AN EXPLORATORY STUDY ON THE USE OF COMPUTER-BASED RECORDING AND ANALYSING (COBRA) INTERFACE IN SCIENTIFIC INVESTIGATION

Ong Eng Tek
SEAMEO RECSAM, Penang, Malaysia
and
Tang Woh Un
Victoria School, Singapore

Computer-based technologies have made a powerful impact on the world of science beyond schools. In their conquest to study about the world around us, contemporary professional scientists are working with the handy access to information and communication technology tools. There is a growing body of research evidence suggesting that the use of computer-based technologies can assist students in the acquisition of the scientific process skills central to carrying out successful science investigation. However, the use of the computer-based technologies remains rare in SEAMEO member countries. Working within the framework of students aged 15-16 years, this exploratory study sought to gauge students' abilities in carrying out a scientific investigation using COBRA interface. A context, which is of relevance to the students, was used as a spring board for scientific planning and thereafter, investigating in a scientific fashion. Besides, it also attempts to delve into students' affective domain by transcribing qualitatively their verbalisation of thoughts in writing such as their likes and dislikes as well as feelings towards the introduction of computer interface experimentation. Finally the implications for the teaching of science are outlined.

INTRODUCTION

Computer-based technologies have made a powerful impact on the world of science beyond schools. In their conquest to study about the world around us, contemporary professional scientists are working with the handy access to information and communication technology tools. For instance, they have access to electronic databases that include on-line and CD-ROM systems, and word processing and desktop publishing for the preparation of papers and reports. In addition, access to data capture, manipulation and display systems is definitely a great help to these scientists.

There is a growing body of research evidence suggesting that the use of computer-based technologies can assist students in the acquisition of the scientific process skills central to carrying out successful science investigation (Friedler, Nachmias & Linn, 1990; Heutinick, 1992; Linn & Songer, 1991; Stuessy & Rowland, 1989). Newton (1997) lends further support to this view by reporting that students involved in computer-assisted experimentation were found to be more actively involved in inquiry processes such as observing, predicting, asking questions, comparing, applying information, and analysing. In a study to determine the effect of the computer-assisted experimentations, Nakhleh and Krajcik (1994) found that the group that were using interface and sensors construct better understanding of acids and bases than the two other groups using pH indicators and pH meters respectively.

Rogers and Wild (1994) are of the opinion that computer-assisted education using interface and probes were found to be effective in measuring various rates of natural events. These tools have the capacity to store vast amount of data that improves the experimental validity and the convenience to explore natural phenomena outside laboratories (Rogers & Wild, 1996; Albergoti, 1994; Scaife, 1993).

However, the use of the computer-based technologies remains rare in SEAMEO member countries. The advantages of experimentation using interface and sensors in science teaching are not exploited in class activities. In comparison to UK, a survey by NCET (National Council of Educational Technology, 1993) shows that, despite some employment of Information Technology (IT) in science, the amount of use is very small, with only 11 percent of schools using it for more than three hours per year.

Factors limiting the use of IT in science resistance to change, inadequate teacher development, lack of hardware and appropriate software, mismatch between IT and curriculum, and poor integration of computer-based activities into lesson plans. According to McFarlane and Friedler (1998), there is still a general lack of recognition of the implications of IT for science education in the science education community—an inference made on the basis of the observed phenomenon in which major science education journals rarely carry papers relating to the use of IT.

This undertaken exploratory study was aimed to gauge students' ability in carrying out a scientific investigation using COBRA interface—patented by Phywe Company of Germany. A context, which is of relevance to the students, was used as spring board for scientific planning and thereafter, investigating in a scientific fashion. Besides, students' affective domain in which they verbalise their thoughts through writing such as their likes and dislikes as well as feelings towards the introduction of computer interface experimentation, was also being delved into. This was done through a survey administered at the end of the investigation when a complete report has been submitted.

METHODOLOGY

Sample

The sample consists of ten students (eight males, two females). They were Form Four students between the age of 15-16 years' old and hailed from an international school in Penang. The exploratory study took place in the RECSAM Secondary Science Laboratory.

Instruments

An open-ended task was presented to the students who were divided into 4 groups; 2 groups of three and two pairs. They have to determine, through the employment of the scientific skills and the COBRA computer interface, whether a baby or an adult gets colder first. Appendix 1 presents the Malay version of the assigned task. After an hour and a half, each group then presented their findings to the class for feedback, analyses and comparison in terms of the controlling of variables and how one's findings are scientifically presented.

COBRA Computer interface was used as the main instrumentation for recording and analysing of experimentation data. Computer interface implies that reading from a sensor (such as temperature sensor) in analogue form is converted to a digital mode which a computer could interpret. To elaborate about analogue and digital, most current media machines (like television sets, video recorders, radios, telephones) are analogue for they transmit information by electrical voltage. In contrast, digital machines (like computers and many cellular telephones) transmit information in the form of electronic code, and are the key to the multimedia revolution. COBRA Computer Interface used in this experimentation consists of the following: COBRA Interface, COBRA data transfer cable, NiCr-Ni measurement module, and NiCr-Ni thermocouple.

A 5-item questionnaire was administered after a group presentation and feedback. the first item aimed to gather the extent to which students have been familiarised to computer interface experimentation prior to this exploratory study. Item 2 intended to compile the statistics of students' perception as to whether or not they enjoy learning of science using computer interface. Item 3, on the other hand, elicited for students' opinion and responses regarding the advantages of using the computer interface in the laboratory. The problems faced in using the computer interface during the exploratory study were gleaned through Item 4. Finally, Item 5 gave the students the liberty to comments on whatsoever observation that they would like to bring to light.

RESULTS AND DISCUSSIONS

With half an hour introduction to COBRA computer interface, the students displayed the manipulative skills of good handling of equipment to tackle the task at hand: whether a baby or an adult gets colder first. This is supported by the fact that the four groups were able to complete the experiments within the stipulated one and a half hour time and had their reports ready for presentation and discussion. Even though all the groups reached the same conclusion, their investigative plans differ from one group to the others.

The four groups investigated the problem by manipulating the size of the beakers with the smaller one representing the baby and the bigger beaker, the adult. However, the responding or the output variable varies. Groups one and three considered the change of temperature within a fixed duration as the responding variable, while group Two observed and measured the time taken for the baby and the adult to cool from 60° to 50° (i.e. fixed the degrees of temperature change). Group Four, by contrast, compared the steepness of the graphs within 15-minute duration without taking consideration the initial temperature of the baby and the adult. Being able to determine the manipulated variable and identifying the responding variable while keeping other variables constant in a novel investigative situation, evidenced in their planning phase before operationalising, showed that the students have acquired and internalised the scientific investigative skills.

All the groups were amazingly able to master the use of temperature probes within half an hour during the introduction to the computer interface before embarking on the assigned investigation. Three groups out of four also displayed an encouraging literacy of information technology when they presented their final reports using a word processor (MS Word).

In the survey, 100% of the students indicated that they have not seen a computer interface before prior to this study, let alone using it in school science experiments. Hence, computer interface in science was relatively new to them. Noteworthy of reporting that 100% of the students pointed out that it was an enjoyable lesson in which computer interface was used. They could see dynamic graphing and discussion among the members could be carried out. They could also repeat their experiments easily should any technical mistake was spotted in the midst of the experimentation. This is in great contrast to the traditional experiments whereby students' precious time is wasted in data collection and the pattern of the data could only be observed after they have tabled the data and plotted the graph.

It was heartening to note the following positive comments in writing, from all the students with regard to the use of computer interface. From the following qualitative response of the ten students, there were a few resounding themes. These themes comprised accuracy, time saving, convenience and easy understanding.

Student 1:
The results are more accurate
It saves time because we can do other things while taking the temperature
It is more convenient

Student 2:
The results are more accurate
It is much easier to use

Time need not be wasted on simple experiments
Easy to understand

Student 3
More convenience
Easier
The results are more accurate
Save time

Student 4
The results are more accurate
The time is easier to keep tract of
Simpler
Easier to get graphs and charts

Student 5
Saves time
Results are more accurate
Data are easily saved and organised
Easy to understand and use

Student 6
The results take a faster time to get
It is more accurate
It is convenient
It is a good instrument to save the students' time

Student 7
The results are more accurate
It is faster and easier to complete an experiment
The graph is neat

Student 8
Easier and faster results
More accurate results
It is more convenient for students and teachers

Student 9
More accurate results
Easily recordable in computers or printed out
Easier to use
Do not need to use too many kinds of apparatus

Student 10
Easier and faster
More Accurate
More convenience

On a negative note, 50% of the students (Students 1, 3, 6, 8, and 10), commented that they were apprehensive about possible power failure that could jeopardise their experiments. Although power failure did happen prior to their arrival at 8.30 am that very morning (24 October 2000), it did not appear to be disruptive.

30% of the students (Students 4, 6 & 9) voiced their concern of "bad connection of wires" to the computer. There was a case when the one of the authors personally helped solve the "connection problem." The group asked for the assistance when the temperature probe was not recording any data during their second run, measuring the baby. It could have ingrained in them the worries about "bad connection" that put their experiments in a quandary.

Item 5 in the questionnaire gives students the liberty to comment. 70% of the students (Students 1, 2, 3, 4, 6, 8, and 10) hope that the use of computer interface could be introduced in the school experiments, as this would interest the school-going children in learning science. Students 8 and 10 were rather critical of the common use of so-called "textbook experiments."

10% (Student 7) of the students supported the use of the computer interface but noted the importance of mastering the basic scientific skills such as the ability to acquire and process the data, and to construct a graph. Besides, this student voiced the concern that the manipulative skills such as the ability to use universal indicator and thermometer should not be neglected.

20% (Students 5 and 9) indicated their apprehension with regard to students' IT literacy. They were concern about students who were not at all familiar with computer but have to work on computer interface in science experiments. Thus, according to them, could pose a serious threat to the learning of science as contrast to the traditional school science experiments.

In summary, it would appear that the use of COBRA computer interface (or any other computer-assisted experimentations) would reinforce and enhance students' science investigative skills. With the accuracy, convenience, time-saving and easy understanding that computer interface offers, students' interest towards the learning of science could be cultivated and nurtured.

CONCLUSIONS AND IMPLICATIONS

The use of computer interface with 15-16 year olds' students are found to be educationally beneficial in cultivating scientific skills which, according to Rezbar, Sprague, Fiel, Funk, Okey & Jans (1995), include Basic Science Process Skills, Integrated Science Process Skills and Manipulative Skills. The use of these machines in practical science work proved highly motivational. Such notion manifested itself not only in students' indication of enjoyment in using computer interface, but also strong advocate from them that the schools tap on the benefits of the use of computer interface. Questionnaire data show that students appreciate technology that helps enhance accuracy, convenience, time saving and better construction of scientific concepts.

These findings naturally have implications for teacher development. As noted earlier that despite advanced planning and preparation, encounter with technical problems such as the reported case on "bad connection of wires", are inevitable. Therefore, teachers should be provided adequate in-service training as to the use of computer interface alongside the mechanics of setting up the computers and peripherals. In addition, teachers teaching the same curriculum content should also put their heads together to look into ways in which the computer interface could be integrated into the existing curriculum.

Students involved in this study cherished the accuracy, convenience, fast and neat results in graphical form. It follows that they have more time for thinking, discussion and problem solving. This is supported by McFarlane and Friedler (1998) who reported that with computer interface, students have instant access to data in an interpretable form and hence, became aware of the shortcomings of their practical techniques and experiment design. Without the computer interface, students are not aware of any inadequacies until graphs have been plotted, often at home, and by then, it would have been too late for the problem to be rectified, even if it was ever recognised. Therefore, education ministries in the SEAMEO member countries should have in their respective master plans, the availability of the computer interface as a natural part of a school to capitalise on the benefits of computer interface in scientific skills development in juxtaposition with acquisition of content knowledge.

Finally, for pedagogical innovations, there is a dire need to revamp the current approach to scientific investigation that parallels a cookbook approach to experimentation. Recipe-type of experimentations still takes the central stage in the practical science classes. Recipe approach promotes "hands-on" but not "minds-on", let alone "hearts-on" in students. With the introduction of computer interface that offers dynamic graphing and real-time plotting by computer, science investigation could be introduced to even primary students so that the ability to handle variables and their interactions, which is central to process science, is nurtured right from the very young.

REFERENCES

Albergoti, C. (1994). Real-world physics. A portable MBL for field measurement. *The Physics Teacher, 32*(4), 206-209.

Friedler, Y., Nachmias, R., & Linn, M. C. (1990). Learning Scientific Reasoning in Microcomputer-Based Laboratories. *Journal of Research in Science Teaching, 27*, 173-191.

Heutinck, L. (1992). Laboratory Connections: Understanding Graphing Through Microcomputer-Based Laboratory. *Journal of Computers in Mathematics and Science Teaching, 11*, 95-100.

Linn, M. C. & Songer, N. B. (1991). Teaching Thermodynamics to Middle School Students: What are Appropriate Cognitive Demands? *Journal of Research in Science Teaching, 28*, 885-918.

McFarlane, A. E. & Friedler, Y. (1998). Where you want IT, when you want IT: The role of portable computers in science education. In B. J. Fraser and K. G. Tobin (eds.), *International Handbook of Science Education*, 399-418. UK: Kluwer Academic Publishers.

Nakhleh, M. B. & Krajcik, J. S. (1994). Influence of levels of information as presented by different technologies on students' understanding of acid, base and pH concepts. *Journal of Research in Science Teaching, 31*(10), 1077-1096.

National Council for Educational Technology (1993). *Evaluation of IT in Science.* Coventry, UK: NCET.

Newton, L. R. (1997). Graph talk: Some observations and reflections on students' data-logging. *School Science Review, 79*(287), 49-54.

Rezba, R. J. Sprague, C. S., Fiel, R. L., Funk, H. J., Okey, J. R., & Jaus, H. H. (1995). *Learning and assessing science process skills.* Iowa: Kendall/Hunt Publishing Company.

Rogers, L. T. & Wild, P. (1996). Data-logging: Effects on practical science. *Journal of Computer Assisted Learning, 12*, 130-145.

Rogers, L. T. & Wild, P. (1994). The use of IT in practical science—a practical study in three schools. *School Science Review, 75*(273), 21-28.

Scaife, J. (1993). Data-logging: Where are we now? *Physics Education, 28*, 21-28.

Stuessy, C. L., & Rowland, P. M. (1989). Advantages of Micro-Based Labs: Electronic Data Acquisition, Computerised Graphing, or Both?. *Journal of Components in Mathematics and Science Teaching, 8*, 18-21.