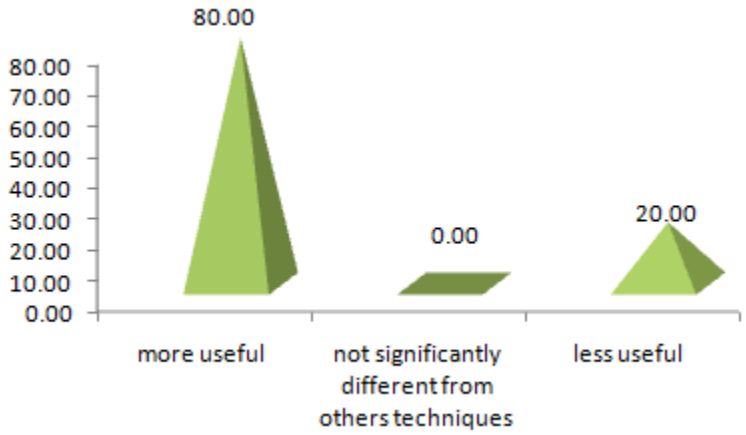

Figure-11: How ICT integrated POE useful?

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.

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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**

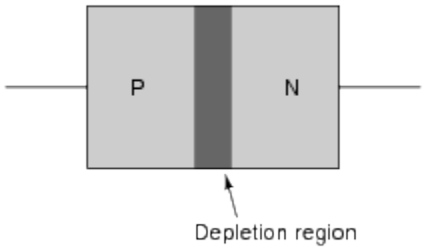
7. Which of the following is true in case of a forward biased p-n junction diode?
a) **The positive terminal of the battery sucks electrons from the p-region**
b) The positive terminal of the battery injects electrons into the p-region
c) The negative terminal of the battery sucks electrons from the 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

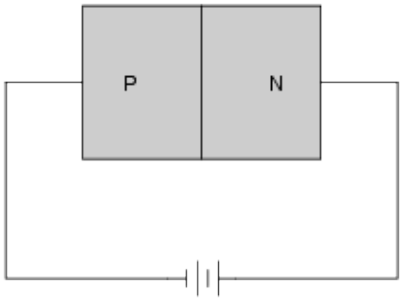
9. What happens to the thickness of the depletion region in a PN junction when an external voltage is applied to it?

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.

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?