GSJ: Volume 9, Issue 3, March 2021, Online: ISSN 2320-9186
www.globalscientificjournal.com

Identification of the combination of microteaching skills best fitted to the highly accepted class to the students of elementary science in secondary level.

Dr. Md. Didar Chowdhury
Assistant Professor, Physics
Govt. Teachers' Training College, Sylhet
chowdhurymddidar@gmail.com

ABSTRACT

This study is an investigation to explore the extent of integrating ICT in teaching and learning in science in secondary schools of Bangladesh. In the present study, the aim of this action research was to make the science education more effective. The research was planned in two cycles. The first cycle consisted of identifying the problems, developing and implementing the action plan, gathering and analyzing the data, and evaluation. The participants of this first cycle were 10 students, 05 observers and a researcher. The first cycle was started with an identification of the existing problems. In order to address the problems encountered in the field, an action plan, including ICT integrated POE strategy, was developed and implemented. To evaluate the effectiveness of the implementation, quantitative (achievement tests) and qualitative (interviews and observations) data were collected and analyzed. The results revealed that the first cycle of this action research will be used in developing an action plan for the second cycle. Statistical findings indicated that the ICT integrated POE strategy was effective in abstract content (understanding, analysis, and application) of Science for 10^{th} grade of students. In this study researcher create an atmosphere so that students became competent to think critical. In addition, the information presented in this study will help to take bold new steps to utilize and integrate ICT more intensively in Science Education in Bangladesh.

Keywords: Microteaching, ICT, POE, TPACK Framework, ICT integrated POE, Action Research

Introduction

Microteaching

Microteaching is considered as one of the most effective tools in bridging the gap between theory and practice (Sharmini Ghanaguru et al., 2013). The art of teaching is highlighted in microteaching by constant practicing in producing quality presentation which serves as a guide for students and teachers to plan and execute their lessons. However, there is concern over the impact lectures have on student teachers regarding ways of teaching (Francis, 1997). Science teachers have a strong influence on what student learn there is a need to look at ways microteaching is approached by educators (Sanders& Rivers, 1996). Most researchers agree that microteaching is an effective method to be applied in the pre-service and in-service stage in the professional development of teachers (Allen & Ryan, 1969). It is considered as a training concept scale down into selected teaching skill under a carefully controlled condition (Cruiekshank, et all., 1996; Sadker&Sadker 1972; Meier, 1968). It is also viewed as a pre-induction, booster or reinforcement involving hands-on and minds-on experiences. Others perceive microteaching as a valuable instructional tool that mediates between theory and practice (Benton-Kupper, 2001; Wahba, 1999). Appropriateness and combination of microteaching skills related to content presentation of elementary science is the main target of conducting this action research.

Integration of ICT in education

ICT has a key role to play in enhancing teaching, learning and assessment practices for teachers and students in schools. We have seen that teachers and schools are constantly engaged in enhancing how they teach, how their students learn and how learning is assessed. An essential part of this continuous improvement, in how we enable students to learn effectively, must be to further embed ICT into our education system at all levels.
It is recognized internationally that meaningful ICT integration can be challenging to achieve and that schools need guidance and support to achieve it. All too often schools are not clear as to what ICT integration looks like and therefore are unsure how they can achieve it. The Strategy will provide advice and guidance for teachers and schools, including examples of good practice on the use of ICT for teaching.

Generally, the following functions of the use of ICT in education are described in literature (SER, 1998, Moonen and Kommers, 1995, Pilot, 1998).

1. ICT as object. It refers to learning about ICT. Mostly organized in a specific course. What is being learned depends on the type of education and the level of the students? Education prepares students for the use of ICT in education, future occupation and social life.
2. ICT as an ‘assisting tool’. ICT is used as a tool, for example while making assignments, collecting data and documentation, communicating and conducting research. Typically, ICT is used independently from the subject matter.
3. ICT as a medium for teaching and learning. This refers to ICT as a tool for teaching and learning itself, the medium through which teachers can teach and learners can learn. It appears in many different forms, such as drill and practice exercises, in simulations and educational networks.
4. ICT as a tool for organization and management in schools.

Wang and Woo (2007, p.149) state that “integration of ICT in education is basically a tool”. In the educational context they claim that it mainly refers to various computer-based resources and tools (software). Other researchers view the integration of useful tools that facilitate the link to various learning communities together in new and different ways (Taylor, 2000). The integration of ICT in teaching and learning is a complex process. Various competencies must be developed throughout the education system for ICT implementation and integration to be successful.

The SITES- M3 study (Plomp, Pelgrum & Law, 2007) reports that the incorporation of ICT in teaching and learning in schools is influenced by a number of factors external to the school, such as the visions and prescriptions that are reflected in the national curriculum and national policies on ICT in education.

However, how ICT is integrated in teaching and learning depends within schools on factors amongst others such as (a) vision on education or the teaching/learning process, (b) knowledge and skills of the teachers, (c) availability of content (educational software) and (d) the hardware infrastructure (Abdel Rahman Mohamed Ahmed Ali, Sara Howie Jane & Izzeldin Mohamed Osman, 2013).

There is growing evidence that “digital technologies change the way students learn, the way teachers teach, and where and when learning takes place” (21st Century Learning Reference Group, 2014; p.4) (Department of Education and Skills, 2012). There is widespread understanding that learning today needs to entail more than knowledge-acquisition; there needs to be an equally strong emphasis on skill-development, particularly 21st century skills or Key Skills (Department of Education and Science, 2008)

Learners need “more open-ended learning experiences that develop the learners’ higher-order thinking, creativity, independence, collaborating and ownership of learning” (Department of Education and Skills, 2013; p.20) (Department of Education and Science, 2008).. When ICT is used effectively, it can provide opportunities for all teachers, students and parents/guardians to develop these Key Skills. ICT has a key role to play in enhancing teaching, learning and assessment practices for teachers and students in primary and post-primary schools.

Effective use of digital technology is associated primarily with constructivist approaches to teaching. Where constructivist teaching approaches are used, learning experiences often include the following features:

- ✓ Engagement with the learner’s prior understanding.
- ✓ Active involvement of the learner in the learning process.
- ✓ Opportunities for the learner to make decisions that affect the subsequent course of the learning activity.
- ✓ A high level of interaction and exchange of ideas between learners.

Some researchers asserted that the classroom atmosphere can sometimes be insufficient with respect to gathering data (Lee & Songer, 2003; Uçar & Trundle, 2011). In such cases, the use of technology in the learning process visualizes the lesson, simplifies the teacher's work, and helps to broaden the students' perspectives (Bozdoğan, 2011). The use of technology helps students transfer their existing knowledge to new situations by strengthening the connection among the independent piles of knowledge in their mind, and includes them in the teaching process (Novak & Krajick, 2006).

TEACHER KNOWLEDGE

Teachers require a wide range of knowledge in order to embed ICT effectively into their practice. The Technological Pedagogical and Content Framework (Wang, Q. and H. L. Woo, 2007) better known as TPACK, was developed by Mishra and Koehler (2006) to describe the levels of knowledge a teacher requires in order to integrate ICT into their professional practice. It describes the three types of knowledge required by a teacher for effective pedagogical practice in a technology enhanced learning environment (Figure 1).

- ✓ Teachers need a mix of technological knowledge (TK) so they can use ICT effectively.
- ✓ Teachers need to have a deep knowledge of the curriculum content they are teaching (CK).
- ✓ Teachers require pedagogical knowledge in order to teach their subject area (PK).

Equally important to the model are the interactions between these bodies of knowledge. When teachers effectively integrate these areas of knowledge, they can embed ICT effectively into their practice.

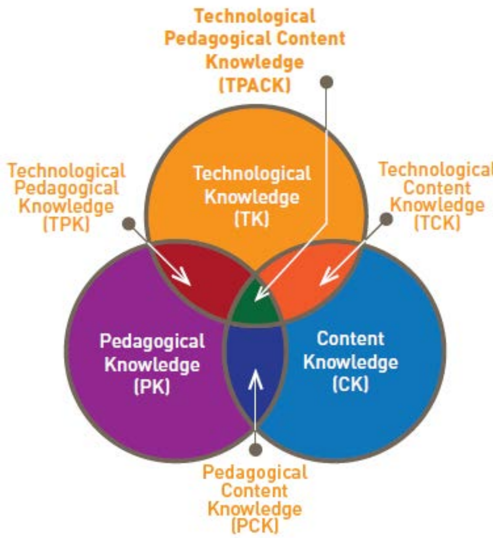


Figure-1: TPACK Framework

In a research on **Problems and Prospects of Science Education in Bangladesh** S. K. Choudhury, *Department of Physics, University of Dhaka, Dhaka* stated "The state of science teaching in schools and colleges in Bangladesh is far from satisfactory. Once the most sought-after subject at secondary, college, and university levels in the country, science is losing its appeal in an alarming shift of choice. Qualified teachers and properly equipped laboratories are few and far between and could hardly be found in most of the schools. The teaching methodology and teachers cannot inspire the serious and meritorious students to take up science for their higher studies. As a result, enrollment in secondary and postsecondary science has steadily fallen over the last 10 years. This is alarming. If we cannot stop this trend, we will very soon be facing a situation where science and scientific enterprises in our country will be seriously jeopardized, leaving us as a nation of traders." (S. K. Choudhury, 2009).

POE

The use of a constructivist teaching approach (POE) encouraged participant teachers to change their teaching perceptions which had been based on a traditional (didactic) approach. These teachers' experiences of using the POE approach guided them in changing their views about collecting and using teaching aids in their practice. The collaborative activities amongst their colleagues within and across the schools helped them to re-examine and reconstruct their understandings of teaching and its relationship to student learning (S M HAFIZUR RAHMAN, 2012).

Predict-Observe-Explain (POE) is a teaching strategy that probes understanding by requiring students to carry out three tasks. First the students must predict the outcome of some event and must justify their prediction; then they describe what they see happen; and finally they must reconcile any conflict between prediction and observation.

Through POE strategy a teacher can create an atmosphere of inquiry and critical thinking in the science classroom (Perver, S., 2015).

Aims and Problems

The main objectives of the study are:

1. To identify the prevalent microteaching skills used by the teacher in the teaching of elementary science.

2. To justify the appropriateness of microteaching skills used in specific science classes of VI to X.

Under these objectives this study aimed to examine whether technology-supported POE techniques have an effect on secondary school students' understanding science subjects especially abstract contents, scientific skills, and views. In accordance with this aim, the primary research question of this study is: "What are the effects of technology-supported POE techniques on secondary school students' science course achievements, scientific research skills, views and perceptions towards scientific research-questioning and technology?" The sub-questions are as followed:

(1) How does the ICT integrated POE technique affect 10th grade students' achievement in science classes?
(2) What are the participants' views on the new learning environment?
(3) How does the ICT integrated POE improve the critical thinking ability of students?

Method
Research Design

Action research unifies the process of developing theory and practice (Barret, 2011). Action research is often conducted to bring about change in practice, while generating new knowledge at the same time. These combined characteristics make it useful in bringing about improvement of practice, or to propose new solutions to practical problems. "A spiral step" action research model of Kurt Lewin will be followed to conduct this action research work. According to Kurt Lewin's "a spiral step" each of which is "composed of a circle planning, action and fact-finding about the result of the action". The diagram of spiral model by Kurt Lewin is given below:

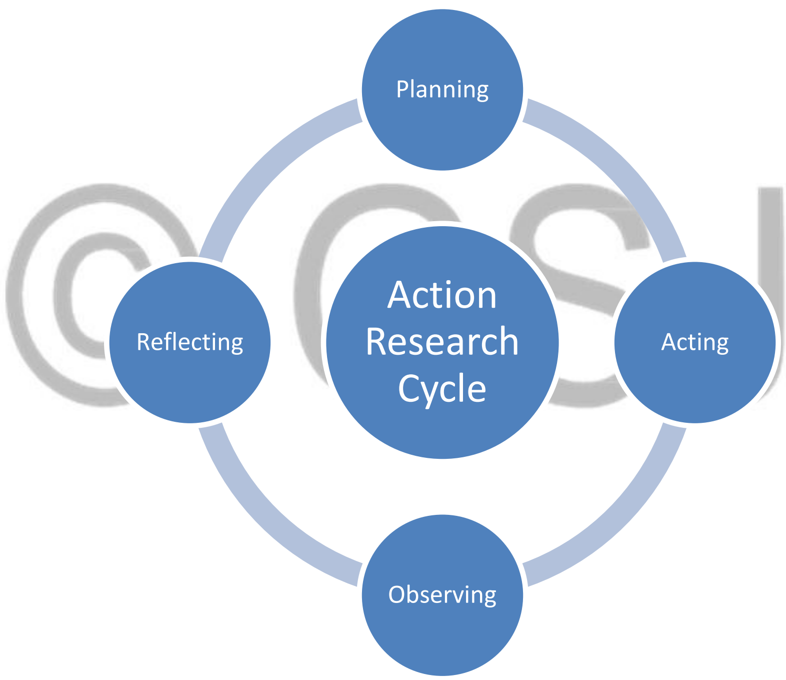


Figure-2: Spiral model by Kurt Lewin

Action research is critically reflective and cyclic. Reflection based on experiences of action is a fundamental part of each cycle. The action research cycles function like mini experiments in practice. In each cycle, the result indicates whether or not what was intended worked or if it needs to be changed (Coolican, 2009; Williamson, 2002).

This study was designed as an action research to combine theory and practice to increase the quality of the learning process. Action research is a systematic type of research conducted by teacher researchers to gather data regarding the activities they carry out at their schools, how they teach, and how students learn better (Mills, 2007, p.5).

The following steps were taken in process:

Steps 1 (**Identifying problems**):

The study started with the identification of existing problems.
When Researcher's Teacher took a class on abstract content like **"Semiconductor and its biasing"** and evaluated the students using **Questions Evaluation (Appendix A**), evaluation was not satisfied.
The problems that the teacher identified based on experience can be listed as followed:
(a) The content discussed in the class was abstract
(b) There have not enough lab facilities to do experiments
(c) Lecture based class and the lack of motivation in students,
(d) The methods and techniques that proposed in the curriculum not being applied effectively to enhance student outcomes,
(e) Used textbooks only in class and could not easily observe and understand
(f) The students' interest level doing activities in science classes being low
(g) Deficiencies in the students' thinking skills about abstract content of physics,
(h) Misconception about the content that should be clear

Steps 2 (Developing an action plan):

The problems that encountered in this research and researcher's interest and related literature about the problem were taken into consideration in developing action plan. To be able to eliminate the problems encountered, the Predict-Observe-Explain (POE), one of the learning approaches, was supported with technology and the lesson plans were prepared properly to the topics. For abstract content the researchers used ICT integrated "Observation" in this study and giving it a new name "ICT integrated POE".

Prediction

Students are asked to predict what will happen if a particular change is made in a situation or question. Students need to be given an environment to think so that they can make predictions. And remember that Accurate guessing is not effective at all. The prediction phase can have two parts. First, the student selects a prediction, and second, selects a likely reason.

ICT integrated "Observation"

At this stage the observation through demonstration is an important component and is carried out carefully so that the students observed the results very well. One of the predicted results may be correct or all may be correct or partially correct or none of them may be correct. For observation here researcher used digital content with PowerPoint Presentation slide.

The digital content used in this study on the "Observation" phase included the animations, simulations, videos, and gifs either developed or found by the researcher on the internet.

The explanation

Deep and mindful thinking is important in explanation. Explanation helped the student in explaining any discrepancy between what was predicted and what occurred. Whether there is a gap between the predicted results and the observations and if there is a gap, what kind of gaps there are and how the gaps can be resolved is discussed at the explanatory stage. The explanation was written on the computer screen and on white board. After proper explanation researcher takes some initiatives to understand their knowledge and skills-

(a) To follow the students' level of understanding during the process, **Digital Content** and **Questions Evaluation (Appendix A**) were used.

(b) To know how the students'/teachers' views and attitudes towards ICT integrated POE, interview questions developed by the researcher based on expert opinion **Appendix B and C** were used.

The interviews were conducted with all the students (N=10) participating in the study and the observer-teacher (N=5) after the class finished.

(c) Activities were developed to follow how the students' abstract knowledge and skills changed.

(d) The teacher and the students were instructed to keep journals to reflect on their feelings and opinions on the learning atmosphere at the end of the last 10 minutes of the lesson.

Steps 3 (**Implementing the action plan**) and **Steps 4** (**Gathering the data):**

The first cycle of the action research was carried out in January 2020. The unit "**Semiconductor and its biasing**" was covered in between the months February-March 2020. The action plan was implemented during that time and the data was gathered.

The analysis and evaluation of the data which was the **Steps 4** of this study were discussed in the "Results" section below.

Participations

The participants of the study were a Teacher Educator-the conductor of the study, and 15 B.Ed. students/trainees. Here 10 trainees acted as students and rest 05 trainees were present as observers-teachers. This study was conducted with B.Ed. students/trainees to see to what extent they were able to apply the ICT integrated POE technique. At the beginning of the study, the students/trainees were asked for their consent.

Data Collection Tools

During the study, the focus was on examining the suitability of the data gathering tools for the study. Achievement tests and questionnaires was used as a data gathering tools.

To evaluate the students'/trainees' level of achievement, achievement tests were developed for the units "**Semiconductor and its biasing**". The "**Semiconductor and its biasing**" test contained 10 questions.

Interviews were conducted through questionnaire to identify the students'/ trainees' views and perceptions towards technology-supported teaching techniques. The opinions of two faculty members were asked to ensure the validity of the interview form developed by the researcher, and revisions were made. In the semi-structured format, 06 questions were prepared for students and 07 questions were prepared for teachers.

2.4 Data Analysis

The data obtained from the achievement tests were calculated using MS Excel.

The data obtained from the interviews on the students'/teachers' perceptions towards views and perceptions towards ICT integrated POE teaching techniques were analyzed with the help of computer, basic statistical tools were used to analyzing data.

3. Results

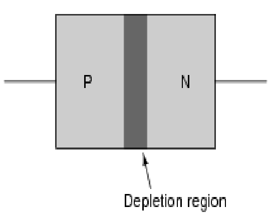
This section is also the **Step 4** (Analyzing and evaluating data) in the action research. In addition to solving the problems, the following results were revealed:

Table-1: Achievement tests

Questions	Normal Class, N=10	ICT Integrated POE Class, N=10	Mean, $\dot{x}$	Sample Standard Deviation for percentage,
	(first cycle)	(second cycle)		

	Correct answer	%	Correct answer	%		s
1. Holes in n-type materials are called	6	60	10	100	80	28.28
a) majority carriers						
b) minority carriers						
c) medium carriers						
d) zero carriers						
2. Process in which conductivity of semiconductor can be drastically increase by adding controlled impurities to intrinsic semiconductor is called	7	70	10	100	85	21.21
a)doping						
b)attenuation						
c)excitation						
d) toxicity						
3. A P-N junction diode offers least resistance when:	5	50	9	90	70	28.28
a) is reversed biased						
b) is doped						
c) **is forward biased**						
d) has high barrier potential						
4. During forward bias:	5	50	10	100	75	35.36
a) **Anode connects to p-side**						
b) Anode connects to n-side						
c) Anode is grounded						
d) Cathode connects to p-side						
5. When a physical contact between a p-region & n-region is established which of the following is most likely to take place?	3	30	8	80	55	35.36
a) Electrons from N-region diffuse to P-region						
b) Holes from P-region diffuse to N-region						
c) **Both of the above mentioned statements are true**						
d) Nothing will happen						
6. Which of the following is true in case of an unbiased p-n junction diode?	3	30	8	80	55	35.36
a) Diffusion does not take place						
b) Diffusion of electrons & holes go on infinitely						
c) There is zero electrical potential across the junctions						
d) **Charges establish an electric field across the junctions**						

GSJ: Volume 9, Issue 3, March 2021
ISSN 2320-9186

7. Which of the following is true in case of a forward biased p-n junction diode? a) **The positive terminal of the battery sucks electrons from the p-region** b) The positive terminal of the battery injects electrons into the p-region c) The negative terminal of the battery sucks electrons from the p-region d) None of the above mentioned statements are true	3	30	8	80	55	35.36
8. When the diode is forward biased, it is equivalent to a) An off switch b) **An On switch** c) A high resistance d) None of the above	6	60	10	100	80	28.28
9. What happens to the thickness of the depletion region in a PN junction when an external voltage is applied to it? Ans. The answer to this question depends entirely on the polarity of the applied voltage! One polarity tends to expand the depletion region, while the opposite polarity tends to compress it.	2	20	8	80	50	42.43
10. The dark shaded area drawn in this cross-section of a PN junction represents the depletion region:	5	50	10	100	75	35.36
						
Re-draw the depletion region when the PN junction is subjected to a reverse-bias voltage:						

In the first cycle there were no significant gains on understanding, however, there were much significant gains in the second cycle in students' perceptions of their understanding. This is because after the first cycle, the researcher adopted the ICT integrated POE technique in his daily teaching prior to the second cycles. It is showed that using ICT integrated POE strategy in learning abstract concept of Physics improved student's achievement.

It is found that students who had not full understanding about "Semiconductor and its biasing" in first cycle (**using Lecture with Brainstorming technique**), showed better and deeper understanding in the second cycle (using ICT integrated POE strategy).

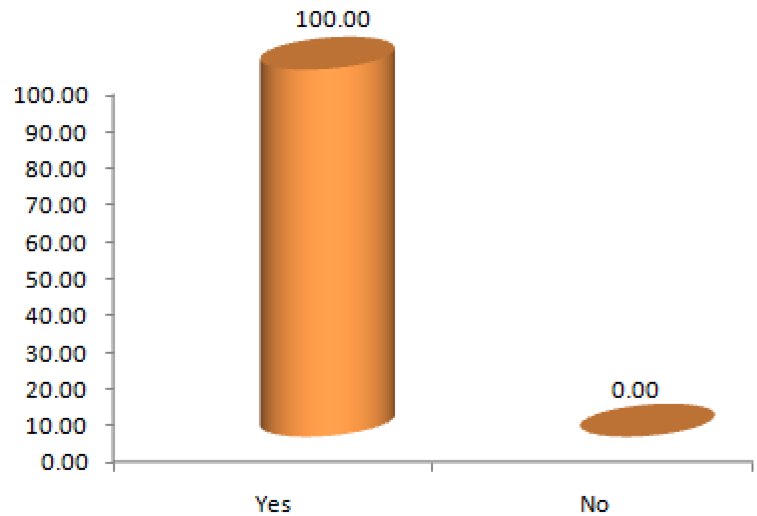


Figure-3: : Do you think teachers should use technology in their teaching?

From **Figure 3**, we see 100 % of the students think that teachers should use technology in their teaching because it made the lesson interesting (**Table-1,2**).

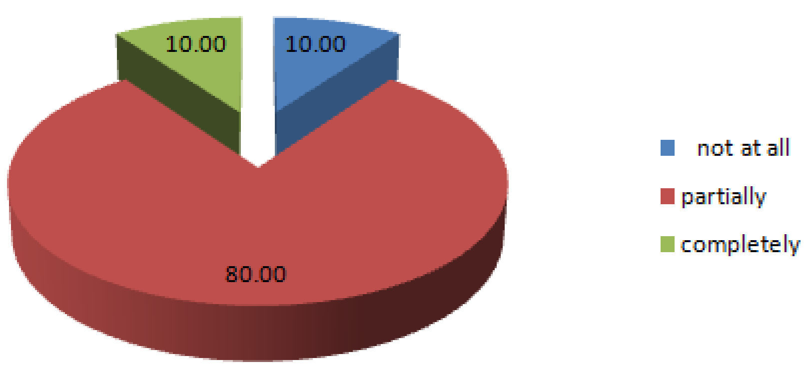


Figure-4: Does Lecture method with Brainstorming technique help students completely?

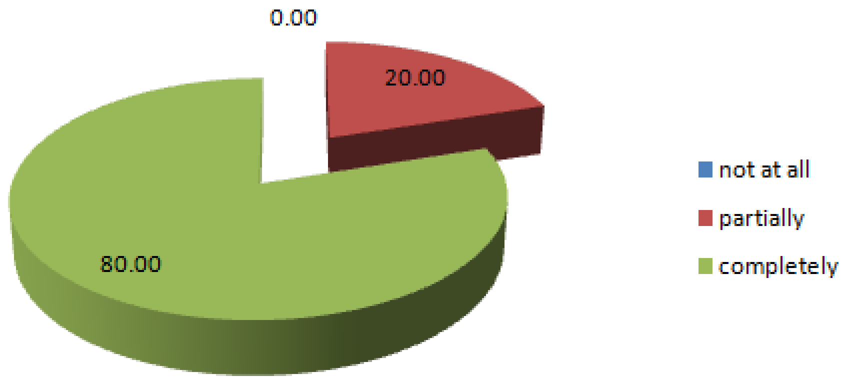


Figure_5: Does ICT integrated POE help students completely?

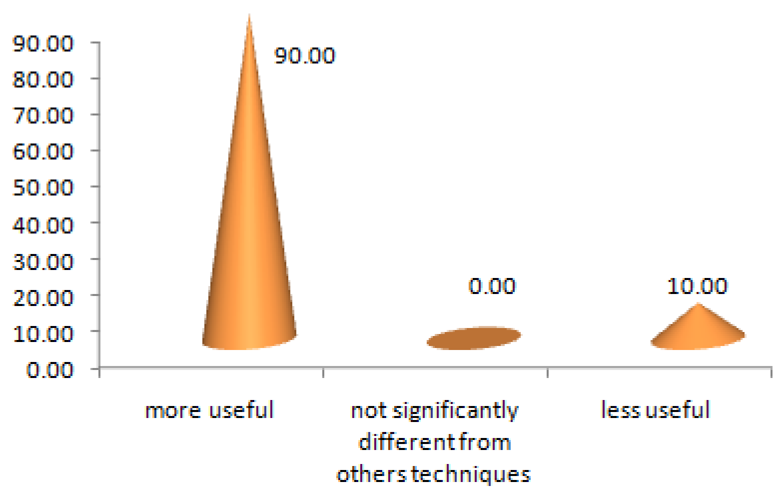


Figure-6: How ICT integrated POE useful?

To get a better understanding of students' perceptions about ICT integrated POE teaching-learning technique, researcher set a 5-point Likert scale in questionnaires **B and C**. The response options were a range from (5) strongly agree, (4) agree, (3) neutral, (2) disagree, and (1) strongly disagree. The highest mean indicated the strongest agreement of all participants, where scores higher than 3 were more towards agreement.

In **Table-2**, the opinions were mostly positive for categories 1 to 4 and strongly disagree for the categories 5 to 8 and, in general, most responses were in agreement or strong agreement with the statements given. **Table-2** has detailed information of the mean for each item.

Table-2: In ICT integrated POE: N=10

CATEGORIES	Strongly Agree 5	Agree 4	Neutral 3	Disagree 2	Strongly Disagree 1	Mean Score
1. Reduced learning time	7	1	1			4.2
2. Increased our participation in teaching-learning	7	2	1			4.6

3. Increased our attention in classroom	7	2		1		4.5
4. Reduced stress and increased satisfaction	7	2		1		4.5
5. Activities do not help us understand concepts easily.			1	2	7	1.4
6. We feel bored in our Science class			1	2	7	1.4
7. The content present in the class difficult to understand.		1		2	7	1.5
8. We don't understand the process our Science teacher explains the lesson			1	1	8	1.3

For abstract contents or concepts of Physics where demonstration of the contents do not possible or not easy to observe, Lecturer method with Brainstorming technique don't help students completely to understand (**Figure-4, 9**). But according to the view of students (trainees act as students) and observer-teachers (who observed the class), ICT integrated POE helped the students completely to understand the concepts (**Figure-5, 6, 10, 11**)

ICT integrated POE is beneficial and useful to learners for learning abstract concept easily and quickly in Physics. According to the view of students (trainees act as students) and observer-teachers (who observed the class) ICT integrated POE reduced learning time, increases students' noticeable participations in teaching-learning ((**Table-2, Table-3**), increased students' attention in class (**Table-2, Table-3**) and helped to reduce stress and increased satisfaction in learning (**Table-2, Table-3**). It is observed that ICT integrated POE strategy not only useful in enhancing conceptual understanding but also useful to enhance motivation, interest and participation in learning (**Table-2, Table-3**).

In response to the statement "Activities don't help students understand concept easily", students and observer-teachers both strongly disagreed with this (**Table-2, Table-3**) and they did not think that students felt boring in their Science class (**Table-2, Table-3**). They also disagreed with the statement "The content present in the class difficult to understand" (**Table-2, Table-3**) and "Students don't understand the process their Science Teacher explains the lesson" (**Table-2, Table-3**)

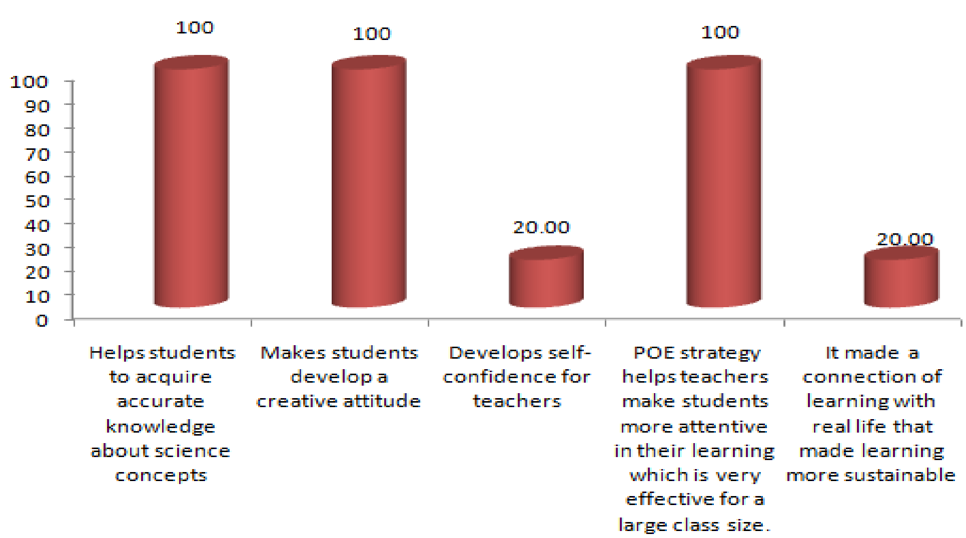


Figure-7: Why should Teachers use ICT integrated POE in their classrooms?

100% of the observer-teachers thought that ICT integrated POE helped students to acquire knowledge about science concepts, make able to develop creative attitude and this strategy helped teachers make students more attentive in their learning which was very effective for large class size (**Figure-7**). Most of the observer-teachers also agreed that they would use it to teach the abstract content of Physics (**Figure-8**).

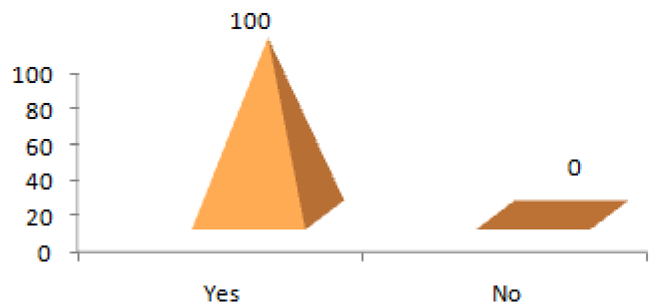


Figure-8: If ICT integrated POE strategies bring to Teachers, Do teachers use it to its full potential to teach?

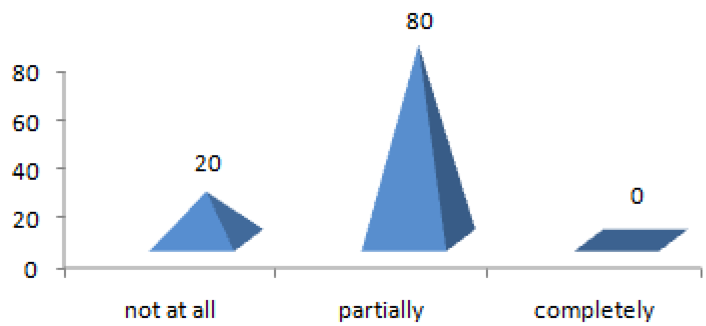


Figure-9: Does Lecture method with Brainstorming technique help teachers completely?

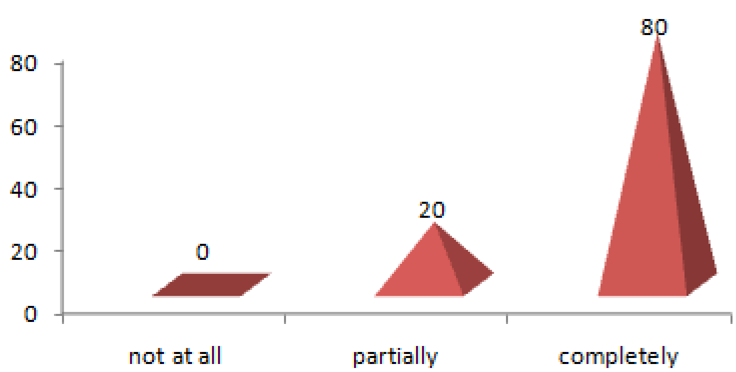


Figure-10: Does ICT integrated POE help students completely?

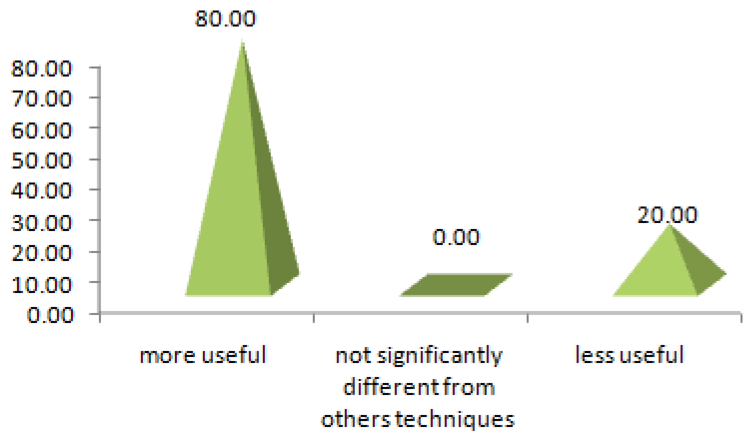


Figure-11: How ICT integrated POE useful?

In **Table-3**, the opinions were mostly positive for categories 1 to 6 and strongly disagree for the categories 7 to 10 and, in general, most responses were in agreement or strong agreement with the statements given. **Table-3** has detailed information of the mean for each item.

Table-3: In ICT integrated POE: N=5

CATEGORIES	Strongly Agree 5	Agree 4	Neutral 3	Disagree 2	Strongly Disagree 1	Mean score
1. Reduced learning time	4	1				4.8
2. Increased students participation in teaching-learning	4	1				4.8
3. Increased students attention in classroom	4	1				4.8
4. Reduced stress and increased satisfaction	3	2				4.6
5. Developed thinking ability	4	1				4.8
6. Made the lesson interesting	3	1	1			4.4
7. Activities do not help students understand concepts easily				2	3	1.4
8. Students feel bored in Science classes			1	1	3	1.6

9. The content present in the class difficult to understand.				1	4	1.2
10. Students don't understand the process we explain the lesson			1	1	3	1.6

Through ICT integrated POE strategy teachers can motivate the students to develop interest in Physics concepts and also help them to develop thinking ability (**Table-3**) and make them able to express their opinion.

4. Recommendation

- In addition, the information presented in this study will help Teacher-Educator as well as secondary teachers to take bold new steps to utilize and integrate ICT more intensively in Science Education in Bangladesh
- the importance of good preparation before taking any class
- Teachers need to be well prepared both in content clarification and using the teaching aids.
- Importance to changes in the culture of Teacher's professional practice and the need to develop an attitude for accepting any new teaching strategies.
- Make materials available so that teachers could continue ICT integrated POE in their teaching.
- ICT integrated POE strategy be used in teaching some contents in Physics that could not observed directly or could not experiment easily in a class or in a lab.

5. CONCLUSIONS

Findings of this research showed that the use of ICT integrated POE teaching methods were effective in improving the abstract knowledge of Science of the learners. Along with the increasing demand for higher education in the country and due to the limited capacity of lab and science instrument, ICT integrated POE teaching methods is a perfect solution. However, it should be noted that any new program requires careful planning, management and evaluation in all aspects.

Acknowledgement

Researcher expresses a deep gratitude to Professor Misbahuddin Ahmed, Principal and Mr. Chowdhury Mamun Akbar, Vice Principal, Govt. Teachers' Training College, Sylhet for their valuable cordial support and suggestions during this study. Thanks TQI-II, DSHE, Dhaka for their financial and logistic support to perform the research. Researcher also expresses gratitude to Mr. Abul Kalam Azad, Research Fellow, SUST, Sylhet for his support during the research.

References

1. Abdel Rahman Mohamed Ahmed Ali, Sara Howie Jane, Izzeldin Mohamed Osman (2013). The Integration of ICT in Teaching Science and mathematics in Secondary Schools: with particular reference to SUDAN, Proceedings of the 2nd e-learning Regional Conference –State of Kuwait, 25-27 March 2013-01-13
2. Barret, T. (2011). Breakthroughs in action research through poetry. *Educational Action Research*, *19*(1), 5-21.

3. Benton-Kupper, Y. (2001). The microteaching experience: Student perspectives. Education, 121(4), 830-835.
4. Department of Education and Skills (2012). "Chief Inspector's Report 2010 -2012." Retrieved September, 2015, from http://www.education.ie/en/Publications/Inspection-Reports-Publications/ Evaluation-Reports-Guidelines/Chief-Inspector's-Report-2010-2012-Main-Report.pdf
5. Plomp T., Pelgrum J., & Law N. (2007). SITES2006- international comparative survey of pedagogical prac-tices and ICT in education. Journal of Education and Information Technology, 12, 83-92.
6. Allen, D.W., & Ryan, K. A. (1969). Microteaching. Reading, Mass: Addison Wesley.
7. Bozdoğan, A. E. (2011). The Effects of Instruction with Visual Materials on the Development of Preservice Elementary Teachers' Knowledge and Attitude towards Global Warming. TOJET: The Turkish Online Journal of Educational Technology, 10(2), 218-233. Retrieved from http://files.eric.ed.gov/fulltext/EJ932241.pdf
8. Coolican, H. (2009). *Research methods and statistics in psychology*. London, UK: Hodder Education
9. Cruickshank, D.R., Bainier., Metcalf,. K.M & Reynolds, R. (1996). Preparing American Teachers. Bloomington, IN: Phi Delta Kappa Educational foundation.
10. Department of Education and Science (2008). "ICT in Schools: Inspectorate Evaluation Studies." Retrieved September, 2015, from http://www.education.ie/en/Publications/Inspection-Reports- Publications/Evaluation-Reports-Guidelines/ICT-in-Schools-Inspectorate-Evaluation-Studies.pdf.
11. Department of Education and Science (2008). "Investigating Effectively in ICT in Schools, 2008-2013: The Report of the Minister's Strategy Group." Retrieved September, 2015, from https:// www.education.ie/en/Publications/Policy-Reports/Investing-Effectively-in-Information-and-Communication-Technology-in-Schools-2008-2013.pdf
12. Francis, D. (1997). Reconceptualising microteaching as critical inquiry. Asia-Pacific Journal of Teacher Education, 25(3), 207-223.
13. Kemmis, S. & McTaggaet, R. (2003). Participatory action research. In N.K. Denzin & Y. S. Lincoln (Eds.), Strategies of Qualitative Inquiry (2nd ed., pp. 336-396). Thousand Oaks, CA: Sage
14. Lee, H. S., & Songer. N.B. (2003) Making Authentic Science Accessible to Students. International Journal of Science Education 25(1), 1-26.doi:10.1080/09500690305023
15. Meier, J. H. (1968). Rationale for and application of microtraining to improve teaching. The Journal of Teacher Education, 19(2), 145-157.
16. Mills, G. E. (2007). Action Research A Guide for Teacher Researcher, Pearson Merrill Hall, 3rd Edition, Ohio.

17. Moonen, J. & Kommers, P. (1995). Implementatie van Communicatie- en Informatietechnologie in het onderwijs. Enschede: OCTO, University of Twente
18. Novak, A. M., & Krajick, J.S. (2006). Scientific Inquiry and Nature of Science. Implications for Teaching, Learning, and Teacher Education, Science & Technology Education Library, 25.
19. Perver, S. (2015). *Predict Observe and Explain (POE): A teaching strategy for enhancing conceptual understanding of enzymes in grader 9 students in a private school of Karachi, Pakistan* (Unpublished master's dissertation). Aga Khan University, Karachi, Pakistan
20. Pilot, A. (1998). De student als junior medewerker. Utrecht: IVLOS, University of Utrecht.
21. S. K. Choudhury (2009). Problems and Prospects of Science Education in Bangladesh, in The 3rd International Conference on Women in Physics (http://aip.scitation.org/toc/apc/1119/1)
22. Sadker, M., & Sadker, D. (1972). The development of affective skills: New Directions for microteaching. Journal of Humanistic Psychology, 17(4), 59-68.
23. Sanders, W.L., Rivers, J.C. (1996). Cumulative and residual effect of teachers on future student academic achievement Knoxville: University of Tennessee Value-Added Research and Assessment Center.
24. SER (1998). ICT en onderwijs. Den Haag: SER Sociaal-Economische Raad.
25. S M Hafizur Rahman (2012). Influence of professional learning community (PLC) on learning a constructivist teaching approach (POE): A case of secondary science teachers in Bangladesh, Asia-Pacific Forum on Science Learning and Teaching, Volume 13, Issue 1, Article 3
26. Sharmini Ghanaguru, Premalatha Nair & Caroline Yong (2013). Teacher Trainers' Beliefs In Microteaching And Lesson Planning In A Teacher Training Institution, The English Teacher Vol. XLII (2), 104-116.
27. Uçar, S., & Trundle, K. C. (2011). Conducting guided inquiry in science classes using authentic, archived, web based data. Computers & Education, 57, 1571-1582. doi: 10.1016/j.compedu.2011.02.007
28. Wahba, E. H. (1999). Microteaching. English Teaching Forum Online, 37(4).
29. Wang, Q. & Woo, H. L. (2007). Systematic Planning for ICT Integration in Topic Learning. Educational Technology & Society, 10 (1), 148-156.
30. Williamson, K. (2002). *Research Methods for Students and Professionals: Information Management and Systems*. Wagga Wagga, NSW, Australia: Centre for Information Studies, Charles Sturt University.

Appendix A

Achievement tests

No: _____ Date: _______ Class: _________

Name:____

1. Holes in n-type materials are called

a) majority carriers
b) minority carriers

c) medium carriers
d) zero carriers

2. Process in which conductivity of semiconductor can be drastically increase by adding controlled impurities to intrinsic semiconductor is called

a) doping
b) attenuation
c) excitation
d) toxicity

3. A P-N junction diode offers least resistance when:
a) is reversed biased
b) is doped
c) **is forward biased**
d) has high barrier potential.

4. During forward bias:
a) **Anode connects to p-side**
b) Anode connects to n-side
c) Anode is grounded
d) Cathode connects to p-side

5. When a physical contact between a p-region & n-region is established which of the following is most likely to take place?
a) Electrons from N-region diffuse to P-region
b) Holes from P-region diffuse to N-region
c) **Both of the above mentioned statements are true**
d) Nothing will happen

6. Which of the following is true in case of an unbiased p-n junction diode?
a) Diffusion does not take place
b) Diffusion of electrons & holes go on infinitely
c) There is zero electrical potential across the junctions
d) **Charges establish an electric field across the junctions**

7. Which of the following is true in case of a forward biased p-n junction diode?
a) **The positive terminal of the battery sucks electrons from the p-region**
b) The positive terminal of the battery injects electrons into the p-region
c) The negative terminal of the battery sucks electrons from the p-region
d) None of the above mentioned statements are true

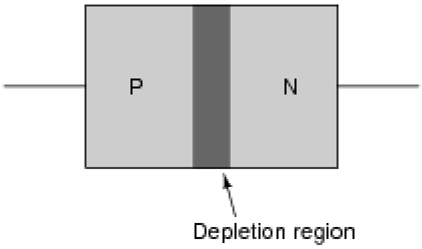
8. When the diode is forward biased, it is equivalent to
a) An off switch
b) **An On switch**
c) A high resistance
d) None of the above

9. What happens to the thickness of the depletion region in a PN junction when an external voltage is applied to it?

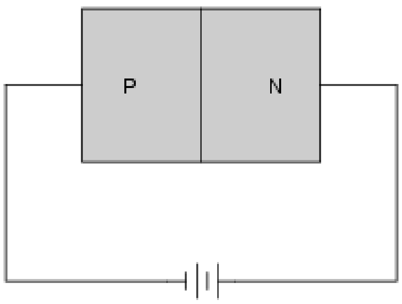
Ans. The answer to this question depends entirely on the polarity of the applied voltage! One polarity tends to expand the depletion region, while the opposite polarity tends to compress it.

GSJ: Volume 9, Issue 3, March 2021
ISSN 2320-9186

10. The dark shaded area drawn in this cross-section of a PN junction represents the *depletion region*:



Re-draw the depletion region when the PN junction is subjected to a reverse-bias voltage:



Appendix B
Questionnaire for Students

No: _____ Date: _______ Class: _________
Name:____

1. Do you think teachers should use technology in their teaching?
   a) Yes
   b) No
2. Does Lecture method with Brainstorming technique help you completely?
   a) not at all
   b) partially
   c) completely
3. Does ICT integrated POE help you completely?
   a) not at all
   b) partially
   c) completely
4. How ICT integrated POE useful?
   a) more useful
   b) not significantly different from others techniques
   c) less useful

5. In ICT integrated POE:

CATEGORIES	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Reduced learning time					
2. Increased our participation in teaching-learning					
3. Increased our attention in classroom					

4. Reduced stress and increased satisfaction					
5. Activities do not help us understand concepts easily.					
6. We feel bored in our Science class					
7. The content present in the class difficult to understand.					
8. We don't understand the process our Science teacher explains the lesson					

6. Any additional comments?

Appendix C

Questionnaire for Observer-Teachers

No: _____ Date: _______ Class: _________
Name:____

1. Why should we use ICT integrated POE in our classrooms?

   a) Helps students to acquire accurate knowledge about science concepts
   b) Makes students develop a creative attitude
   c) Develops self-confidence for teachers
   d) POE strategy helps teachers make students more attentive in their learning which is very effective for a large class size.
   e) It made a connection of learning with real life that made learning more sustainable

2. If this technique brings to you, do you use it to its full potential to teach?

   a) Yes
   b) No

3. Does Lecture method with Brainstorming technique help you completely?

   d) not at all
   e) partially
   f) completely

4. Does ICT integrated POE help students completely?

   d) not at all
   e) partially
   f) completely

5. How ICT integrated POE useful?

   d) more useful
   e) not significantly different from others techniques
   f) less useful

6. In ICT integrated POE:

CATEGORIES	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Reduced learning time					
2. Increased students participation in teaching-learning					
3. Increased students attention in classroom					
4. Reduced stress and increased satisfaction					
5. Developed thinking ability					
6. Made the lesson interesting					
7. Activities do not help students understand concepts easily					
8. Students feel bored in Science classes					
9. The content present in the class difficult to understand.					
10. Students don't understand the process we explain the lesson					

7. Any additional comments?