January - February 2020
ISSN: 0193 - 4120 Page No. 9528 - 9534

Teaching and Learning Scientific Inquiry through Simulations using 5e Model of Lesson Plan

Ms. Jayati Bhatta charjee
Research Fellow, Amity Institute of Education, Amity University, Noida, India
Dr. (Prof) Alka Muddgal
Professor, Head Amity Institute of Education, Amity University, Noida, India

Article Info
Volume 82
Page Number: 9528 - 9534
Publication Issue:
January-February 2020

Abstract:
The thrust in science education today is more on using Inquiry based learning methods in the classroom in order to increase scientific literacy among students. This paper presents a case study of implementing an inquiry approach with two different classes of grade 7 in a public school in India. The focus was using a range of information technologies such as phet simulation, Chalo padho (educational web portal) and open door online assessment to support student inquiry learning. In this action research a topic 'Different Methods of Separation of contents of a mixture' was chosen. The lesson was delivered using online simulations in one section and live demonstration of experiment in the other using the 5E model. The study demonstrates the need to consider the characteristics of students when implementing an inquiry approach, and also the influence of the teachers' level of understanding and related confidence in such an approach. The case also indicated that a range of information and communication technologies can be effective in supporting student inquiry learning.

Article History
Article Received: *18 May 2019*
Revised: *14 July 2019*
Accepted: *22 December 2019*
Publication: *12 February 2020*

Keywords – Nature of Scientific Inquiry, National science education standards, Scientific Inquiry approach, web based learning, e- learning, 5E model

Introduction:

This research project aimed to understand and explore the ways electronically networked (e-networked) tools can support authentic science inquiry in middle school classrooms in order to address concerns about student engagement in science. Internationally claims are made about the potential for inquiry-based learning to address the challenges of relevance for the 21st century school science learner (Aikenhead, 2005; Bolstad & Hipkins, 2008). Deliberate inclusion of activities such as collaboration, co-construction and confirmation of ideas is appropriate and valued in science inquiry but they tend to contrast with many of the practices found in conventional classrooms. The notion of "inquiry" proposed by the National Research Council (NRC) was adopted to guide this research. The NRC describes inquiry as the "abilities students should develop to be able to design and conduct scientific investigations" and the "understandings they should gain about the nature of scientific inquiry", as well as "the teaching and learning strategies that enable scientific concepts to be mastered through investigations” (NRC, 2000, p. xv).

Inquiry based approach through 5E model: Can active, collaborative, Inquiry based learning be made effective by the 5E Instructional Model?

Passive absorption of information cannot lead to learning outcomes of scientific inquiry. Students are involved in more than listening and reading. They are developing skills, analysing and evaluating evidence, experiencing and discussing, and talking to their peers about their own understanding. Students work collaboratively with others to solve problems and plan investigations. Many students find that they learn better when they work with others in a collaborative environment than when they work alone in a competitive environment.

When active, collaborative learning is directed toward scientific inquiry, students succeed in making their own discoveries. They ask questions, observe, analyse, explain, draw conclusions, and ask new questions. These inquiry-based experiences include both those a constructivist view of learning recognises that students need time to

1. Express their current thinking;
2. Interact with objects, organisms, substances, and equipment to develop a range of experiences on which to base their thinking;
3. Reflect on their thinking by writing and expressing themselves and comparing what they think with what others think; and
4. Make connections between their learning and experiences of the real world

The 5E model sequences learning experiences was used so that students have the opportunity to construct their understanding of a concept over time. The model leads students through five phases of learning that are easily described using words that begin with the letter E: Engage, Explore, Explain, Elaborate and Evaluate.

Although Practicals have become the centre stage in science education yet the recipe method of handing out equipments and procedures have not succeeded in achieving the learning outcome of a scientific inquiry. The students appear to be more engaged in a practical hands-on or Demonstration based class yet they do not seem to enter into deep thinking of the content or think beyond textbooks and come up with alternative solutions. On the other hand, the web based interactive practical has the following characteristics *of the instructions:*

Simple precise language, Clear objectives & short introduction, Directions of practice as required, sequencing of steps., The diagrams followed criteria, Pictures illustrating new equipment, Diagrams illustrating construction of apparatus and use of correct procedures, Diagrams showing procedural sequences.

Literature survey

A well-documented work on the potential of web-based technologies to support the more interactive and collaborative pedagogies required for effective inquiry-based learning is presented by (Bolstad, Gilbert, McDowall, Bull, Boyd & Hipkins, 2012; Erstad, 2005; Voogt, Erstad, Dede & Mishra, 2013; Wright, 2010). Opening up more variety of resources and making the outside world accessible provides opportunity for students to pursue questions that are of interest and relevance to them (Erstad, 2005; Wallace, Kupperman, Krajcik & Soloway, 2000). New opportunities for teaching authentic science practices is offered by the application of technology in classroom teaching. These simulations allow students to engage in activities based on inquiry that are otherwise not feasible in a simple demonstration based class setting. Scaffolds that help students manage complicated tasks and flexibility to pursue authentic scientific inquiry are the added

January - February 2020
ISSN: 0193 - 4120 Page No. 9528 - 9534

advantage of using simulations in class. Quinta et al has outlined a strategic framework for successful use of scaffolding. They have also cited various examples of technology that support student led inquiry tasks. These technologies are promising as educational tools to advance science education. Overall, these technologies are promising candidates as educational tools to advance science education as they can simultaneously improve student understanding of concepts and processes while maintaining student motivation for learning. [1]

Method

This article is based on the findings of an action research based on a case study.The aim of the study was to explore the nature of science inquiry in the development of knowledge supported through technology Williams et al., 2013). The study was based on the following research questions:

i) What scientific inquiry skills are learned in a classroom based on experimental demonstration

ii) What scientific inquiry skills are learned through online interactive web based experiments?

iii) Is there any difference in the achievement level of the students learning through demonstration based and interactive web based teaching?

Two sections of grade 7 in a public school were chosen where the researcher taught them for a year. Both the sections were exposed to the technology based teaching in various topics of chemistry. They had learnt the particle theory, Atoms elements and compounds through videos on Chalo Padho and observed demonstration activity on PHET simulation. They were familiar with the open door assessment procedure of Marking options on OMR sheets and getting their answers scanned for assessment. Keeping this similar learning environment in mind, the researcher chose the topic Methods of separation of components of a mixture' as a case study. One section of class seven coded as 'X' and the other section as 'Y' were given different treatment for teaching this above mentioned topic through 5E approach What students did in the 5E approach of the two treatments in Section X and Y of grade 7.

Stage	Experiment demonstration based teaching in 7X	Web based technology using interactive PHET simulation
Engage	The students became curious about the apparatus and the experimental demonstration.	The students become curious and excited about **using the web technology and finding out for themselves.**
Explore	They could explore the experiments demonstrated by asking questions and careful observation. They could not try different ways to solve the problem.	Conduct investigations in which they observe, describe, and record data **Try different ways to solve a problem or answer a question**
Explain	Explain concepts and ideas in their own words. Base their explanations on evidence acquired during previous investigations	Explain concepts and ideas in their own words Base their explanations on evidence acquired during previous investigations. **Reflect on and perhaps revise their ideas**
Elaborate	Make conceptual connections between new	Make conceptual connections between new

	and former experiences	and former experiences
Evaluate	MCQ through Open Door Assessment	MCQ through Open Door Assessment

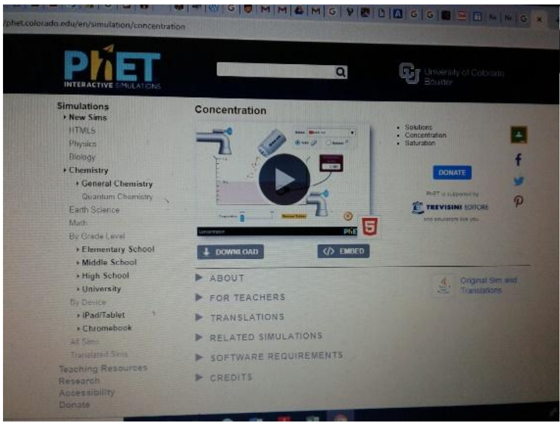


Fig 1 PHET Simulation website

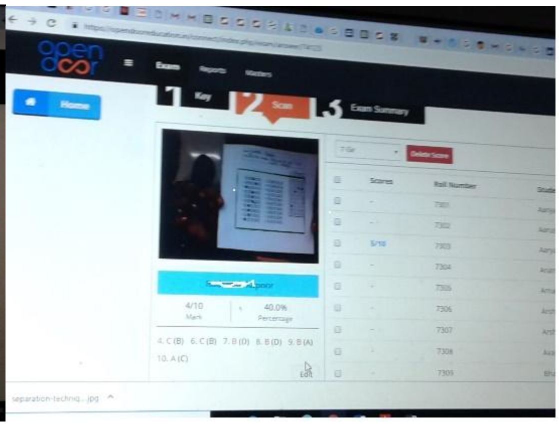


Fig 2. Open Door Scan and Assessment page

Table 1 Conceptual assessment of students of two sections of Grade

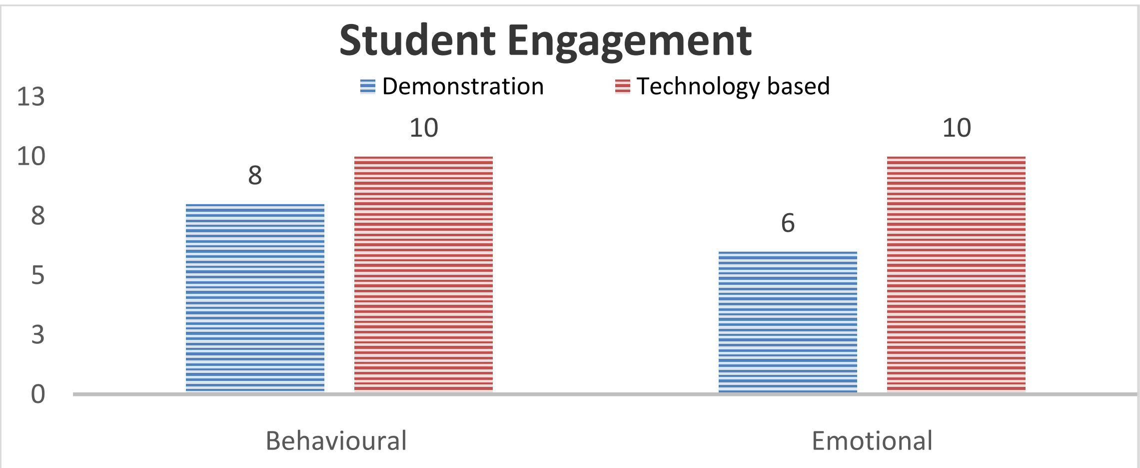
Class 7X	13.5	13	14	14.5	14	11.5	13	15	11.5	14.5	14	10	15	13
Class 7Y	15	11.5	12	14	11	13.5	15	12	11.5	13.5	14.5	13	11.5	11.5

Class X Mean 13.3
Class Y Mean 12.8

Analyzing the acquisition of scientific inquiry skills by 5E model.
Engage, Explore, Explain, Elaborate, Evaluate.

1. Engage:

- Behavioral engagement- punctual, adherence to rules, focus and concentration
- Emotional – happy, excited
- Cognitive- metacognition, retention, questioning, comprehension



January - February 2020
ISSN: 0193 - 4120 Page No. 9528 - 9534

- Students appear to be engaged in the demonstration method
- Emotional engagement or excitement dips as the students become familiar with the environment and tools

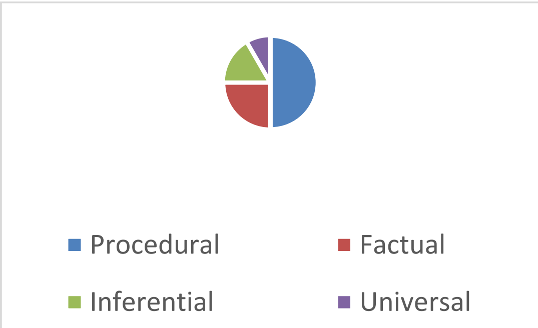
Cognitive Engagement measure through:

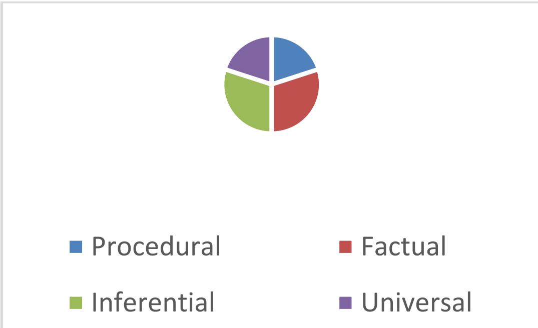
Levels of questioning-

- Procedural (How do we measure the volume of liquid taken?)
- Factual (What is evaporation?)
- Inferential (Do all liquids evaporate at the same rate?)
- Universal (What are the key factors that affect evaporation?)

Engage:

Demonstration Method **Technology based Method**

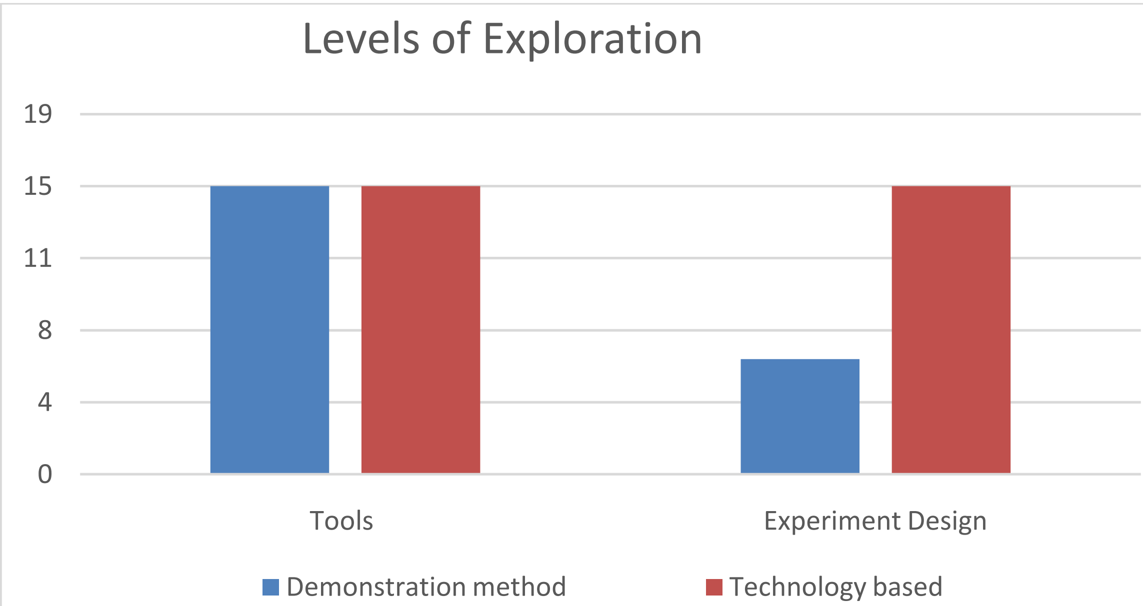


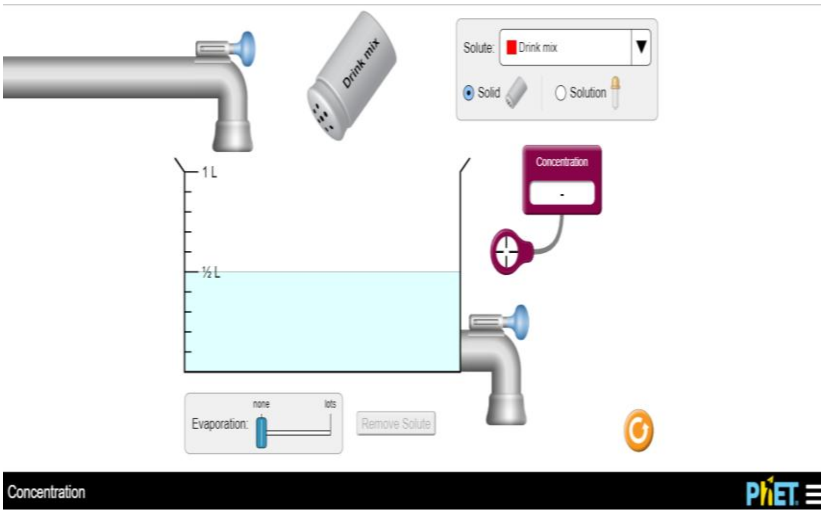


Explore:

Levels of Exploration

- **Tools**
- **Experimental Design**

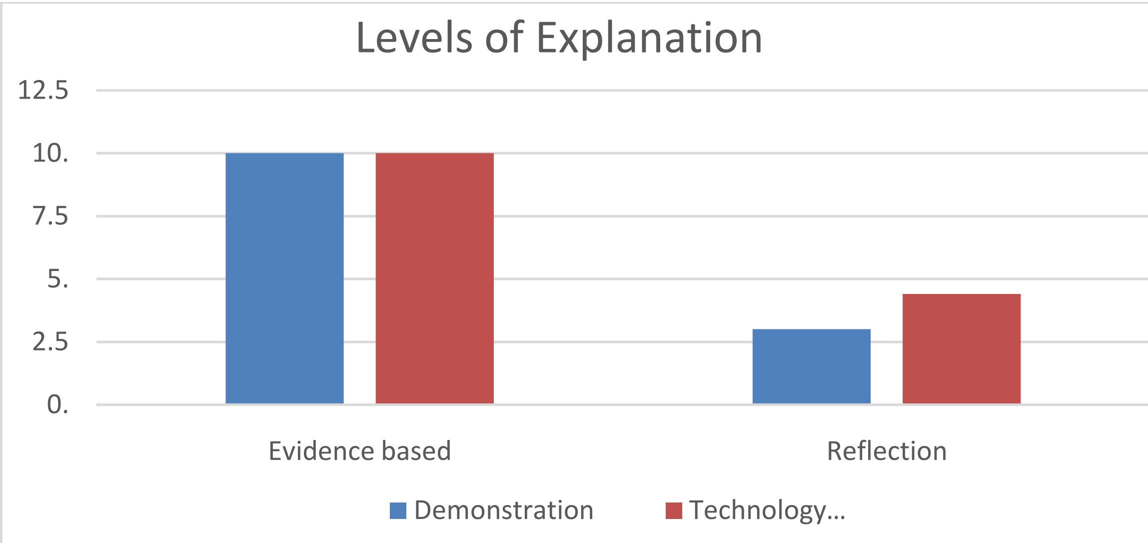




Phet Simulation

Explain:

- **Evidence Based**
- **Reflection Based**



Elaborate

Make conceptual connections between new and former experiences.

Key Findings

1. Students of both the sections performed with a comparable mean average. The performance of the students in the conceptual or knowledge based questions on the topic Different methods of separating contents of a mixture was comparable in both the sections.

.2. The students who performed the interactive simulation on the experiment of Evaporation reported a change in their perception of alternative processes and combinations used to test the process of Evaporation.

3. The students who used the simulation had a changed perception on how the scientists work by varying the conditions of the same experiment to test the outcome. They had a better understanding of the variables used in the experiment.

Discussion and conclusion

This case study, on analysis revealed that although the mean of the achievement by both the sections were almost comparable indicating that the content knowledge acquired by the students in both the classes were same. The difference highlighted was in the following parameters of Scientific Inquiry:

1. The type of questions asked by the students.
2. the ability to think of alternative procedures and alternative solutions.

This study also indicated that flexibility in terms of planning the lesson, alternatives when the technology does not work, conceptual and procedural scaffolding is required for the successful use of information and technology for inquiry based learning. Awareness of teachers and students in the areas of the nature of inquiry, the use of science and technology, scaffolding of students and sources of expertise is essential.

References

1. Hilton M, Honey MA, Learning science through computer games and simulations. Washington DC: National Academies Press; 2011.
2. Quintana C, Reiser BJ, Davis EA, Krajcik J, Fretz E, Duncan RG, et al. A Scaffolding design framework to support software for science inquiry. Journal Learn Sci.2004; 13:337-386
3. Hofstein, A., & Lunetta, V. (2004). „The laboratory in science education: Foundations for the twenty-first century". *Science Education*, 88, pp.28-54.
4. NGSS Lead States Next Generation Science Standards: For States, by States. Washington, DC: The National Academies Press; 2013.
5. Schweingruber H, Keller T, Quinn H. A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, DC: National Academies Press; 2012.
6. R. Bolstad & J. Gilbert, S McDowall, A Bull, S Boyd & R Hipkins. Supporting future oriented learning and teaching- A New Zealand Perspective, Ministry of Education New Zealand;2012.
   Website
7. http://www.uwyo.edu/scienceposse/resources/nih_doing-science.pdf
8. https://www.nap.edu/read/9596/chapter/5
9. https://phet.colorado.edu/en/simulation/concentration.