major, 2020). To address this issue, the PEARL model (Predict, Elicit prior knowledge, Add daily life-related illustration, engage in an interactive demonstration, reflect the outcome of ID, and Look back and learn through the reflection of ID) has emerged as a promising framework for interactive learning in science education. The PEARL model enhances the learning process by including a series of carefully crafted stages that foster student engagement, knowledge acquisition, and critical thinking skills (Pospisilova & Rohlíkova, 2023). Each step of the model is strategically designed to build upon the previous one, creating a dynamic and comprehensive learning experience. The first stage, Predict, encourages students to make predictions based on their existing knowledge before delving into a learning activity. By activating their prior knowledge and generating hypotheses, students become actively involved in the learning process from the outset (Lachner, Hoogerheide, van Gog & Renkl, 2022). This stage sets the foundation for deeper engagement and inquiry.

The subsequent stage, Elicit prior knowledge, allows students to share their current understanding of the topic. Creating a collaborative learning environment will enable students to exchange ideas, challenge misconceptions, and build upon their collective knowledge (Goh, 2022). This stage promotes active participation and peer learning, enhancing the learning experience. The Add Daily, a life-related illustration stage, integrates real-life examples and illustrations into education to ensure relevance and applicability. By connecting scientific concepts to familiar situations, students can grasp complex ideas more efficiently and recognize the practical implications of scientific knowledge in their daily lives (Doyle, 2023). This stage bridges the gap between abstract concepts and real-world applications, making the learning experience more relatable and meaningful. The Engage in interactive demonstration stage is a hands-on component of the PEARL model. Students actively participate in learning through interactive activities, experiments, or simulations (Lin, Hwang, Chou & Tsai, 2023). This stage reinforces theoretical concepts and cultivates students' curiosity, critical thinking, and problem-solving skills. By engaging in hands-on activities, students gain a deeper understanding of scientific principles and develop valuable skills applicable to real-world challenges. Following the interactive demonstration, the Reflect the Outcome of ID stage prompts students to evaluate and reflect on the results of their activities. This stage encourages metacognition, allowing students to analyze their learning process, identify misconceptions, and make connections between theory and practice. Reflection plays a vital role in deepening understanding and promoting long-term knowledge retention. The final stage, looking back and learning through the reflection of ID, involves a comprehensive reflection on the entire learning experience. Students are encouraged to review their initial predictions, prior knowledge, and learning outcomes (Huang, Wu, & Yang, 2023). This stage allows students to consolidate their understanding, identify areas for further improvement, and transfer their newly acquired knowledge to future contexts.

The PEARL model offers a structured and dynamic approach to science education, providing students with an interactive and engaging learning experience (Jeno, Nylehn, Hole, Raaheim, Velle & Vandvik, 2023). By incorporating prediction, prior knowledge activation, real-life illustrations, interactive demonstrations, and reflection, the PEARL model promotes qualitative outcomes such as increased student engagement, improved knowledge acquisition, and enhanced critical thinking skills. It has the potential to transform science education into a more immersive and meaningful experience, equipping students with the skills and knowledge necessary to become scientifically literate individuals in today's world.

Motivation

We have facilitated school education for 14 years. We visited over fifty Kathmandu community schools to observe B.Ed. and M.Ed. students learning to teach. We spoke to several science teachers and students during monitoring. Most students and teachers found chemistry difficult. They struggled with teaching and learning chemistry. As chemistry teachers, we wondered why chemistry was so hard to learn. How can we fix these? Dewey (1938) believed the traditional setting of schools tantalizing student growth. NASA's (2015), (2017), and (2020) studies on grades 8 and 10 demonstrate that students perform poorly in science. Women get poorer science grades than men. PISA (2018) and WAEC (2015) test it. These studies make us wonder if gender affects science performance. Is her science performance lower because she's female? From these arguments, We wondered if this was due to the way chemistry is taught, the way students think about it, the fact that they don't know much about it, the fact that they may not like chemistry or the fact that what they learn in the classroom may not be related to what they do every day. We did this by employing "interactive demonstration," which profoundly connects chemistry to students' lives. Interactive example teaching may help students make links between class and life. This could make chemistry easier, improve students' attitudes, and boost science performance. "Learning Chemistry through Interactive Demonstrations" was a science education study that answered our questions.

Statement of the Problem

The national curriculum framework (NCF) states that current school science instruction should foster learning. Schools should have labs and science equipment so students can practice science skills and behavior. It also aims to apply science to children's daily lives. However, Nepali schools are far from implementing these objectives. Science education does not meet curriculum requirements in poorly managed institutional and community schools. Theoretical material and classroom teaching-learning processes remain. However, schools lack infrastructure and an admirable social and psychological environment. Students face caste, gender, poverty, handicaps, and regional discrimination. Curriculum upgrading, teaching-learning techniques, teacher expertise, and curriculum implementation are all problematic. Nepal's grade 8 NASA (2017) and grade 10 Science (2015; 2020) results show below-average science achievement. Science performance is declining due to a lack of facilities, practical and laboratory work, and classroom engagement and demonstration. Thus, science educators must find ways to address the current science achievement gap (WAEC Reports, 2015). We value chemical science's importance for economic growth. Thus, appropriate science teaching in secondary school improves students' internal and external exam scores. Student teaching also facilitates content transmission. Lectures do not promote interactive, critical, creative, or collaborative problem-solving (Hiremath, 2015; Freire, 1970). Thus, educators are beginning to see the value of participatory science instruction.

Our strategies fail to teach kids to lead and retain vital concepts. Thus, the NCF report emphasizes explorative, interactive, and innovative teaching-learning activities for optimal learning. Priority has been given to students' attitudes toward understanding and other phenomena, mobilizing local resources related to students' daily lives in the local environment, linking co-curricular and extracurricular activities to strengthen teaching and learning, and removing science's difficulties. However, rote memorization dominates science instruction in our classrooms, and we haven't addressed kids' learning attitudes or teachers' challenges. Thus, teaching and learning are unrelated to daily life. According to studies, chemistry is more complex than physics and biology (Atagana & Engida, 2014). No contact, demonstrative practice, lab exercise, or hands-on and mind-on activities make understanding chemical ideas tough; therefore, kids don't like chemistry (Ali, 2012). Recitation and memory dominate science education. Secondary school science performance is a significant issue. Thus, it may explain the teaching approach, students' attitudes toward chemistry, and the difficulty of chemical ideas. This study examined how efficient the interactive demonstration method is in science instruction, focusing on students' chemistry achievement, attitude, and challenges.

The Rationale for the Study

Developed nations describe demonstration and interactive techniques (Buckler, 2016). Thus, assessing how these instructional techniques promote achievement in developing countries like Nepal is crucial. Teachers are using demonstrations, but little research is on their effectiveness. This study requires a qualitative study on how demonstration strategies affect the performance of secondary school students (Olatoye & Adekoya, 2010). Most schools followed lectures (Newton, Driver, & Osborne, 1999). Teaching and learning are teacher-centred. They neglect science. They memorize textbooks and notes without understanding chemistry (Otukile-Mongwaketse, 2018). School chemistry makes bores to learning for pupils. Chemistry teaching and learning problems and student attitudes affect school science. Our science curriculum and NCF emphasize explorative, interactive, and innovative teaching, students' learning attitudes, mobilizing local resources related to students' daily lives, and decreasing science obstacles. Scientific education research should consider student learning, attitude, and problems. Interactive demonstrations teach chemistry better than lectures. Interactive demonstrations may work better if teachers and students actively participate in chemical concept learning. This method improves chemical understanding more than lecturing. Students can see chemistry in their daily lives. Pupils actively learn chemical principles. This strategy helps students understand chemical ideas better than preaching alone. This way, students can see chemistry topics in their daily lives.

Materials and Methods

The qualitative research method was used to develop the PEARL model. It has consisted of need analysis, intervention, theorization of science learning, and model purposed stage in the study. The need analysis stage explored the kinds of teaching-learning activities and practices in the science classroom and what learning model may be better for science teaching and learning through classroom observation and teacher and student interviews. Five science teachers and 18 students were interviewed. Similarly, three FGDs and an open-ended questionnaire filled with respondents were taken and analyzed thematically. In the intervention stage, the three experimental groups of students were intervened through the PEAR model, and three control groups remained in the usual teaching method. There were six groups, each comprising 20 students from community secondary schools in Nepal. The PEAR model was seen as effective in the students' learning outcomes. Similarly, attitude theory, like a theory of planned behaviour (TPB), constructivism, pragmatism, cognitive approaches, and the Johnston learning triangle, was theorized and linked with the study and checked whether it fit the theoretical landmark. The PEARL model was proposed for a better outcome for teaching learning of science in the final stage based on field information and visionary landmark.

The Study's Credibility

Trustworthiness is a crucial quality criterion in qualitative research, according to Lincoln and Guba (1985). In our study method, we did our best to maintain trustworthiness by assuring credibility, transferability, dependability, conformability, and reflectivity. The findings result from a thorough research procedure that includes data collection, analysis, and interpretation. The researcher's critical self-reflection is included in the interpretation phase, and a healthy relationship is built with the respondents.

Triangulation in Research

Referential adequacy preserved the study's validity and reliability. Data triangulation, investigator triangulation, theory triangulation, and methodological triangulation have all been stressed by Denzin (1978). We employed various data collection methods for data triangulation, including CAT and CAS, interviews, focus groups, and observation. We compared the findings of previous research studies to mine to maintain investigator triangulation. we referred to several theories for theoretical triangulation, particularly constructivism and pragmatism. Finally, for methodological triangulation, we used a variety of data analysis approaches, including quantitative, qualitative, and mixed study designs.

Result and Discussion

The discussion carried out on the need analysis, intervened PEAR learning model, the purposed PEARL model, the theoretical foundation of the model, theories which work or not in this study, the role of the teacher in the PEARL model, and reflection on the model. These are discussed under the following heading.

Need Analysis

In need analysis, the students' pre conceptions' and existing teaching and learning practices of science in the classroom were explored.

Students' Prior knowledge on Chemical Concepts

Prior knowledge of students in chemistry is another cause of student learning difficulties, which means the student's previous knowledge of chemistry. The simple knowledge of science at the primary level is the central aspect that resolute the excellent performance of the students at the secondary level. It also helps the student's achievement in additional study. Chemistry prior knowledge is the building block and the base of the holistic development of students in the chemistry sector of science. Those students who had a lack sufficient prior knowledge did not want to learn and could not get success at a further level. It is blamable for students to feel difficulty in chemistry in all schools at the secondary level. For the discussion of the above heading, the following views of students were stated here related to prior knowledge of students.

> The above view of students and teachers highlights that students do not have sufficient prior knowledge of chemicals. The students have not integrated from relating a new chemical concept and principle to formerly learned chemical concepts. The science teacher asked the students about their prior knowledge of chemistry, but the students were silent, and nobody answered this question. They are reserved and not to be opened with the teacher and their friends in class. They looked fearful of the teacher. (Classroom observation note; September 1 2017).

The information obtained through classroom observation shows that students lack prior knowledge of chemistry subject matter in the science course. Teaching is also teacher dominant because they are reserved and do not respond to teachers' teaching activities. Similarly, Kailash also gave a supportive view as follows:

> I had the main problem learning chemistry and science at the secondary level. The science course was not finished in time. I have no previous concepts of basic-level chemistry for the secondary level. So I do not like to learn chemistry when I face mathematical problems, and balancing chemical reactions is beginning to be difficult (Field note; September 11 2017).
>
> In addition, as a chemistry teacher, Rabindra added. Students experienced difficulty in learning chemistry due to a lack of skill of the teacher to deliver the prior knowledge for students related to chemistry. The teacher has less focus on

> chemistry teaching in the lower class. So they lack previously learned chemical concepts at the secondary level. (Informal talk; September 2017).

Both teachers' and students' experiences indicate that the cause of common difficulties in learning chemistry, among others, is students' prior knowledge and learning of chemical concepts is one of the causes of learning difficulties in chemistry.

Teaching Methods and Understanding of Chemical Concepts

In the science field of chemistry, learning problems in middle and high school are caused by the way teachers teach. A good teacher gives students the information, skills, and attitude they need to participate in teaching-learning activities. The part of the teacher in teaching-learning activities affects how much the students learn and what they understand. For students to learn chemistry, a teacher's method of teaching that is based on the learner helps them understand chemical ideas. In this part, we focused on how the teacher's teaching methods, knowledge of chemical concepts, and classroom setting affected how students learned chemistry in high school science. The way a teacher teaches is one of the things that can make it hard to learn chemistry. Less success in science is partly due to the way science is taught. Suitable teaching methods excite the students about learning, giving them the energy they need to be interested in and committed to learning about a subject. Kuls' has the following thoughts about how teaching and learning work in our world:

> Our training is based on memorization, and teachers don't help us understand chemical ideas in any way. I start with the basics, like a symbol, an electron, a proton, a neutron, and how atoms are grouped (Interview, July 30 2017).

Kul's information shows that science teachers teach their classes in a way that focuses on the teacher and makes the students listen while the teacher gives a one-way lesson. It seems like the same thing over and over, and students get tired of learning. Due to how hard it is to understand chemical ideas, students also tend to learn things by heart. This subject needs hands-on and mind-on activities, but how we teach and learn in the classroom has nothing to do with what students do in their daily lives. So, students thought that chemistry was a challenging course. For proof, here's what we saw happen during a typical school "D" lesson when we were in ninth grade:

> We got to school "D" at 12:15 pm. At 12:30, the class began. Mr. "B" was already five minutes late when the lesson on the chemical process was

supposed to start. He went into the context without using motivational methods or asking the students about their previous learning experiences. He began his lesson by showing how the molecular formulas of some chemicals, like sodium chloride and sodium bicarbonate, were written on the whiteboard. He asked the class, "What are the things sodium chloride is made of?" Kabita said that salt and chlorine were the answers to the question. He also asked the kids about "khane soda," a sugar and sodium bicarbonate mixture. The answers come from Susmita and Jubin.

In the same way, he told all his kids that not all chemicals harm them. Without salt, the vegetables or meal won't taste good. But some substances, like sulphuric acid, nitric acid, and hydrochloric acid, are bad for people. He said the sulphuric acid and nitric acid formulas were H_2SO_4 and HNO_3, respectively. The charge light shows that the lead acid cell has sulphuric acid. The properties of matter change when two or more atoms and molecules interact. His voice was strong, and he taught faster in the science classroom without using any teaching materials or possible tasks to show what he was talking about. He hadn't shown and talked about useful and tasty chemicals like carbonic acid in cold drinks like Coke, Fanta, and soda water, and citric acid in lemons, oranges, and other citrus fruits that students use daily. We watched him teach science and learned a lot from him from the start. (Video shot on September 10, 2016).

Classroom observations showed that teacher "D" was responsible for teaching and learning. The focus is on the teacher, and learning is done by memorizing facts. The examples of the subject didn't have anything to do with the student's everyday lives. He used the chalk-and-talk method of teaching, which didn't pay attention to how the kids were doing in class. These ways of teaching and learning can't connect the student's hands, heart, and head. So, how we teach and how well we understand chemistry ideas are two more significant reasons why it's hard to learn Chemistry in high school.

Complexity in Conceptual Understanding of Chemistry

Johnstone (1993) categorizes a conceptual understanding of chemistry into three levels. They are the macroscopic, submicroscopic, and symbolic levels of chemical concepts. The macroscopic knowledge of chemistry is the level most frequently students experienced in the chemistry laboratory, which deals with observable phenomena that can be experienced by the five senses organs of the human being. The macroscopic level is real to the student and includes concrete concepts of chemistry. The submicroscopic level consists of understanding chemical concepts like the particulate nature of matter, including molecular and atomic, as definite points of view. The symbolic level of chemistry concepts focuses on making sense of chemistry contents and using representations such as chemical symbols, equations, stoichiometry, and mathematical manipulations.

According to Johnstone (1991), students must link the three basic conceptual levels of understanding to gain capability in learning chemistry. But the students do not link their learning with the conceptual understanding of chemistry. Teachers do not think over the communication explanations of understanding chemical concepts and their phenomena. It was found that students improved their performance and feel easy to learn chemical concepts after instruction when encouraged to connect the three levels of understanding (Gilbert, 2009). Most teachers and students opined that chemistry was complex due to the abstract nature of the symbol, gases, and many representations. They did not know the complexity of chemistry and their conceptual understanding. Thus, complexity in the conceptual understanding of chemistry was another cause of the learning difficulty in chemistry.

Chemistry Anxiety

Chemistry nervousness is the main reason students have trouble learning about the subject. Chemistry nervousness is a bad feeling that makes it hard to learn about chemistry. Anxiety is a feeling of stress, unease, or fear that makes it hard for the test student to do well in chemistry. Anxiety about chemistry means you can't remember or figure things out on your own. It changes how chemistry is taught to kids. Also, it affects how well the kids do on the SEE science test. For the discussion, here are some ways students feel about chemistry fear.

> Chemistry is hard to learn; "*tatho manchhe*" means that only smart kids can read science. I'm also not very good at science. At the start of science class, our teacher told us that chemistry is complicated and that we would have to work hard to read and write about it. I feared this part of chemistry in high school science because he explained it well. Other teachers also told us that studying is hard, so I don't want to read science (Jubin Interview, September 17, 2017). Another student

> named Kailash said to me that chemistry had a lot of symbols and formulas that were hard to understand and had to be remembered when learning about chemical processes. This made me think that chemistry was a hard area of science. So, I was afraid of chemistry and didn't want to take the science class (Interview, September 23, 2017).

The fact that science students and teachers talk about how scary chemistry is shows that it has many symbols and numbers that are hard to understand, making it different from other subjects. Students thought that chemistry was a vague subject.

> Pasang told me that many kids' science teachers told them that chemistry has a lot of symbols, equations, and formulas. Due to a fear of chemistry, many students are not ready to learn this method. Students can't read about science. So, kids don't do well in science and get low grades. Why I don't like science: When my science teacher teaches chemistry in class, I get very nervous, and when class is over, the teacher may leave (Interview taken on September 19, 2017).

According to what the students and science teachers think, chemistry is a challenging part of science. It is only for brilliant kids. Students believe that chemistry is a challenging subject to learn. It has nothing to do with what people do in their everyday lives. It is different from other topics. So, it made me nervous to learn about the chemistry part of science.

Intervened Learning Model

We used the PEAR as an instructional model for the intervention of classroom teaching. The result shows that it is better than the lecture method, but students' achievement is inadequate. It helps to develop a positive attitude and minimize learning difficulties at a particular level. The PEAR model has four steps. The first step is predicting the learning outcome and interaction with the demonstration procedure. In the second step, students experience and engage in the demonstration. In the third step, the illustrations and demonstrated materials should be related to the student's daily life experiences. In the last step, students reflect on the learning outcomes of teaching. These outcomes help to make effective learning. It can be shown as the model in the following form.

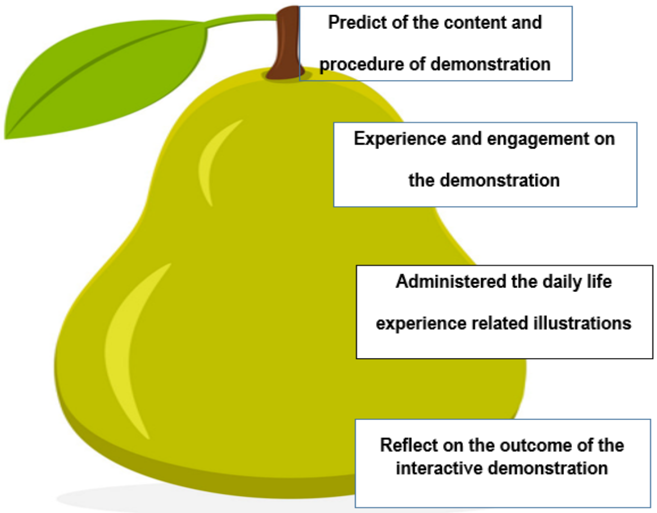

Figure 1: PEAR model for learning chemistry

Engaging Ways in Interactive Demonstration

Students participate in activities that challenge their prior understanding of a basic idea during Interactive Demonstrations. The activity is based on an experiment conducted in the classroom. Interactions present a carefully organized activity, establishing a "time for telling" about classroom experiments. Students are ready to learn in a subsequent engagement because the activity provokes their past comprehension of a basic idea. Like other active learning strategies, interactive Demonstrations consist of three planned phases carried out in the classroom. Students forecast the conclusion of the demonstration, experience the demonstration, and then reflect on the outcome in three steps during interactive demonstrations.

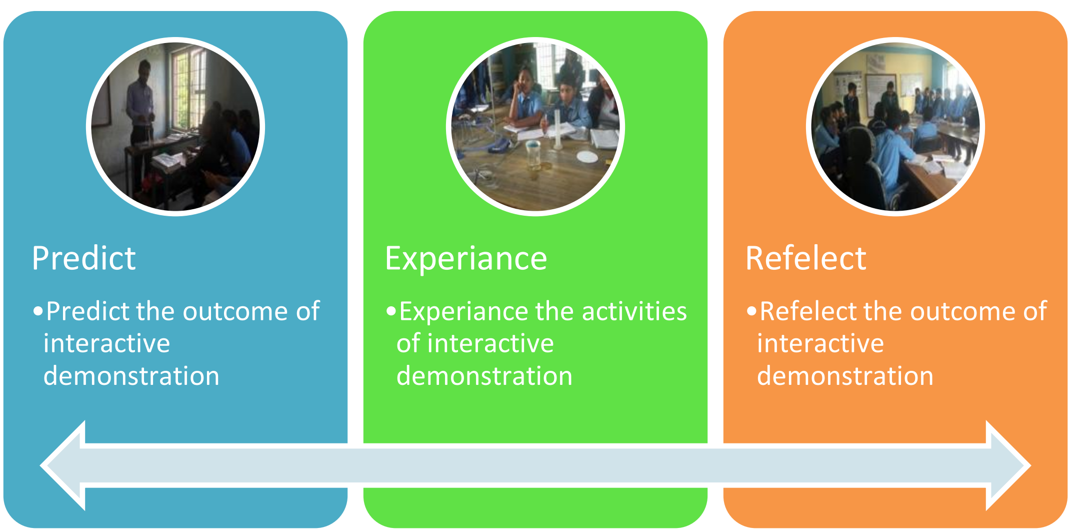

Figure 2: Interactive demonstration model

We created an interactive demonstration manual for the unit chemical reaction, solubilities, and certain gases from the secondary science curriculum's chemistry section, as prepared by the curriculum development centre (CDC). The interactive demonstration model described by Couch et al. (2004), Schwartz and Martin (2004), National Research Council (2005), Mestre (2012), and Vincent and Akpan (2014) serves as the foundation for the manual. The handbook is divided into 19 educational episodes, including demonstrative classroom interaction exercises. Due to individual variances in teacher instruction, the main goal of this manual was to create homogeneity in the treatment of the experimental group in each sampled school. The manual was validated by comparing it to an interactive display model and secondary science curriculum, and my thesis supervisor and a science specialist also accepted it.

Interactive Demonstration and Learning Difficulties

The teachers' experience expressed that learner-centred methods like an interactive demonstration, laboratory demonstration, and experimental teaching method would help minimize the learning difficulties and enhance the positive attitude towards learning chemistry. The above views suggest that teachers should use learner-centred teaching strategies corresponding to the outcome of students' learning. Most of the teachers had similar thoughts. For the supportive evidence, one usual lesson in school "B" that we observed in grade nine was as follows:

> When we reached school "B", it was 10:00 morning clocks. The class started at 10:15 Am. Mr. "C" started the class on time. He taught the lesson on physical change. He continued his style by using motivational techniques and linking his teaching to the student's previous learning experiences. He started the education by asking for some examples of physical change. He noted the students' responses with their examples written on the whiteboard. He asked the class what the physical transformation was. Kailash answered the question. He also asked the students about the physical state of matter. Nirmala and Pasang responded to the question.
>
> Similarly, he interacted with all students about the procedure to show the activity of physical change. He demonstrated the reversible transformation of ice into water as it turned into vapour which got condensed from water with the help of students. He followed the interactive demonstration manual for the demonstrative

activities of physical change. His voice was commanding and accelerated his teaching in the science classroom with students engaging in learning activities and materials like ice, glass rod, test tube, porcelain basin, spatula, tripod stand, wire gauze, etc., and demonstrative actions. He demonstrated and interacted with the reversible change in the ice into water and vice versa. We observed his interactive teaching in the classroom from the beginning to the end of the class. (Video recorded; September 15 2016)

The information about classroom observation indicated that the teaching-learning process was based on a learner-centred approach. Illustrations of the subject were connected with students' daily life experiences. He follows the interactive demonstration types of learning, which engage the students in demonstrative activities. These teaching-learning patterns can join the student's hand, heart, and head. Some examples of interactive demonstration activities were given as follows;

Interactive Demonstration of Physical Change

The teacher took a clean beaker to the demonstration table. He dissolved the sugar into the water and heated the solution over the flame of a spirit lamp until the crystallization point. When a crystal of sugar appeared in the beaker, the heat was disconnected and allowed to cool for some time.

Sugar + water $\xrightarrow{\text{solution}}$ crystallization $\longrightarrow$ sugar

Fig: Crystallization of Sugar

- The teacher took the help of the students for the demonstration.
- Before the demonstration teacher gave clear information about the apparatus required and the demonstration procedure to the students.
- The teacher asked the question to the student as follows;
  - What kinds of changes occur in the dissolving of sugar in the water?

- What happens during physical change?

- The student observed the demonstration material and actively participated in the discussion.

Interactive Demonstration Activities of Physical Change

The teacher took a clean beaker containing cold water and heated it over the flame of a spirit lamp with the help of the students. When water changed into vapour, then the entire test tube of cold water was taken over the beaker the drops of water appeared around the surface of the test tube

Water $\xrightarrow{\text{Evaporation}}$ steam $\xrightarrow{\text{cool}}$ water

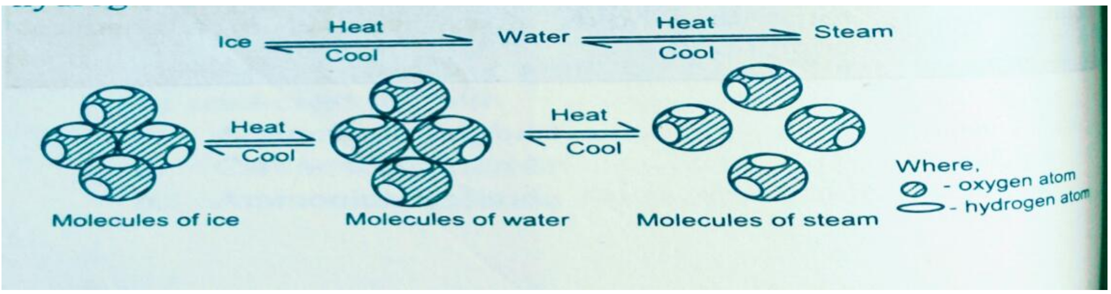

Fig: Physical Change

- The teacher took the help of the students for the demonstration.
- The teacher asked the question to students as follows;
  - What kind of change occurs in changing the water into vapor?

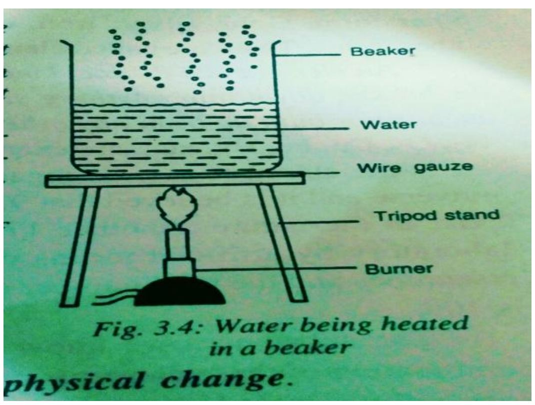

Fig: Physical Change

Interactive Demonstration Activity on Chemical Change

The teacher demonstrated the rusted iron tack without the rusted iron tuck. He wrote the change that occurs in the rusted tack of iron as follows;

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3$$


Fig: Rusting of Iron Demonstration

- The teacher took the help of the students for the demonstration.
- Before the demonstration, the teacher gave the students clear information about the demonstration material.
- The teacher asked the questions to students as follows;
  - What kind of change occurs in burning magnesium ribbon and rusting iron?
  - What happens during chemical changes?
- Students will observe the demonstration material & they will participate in the discussion.

Link of Chemistry to Everyday Life

Many of the chemical concepts are related to our daily life experiences, like the chemistry of the kitchen, medicines, foods, fibres, and fuels. Most of the chemistry illustrations are familiar to students' daily life experiences. It is the predominant problem in which our classroom teaching is not connected with students' everyday life experiences. In support of the above statements among the many participants, one participant presented the following view:

> I have been teaching all five science sectors for the last 36 years. The characteristics of gas can be visualized by using an interactive demonstration. Teaching chemistry can be related to the daily life experiences of students. I make them feel many examples of everyday life experiences by deep inhalation of oxygen and excretion of carbon dioxide. Some other examples are letting them taste lemon using chlorine to purify the water, showing turmeric, tomatoes using soap for cleaning purposes, etc. (Interview recorded; August 4 2017).

Nani's views indicate that chemistry learning is closely related to our daily experiences. Students' everyday life experiences must relate to our teaching-learning activities of science. It helps to understand the chemical concept by concretizing the abstract concept of chemistry. Most of the teachers give a similar view to Nani miss. Thus, a link to the chemistry of everyday life experience enhances the minimizing of students learning difficulties in chemistry.

The Purposed PEARL Educational Model

The "PEARL model" was developed based on abilities such as collaboration, interaction, demonstration, the connection of daily life experiences, group communication, cooperation, expression of feelings, expression of self, unity in overcoming problems, planning, following instructions, and understanding. We proposed the PEARL as an instructional model for students' academic success, enhancing positive attitudes and minimizing the learning difficulties in chemistry. It has five steps. The first step is predicting the learning outcome for the learner. In the second step, teachers help to elicit students' prior knowledge. The illustrations and demonstrated materials should be related to the student's daily life experiences and engage students in interactive activities in the third stage. In the fourth step, students reflect on the learning outcomes of interactive demonstrative activities. In the last step, students get looks back and make a reflection on learning through daily life experience. These learning experiences are durable and make effective learning due to students' hand, head, and heart connections (Doyle, 2023). Suppose this model is used in school classroom teaching and learning. In that case, it may be more fruitful to enhance student achievement, develop a positive attitude toward chemistry learning and minimize the learning difficulties in chemistry. It can be shown as the model in the following form.

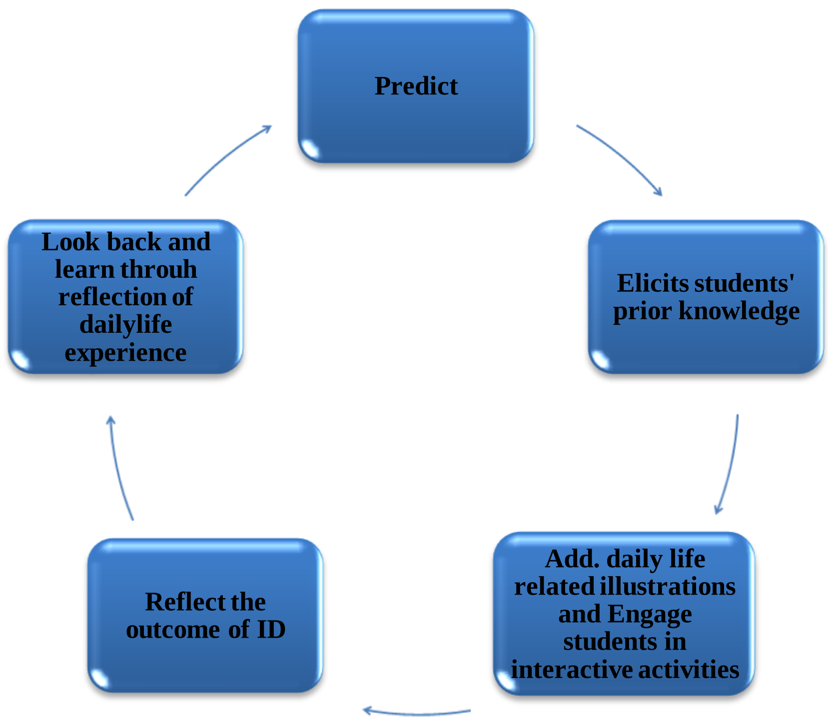

Figure 3: PEARL model for learning chemistry

Theoretical Foundation of the Model

The PEARL educational model was created based on Vygotsky's zone of proximal development, Dewey's learning by doing, the theory of planned behaviour, and Piaget's theory of learning. The constructivist approach utilizes resources and the ideas of interactive demonstration learning and knowledge representation. According to Piaget, learning occurs due to the interplay between the environment and the mind. The person tries to describe the context they have just been in using the schemas they have developed in the past. If an established theory can explain a new context, reinforcement of prior knowledge rather than learning occurs. If preexisting ideas cannot adequately describe a unique situation, a new approach is required, and the learning process starts. During learning, the person passes through schema, assimilation, accommodation, and equilibration stages (Asım, 2017). Using the PEARL Education Model aims to build the information kids pick up from interacting with their environment.

Regarding social constructivism, Vygotsky spoke a person makes knowledge through interactions with others in their social context (Abdulla, Fenech, Kinsella, Hiasat, Chakravarti, White, & Rajan, 2023). The person is aware that they can create their knowledge. On the other hand, in the zone of proximal development, there is the knowledge that a person can construct while being assisted by a peer or an adult (Thompson, 2013). The individual can also build knowledge through the scaffolding method that they cannot make on their own. The PEARL Educational Model stresses the significance of the zone of proximal development and contends that for kids to reach their full potential, reasonable teacher assistance and peer communication are essential. The constructivist framework for the PEARL model is based on the theories of Piaget and Vygotsky. The constructivist approach clarifies what knowledge is and how it is acquired. It encourages the child to build knowledge using their practices in the process in which they are engaged through living and experiencing rather than through memorization of rote learning (Ritchhart & Perkins, 2008). Education is durable because of children's active involvement in their learning processes and their construction of knowledge through living and experiencing. Cole and Wertsch (1996) argue that children are better able to build understanding with the help of concrete experiences and well-designed resources. Additionally, advising teachers who follow the scaffolding approach want to assist the child's potential for development.

For all children to participate in the educational process and develop to their full potential, regardless of their ability, it is crucial in the PEARL Educational Model. Children can learn at their pace and appreciation our child-centred approach. It is highlighted that active use of the five senses is necessary for learning (Koh & Divaharan, 2011). Children's experiential learning is valued by the PEARL Education Model as well. Learners' prior knowledge, Peer relationships, the growth of empathic emotions, and group interaction are all emphasized in the PEARL education approach. According to their developmental stage, children seek peer support when struggling. The child can assume various roles, work together in a small group, understand the viewpoint of others, and groom sharing skills in relationships with peers.

Children internalize solving issues in groups, fostering cognitive and emotional development. In the PEARL educational model, tasks tailored to children's developmental stages have been created using academic science and outdoor activities. The model was designed to show how these problems, typically associated with cognitive growth, can help kids learn how to cooperate and share when the right learning environment is provided.

Theoretical Standpoint to Analyze and Interpret the Data

This study consists of attitude, achievement, and learning difficulty, as the attributes. In the analysis and interpretation of information, these attributes are analyzed by social constructivism, John Dewey's theory of pragmatism, Azen's theory of planned behavior, and the Johnstone triangle as the theoretical lens. The overall framework is given in the following figure.

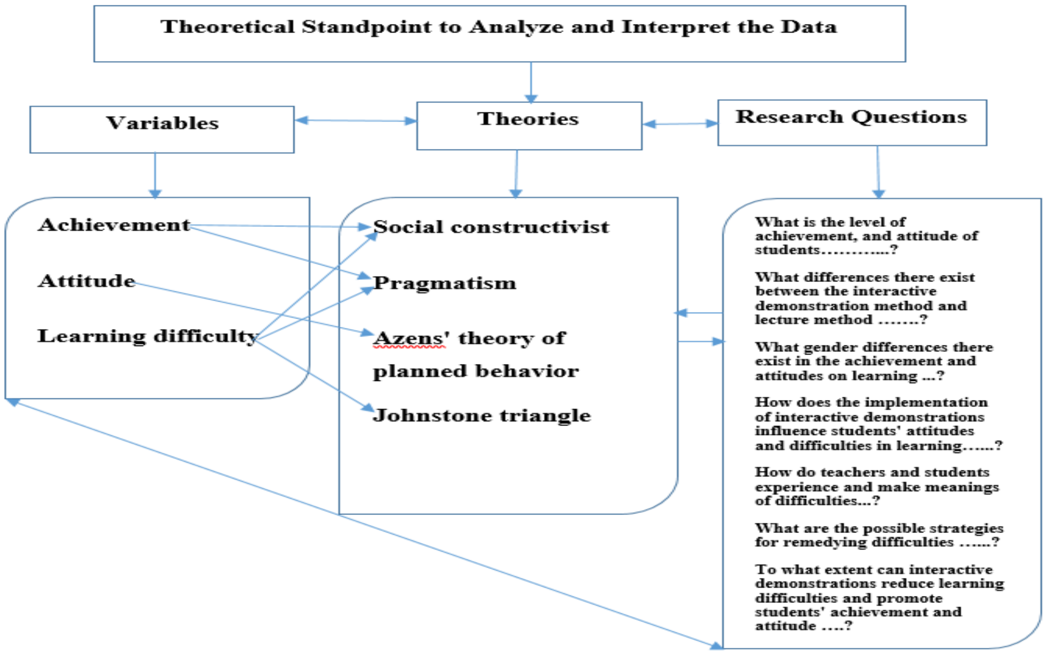

Figure 4: A theoretical framework to analyze and interpret the data

Theory Which Worked Well or not With the Models

We used four theories for developing PEARL model regarding theoretical literature and discussion of the model. They are social constructivism, pragmatism, Azens' theory of planned behaviour, and Johnston's triangle. Therefore, the following table represents which theory worked well with the model and which did not.

Table 1: *Theory which worked well or not with the findings*

S. N.	Name of theory	Well, work with the findings	Not work with findings
1	Social constructivism	Worked well	-
2	Pragmatism	Worked well	-
3	Azens' theory of planned behaviour	Worked well	-
4	Johnston's triangle	Worked well	-

Role of Teachers in the PEARL Model

The constructivist learning approach supported by the PEARL education model claims that peer interaction and teacher direction can assist a child's growth and that this approach may be superior to other teacher-centered ones. In the PEARL Education model, the teacher must: give students a chance to express themselves; observe their level of development and be able to provide the support they need to those with special needs; provide appropriate support for proximal development intervals; listen with interest to the solutions the students come up with in potential problem situations and give students a chance to try these solutions (Li, Blijd-Hoogewys, Stockmann, Vergari, & Rieffe, 2023). They must cultivate conditions that allow kids to feel empathy and establish settings where they can work with their peers to overcome obstacles in their developmental stage. It must provide kids with the chance to settle any arguments that may come up between them. Must observe the value of children's cooperative task-sharing and idea-sharing behaviours. Children must be allowed to attempt trial and error.

Reflection on the Model

This study discovered that interactive demonstration is superior to the lecture style; however, students do not attain enough chemical achievement (Timilsena, 2022). Due to previous chemistry learning difficulties, students have a relatively unfavourable attitude toward learning chemistry. Science, in our opinion, is not a difficult but rather a simple subject. It is ingrained in our everyday lives. For example, the butcher colours the body of the cutting goat with a mixture of turmeric powder and ash. Cooking rice as a hydrolysis reaction, burning firewood, salt, zinger, and oil are used for cooking vegetables, rusting iron, cooking tea, and freezing and melting ice in a refrigerator. A water mill (Pani Ghatta) is also used as a motor effect concept (Baur, 2018). Students face countless similar scenarios in their daily lives. All of these exercises are relevant to our school science curriculum. Even though teachers do not integrate these students' daily life experiences into classroom teaching and learning. As a result, the failure of teachers to incorporate students' everyday life experiences into school science classroom teaching and learning leads to chemistry learning challenges. When the PEARL education model is adopted in school science, it improves student achievement, fosters positive attitudes toward chemical study, and reduces chemistry learning difficulties.

If a youngster has a solid understanding of science and scientific thinking, they can apply scientific procedures daily. They should be exposed to science, which can lead to various occupations. Even those who go on to work in disciplines unrelated to science will need to use scientific techniques to inform their decision-making. Every day, families throughout the world benefit from science education. When people read late at night, play video games, or cook meals, they utilize a sort of energy known as electricity. Science is still taught in schools today, so children have no idea what it is or how it works. Children learn the scientific process, which "not only makes science more accessible and entertaining to all people but also reflects more clearly and openly how science proceeds," in addition to learning about electricity. In the scientific method, students are encouraged to generate a hypothesis through deductive reasoning. In everyday life, we also use deductive reasoning. Science has an impact on everyone and is evident everywhere every day. We all start learning science at a young age, whether in playgroup or first grade. Regardless of our feelings or ideas, it is critical to keep studying and expanding our understanding of science, even if some people are better at it than others. However, teachers must have firsthand knowledge of the subject for their students to thrive. Science is essential for gaining a comprehensive grasp of the universe around us. As we can see, science plays a vital role in everyday life. Science can and will help future adults understand their surroundings as long as it is taught. Science, which is used in almost every profession, may benefit everyone. Students who major in science have a better chance of living long, satisfying lives and attaining success. As a result of our research, we proposed that the interactive demonstration technique (PEARL model) be linked to students' daily lives and lived experiences when teaching science in general, and especially chemistry.

Conclusions

The qualitative information revealed that the interactive demonstration method effectively taught chemistry, as the experimental group performed well. Chemical reactions were complex for students due to the teacher's incapacity to relate daily life experiences with classroom instruction and learning. Employing interactive demonstration methods, comprehending the complexity of the chemistry subject, utilizing appropriate teaching resources, and adjusting the scope and order of the secondary science curriculum can help overcome learning obstacles.

Theoretically, knowledge production is founded on the constructivist learning theory's zone of proximal development. A pupil's level of learning ability determines how well they perform in school. According to the attitude theory, if one student in a class develops a bad habit, it spreads to others, causing them to have a negative outlook. Students in the experimental group perform better in school when they use the learning approach based on pragmatic theory. The interactive demonstration strategy improved students' achievement in the experimental group. Understanding the John Stone triangle and the complexities of chemistry instruction will assist students in overcoming learning challenges and developing a positive attitude toward learning chemistry. Therefore, in these situations, we proposed the PEARL educational model as the interactive teaching model for the teaching and learning of science education.

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