PS 2402 ICT IN PRIMARY MATHEMATICS AND SCIENCE LEARNING
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Virtual Experiments in Primary School Science

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1. Introduction

The use of technology has become significant in the Primary Science Curriculum of Brunei Darussalam. In this effort, several recommendations have been outlined by the Curriculum Development Department (2002, p.10) to enhance the teaching and learning process, such as the use of Internet resources, interactive multimedia, educational software and other ICT tools. Generally, it is believed that the use of technology can enhance the quality and standard of science teaching and learning.

A useful ICT simulation tool for primary science is ‘Virtual Experiment’, because it provides a unique way of reinforcing children’s conceptual and practical understanding. This kind of technology will be discussed in this essay, including its advantages, limitations and usage towards “electronic experiential learning”.
2. Technology in the Primary Science Curriculum

The use of technology, particularly ICT has become apparent in the world of education. The emphasis of incorporating technology in education has been a major focus in recent years. Pertaining to ICT in the Primary Science Curriculum, the use of ICT is aimed to improve the following areas (Curriculum Development Department, 2002, p.10):

1. Children’s understanding of scientific concepts
2. Development of investigative skills
3. Development of positive science attitudes

To achieve the above aims, children should be given the opportunities to utilise technology in a way that can enrich and stimulate their science knowledge and experience. Furthermore, using educational technology enables pupils to practice science and technology in ways similar to professionals in the field, leading to a deeper understanding of concepts and improved thinking and problem-solving capabilities (Carin, Bass and Contant, 2005, p.311).

According to Sandholtz, Ringstaff and Dwyer (1997, p.176), “technology provides an excellent platform – a conceptual environment – where children can collect information in multiple formats and then organize, visualize, link, and discover relationships among facts and events”. Such opportunities are essential towards the development of science process skills, such as analysing, classifying, evaluating and inferring.
It is important for children to understand that technology uses science in practical ways to find solutions to challenges (Benbow and Mably, 2002, p.113). Such situations provide children the opportunities to use their logic thinking skills and problem-solving abilities as they explore the potential uses of technology in solving problems related to scientific concepts. One of the ways to initiate this is through the use of virtual experiments.
3. **What is Virtual Experiment?**

‘Virtual experiment’ is a computer simulation tool that allows users to interact and manipulate objects in computer-generated environments, usually through “drag-and-drop” technologies. For example, users can drag, rotate and control objects or apparatus in virtual environments through the mouse input. This kind of technology is similar to “virtual laboratory”, which is an interactive environment for creating and simulated experiments (Penner, 2001). Virtual experiments can be in the form of web-based application such as Java applet and Flash document, or standalone programs, including multimedia simulation and virtual reality (VR).

![Figure 3: An example of standalone program called ‘Virtual Chemistry Lab’](image)
4. Advantages of Using Virtual Experiments

The advantage of using virtual experiment in the classroom is that it saves time compared to the real experiment, because the apparatus have been readily-setup at all times, and can be used without consuming too much time in the classroom. Thus it allows teachers to allocate or shift the learning time for other activities.

Another benefit is that it is inexpensive. One of the many reasons is because the Internet provides a wide range of access to computer simulations, including virtual experiments. Its use becomes significant especially in schools where apparatus and other science facilities are very limited. Furthermore, it is safe compared to real-life experiments. Thus virtual experiments can be used without worrying too much on safety issues, such as handling fragile or sharp objects. This is important because safety issues should always be a main priority in the classroom/laboratory.

Meanwhile, virtual experiments have a great potential as a teaching tool. The use of this technology can stimulate children’s learning experience, because they are placed in a situation where they can control an environment by interacting with the computer, collect data, correlate results, and learn skills, attitudes, and concepts (Carin et al., 2005, p.318). Thus they are actively involved in the learning process as thinkers and problem solvers. The use of virtual laboratories provides a mechanism to allow students to really design and interpret experiments as scientists actually do (Bell, 2005, p.174).
Another positive aspect of using virtual experiments is that it offers flexibility. Teachers can use this simulation tool for various strategies and purposes. Its use has no profound restrictions when it comes to the teaching and learning process. This teaching tool can be used for numerous occasions, including for set induction or the “hook”, demonstration, discovery learning, inquiry-based learning, investigative activity and concept reinforcement etc.
5. Limitations of Using Virtual Experiments

Although the use of virtual experiments have numerous benefits to science teaching and learning, there are few limitations that needs to be underlined. Bell (2005) stated that “...many instructors are concerned about the use of computer-based simulations of laboratories, because although they may retain the active learning component, the actual hands-on experience is lost” (p.173). Inadvertently, this affects the development of science process skills, especially those involving the physical skills of manipulating laboratory equipment.

These practical skills must not be isolated from science teaching and learning, because such skills are crucial in the field of science, especially in secondary level and higher-education. Therefore, teachers need to be coherent in determining the best way to use virtual experiments in science lessons.

Another issue relates to the quality of simulation tools. In reality, not all virtual experiments are effective. Several problems may arise, such as the occurrence of technical errors and learning misconceptions. Learning misconceptions can occur particularly when children fail to acknowledge the existence of certain phenomena or concept in the real world. For instance, they think that whatever “causes and effects” they learn from the virtual experiment only exists in the virtual world. Thus teachers need to be ready to encounter such issues in the classroom, and find solutions to resolve them; there should always be a ‘Plan B’ when considering the use of virtual experiments in the classroom.
6. Using Virtual Experiments Towards ee-Learning

The term “ee-learning” is a hybrid concept that brings together two kinds of e-learning: it is the combination of electronic learning and experiential learning in a single and powerful pedagogical practice (Eskow, 2007). The implication is that the use of technology and hands-on activities should be combined together to provide a rich learning experience. Thus this strategy is very important for the Primary Science Curriculum, especially when considering the use of virtual experiments.

Simulations have great potential as a teaching tool. Simulation tools such as virtual experiments follow “the constructivist idea that learners construct their own unique concepts through active participation (Carin et al., 2005, p.317). Such tools train children to become “independent learners”, because they control the environment, manipulate the objects and use their problem-solving skills to find innovative solutions.

Although new technologies such virtual experiments have a great influence on children’s scientific understanding, the importance of practical activities should not be isolated from the classroom. Twining (1999) as cited in Meadows (2004, p.30) suggests that simulations should supplement rather than replace practical activities. Therefore, real experiments and other investigative practical activities are essentially required for the development of science process skills, especially those involving the use of laboratory equipment.
Virtual experiments is best utilised through the ee-learning practice, because by combing both technological and practical aspects, the development of children’s scientific concepts and science practical skills can be reinforced tremendously. To conclude, ee-learning helps children to gain better conceptual and practical understanding as a whole.
7. **Examples of Virtual Experiment**

The following are several examples of virtual experiment for the topic *Conductors and Non-Conductors of Electricity*:

7.1 **The Blobz Guide to Electric Circuits (Blobz)**

‘The Blobz Guide to Electric Circuits’ (Blobz) is a web-based interactive learning tool, developed by Andy Thelwell as part of the ‘Hypermedia’ module at Staffordshire University, United Kingdom. Furthermore, Blobz has won several prestigious awards, namely the ‘2003 SIGGRAPH SPICE Competition Award’ for the educational category, and the ‘2004 AECT International Student Media Festival Award’.

![Image of Blobz Guide to Electric Circuits](Website: www.andythelwell.com/blobz)

Figure 7.1.1: Introductory page to ‘The Blobz Guide to Electric Circuits’

(Website: www.andythelwell.com/blobz)
Blobz is designed to support the UK National Curriculum for Key Stage 2 Science, which focuses mainly on electric circuits and conductors of electricity, which is also similar to the Upper Primary Science Syllabus of Brunei Darussalam, particularly for the Primary 6 Unit ‘Electricity’.

![Interactive features of Blobz](image)

**Figure 7.1.2: The Interactive features of Blobz**

This e-Resource features educational activities such as games, simulations and quizzes to keep children entertain. Its distinctive multimedia elements such as graphics, sound and animated effects can stimulate children’s attention. Furthermore, it is designed to be tactile using technologies such as “drag and drop” in order to facilitate a rich learning experience.
One of the interesting features of Blobz is its virtual experiment. This simulation tool is accessible in ‘Section 2: Conductors and insulators’. The experiment simulates the practical activity to test for conductors and non-conductors of electricity.

Figure 7.1.3: How to access the ‘Virtual Experiment' in section 2
The setup for the virtual experiment is shown below in Figure 7.1.4:

- Provides helpful guide.
- Virtual circuit board
- Crocodile clips (movable)
- There are 10 items to be tested for the experiment (movable).

Figure 7.1.4: How the virtual experiment looks like

This simulation tool is easy to use, and most of the objects are manipulative. For example, the items can be “dragged and drop” to the circuit board, and the crocodile clips can be easily adjusted by clicking and dragging. Thus allow children to control the experiment easily. After an item is dropped to the circuit board, a feedback message automatically appears to interact with the user. Typically, the message shares or recalls information about the item or material chosen.
An example on how to use the virtual experiment:

1. Adjust the clip by clicking and dragging. Make sure both clips touch the material.

2. Simply “drag and drop” any item onto this section. This step is repetitive at most times.

3. Once the clips have been connected to the item, observe and check whether the bulb lights up or not. Is it a conductor or non-conductor?

After each item is dropped to the circuit board, popup messages appear to interact with the user by sharing or recalling information.

Figure 7.1.5: Brief steps on how to carry out the experiment

The steps involved are similar to the “real experiment”. It allows children to use their logic thinking skills and problem-solving abilities during the experiment. Children make inferences through observation, and link the findings to their existing schema, i.e. relate observable event to the known scientific concepts.
The advantage of using this virtual experiment is that it provides “reliable” outcomes, because they are similar to the ones gained in the real world. Thus minimise the occurrence of learning misconceptions.

Figure 7.1.6: A “real” experiment outcome

Obviously testing the handle (plastic) of the knife would not make the bulb light up. What if we test the blade?

The bulb lights up, because the blade of the knife is made from metal, and it conducts electricity.
7.2 BBC KS2 Bitesize Revision for Science

Another interesting virtual experiment that can be used for the topic electrical conductors and insulators is from the ‘BBC KS2 Bitesize Revision’ website. It is simple and easier to use compared to the previous one. Nevertheless, it does not allow users to manipulate much of the objects in the environment. Yet it is good to be used for whole-class discussions, and revision.

Figure 7.2.1: BBC KS2 Bitesize Revision Website

(Website: http://www.bbc.co.uk/schools/ks2bitesize/)
The following demonstrates the steps on how to access the virtual experiment:

1. Click this icon.

2. Then click this picture.

3. Find ‘Circuits and conductors’ and click ‘Activity’ to access the virtual experiment.

Figure 7.2.2: Steps on how to access the virtual experiment
The virtual experiment should appear as shown below:

![Virtual experiment screenshot]

Figure 7.2.3: Brief explanation on how the virtual experiment works
The advantage of using this virtual experiment is that it provides immediate feedback. This appears automatically after an item is placed into the gap despite whether the item is a conductor or insulator. Such interactivity is important to strengthen children’s understanding on scientific concepts.

Observe the bulb.

Place the item here.

Click and drag the selected item.

Figure 7.2.4: An example of feedback message
8. **Lesson Ideas on Using Virtual Experiment**

There are many ways that virtual experiment can be used in science lessons. The following presents several ideas on how to utilise this technology in science teaching and learning:

i. **Discussion**

Using virtual experiment for whole-class discussion can be a very useful tool. It can bring a lot of benefits, such as: (1) discussions encourage children to think and build their own understanding; (2) using simulations can increase children’s attention span; (3) strengthen children’s understanding on scientific concepts through simulations.

ii. **Discovery Learning**

In this strategy, the teacher acts as a facilitator rather than an instructor. The pupils are given opportunities to learn and explore scientific concepts through the use of virtual experiment. This can help children to become “independent learners”. This can be an effective strategy because the pupils build their own conceptual understanding at their own pace.

iii. **Problem-Based Learning**

Virtual experiment can also be used for investigative activities. The teacher can form 3 to 4 groups in the classroom, and assign each team to solve a set of problems. The virtual experiment will be used as a primary tool to solve the problems given. Such activities encourage children to think, share ideas and use their creativity in finding innovative solutions. When pupils are able to discover the keys and understand how concepts work, learning is at its best.
9. Conclusion

Generally, the use of virtual experiments has many benefits to science teaching and learning. Its use has some profound impact towards the development of science process skills and science attitudes. Importantly, the use of simulations can increase children’s understanding on scientific concepts. Although there is a concern that virtual experiments can isolate children’s scientific practical skills, yet this issue can be resolved through the e-learning initiative. Thus teachers need to acknowledge the importance of this pedagogical practice in the primary science curriculum. By combining both technological and hands-on aspects, children’s conceptual understanding and practical skills can be developed at the same time.
References


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