Initiating Inquiry-Based Teaching (IBT) in Classroom at Middle level School in Karachi

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Abstract

The ultimate aim of teaching of science is to foster scientific and critical thinking among students that they could be able to understand the process of science and they can solve scientific problems. Such kinds of disposition are fostered in students when they are taught employing students centered teaching methodologies. IBT is one of them which developed the above-mentioned dispositions in students. However, the IBT is not reflected in our classroom practices. This study is conducted to explore the feasibility of IBT in science class of a government school in Karachi Pakistan. Findings of this study reveals that during intervention inquiry was initiated from cookbook approach and at the end of nine lessons students were able to reach somewhere between structured and guided inquiry. Findings of this study suggest that in order to improve culture of inquiry in the classroom, students' questioning skills needed to be improved.

Keywords: Inquiry-Based Teaching, Middle School, Karachi, Classroom Engagement, Student-Centered Learning

Background of the study

In Pakistan, science is taught as a compulsory subject from class I to class VIII. While at secondary and higher secondary level, science is taught as a discipline, which is comprised of three subjects i.e. physics, chemistry and biology. Science curriculum for all levels is developed in the curriculum wing and the four provinces implement this curriculum through their respective textbook boards (Ahmad et al., 2023, 2024; Altaf et al. 2023; Dehraj et al., 2023; Hussain et al., 2023,2024; National Curriculum for Science, 2006).

The practices of teaching science in Pakistan are mostly teacher centered. Science is taught through telling and reading. There is less participation from students since they sit in the class as a silent recipient and teachers try to fill them with scientific knowledge. Right answers is considered important indicator of "learning" (Muhammad et al., 2023; Sindhu et al., 2023; Zafar et al., 2024; Siraj, 2002; Khan, Nisar & Yasmin, 2000). Apart from this Science teachers are also lacking in content knowledge as well as pedagogical knowledge. In most of

the school's science is mostly taught by those teachers who have no background of science (SPDC, 2002). Consequently, science is taught through rote memorization which is not encouraged in teaching and learning of science.

Theoretical perspective

Inquiry is a method of teaching where learners are involved in a challenging situation and allows them to identify a perplexing problem and reach to informed conclusion by going though a systematic process of formulating questions, making hypothesis, testing the hypothesis and drawing conclusion (Alvarado & Herr 2005). Rankin (2000) is of the view that inquiry is an exploratory and discovery-based process put learner into a situation, where they engage in intellectual operation and problem solving for enhancing their critical thinking, observational skills and decision-making skills, which leads to the exploration material and physical world. According to National Research Council NRC, (2000) IBT in science is said to be a systematic way of teaching science, where students identify a problem, generate a question, make hypothesis, test hypothesis, read pertinent literature and draw a conclusion. In this way student generate and construct knowledge. Inquiry is not only confined to the classroom rather it provides opportunities for learning outside of the classroom. It urges the learners to reflect and ponder about the events happening in the surrounding and relate them with classroom science though inquiry (Bera, 2004).

IBT is not limited to the domain of science. It is also used in other subjects therefore; different modes of IBT emerged because of its usage in different areas (Trwobridge, Bybee and Powell 2000)

Basically, inquiry is categorized into two major types issue based and knowledge based inquiry. Windschitle (2002) further categorizes scientific inquiry into four types on a continuum i.e. cookbook inquiry; structured inquiry; guided inquiry and independent inquiry. Cookbook and structured is mostly teacher dominated. In guided students and teachers both equally participate while independent inquiry is student dominated. Hartland, C. (2006) has categorized inquiry into three types and has excluded cookbook from the continuum.

IBT is considered beneficial for teaching and learning of science in many ways. Melear, Lakson, Warne & Hickon (2000) states that IBT supports meaningful learning and foster self-motivation with greater skills of communication and critical analysis. Moreover, IBT also gives students a sense of freedom and self responsibility, where they work independently for developing their own questions and do the investigation in their own way. In this way, students become life long and self directed learners.

Besides students IBT is also beneficial for the teachers. By involving teachers in the IBT teacher get in depth understanding of science as well as nature of science. By involving teachers in inquiry during pre and in service professional development sessions, teachers not only read and discuss science but also do science (Morrison 2008). Apart from intellectual development, IBT also contributes to students' social development, where students learn different types of social skills when they are engaged in inquiry. When students are given group work during the process of inquiry they interact with each, listen to each others ideas, share their ideas with each other and some times they challenge each other ideas (Dyasi, 2000).

Although IBT is very helpful for the effective teaching and learning of science, but at the same time IBT is also challenging. The major challenge is the lack of time. In our classes mostly 40 to 45 minutes are allocated for teaching of science, which is not sufficient for IBT. IBT demands for more time. Apart from teaching, planning of IBT also requires more time and energy (Dowell, Short & Landes, 2002; Burkett & Leard 2007). Ali (1998) is of the view that it is difficult to maintain classroom discipline while teaching through inquiry, especially in large classes due to lack of resources and classroom structure, it is difficult to engage each and every student in inquiry. As a result, different types of disciplinary issues rise.

Students and teachers are considered important role player and stake holders of IBT. Both play important role however, the essence of IBT lays in students centered teaching. Gutek, G. L. (2007) used metaphors "fellow investigator" and "classroom secretary" for defining teachers' role in inquiry. These metaphors imply that students play dominant role in IBT. Teachers' task is to facilitate them by providing them scaffolding during the process of inquiry. In IBT students need to take the ownership and responsibility of their own learning by constructing and generating knowledge (Wee, B., Shepardson, D., Fast, J. & Harbor, J. 2007). In addition, teacher needs to provide specific directions to the students, through which they could be able to conduct inquiry (Kai Wu & En Hsieh, 2006).

As it has already been shared that students are considered important stakeholder of IBT therefore, they should actively participate in IBT by formulating inquiry questions; collecting relevant data; doing scientific investigating and drawing conclusion (Keys & Bryan, 2001). In inquiry mostly students need to do the inquiry in groups, where they try to develop a census having a different point of view. In this way a sense of collaboration and collegiality developed (Dyasi, 2000).

Previously scientific knowledge was considered as an ultimate truth where there was no possibility of change. However, according to the Nature of Science (NOS) scientific knowledge is evolving, flexible and tentative, where there is a possibility of change. In the same way philosophy of inquiry also stresses that scientific knowledge construct through inquiry is tangible and flexible and it can be when some one else do inquiry through a different perspective (Venvill and Vaille 2000).

Research Question

The main research question of my research was

- How can a teacher promote IBT in science at lower secondary level (grade VII) in a government school of Karachi?

Subsidiary questions:

The main question is supported by the following subsidiary questions.

- What are the existing practices of teaching and learning science in grade VII?
- What are the strategies a teacher can use to promote IBT in a science classroom?
- What are the factors which facilitate in promoting IBT in a science classroom?
- What are the challenging factors in promoting IBT in a science classroom?

Research context and Research participants

I conducted my studies in a government lower secondary boys' school in Karachi. It is located

nearer AKU-IED and has two shifts. Morning shift starts at 8:00 am and close at 12:30 pm while the duration of second shift is from 12:30 pm to 5:00 pm. There are three classes i.e. VI, VII and VIII and each class has two sections. According to the head teacher, the school has been serving children from middle and low socio-economic background. There were more male teachers (n=10) than female (n= 6). There is only one science teacher handling six sections of the three classes (VI, VII and VIII). Furthermore, books of Sindh Textbook board are taught in this school. The average number of students in each section is 35.

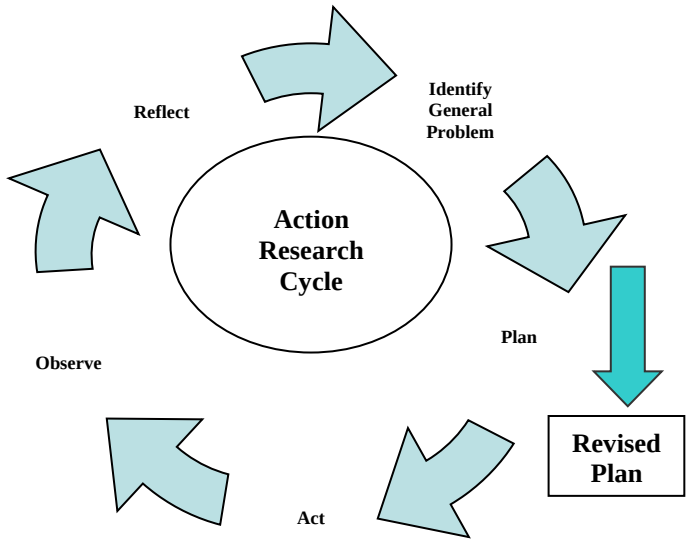
Although the entire class of VII section B was my research participants however for interview purposes and to explore progression I selected six students Salim, Mudasir, Hadi, Amman, Kamran and Irfan (pseudonyms) of mixed ability group i.e. above average, average and below average.

Research Methodology

Taking the nature of study into consideration, I opt for qualitative research since; I was to explore a holistic and in-depth view of the feasibility of using IBT in a lower secondary science classroom. For this purpose I had to do research in a natural setting without disturbing the natural setting (Robson, 2002). Dyasi, H. (2000) states that qualitative method occurs in a social and natural setting attempting to make sense of or interpret phenomena in terms of the meanings people bring to them.

Within the qualitative paradigm I select action research. There were many reasons for selecting action research as a method. First my research question was demanding for the action research. Secondly, the nature of my research as well research question emphasizing my own involvement in the process of research as I had to teach in a real classroom situation (Zion, Cohen & Amir (2007). Thirdly, the aim of research was also to improve my own skills of IBT. As Kimmis, Mc Taggrat and Retallick (2004) and Dyasi, H. (2000) urges that the aim of action research is to improve the rationality and justice of practices, understanding of the practices and the situation in which practices are carried out. Hence, action research is a way to bring improvement in terms of practices. In this study, I used Kemmis, McTaggart and Retallick's (2004) model a modified version of Lewins's model of action research. I selected this model, since it was simple and flexible in nature as compared to other models of action research and it guided me at every step.

GURE 1
Model of action research



Data Collection Method
In order to collect rich, in depth and relevant data I employed following data collection method.

Observation
I observed the two classes of science teacher of participant school in the reconnaissance stage. The purpose of observation was to become cognizant with the current practices of teaching and learning science. Moreover, this observation also helped me to explore the students' level of inquiry. Because of unavailability of critical friend I had to observe my own teaching during the implementation stage. While observing I took field notes later on I described them.

Semi-structured interviews
I interviewed a focus group of six student of mixed ability group before and after the implementation phase. Through these interviews I tried to explore their views of about the current teaching practice of science as well as IBT. The interviews were conducted in Urdu language and they were translated into English while transcribing. I also took an interview guide with me during interview to keep my self focus on research topic.

Reflective Journal
Reflection plays a vital role in action research. Writing reflection was the essential part of my study. It helped me to record my understanding and personal believes about the feasibility of IBT. Reflective journal also helped me to identify both different problems that I encountered during the study and the possible improvements. During the classroom observation, I recorded all the data including the events, actions and interaction in a reflective journal in the form of reflection. While during classroom teaching I noted the points as a field note. After teaching I

critically reflected on them. On the basis of reflection I planned for next day teaching.

Data Analysis

Data analysis was done at two phases one is on going and another is final analysis. On going analysis was done during implementation stage where I wrote reflection soon after delivering lesson. In these reflections I reflected on strengths as well as weak points of my lesson. Through this way I tried to bring improvement in my upcoming lessons. The final analysis was done when field work was done. In this analysis, first of all the documents were given organizational codes like, Tr-Ref for teacher reflection and Sts-Int for students' interviews. After that, themes were made and coded. Then, themes were categorized on the basis of similarities and differences. Finally different types of data set gathered from different sources like, interviews, reflections, informal discussions and field notes were triangulated.

Findings

Following are the main finding which emerged from this study.

Simple to complex approach

Keeping the students level in mind I started every strategy in a simpler form and then I proceeded to the complex one. Firstly, I started the inquiry from its simple form. I initiated the inquiry from the cookbook approach which is the simple form of inquiry. Then I proceeded to structured inquiry.

Secondly, questioning process was also started from the simple level. Initially, students were asked to share close ended, factual and convergent questions. Later on, they shared open ended and divergent questions. In this way students' questioning skill improved.

Lastly, in doing experiments same trend was followed. In experiments first students were exposed to demonstration where most of the work was done by the teacher. In the next step students were lead to confirmatory tests. In these tests, students were given some sort of leverage, but the already aware about the result of the experiments. After that they were involved in experiment that answers were not known to the students. Students were scaffoleded wherever they required. In the last phase they were asked to do the experiments by their own. They set the apparatus, do the experiment, observe the experiment, collected the data and drew the conclusion.

Experiments enhance students questioning skill

In the first cycle it became very difficult to probe open ended and divergent questions from students. Students raise only factual, convergent and close ended questions. These questions cannot lead students to the inquiry questions. For this purpose students need to pose more and more open ended question. Through which they would be able to formulate inquiry questions. For this purpose I used different kind of strategies. One strategy remained successful. In this strategy I asked the students to formulate questions before the experiments and after the experiments. Here I observed that the questions which were formulated before the experiments were mostly close ended and factual. While the post experiments questions were mostly open ended and some of them were inquiry questions. Following are the examples of questions raised by the students before and after the

experiments.

Before doing the experiment of Expansion of Heat, where metal ball was supposed to passed through the metal ring before and after heating. Students shared these questions.

- Will the metal ball pass through the metal ring after heating?
- Will the metal ball become hot when it will be heated?

After the experiment

- Why did the ball not pass through the ring, after heating?
- How did the size of ball become bigger? (Ref-Jr, Jan29, 2009).

It can be implied from the aforementioned questions that experiments play an important role in enhancing students questioning skill. In experiments students observe the experiment. In this way experiments provide them a base line for formulating questions. Keeping the observation in mind students can formulate open ended and inquiry questions.

Ward, Roden, Hewlett and Forman (2005) also support this argument, saying to promote students' questioning skill, students need to be provided with opportunities to explore and observe objects through experiments. Therefore, it is necessary that in order to improve students questioning skill, they need to be given the situation before asking them to develop questions because their involvement in inquiry-type experiment improve their ability to ask better scientific questions (Hofstein, Shore, &, Kipnis, 2004).

Facilitating and challenging factors

I confronted number of facilitating and challenging factors during this four-week research. First facilitating factor was planning. I taught every lesson with prior lesson planning where I made a written for each lesson. In these lessons I set objectives and related them with the activities as well as inquiry skills. Due to planning I confidently delivered my lesson in an effective way by trying out new ideas. I gave more and more time to involve the students in classroom activities.

As far as the nature of planning was concerned it was not rigid rather it was flexible. Some time I planned for group work but when I reached school for teaching school asked me to teaching both the section jointly where it was not possible to teaching using group work. So, as an alternative I taught through demonstration method.

Piloting

After planning I used to pilot the activities. Piloting helped me allocating proper amount of time. Apart from time, piloting of experiments facilitated me in rectifying some of my misconceptions. For example, in the third lesson, I devised an experiment where different kind of material had to burn through magnifying glass. For this purpose, I selected paper, tissue and dry leaves. The paper that I had selected for the experiment was white in colour. Before piloting, I was of the view that the magnifying glass will burn the white paper, but it did not happen. I held the magnifying glass over the white paper for twenty minutes on a full sunny day, but I could not succeed in burning the white paper through the magnifying glass. In this way, piloting rectifies my misconception that white paper reflects the light. Therefore, it takes more time than other color paper. Piloting of "burning paper" enabled me to choose the appropriate material as it would not be possible to spend 20 minutes in a 40 minutes class just to pilot the activity.

References

1. Ahmad, M., Hussain, S., & Qahar, A. (2024). Comparison Between Virtual Reality and Integrating Blended Learning Flipped Classroom Model: An Experiment on Secondary School Students. *International Research Journal of Management and Social Sciences*, *5*(1), 1-11.
2. Ahmad, M., Hussain, S., Mehmood, M. A., & Qahar, A. (2023). Learning Outcomes by Integrating Virtual Reality: An Experiment on Secondary School Students. *International Research Journal of Management and Social Sciences*, *4*(4), 473-484.
3. Ali, T. (1998). *Use of Inquiry in science classroom: Teaching in Pakistani middle school.* Unpublished master's dissertation, The Aga Khan University, Karachi. Institute for Educational Development.
4. Altaf, S. H. M. A. S., & Ahmad, M. F. (2023). Quality Education Sustainable Development (SDG-4) 2025: A Comparative Study of Government and Punjab Education Foundation Secondary Schools. *Pakistan Journal of Education*, *40*(2).
5. Alvarado, A. E. & Herr, P.R. (2003). *Inquiry based learning: Using everyday objects*. Thousand Oaks: Corwin Press.
6. Anderson, C.W. (2000). *Transform Teaching in Math and Science.* London: Teachers College Press.
7. Ash, D & Kluger- Bell, B. (2000). *Inquiry thoughts views and strategies for K-5 classroom.* New York: MacGraw Hill.
8. Bera. (2004). *Revised Ethical Guidelines for Educational Research*. British Educational Research Association.
9. Blatchford, P., Goldstein, H., Martin, C., & Browne, W. (2002). *A Study of Class Size Effects in English School Reception Year Classes, British Educational Research Journal, 28, (2).*
10. Cuevas, P., Lee, O., Hart, J., & Deaktor, R. (2005). Improving Science Inquiry with Elementary Students of Diverse Backgrounds. *Journal of Research in Science Teaching*, 42, 3, 337-357.
11. Dehraj, M. A., & Hussain, S. (2024). Integration Of Artificial Intelligence (AI) To Revolutionize The Learning Opportunities: A. *Migration Letters*, *21*(S14), 283-289.
12. Dowell, J.C., Short, J.B., & Landes, M.N. (2002). Curriculum reforms, Professional Development and Powerful Learning. In R.W. Bybee (Ed). *Learning science and science of learning. (pp.121-136).* Arlington, VA: NSTA Press.
13. Dyasi, H. (2000). *Inquiry thoughts views and strategies for K-5 classroom.* New York: MacGraw Hill.
14. Fast, J., & Harbor, J. (2007). Teaching and learning about inquiry: Insights and challenges in Professinal Developmen. *Journal of science Teacher Education, 18, 63-89.*
15. Gress-Newsome, J. (2002). The use and impact of explicit instructions about the nature of science inquiry in an elementary science method course. *Science and Education,* 11, 55-67.
16. Gutek, G. L. (2007). George S Count and social issues. In S. Totten. & J. Pedersen. (Eds.) (2007). *Addressing social issues in the classroom and beyond* (pp. 31-49). Chicago: Information Age Publication.
17. Halai, N. (2002). Science teacher education: A wonderful journey around the world. *Canadian Journal of Science. Mathematics and Technology Education*. *2*(4).
18. Hartland, C. (2006). Inquiry- based learning: Why? Where? How? *Reflecting Education*, *2(*1), 5-18.
19. Hofstein, A., Shore, R, &, Kipnis, M. (2004). Providing high school Chemistry students with opportunity to develop learning skills in an inquiry type laboratory: A scase study, *International Journal of Science Education, 26(1), p. 47-62*
20. Hoxby, C.M. (2000). The Effects of Class Size on Student Achievement: New Evidence from Population Variation, *The Quarterly Journal of Economics, 1-47*.

21. Hussain, S. (2024). The Multifaceted Impact of Academic Pressure on the Mental Health and Well-being of University Students in Pakistan: Exploring the Interplay of Systemic Factors, Individual Vulnerabilities, and Coping Mechanisms. *International Research Journal of Education and Innovation*, *5*(2), 8-14.
22. Hussain, S., Fakhar-Ul-Zaman, D. B. K., Kanwal, M., Hussain, T., Nawaz, I., & Thaheem, M. I. (2024). TPACK and ICT, the new hope for Pakistan's education system: analysis of the perception of prospective teachers. *Remittances Review*, *9*(2), 743-754.
23. Jan, A. A. (2003) *Developing students' understanding about nature of science through specially designed hand-on activities*. Unpublished Master's thesis of the Aga Khan University, Institute for educational Development. Karachi, Pakistan.
24. Jone, M.T& Eick, C.J. (2007). Providing Bottom-Up Approach to the Middle School Science Teachers Reform Effort in Using Inquiry-Based Kits. *Journal of Science Teacher Education, 18:913-934*
25. Jones, M.T. (2007). Providing Bottom-Up Approach to Middle School Science Teachers' Reform Effort in Using Inquiry-Based Kits. *Journal of Teacher Education 18: 913-934.*
26. Kai Wu, H & En Hsieh, C (2006) Developing Sixth Graders' Inquiry Skills to Construct Explanations in Inquiry-based Learning Environments. *International Journal of Science Education. 28(11) 15, pp. 1289–1313*
27. Kember, D. (2000). *Action learning and action research*. London: Kogan Page.
28. Kemmis, S., McTaggart, K., & Retallikck, J. (2004). *The Action Research Planner (2nd Ed. Revised).* Karachi: Aga Khan University-Institute for Educational Development.
29. Melear, C.T., laxon, G.D., Warne, T.R, & Hickok, L.G. (2000). Teaching pre service teachers how to do science: Response to research experience, Journal of science teacher education, 11, 77-90.
30. Ministry of Education Curriculum Wing. (2006). *National Curriculum science for class VI-VIII*. Islamabad: Government of Pakistan.
31. Morrison, J.A. (2008). Individual Inquiry Investigation in an Elementary Science Method Course, Journal of Science Teacher Education 19,117-134.
32. Muhammad, S., Nadeem, M., Hussain, S., & Qahar, A. (2023). Comparison of the Impact of Oral and Written Feedback on the Students' Academic Achievement. *International Research Journal of Management and Social Sciences*, *4*(3), 375-385.
33. Nasim, S. (2003). *Improving classroom practices through curriculum enrichment.* Unpublished dissertation in Master of Education. Aga khan University- Institute of Professional Development Karachi, Pakistan
34. National Research Council (2000). *National Science Education Standards* (Washington, DC: National Academy Press.
35. Newby, D.E. & Higgs, P. L. (2005). Using Inquiry to teach social studies. *The Chatter Schools Resource Journal*, *1* (1), 20-31.
36. Panah, K. (2000). *Teaching and learning school science through the medium of English in Pakistan.* Unpublished Master's thesis of the Aga Khan University, Institute for Educational Development. Karachi, Pakistan
37. Rankin, L. (2000). *Inquiry thoughts and strategies for K-5 classroom.* New York: MacGraw Hill.
38. Simson, S. (2000). Scientific attitude toward science. In M, Monk &J, Osborne (Eds.), Good Practices in Science teaching What research has to say (pp.100-109). Buckingham: Open University Press.
39. Sindhu, S., Khan, R. M. A., & Hussain, S. (2023). Enhancing English Learning through Technology: Assessing the Role of Technological Tools in Advancing Outcomes-Based Education within the

English Access Micro Scholarship Program. *International Research Journal of Education and Innovation*, *4*(4), 29-44.

40. Siraj, S (2002). *Inquiry in science classrooms.* Unpublished master thesis, The Aga Khan University Institute for Educational Development, Karachi.
41. Social Development in Pakistan-Annual Review 2002-03. The state of Education by Social Policy Development centre(SPDC)
42. Taitelbaum, D., Naaman, R. M., Carmeli, M., & Hofstein, A. (2008). Evidence for Teachers' Change While Participating in a Continuous Professional Development Programme and Implementing the Inquiry Approach in the Chemistry. *International Journal of Science Education. 30, 593-617.*
43. There, H.D & Daviss, B. (2001). *Developing Inquiry-Based Science Materials: A Guide for Educators.* New York: Teacher College Press.
44. Trowbridge, W., Bybee, R., & Powell, C.J. (2000). *Teaching Secondary School Science Strategies for Developing Scienctific Literacy. New Jersey: Prentice Hall.*
45. Venvill, G., & Vaille, D. (2000). *The Art Book of Teaching Science: The Nature of Science and Scientific literacy*. Australia: Allen & Unwin Press.
46. Ward, H., Roden., J., Hewlett, C., &, Foreman, J. (2005). Teaching Science in the primary classroom: A Practical Guide. UK Open University Press.
47. Wazir, N. (2004). *Research Ethics: Significance and Obligation to the Practice of Research.* Journal of Ethical Research. 7(1, 2).
48. Wee, B., Shepardson, D., Fast, J., Harbor. J (2007) Teaching and Learning about Inquiry: Insight and Challenges in Professional Development, *Journal of Science Teacher Education, 18:63-86*
49. Wenning, C.J. (2005). Levels of inquiry: Hierarchies of pedagogical practices and inquiry processes. *Journal of Phys Educ Online, 2(3)*
50. Windschitle, M. (2002). Inquiry Projects in Science Teacher Evaluation: What Can Investigative Experiences Reveal About Teacher Thinking and Eventual Classroom Practice? *Science teacher Education*, 87(1), 112-143.
51. Zafar, A., Mannan, T., & Hussain, S. (2024). Knowledge, Attitude and Behavioral Components of Environmental Literacy: Perceptions of Prospective Teachers for Quality Education in Lahore. *Journal of Education and Educational Development*, *11*(1), 95-118.
52. Zion, Cohen & Amir (2007). The Spectrum of Dynamic Inquiry Teaching Practices. Research in Science Education, 37:423-443.