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Usage of Effective Questioning to Enhance Students 'level of participation in a Grade XI Chemistry Classroom of a Government Degree College in Rural District of Jacobabad

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Abstract

The purpose of the current study was to explore the usage of effective questioning during lecture-based teaching in the higher secondary chemistry classroom to enhance students' active participation. The qualitative paradigm was used in the study within its action research was conducted. The data was collected through multiple sources such as interviews, observations, document analysis, and reflective Journals. The multiple tools helped in the process of triangulating the data. The researcher has used semi-structured interviews, participant observations, field dairies, and reflective journals to gather in-depth, rich, and relevant data. Data were analyzed through thematic analysis. The findings of the study revealed that the use of effective questioning serves as a powerful tool for enhancing students' level of participation in chemistry teaching. Therefore, the use of effective questioning must be at the heart of lecture-based teaching-learning processes. In the study, students revealed that they had developed enough confidence which in the future will help them to take part in classroom activities. Moreover, it has also been found that the classroom discussion encouraged students to express their thinking in a fearless environment. It has been revealed that use of effective question not only develops students' participation but also enhance their learning. Furthermore, students' conceptual understanding was improved using effective questioning by integrating it into the college level chemistry teaching-learning activities. The results of the study have practical implications for teaching and learning in the chemistry classroom. Most of the studies around teacher's questioning have been undertaken in Western countries. However, this may be the first study that was conducted in Government Degree College for Boys, in the rural context of Sindh, Pakistan. Moreover, the study can contribute to the body of knowledge already available on classroom questioning and will be helpful for teachers in teaching science generally and chemistry particularly to enhance students' participation. This study recommends that questioning skills should be incorporated systematically into teaching-learning activities and practice to enhance students' level of participation.

Keywords: Effective Questioning, Students' Level of Participation, Chemistry Classroom, Rural Context of Sindh

Introduction

One of the goals of science education in Pakistan is to encourage students at all levels to develop a critical sense of wonder and curiosity about scientific and technological endeavours (Government of Pakistan, 2006). As the teaching and learning of science is a two-way process because in which both teachers and students simultaneously play a key role. The participation of the teachers and students in the teaching-learning process is equally important because it leads them to construct a better sense of the subject. Similarly, Shacham and Wiser-Biton (2009) also argue that a major goal of today's science education is to enhance students' active learning because it will promote questioning skills of teachers and students to make them critical thinkers. Furthermore, students' attitudes and interests also play a significant role in studying science. Teaching methods, teachers' attitude, cognitive styles of

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pupils, social view of science and scientists, social implications and achievement of science are the important factors which influence the attitude of students towards science (Adesoji, 2008). It is the teaching methodology of teachers that develops a positive attitude in students towards science. Hepburn, Beamish & Alston-Knox (2020) argues that teachers' ability to organize the classroom and manage the behaviour of their students is critical to positive educational outcomes.

Moreover, there is clear evidence in current literature for the benefits of active learning but on the other hand, most of the public sector degree colleges are following lecture-format teaching in higher secondary classrooms. If teaching practices in the classroom are not supporting student participation, then consequently learning will become less attractive for science students. Hence, less participation in classroom activities compels students to memorize the whole content of a course given to reproduce it in the examination (Glaze, 2018). Likewise, in college education in Pakistan lecture-based teaching is dominant (Kamran, 2018). This method of teaching is responsible for students' passivity in chemistry classroom practices.

However, while studying at AKU-IED the researcher was exposed to different ways of teaching and learning. Going through three different semesters of the M.Ed. the program, particularly two semesters of Science teaching, he found that the classroom was more interactive in M.Ed. course. There were opportunities for all the course participants (CPs) to participate in learning science either through the teacher's questioning or CPs' questioning. The researcher also found that facilitator's questions were important to probe participants thinking. The facilitators used to ask questions while performing an activity e.g. demonstration and to identify our prior knowledge about the concepts. These questions aroused the curiosity of the researcher to know what the next step will be. This helped him to ask questions to learn more about science concepts. The significant point was that the facilitators did not perform the activities but rather provided opportunities to CPs' to participate in class by answering and asking questions.

Also, the researcher has studied Piaget's (1969) work on how students learn, he started believing that knowledge is actively constructed. Therefore, for the students to become better learners, they should actively participate in teaching and learning. According to Van Hien, Hai, & Van Bien (2020) participation of students' in the teaching-learning process is important for their learning. They also support that the teaching and learning processes are effective only when the teacher, as well as the students, are active and co-operative in the classroom. Therefore, to meet the demands of the 21st century which prioritizes advancement in science and technology, it becomes imperative to investigate the issues students come across in learning chemistry, and also identifying ways for chemistry teachers to deal with such issues (Tigaa & Sonawane, 2020).

The lack of interest among students in studying chemistry is evident in the colleges of rural context. This is because students could not develop much interest in learning chemistry and complaint about boredom and frustration. The reason for students taking less interest in learning chemistry is due to the teaching of chemistry solely through the lecture method. Generally, in science classes teachers neither ask questions from the students nor respond to their questions during the lecture; also, students are not encouraged to ask questions from the teacher or the co-learners. Teachers only allow students to ask questions at the end of the session if they have any confusion about the lesson. This type of teaching approach makes students perceive science (chemistry) as a difficult subject which causes passivity among students; students feel bored in the classroom and find their learning irrelevant to their practical lives (Mujtaba et al,2018; Memon, 2007).

Keeping in view the researcher's experience as a student and as a chemistry teacher about lack of interest and less participation of the students in their education he realized that by using teacher's questioning as a teaching strategy the teachers could enhance students' level of active participation (Kayima, 2018). Hence, this study was an attempt to investigate how teacher's effective questioning can enhance students' active participation in the chemistry classroom at Government Degree college of Boys, Jacobabad in the rural context of Sindh, Pakistan.

Objectives of the Study

1. To explore the effectiveness of questioning in lecture-based teaching of Chemistry in the college-level classroom
2. To enhance the students level of participation in the XI Chemistry Classroom in the rural context of Jacobabad

Research Question

This study was conducted to explore the effectiveness of questioning in lecture-based teaching for enhancing student's active participation. Therefore, the following research question was formulated to comprehend multiple aspects of the problem-focused in the research question.

RQ1: How can effective questioning be used in lecture-based teaching to enhance students' active participation in a Grade XI chemistry classroom in a Government Degree College for Boys in rural Sindh, Pakistan?

Literature Review

Teaching Science through Traditional Way

Science plays a very significant role in the lives of individuals because of the technological advancement in all fields of science which benefits society. The influence of science can be seen from the production of the basic human need to social, political, education, technological, and economic advancement. These advancements can only be achieved through innovative ideas that come from scientific thinking and questioning (Rahayu, 2017).

The teaching methodology employed by traditional teachers –as-information giver, or textbook –guided classrooms failed to bring about the desired outcome of producing students who are capable of thinking in the classroom (Meguid & Collins,2017). As current classroom practices of public sector colleges signalled to change the focus of the classroom from teacher-dominated to student-centred integrating effective questioning with lecture-format teaching. However, the core science including chemistry was taught through the traditional way. It has been observed that most students are fearful of chemistry and hence they see chemistry as difficult to understand, which may be a result of the abstract nature of concepts of chemistry (Iwuanyanwu, 2019). Also in Pakistan, most of the teachers teaching chemistry at the higher secondary level and beyond predominantly use the lecture method with a limited purpose to transmit information so that students memorize that information to be able to reproduce it an in-the-end-of-year examination.

Unfortunately, the participation of students is given less importance during lecture-based teaching in chemistry classrooms because a teacher must complete his/her lesson within a given time. He/she also has a fear that if they allow students to ask questions and discuss the subject matter in detail then some points of his/her lesson may remain uncompleted. It is seen that most teachers did not ask questions during their lectures and did not respond to students' questions. Consequently, the participation of students in chemistry classrooms would always below. Thus, due to the low participation of students in the learning of chemistry, it impacts their examination results. Then due to bad results parents blame the teachers, teachers blame the children and the children blame the system (Kay, MacDonald & DiGiuseppe, 2019). However, everyone tries to see only one side of the picture by focusing on a single aspect of the problem, but few stakeholders focus on finding out the root causes of low participation of students in learning science generally and chemistry particularly.

On the teacher's side, the withdrawal and lack of interest of the students create disappointment among parents, teachers, and head-teachers at public sector educational institutes. Glaze (2018) argues that science teachers are dealing with learners who may not find science difficult and uninteresting but bring with them preconceived ideas into the classroom which makes teachers' task difficult. One of the reasons may be that after recruitment, the government college teachers are directly inducted in the department without attending any professional training. No doubt they may have strong command over the subject matter but being untrained they do not possess adequate knowledge in pedagogy. In the chemistry classroom at the college level, most teachers employ lecture-based teaching, and students are found as passive receivers of knowledge transmitted by them.

However, the current literature suggests that during teaching-learning of chemistry students should actively participate in their construction of knowledge in the classroom but on the other hand at college-level education in Pakistan teachers employ lecture-format teaching and do not encourage student's participation (Saad, 2017). The use of lectures only may not enhance students' level of participation as current literature suggest. The aim of the secondary Chemistry curriculum is "to produce students who will be capable of doing independent thinking, asking questions and looking for answers on their own" (National curriculum, 2006, p. 1). To achieve this aim, classroom participation must be at the heart of teaching-learning processes. Moreover, science educators are constantly interested in how and when to optimally adopt different science instructional strategies to achieve stated educational objectives (Saad, 2017; Jesa, 2017).

The Participation of Students in the Classroom

Encouraging students' participation in the classroom is consistent with social constructivism, which emphasizes that learning entails both cognitive and social processes. Students learn actively when they are involved in the teaching-learning process. Students can participate in science classrooms by responding to the teacher's prompts or assignments and asking questions or initiating discussions in the science classroom (Chen, Hand & Norton-Meier, 2017).

The literature identifies some of the inhibiting factors regarding students' participation in the classrooms. Firstly, according to Nisa (2000) students' participation is dependent on teacher's teaching strategies. She further explains that the teacher's close-ended factual questions from the text limited the students' responses in one or two words. Therefore, the teacher's factual questions are not useful in the sense that it neither promoted thinking nor discussion in the classroom. Conversely, if the teacher formulates or asks open-ended questions related to students' daily life, then students can participate more. Secondly, the relationship of students with teachers, peers, and subject matter influences their participation in the class. An enabling environment safe for students to participate in subjects' activities is significant (Foster, 2002). Thirdly, expectations of teachers from students in the class facilitate students' participation in the classrooms. Teachers should define students' level and mode of participation for the class and communicate it to the students. Students should know what is expected of them in the class. If students have the idea of teachers' expectations for themselves, then they easily do so in the class.

Active Learning Strategies in Science Classroom

According to Pereira-Santos, Prudêncio, & de Carvalho (2019), active learning strategies enable students to take an active role in using a variety of strategies to construct new knowledge based on their previous understanding. Furthermore, they can initiate their activities and take responsibility for their learning, make decisions, solve problems, and feel good about themselves as learners. But for active learning, there needs to be a non-threatening environment and opportunities for the students to make decisions about the content of their learning. The teachers should put more emphasis on interaction among students and guide their students by asking questions (Uzuntiryaki, 2007). Students learn from one another because, in their discussion of content, cognitive conflicts arise, and higher quality understanding emerges. Therefore, students' participation is very important for their learning and it can be enhanced when the students are involved by using active learning strategies which are exploration, making connections between the concepts, and using effective questioning. If the students learn by memorizing the concepts, they do not understand or make connections between the concepts. So, it is necessary to provide the students with the opportunities to actively participate in the teaching and learning process. Making lecture method active and collaborative by integrating effective questioning is not only desirable to many students, but they also appear to produce significant improvement in terms of learning outcomes (Pereira-Santos, Prudêncio, & de Carvalho 2019).

Effective Questioning: A tool of Promoting Interactions

Effective questioning has been used by many teachers as a contemporary teaching method. However effective questioning does not always happen even among experienced teachers. Therefore, many researchers argue that the result of contemporary schooling at both secondary and higher secondary level is disappointing. The asking of the question lies at the heart of science (Yang, 2017). The asking and answering of questions play a key role in the technique of classroom teaching. Research indicates that effective questioning has gained status in popularity as a teaching method and that classroom teacher spend anywhere from 35% to 50% of their instructional time conducting effective questioning sessions. Asking the question is a vital part of information seeking. Besides, asking questions promotes interaction which stimulates curiosity and harness inquiry proficiency while experiencing the process of learning and owning the knowledge generated by the learner, raising questions on controversial issues, and searching for information from diverse sources and questioning the reliability of the sources (Haydon, & Childs, 2018; Yang, 2017).

Asking, raising, and framing a question is the core of teaching and learning. However, it has been experienced generally in all classroom instructions, and particularly in the lecture-format classroom questioning is not encouraged. Most of the teaching and learning revolves around the textbook, which itself does not encourage the teacher and learner to be engaged in raising issues and deliberately in the different aspects of the issues from different perspectives. Siddiqui (2016) asserts

that the syllabus offered in our education and its execution in the classrooms revealed that this type of education program cannot prepare the students to meet the challenges of the new millennium. Moreover, the education system has developed a product which avoids raising and asking questions.

The ability to ask questions is central to information seeking, learning how to learn, bridging unknown to known, encouraging enquiring minds and it is essential to the systematic investigation of information. Moreover, questioning is a skill that enables one to discover the hidden treasure of knowledge (Watson, 2018). Therefore, every aspect of lecture-format teaching can cater to questioning to understand the complexity of teaching and learning chemistry. Through raising questions on all these areas and looking into it with different dimension and to reacting critically, we could be able to develop good informed, active and responsible citizens for the society to participate in the scientific investigations and to improve the quality of today's life as a prime objective of teaching and learning chemistry.

A large body of literature is on the nature of classroom questioning which has been focused in terms of teachers' questioning and do they use questions in teaching both in developed and developing countries especially in science and language (Watson, 2018; Wangru, 2016). Very little literature from Pakistan is found on teachers' questioning where schooling is focused on the acquisition of factual knowledge (Dean, 2005). Thus, there is a lack of literature on the nature of classroom questioning in developed and developing countries. Teaching in the science classroom at higher secondary level in Pakistan is teacher dominant and students are treated as passive learners. Siddiqui (2016) also indicated that the education system is lacking the ability of students to think on their own, use reasoning skills, raising pertinent questions, and explore alternatives. The result is large-scale production of graduates who cram the contents of a subject to do well in their exams. To find the answer, there is a need to peep into the classrooms.

A typical classroom of a mainstream college is a teacher dominated classroom where students are put at the receiving end. Questions by students are not encouraged. In a teacher fronted classroom the teacher acts as a knowledge giver who transmits knowledge to empty vessels.

Similarly, the schooling system in the rural context also does not encourage classroom questioning, where most of the students learn the answers by heart. Students in the classroom are considered the sponge and a good student is the one who sits in the class quietly and behaves nicely. He never disagrees with the teacher, hardly asks any question, and has a sharp memory to repeat what the teacher has taught (Siddiqui, 2016). Because of this tradition, chemistry is considered a boring subject, and students are compelled to rote memorization and they cannot enjoy the learning experiences, which further demotivate the students to think and raise issues. This ultimately hinders the development of their thinking skills (Watson, 2018; Siddiqui, 2016) and retards their classroom participation. Teachers themselves are coming from the home environments where questioning is not encouraged, and children are shunned by saying that it is rude to ask adults. This adult dominancy culture of society influences the school culture.

Furthermore, if the questioning approach is not integrated spontaneously with the teaching-learning processes, the students and teachers will not develop the skill to ask good questions. Questioning skills help in nurturing the children's inquiry skills and critical thinking and ultimately will affect their learning outcomes. The high incidence of questioning as a teaching strategy has a potential influence on students' learning outcomes (Nappi, 2017). Student questioning is crucial in terms of generating and refining the ideas and building their understanding based on prior understanding. The knowledge students will generate with the questioning approach, will develop in learners a sense of ownership towards that understanding. Consequently, every event of learning will become an occasion of pleasure and enjoyment for the learner rather than recalling of facts and figures. This is what the main aim of teaching and education is. Keeping in view the above-mentioned facts, it can be considered vital to explore the dynamics and possibilities of using effective questioning in a classroom. That could help to open the opportunities to create a rich questioning culture in the class which may help the learners to enhance their classroom participation which ultimately leads them to construct their knowledge and become independent learners. Therefore, the purpose of this study was to explore the use of effective questioning in enhancing students' participation in a higher secondary chemistry classroom.

Hence, effective questioning is not only enhancing students' level of participation, but it also creates a conducive environment for learning. Moreover, effective questioning is a tool to reduce the

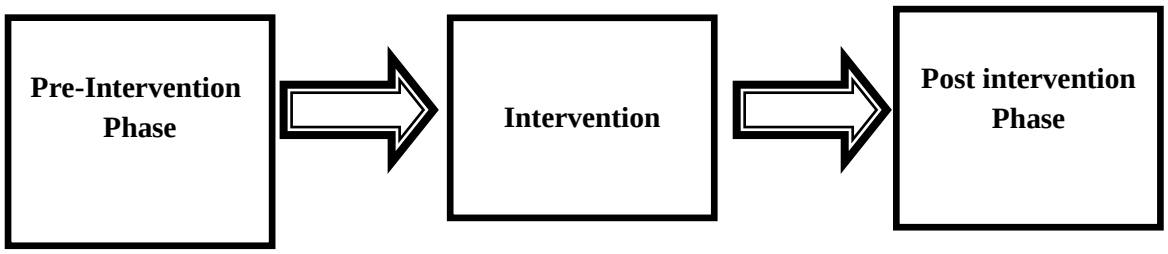
gap by connecting known to unknown between the learner and the concept which is to be learned (Nappi, 2017). According to Siddique (2016) if the teacher supports effective questioning in the classroom students will be motivated to ask more questions. Moreover, effective questioning fosters interaction between teacher and student but this relationship is created through a friendly atmosphere in the classroom. To conclude, it is believed that effective questioning enhances students' participation in classroom activities that leads them to focus their attention and understand lesson content, arouse their curiosity, stimulate their imagination, and motivate them to seek new knowledge which is the ultimate aim of chemistry education.

Methodology

The action research method was employed in this study within the qualitative research paradigm. Moreover, multiple sources of data collection such as interviews, observations, document analysis, and reflective journals were used in data gathering (Altrichter, 2020; Daniel, & Harland, 2017). Data were triangulated using multiple tools in the research. Additionally, the researcher has used semi-structured interviews, participant observations, field dairies, and reflective journals to gather in-depth, rich, and relevant data. Data were analyzed through thematic analysis. The participants of the study were one chemistry teacher and six students of grade XI of Government College of Boys, Jacobabad.

Process of Carrying out Action Research

The focus of the research was to study in-depth about teacher's instructional practices within a particular social setting for bringing improvement in it. In this study, the researcher has played dual roles, as a researcher and as well as a Chemistry teacher during the study period. The researcher planned, acted, implemented, and observed his actions throughout the study (Manfra, 2019). According to Daniel, & Harland (2017), action research is a systematic process of reflection, inquiry, and action carried out by individuals about their professional practices.



This action research was carried out in three phases. The three phases were pre-intervention, intervention, and post-intervention. In pre-intervention or reconnaissance, the researcher observed four lessons of a participant teacher and interviewed him. He also conducted group discussions with the focused group students. The purposes of observation and interviews were to learn about current perceptions and practices of using effective questioning of chemistry teachers. In the intervention phase, the researcher ran two cycles of planning, teaching, and reflection. In the first cycle, he incorporated how my learning about the use of effective questioning could be developed through observation of the participant teacher's teachings and interviews of the teacher and students. Then in the subsequent cycle, he incorporated his learning from the previous cycle. The researcher invited the participant teacher for observing his teaching and giving critical feedback on his teaching. In the post-intervention phase, the researcher has interviewed students and the teacher to know about the views on my teaching and their learning throughout the process.

Results and Findings

Findings from Reconnaissance Stage

The data gathered from the reconnaissance stage revealed that the students were neither aware of discussions in class nor did they have the culture of sharing of their understanding during teaching-learning activities. Moreover, they were not used to asking questions from their teacher, and reluctantly responded to the teacher's questions if he asked any. Without creating an interactive environment where students can express their thinking and learning, it was difficult to implement the idea of effective questioning in the class. Therefore, the researcher planned the first cycle of action research to address the issues of discussion in class, interaction among students and with participant teachers and being able to express their ideas. Also, the researcher, as well as the teacher, tried to encourage students to express their ideas because their participation in classroom activities is an integral part of their learning' that can be enhanced either by asking questions or responding to the

questions of their teacher. The researcher co-planned with the participant teacher and developed lessons for teaching chemistry aiming to enhance students' level of participation.

Findings from Implementation Stage

In this action cycle, the researcher came to know that wait time, praising students, and integrating demonstration with questioning are the vital factors for enhancing the level of participation of students during lecture-format teaching. Also, these factors changed the pattern of interaction which initially was student-teacher now become student-student which consequently enhanced the students' level of participation. In this cycle, students not only responded to questions asked by the teacher but also commented on other students' responses for justifying their answers. Moreover, the above-mentioned factors enabled students to ask questions for their clarification. In this cycle, the discussion becomes an essential part of teaching and learning processes which provided students opportunities to relate their previous learning to the situation. They were also building on each other's' ideas as the background information about thermodynamic terms and the first law of thermodynamics. Furthermore, analysis of data also confirmed that while teaching abstract concepts of chemistry lecture cum demonstration method motivate students to respond on teacher's questions but also asked questions from the teacher for their clarification

4 Findings from the Interview

The teacher recognized the idea of alternative frameworks in students and the source of these alternative frameworks could be teachers, textbooks, community, or students' interpretations. He also accepted the importance of instruction embedded in effective questioning to elicit students' prior knowledge of understanding for their further learning by creating opportunities for them to take part in teaching and learning processes. However, the teacher highlighted the issues related to the use of effective questioning. Syllabus coverage in the given time frame seems that coverage, of course at the cost of understanding, is the aim of teaching chemistry.

Students' Views on Intervention: Questioning, Participation, and their Learning

Most of the students in the class liked the way they could participate in classroom teaching and learning activities. It was a shift from highly structured class where they were supposed to listen and look at the whiteboard, to an interactive class where they were free to talk, ask the question, respond to any question or even make comments on the responses of their classmates or their teacher but under some rules developed by the habit of interaction. Discussions also help students to begin to analyse and reflect on what they considered to be important, and how they can achieve their desired objectives. Hence, this leads students to generate a shared understanding.

Discussion on Findings

This study revealed that the use of effective questioning serves as a powerful tool for enhancing students' level of participation in chemistry (science) teaching (Haydon, & Childs, 2018). It is important to know how students take part in classroom activities. Students come to the chemistry classroom with a variety of ideas. Before this study, the researchers' classroom practices were based on one-way transmission from teacher to student. The researchers' beliefs and assumptions that students can assimilate the information and integrate it into their existing understanding through restructuring their ideas about chemistry concepts, changed. Now, he realizes that without using effective questioning it is too difficult and even impossible to enhance students' level of participation during lecture-format teaching. There is a need to re-think to change the common model of teaching-learning in higher secondary chemistry classrooms, which is a one-way transmission of knowledge without allowing students to justify and clarify their understanding.

The aim of a higher secondary Chemistry curriculum is "To produce students who will be capable of doing independent thinking, asking questions and looking for answers on their own" (National Curriculum, 2006, p. 1). To achieve this aim, the use of effective questioning must be at the heart of lecture-based teaching-learning processes. It should be incorporated systematically into teaching-learning activities and practices to enhance students' level of participation. Mostly, in classroom practices, selection of activities, materials, classroom discipline, and time are emphasized more, and students' participation goal is ignored. As a result, students memorize the content and face difficulty seeing the relationship of chemistry concepts with the world around them.

This action research study aimed to explore the possibilities of using effective questioning to enhance students' level of participation in Grade XI Chemistry classroom during lecture-format teaching. During the second cycle of action, while delivering lectures the researcher observed,

listened, probed, and taught students on the spot, and encouraged the students to express their ideas. Students' responses revealed that they had developed enough confidence which in the future will help them to take part in classroom activities. The classroom discussion aimed to encourage students to express their thinking in a fearless environment. This developed relationships between the usage of effective questioning and students' participation and the other between their participation and their learning.

Classroom environment plays a vital role in using effective questioning in the classroom to enhance students' level of participation. Students showed the motivation to learn more in a friendly environment (Fraser & Kahle, 2007). In an interactive classroom, it was possible to encourage students to share and explain their understanding and make thinking explicit. Students' conceptual understanding can be improved using effective questioning by integrating it into teaching-learning activities (Nappi, 2017)

This study made the researcher think and recognize the importance of using effective questioning for enhancing students' level of participation. While using effective questioning, the investigator's role as a teacher was also important to engage students in discussion. It helped them to express their ideas and to re-structure their knowledge so as they are accepted useful members of the society by the scientific community.

In addition to enhancing students' level of participation, the classroom culture also changed from a silent and strictly structured to a highly interactive one, where students were encouraged to talk, ask, and respond to questions. Giving importance to students' ideas was perceived by students as a level of care. Moreover, the classroom became a place where students could share their ideas without any fear. Students recognized that enhancement of their level of participation in classroom activities consequently has developed their understanding of chemistry concepts, which was earlier underdeveloped, and they were not able to explain similar situations beyond the book. This recognition was also a strong motivational factor for them.

However, there were many challenges in using effective questioning in the Grade XI chemistry classroom, such as the teacher's unawareness and resistance to change the traditional mode of teaching, the workload on chemistry teacher, time constraints, and large class size. Despite the challenges, providing on-going professional support for the teachers, it is possible to use effective questioning for enhancing the level of students' participation during lecture-based teaching.

Conclusion and Recommendations

Effective questioning as teaching and learning strategy during lecture delivery in the higher secondary classroom is a shift from traditional lecture-based teaching to instruction embedded lecture-format teaching. It can be implemented gradually with a context related and manageable approach; because, change is considered as a process, not an event (Fullan, 2020). It is all about change in perceptions and beliefs, to shift from simply delivering lectures as teaching and learning strategy to effective questions integrated with teaching-learning activities in lecture-based teaching.

The study recommends training college teachers in pedagogical content knowledge of Chemistry and provides ICT tools to develop the thinking skills of students while teaching science topics from early classes.

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