# TEACHER PERCEPTION OF DIFFERENT MODES OF CONDUCTING A PHYSICS EXPERIMENT

Devadason Robert Peter
SEAMEO RECSAM
<drobertp@recsam.edu.my>

## Abstract

This study explores how experienced science teacher educators new to the use of ICT perceived the use of the traditional apparatus, data logging system, computer based interactive simulation and computer based virtual experiment to understand relationships regarding simple pendulums. Twenty teacher educators with 15 to 20 years of teaching experience participated in this study. The four modes of experiments together with three possible scenario of usage for each mode were demonstrated to the respondents. Data was collected through two questionnaires, one measuring their attitude towards IT and the other their perception towards the use of each mode in the scenarios shown. Although they showed a very high positive attitude towards IT, the respondents perceived the efficacy of traditional experiments more positively.

Key Words: ICT, Microcomputer-based laboratories, virtual experiments, simulations, practical science, physics

## 1. Introduction

### *ICT Helps Improve Learning*

There is a general consensus that the use of ICT in teaching and learning brings about positive benefits in student learning. The findings of the ImpaCT2 survey (Harrison et al., 2002) provide concrete evidences of ICT having an impact on teaching and learning in the classroom. At the subject level, ICT supports the development of science concepts (Nakleh and Krajcik, 1994). Friedler and McFarlane (1997) found that that pupils' ability to interpret data improves with the use of data loggers. Harlen (1999) in his review of literature suggests that data-loggers and simulation in practical work improve learning when used in appropriate ways. Similarly, Cholmsky (2003) also gives evidence for learning improvements when simulations are used. Barton (1997) argues that data logging could change the nature of children's thinking in experimental work in science. Barton (2004) adds that data logging helps pupils by reducing data collecting and processing times.

### *ICT Tools for Learning Available Widely*

The past few years has seen the development of lots of interactive tools for the teaching and learning of science especially using the Internet. Other than the commercial ones (e.g., Gizmos at http://www.explorelearning.com), many of them are available for free to use online and freely downloadable for use off-line (e.g., http://www.skoool.co.uk, http://phet.colorado.edu/web-pages/index.html). Carlos (1998) describes a number of tools to help teach physics concepts. As our knowledge of design principles improve (e.g., Mayer, 2005), so has these interactive tools improved over time. One has only to browse the Internet to see the qualitative changes occurring to these tools over time.

***Many Initiatives in Place to Provide School ICT Infrastructure***

Many countries have and are continuing to spend considerable amount of money to equip schools with ICT facilities. For instance, countries like Malaysia, Vietnam and Thailand have their own ICT Master Plan which includes provision for equipping schools with the necessary ICT infrastructure. Heavy investments are also being made to equip teachers with the necessary skills to effectively use ICT in the classroom.

***Are we Satisfied with the Level of use of ICT in the Classroom?***

While we are aware of ICT impact on learning and the huge investment on hardware, software as well as training in the schools, are teachers using ICT regularly in the classroom for instructional purposes? Cuban (2000) argues that despite these huge efforts very few teachers are serious users of computers in the classroom. Among his reasons are that teachers face intractable working conditions, external groups making constant demands on the teachers and technology being inherently unreliable. Becker (2001) reports that very few teachers reported students using computers during class hours and provides reasons ranging from block scheduling, too many topics to teach (versus few topics to be covered in depth) to lack of teacher expertise with technology.

Becker & Ravitze (2001) found that teachers with reasonable expertise in using computers, when 5 to 8 computers are available for use in the classroom, and where they believe strongly in a constructivist pedagogy tend to regularly use computers in the classroom. Teachers engaged with peers in collaborative and leadership roles and who thus influence their peers more than most likely to have their students exploit computer resources during class.

Becta (2004) divides barriers/factors leading to the effectiveness of classroom use of ICT into teacher-level and school-level. Most of the barriers referred above falls into the school-level category. School-level barriers are generally beyond the purview of trainers. However many of the teacher-level barriers can be addressed at the trainer level. One major teacher-level barrier which has drawn considerable attention is teacher belief (Ertmer, 2006). For instance, teachers whose beliefs support the view that ICT need to play an integral part in classroom learning are likely to use ICT powerfully in the classroom. Baggott, McFarlane, John, and Brawn (2005) suggest that beliefs are difficult to change. Any training on ICT integration should take into account the belief factor to ensure the likelihood of the participants to practice what they learned during training.

***Purpose of the Study***

As part of its mandate in promoting science and mathematics in the region, SEAMEO RECSAM regularly conducts short courses on science and mathematics for the Southeast region and beyond. These past few years has seen an increasing demand for ICT integration in its courses. The courses offered are designed based on the constructivist philosophy and teacher educators get to not only see the integration of ICT in the teaching of the courses but also ample opportunities are provided for them to explore and experience ICT on their own. It is hoped that they will go back to their countries with very positive attitudes towards the use of ICT in the classroom.

The major question to be answered is that by the end of the course were teachers' beliefs about ICT changed positively to increase the likelihood of them using ICT in their classrooms?

Specifically, the questions are formulated as follows:

- Do teacher educators have a positive attitude towards ICT at the end of the course?
- Barring school level barriers to using ICT in the classroom (like no computers), how do teacher educators perceive the use of ICT in practical work?

## 2. Methodology

Twenty science teacher educators from an African country with more than 15 years of teaching science and with at least a basic degree participated in this study. These respondents had just concluded a four week in-service course on science pedagogy. Prior to coming for this course, the majority had no access to computers. As part of the course they were exposed formally to 8 hours of computer literacy (operating a PC, word processing, spreadsheet, presentation and Internet exploration). During the evenings they had access to at least two hours of individual use of the PC. It was observed that they made full use of the opportunity throughout the course. During formal classes they had opportunity to see facilitators integrating ICT into their teaching mainly through presentation tools as well as exercises which involved the use of word processors to produce reports, presentation and exploration using the Internet.

At the end of the fourth week we demonstrated for about an hour the use of four different media to help in the teaching and learning of simple pendulums. Simple pendulums was chosen as a topic because it is a common subject that all science students should be familiar with and that it is tenable to misconceptions especially regarding the relationship of its period to mass or the swing angle, even if one were to mentally imagine the relationship. This was confirmed among a large number of respondents who gave erroneous responses to the above two relationships. Another important reason was to create equivalent conditions so that all four media can be used to perform the same practical task and thus not putting any one media at an advantage.

The demonstrations for about one hour consisted of the following

- Traditional pendulum and stopwatch
- Traditional pendulum when connected to data logging system (http://www.data-harvest.co.uk/index.html)
- Computer based simulation using gizmos (http://www.explorelearning.com)
- Virtual pendulum (http://www.crocodile-clips.com/crocodile/physics)

Each of the above experiments were demonstrated in the context of three possible scenarios; interactive demonstration by the facilitator, procedural experiment with teacher facilitation & open ended experiment with teacher facilitation. The term ‘teacher facilitation’ had to be included in the explanation because the respondents were overtly concerned that teacher presence in all modes of instruction is necessary and vital.

Before the demonstration, two questionnaires were administered; the Constructivist Learning Environment Survey (CLES) (Taylor, 1994) and FAIT - Survey of Faculty Attitude Toward Information Technology (Gilmore, 1998). Only the FAIT scores will be described here, the use of CLES will be described in a forthcoming paper.

After the demonstration, a separate questionnaire was administered. The core of the questionnaire consist of six statements which required the respondents to respond to a 5 point Likert scale ranging from strongly disagree to strongly agree. The responded to each

statement for each of the four media used under three conditions. Thus the respondents responded a total of 12 times for each statement.

The six statements which reflect some of the common reasons teachers use a certain media or method (Harlen, 1999) are:

- Highly engaging and motivating experience for students;
- Deeper understanding of concepts by students;
- More time for student to focus on understanding concepts;
- Enable students to remember concepts longer;
- Most practical method;
- Most pedagogically desirable;

In order to allow the respondents to focus on teacher level rather than school level (e.g. lack of materials), they were asked to imagine a scenario where the laboratory was fully equipped and technical support readily available.

## 3. Results

The FAIT questionnaire consists of 68 items categorized into five categories of Enthusiasm, Anxiety, Productivity Improvement, Avoidance and Email Use for Classroom Learning. Some of the items were worded negatively and thus these scores had to be adjusted so that a score of 5 in the Likert scale can be interpreted in a positive sense as regards to attitude towards IT.

Table 1
*Survey of Faculty Attitude Toward Information Technology (FAITv1.1)*

| Category | N | Mean | Std Deviation |
|---|---|---|---|
| Enthusiasm | 19 | 4.45 | 0.26 |
| Anxiety | 18 | 3.82 | 0.41 |
| Productivity Improvement | 17 | 3.84 | 0.28 |
| Avoidance | 19 | 4.12 | 0.71 |
| Email Use for Classroom Learning | 19 | 4.04 | 0.48 |

Table 1 shows the mean score for each category. The raw scores were transformed for the anxiety and avoidance categories so that a higher score for anxiety and avoidance would mean less anxiety and less avoidance respectively. All categories show a positive mean around 4 or 'agree', indicating that the respondents hold a positive attitude towards IT. This is further evidenced by written open-ended comments and verbal comments by some respondents (e.g. "Computer course was the most addictive to the participants and most motivating. People worked without any supervision")

Teacher educator response to the six statements for different media and different modes of instruction are summarized in the form of six figures (Figures 1 to 6) below. For example, figure 1 shows teacher educator perception of different media and different modes of instruction in providing a highly engaging & motivating experience for students. For each

item, data is presented in terms of the Likert score for the four media (Traditional, Data-Logger, Simulation and Virtual Experiment). Within each media is included three possible modes of delivery (Demonstration, Procedural Experiment and Open Ended Experiments).

To find out if the differences between each media were significant for each mode, the Friedman's test was performed. This test was used since the sample was small, ordinal data was used and more than two variables were compared. An asterisk beside the legend for the mode (i.e., Demonstration, Procedural, Open-Ended) indicates a significant difference for that mode at an alpha level of least 0.05. For example, in Figure 2, there is significant difference in teacher educators' perception of different media for open-ended mode of instruction regarding promoting a deeper understanding of concepts by student.

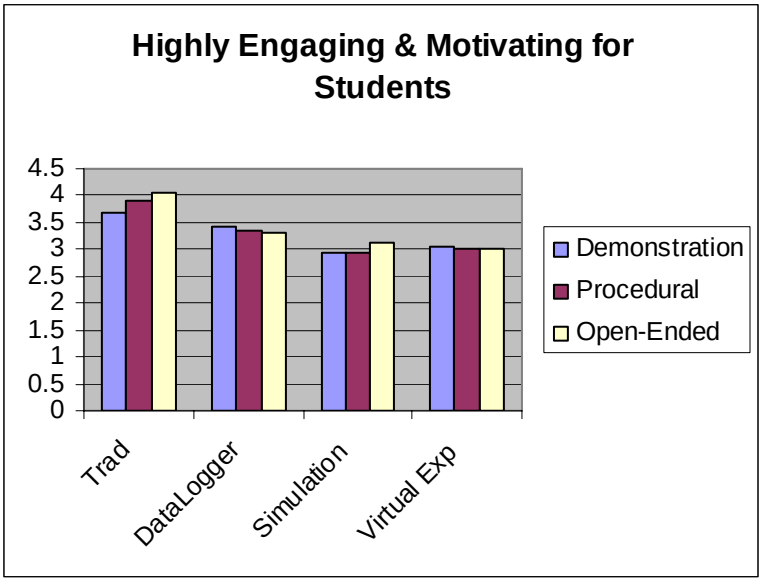


*Figure 1*. Teacher Educators' Perception of Different Media and Different Modes of Instruction in Providing a Highly Engaging & Motivating Experience for Students.

As shown in Figure 1, there is no significant difference between the four media for all three modes of instruction. Note that this result seems to contradict with the common notion that computer based interactive simulations are highly engaging and motivating. Overall, teacher educators hold perception toward traditional experiments more positively compared to other approaches using ICT tools although not statistically significant.

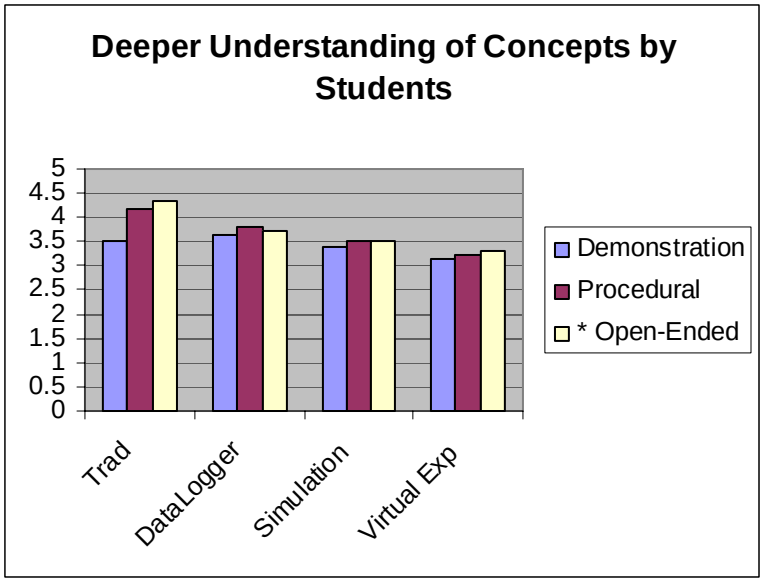


*Figure 2*. Teacher Educators' Perception of Different Media and Different Modes of Instruction in Promoting a Deeper Understanding of Concepts by Student.

As shown in Figure 2, there is significant difference for the open-ended mode of practical only. The respondents perceived that the traditional apparatus promotes deeper understanding of concept by students than other media. Comparing Figures 1 and 2, one can see a general pattern that the respondents seem to favour the traditional apparatus followed by data logger over the simulation and virtual experimental lab.

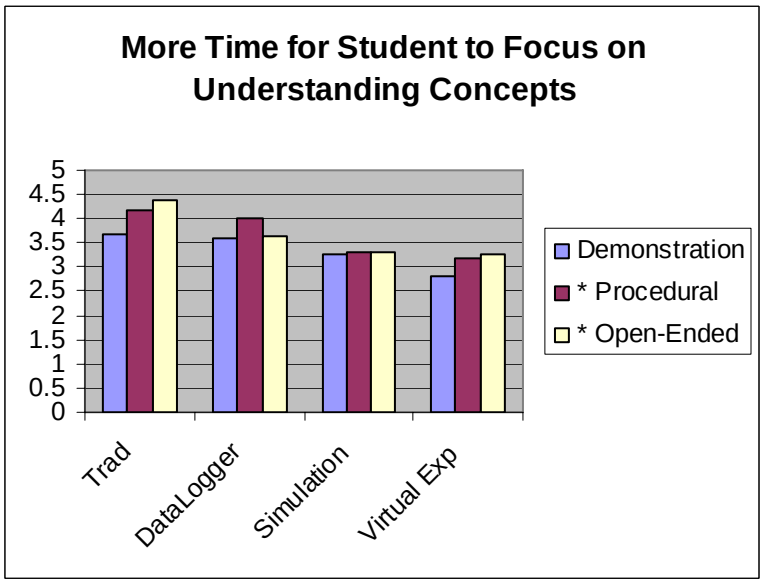


*Figure 3*. Teacher Educators' Perception of Different Media and Different Modes of Instruction in Allowing More Time for Students to Focus on Understanding Concepts.

Figure 3 shows that there is significant difference for both the open-ended and procedural modes of practical. The respondents perceived that the traditional apparatus promotes deeper understanding of concept by students than other media.

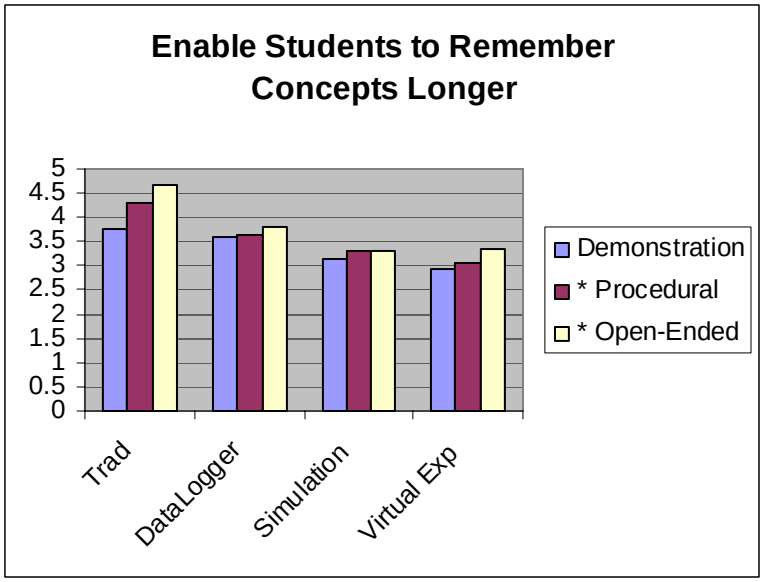


*Figure 4*. Teacher Educators' Perception of Different Media and Different Modes of Instruction in Enabling Students to Remember Concepts Longer.

As shown in Figure 4, there is significant difference for both the open-ended and procedural modes of practical. The respondents perceived that the traditional apparatus enables students to remember concepts longer than other media. Again, one can see a general pattern that the respondents seem to favour the traditional apparatus followed by data logger over the simulation and virtual experimental lab.

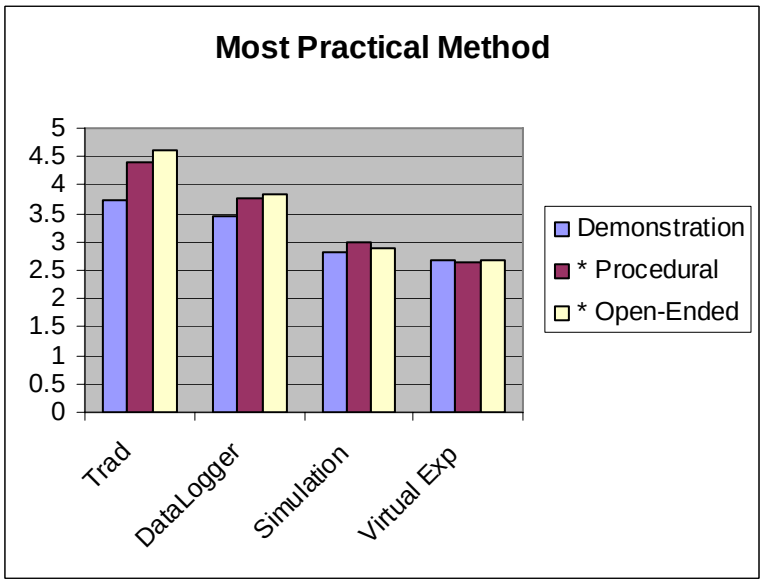


*Figure 5*. Teacher Educators' Perception of Different Media and Different Modes of Instruction in Being the Most Practical.

As shown in Figure 5, there is significant difference for both the open-ended and procedural modes of practical. The respondents perceived that the traditional apparatus as well as data loggers as more practical than other media.

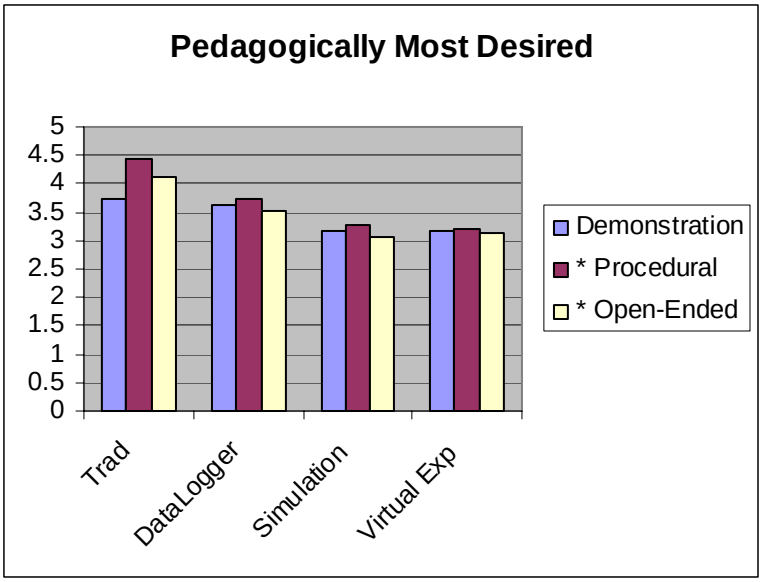


*Figure 6.* Teacher Educators' Perception of Different Media and Different Modes of Instruction in Being Pedagogically the Most Desired.

As shown in Figure 6, significant differences are found for both the open-ended and procedural modes of practical. The respondents perceived that the traditional apparatus and the data loggers as pedagogically more desirable than simulations and virtual experiments.

## 4. Discussion & Conclusions

It is a generally accepted fact that when you have a positive attitude towards an experience the tendency is for you to go for a repeat of that experience and the chances are greater that you will persevere even if subsequent experiences are more challenging. In the case of the 20 respondents, they had a positive attitude towards IT based on the FAIT score. The chances are therefore great that they will perceive new IT based solutions in a positive light.

However, when perceiving the efficacy of the various media, the opposite seemed to be true for these respondents. In most cases they perceived the traditional experiment, and in some cases, data loggers more positively than simulations and virtual experiments. But further reflections suggest that the respondents did indeed perceive the simulation experiment and the virtual experiment in a positive light. It was just that traditional experiments and data loggers were perceived at an even more positive light.

Why was this so? One argument put forward by Baggot et al. (2004) is that there is a subject subculture of secondary science as seen through the eyes of individual teachers. According to Goodson as found in Baggot et. al. (2004), "subjects are well-established bodies of knowledge and social practices that carry with them particular assumptions about 'worthwhile knowledge', 'effective teaching', 'the good' student and 'appropriate assessment'". In that sense teachers already have a belief on what constitute to be effective science practical. In this subculture, there is a tendency for teachers to view science as a practical subject. Thus it is greatly possible that these experienced teachers do not regard 'virtual' experiments as highly as physical experiments.

Another argument is that these teachers view the role of ICT as a functional tool. In that case, data loggers, simulations and virtual experiments can only play a supporting role when doing practical science.

One other plausible explanation that can be put forward is that the design of the demonstrations are such that the content (simple pendulum) could be learnt adequately without the need for use of innovative ICT tools like the data logger, simulations and the virtual experiment. Experienced teachers have already through experience developed the most efficient way to teach the curriculum using existing technologies. Thus their perceptions toward traditional experiments was more positive.

However there is a positive tone to the above argument. Perhaps if the demonstrations were on a content which is pedagogically dependent on the ICT resource (Ruthven, Hennessy, & Brindly, 2004), that is, where the success of the learning is dependent on the nature of the ICT resource and its affordances the participants would have been likelier to have perceived it in a more positive light (John, 2005).

Further studies needs to be done to see if teacher perceptions would differ if the practical topic was such that it is pedagogically dependent on the ICT resource.

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