HOW TECHNOLOGY IS INTEGRATED INTO SCIENCE EDUCATION IN A DEVELOPING COUNTRY: NORTH CYPRUS CASE

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ABSTRACT
A key to the success of science education is the use educational technology which can greatly enhance a student's understanding of science concepts. The educational technology tools can take a difficult to learn science concept and change it from abstract to concrete to make it easier to understand. Hence, the power of educational technology tools in a science classroom should be valued by the science teachers. Is this the case? Do classroom teachers in North Cyprus understand the power of educational technology tools in science instruction? Do they value it's use for science teaching? How often do they use educational technology resources in their lessons? To answer these questions data were collected through a questionnaire from 100 secondary school science teachers. Educational technology tools have been divided into four main categories as **classical technology, modern technology, computer technology and laboratory technology tools** for easier analysis. Analysis results revealed that most teachers are frequently using classical technology tools whereas modern technology, computer technology or even the laboratory technology tools are not being used to the extent that they should. ANOVA and t-test results indicated that there is no significant difference about the integration of educational technology tools based on gender and level of education of teachers. On the other hand, ANOVA test results revealed that there were significant differences in teachers' responses about the use of educational technology resources based on the location of school, age, and teaching experience of the teachers.

INTRODUCTION

As it is defined by Roblyer (2003) "Educational technology is a combination of the processes and tools in addressing educational needs and problems, with an emphasis on applying the most current tools: computers and their related technologies." (p. 6). Hence, educational technology is viewed to have two components as **processes** that are simply the learning activities necessary to attain a learning objective and **resources** to enhance learning. Smaldino, Russell, Heinich and Molenda (2005) stresses that most people think of technology as products like computers, CD players, the Space Shuttle, etc. and they state that "This is one type of technology, which we will refer to as **instructional technology** when it is used for instructional purposes."(p.21). This study concentrates on the resources component of educational technology with an equal emphasis on all four categories of instructional technology used in science lessons: **classical technology, modern technology, computer technology and laboratory technology**.

It can be said that technology performs a bridging function between research and theoretical explorations on the one side and the real-world problems faced by practitioners on the other (Newby, Stepich, Lehman and Russell, 1996). In this bridge, educational technologists should use research methods, pay attention to theory, plan activities, implement theoretical knowledge, and evaluate the application results. These steps could help educational technologists to redesign the technological equipment in order to achieve successful use for teaching and learning towards the goals of education in the classroom. As Marcia C. Linn (2003) stresses "The close coupling of science and technology over the past 25 years has stimulated research that reformulates science instruction, introduces new fields, and explores new impacts of new technologies." (p. 727)

Rapid technological developments have its impact on education. It can be said that the practice of teaching science has been more traditional than any other curriculum area, but technological developments have affected science education also. There are some issues and problems in science education. The technological developments could help science teachers to overcome these problems.

ISSUES AND PROBLEMS IN SCIENCE EDUCATION

The three prominent issues of science education are related to

- standards,
- inquiry approaches,
- integrating technology (Roblyer & Edwards, 2000).

First problem is related to science standards. North Cyprus is a developing country and is rapidly progressing to become a technology based society, and as all sectors of the society science educators should also try to adopt new standards parallel to new developments. For this reason, science teachers and curriculum designers and

subject specialists should work collaboratively to develop a new technology based science curriculum which would be in harmony with the technological developments in the society. The standard problems in science courses can be solved by the use of the new technological resources such as the Internet, word processors, presentation software and spreadsheets which are some of the forthcoming examples among many others (Linn, 2003).

Second problem is related to the lack of the use of the inquiry approaches in science lessons. Science teachers "…should emphasize methods for providing students with opportunities to *do* science, in addition to learning the facts and concepts of science." (Flick and Bell, 2000, p.41). Hence, activities involving technology and supporting scientific curricular goals should be planned and implemented to promote student-centred, inquiry-based learning. To improve scientific inquiry computers must be used for the collection, analysis, and display of data and "A variety of technologies, such as hand tools, measuring instruments, and calculators, should be an integral component of scientific investigations." (NSES, 1996, p. 3).

Last problem is about lack of integrating technology into instructional activities. Science teachers should seriously consider the integration of technology into science curriculum because this practice will not only solve the third problem but will also facilitate the solution of the first two problems. As Lederman (2000) asserts "Placing technology within the context of science content, if done effectively, necessitates the use of appropriate pedagogy, takes advantage of the unique features of technology, makes science more accessible, and sets the stage for the development of students' understandings of the relationship between technology and science." (p. 3).

SOME NEW TECHNOLOGICAL APPLICATIONS IN SCIENCE EDUCATION

In science education, teachers and students have a chance to use a variety of valuable resources offered by information technology. The forthcoming information technology tools can be listed as the Internet, simulations, hypermedia, software/video resources, and probeware (Roblyer & Edwards, 2000).

One product of technology is the Internet which can be used extensively for science education. Students can get first hand information from sources such as government offices, universities and other private companies. It could help students to acquire information whenever, wherever, and whatever they want. Science teachers also can design collaborative learning environments. In these environments science learning can become more effective, motivating and interesting for students.

Science teachers can also use simulators for teaching science. A simulator is a device that reproduces the operating characteristics of real equipment (Gagne et al., 1988). Simulations can assist students to get experiences in applications which are dangerous to try in real life situations.

Hypermedia software that connects elements of a computer system such as text, movies, pictures and other graphics through hypertext links could be used to offer more visual instructional materials and activities to motivate students more to learn science. These hypermedia programs are available for all age levels.

Software and video resources can also be used for teaching higher-level science. They can provide effective assistance in the teaching learning process. Students can be exposed to various experiments and concept demonstrations about how to use science in their real lives. They can also offer many experiences that the students can never get in real life situations such as the structure of an atom or the motion of the pistons of an internal combustion engine and so on. Hence, software and video resources can assist students to perform experiments and observe concept demonstrations.

Microcomputer-based lab (MBL) sometimes referred to as probeware has proven to be useful in science classrooms (Roblyer, 2003). MBL consists of a type of instructional software tool accompanied by special hardware sensors (probes) that allow scientific data to be collected and processed by a computer. If a graphing calculator is used instead of a computer then the resulting tool is called a calculator-based lab (CBL). By the use of MBLs students can enjoy doing experiments easily where measurement of phenomena such as light, temperature, voltage and/or speed is required.

Hence, as explained in the above examples, emerging educational technology tools can help science teachers in teaching science effectively and without difficulty. Today's science teachers should be trained in how to use and adopt these technology resources in their classrooms to provide them with the necessary competency as well as the interest for designing their lessons by using technological facilities.

Unfortunately, the very meaning of the term *technology* causes a problem in the sense that educational technology is usually identified with computers. Fernando Cajas (2001) asserts that "A growing number of individuals and institutions acknowledge that technology goes beyond computers" (p. 727). Hence, classical technology tools such as the blackboard, and laboratory technology resources such as the equipment used for science experiments are to be considered as technology tools which must be integrated into teaching science.

THE AIM OF THE RESEARCH

A key to the success of science education is the use of educational technology. As it has been identified above, the use of educational technology tools when teaching science can significantly enhance a student's understanding of science. For example, the educational technology tools can take a difficult to learn science concept and convert it from abstract to concrete to put it in a form to be understood easily. The power of educational technology tools in a science classroom should be valued by the science teachers. Is this the case? Do classroom teachers in North Cyprus understand the power of educational technology tools in science instruction? Do they value its use for science teaching? The main goal of this research study was to find out the responses of teachers about the integration of technology into science teaching. Investigation was carried out to find out how often the science teachers of North Cyprus utilized educational technology which had been divided into four main categories as **classical technology, modern technology, computer technology and laboratory technology resources** (See Table 2). The research also aims to analyze relationships that exist between teachers' perceptions about the use of educational technology in relation to their gender, age, experience, level of education and location of schools. The quality of science teaching may well be dependent upon the perceptions of science teachers about the use of educational technology resources.

RESEARCH QUESTIONS

Using the current literature as a guide, this study attempted to answer the following questions:

1. How often do the science teachers use educational technologies?
2. Is there any relationship in the teachers' perceptions about the use of educational technology in science lessons based on their gender?
3. Is there any relationship in the teachers' perceptions about the use of educational technology in science lessons based on their age?
4. Is there any relationship in the teachers' perceptions about the use of educational technology in science lessons based on their teaching experience?
5. Is there any relationship in the teachers' perceptions about the use of educational technology in science lessons based on the location of the schools?
6. Is there any relationship in the teachers' perceptions about the use of educational technology in science lessons based on their level of education?

SIGNIFICANCE OF THE STUDY

The results of this study can be used by educators to determine professional development needs of science teachers. According to the responses of the teachers that have been identified by the study professional development opportunities can be planned and delivered to scale up their understanding of educational technology tools and to provide them with necessary skills for practical uses of these tools. Also the educational authorities will be obligated to check for the existence of the technological tools that have been claimed not to be used frequently by the teachers and if any are missing they should try to provide them as soon as possible.

SCOPE AND LIMITATIONS

In this study, a sample of size 100 science teachers was used. They voluntarily filled out the questionnaires but still this study is subject to the following limitations:

1. The data were collected through the administration of a survey instrument.
2. The study assumed truthful, candid responses by the teachers who understood and were not fearful of reprisal for their completion of the questionnaire.
3. The responses to the survey items by the teachers could be subject to unknown personal biases and perceptions.
4. The researchers did not have manipulative control of the independent variables because the study was non-experimental; therefore, no explicit cause-and-effect relationship can be determined.

METHOD

Operational Definitions of Variables

This study was designed to examine teachers' responses about using educational technology for teaching science and to compare their responses based on gender, age, experience, school location, and educational level of teachers.

Independent Variables

Teacher's Characteristics:

a. gender,
b. age,
c. experience,
d. school location,
e. level of education.

Identification of the Population

The population under investigation includes teachers who teach science courses at elementary, middle and high schools in North Cyprus. Groups in this study represent all science teachers in North Cyprus.

Sample

Sample was selected by the method of random sampling as 100 teachers from the public schools of the Ministry of Education and Culture of North Cyprus for administering the questionnaire prepared to assess the perceptions of teachers about the use of technology in their science lessons.

Instrument

For this research study, a questionnaire was prepared by the researchers. This questionnaire was designed to assess teachers' perceptions and consisted of one hundred and fifty three items. Teachers recorded their responses on a series of four-point Likert-scale (1=never, 2=sometimes, 3=often, 4=always).

Data Collection

The teachers' responses were assessed by the prepared questionnaire. Educational technology questionnaires were given to 100 teachers. Two steps for the collection of data were used as follows:

1. A copy of the questionnaire was given to each science teacher.
2. After the completion of the questionnaires, the teachers gave them back to the researchers.

Data Analysis Procedures

In this study, quantitative research methods were used in order to fully investigate the research problem. Teacher responses to the questionnaire were statistically analyzed according to gender, age, experience, location of school, and level of education of the teachers.

The frequency data indicated the level of implementation of each item. ANOVA and t-test were used to analyze each item for comparing potential relationships in ratings based on gender, age, experience, location of school and educational level of teachers. The data were analyzed using the statistical software package SPSS for Windows. In this process, an alpha level of 0.05 was set to test each hypothesis.

PRESENTATION OF DATA

This part presents the summary of the data collected. The main purpose of the study was to investigate teachers' responses about the integration of educational technology resources into science lessons. Hence, quantitative data collected from 100 science teachers are presented as demographic data and as frequencies of individual items of the questionnaire (Tables 1, 2, 3 and 4).

Demographic Data

Teachers completing the questionnaire were 40% (40) Female and 60% (60) male.

The age levels of the respondents were

30% (30) below 25 years,
25% (25) between 26-30 years,
23% (23) between 31-35 years, and
22% (22) between 36-40 years of age.

The experience of teachers were

30% (30) 0-5 years,
25% (25) 6-10 years,
23% (23) 11-15, and
22% (22) 16-20 years of experience in teaching.

68% (68) of teachers work at urban schools and 32% (32) of teachers work at rural schools.
The educational level of the teachers indicated that 80% (80) have a B.S or a B.A. degree, and 20% (20) have a master's degree.

Tables 1, 2, 3 and 4: Frequencies of individual items of the questionnaire

1. Percentage of Teachers who often or always use **Classical** Educational Technology Tools

Technology	Percentage	Technology	Percentage
Blackboard	100	Exercise Books	38
Books and Practice Books	95	Graphics	35
Figures and Tables	68	Drawing Instruments	25
Bulletin Boards	55	Slides	10
Measurement Instruments	48		

2. Percentage of Teachers who often or always use **Modern** Educational Technology Tools

Technology	Percentage	Technology	Percentage
Internet and WWW Pages	37	Chat or Teleconference	0
Television and Video	26	VCD or DVD	0
Search Engines Over Internet	25	Laser Disc or Film	0
Overhead Projectors	22	Video Camera	0
Calculators	7	Radio or Tape	0
Internet Cameras	5		

3. Percentage of Teachers who often or always use **Computer** Technology Resources

Technology	Percentage	Technology	Percentage
Windows and MS-Office	22	Digital Cameras	0
Data Projector	11	Multimedia	0
Special Software	0	Laptops	0
Practice Software	0	Printers	0
Scanners	0	CD-ROM or DVD-ROM	0

4. Percentage of Teachers who often or always use **Laboratory** Technology Tools

Technology	Percentage	Technology	Percentage
Gloves	75	Beam balance	33
Safety masks	65	Manometers and barometers	33
Connection cables	61	Prisms	31
Models	58	Scissors	31
Power supplies	51	Connection pipes	31
Bulbs and lamp socket	45	Balance	31
Electrodes (carbon or steel)	42	Tube holders	31
Stoppers	41	Conductive wires	29
Circuit switches	40	Stirring rods	29
Plastic rods	39	Electrical ovens	29
Electroscopes	39	Glass Plates	29
Hoods	38	Glass Markers	29
Magnetic bulbs	38	Tri-pots	28
Inclined plane carts	38	Electrodes	28
U-Tubes	38	Volumetric Flask	27
Lenses	37	Pulleys	27
Test-tubes and test-tube containers	35	Voltmeter	27
Stands	35	Tubes25	
Cones	35	Erlenmeyer Flask	25
Watch glasses	35	Bell-Jars	25
Microscopes	35	Dynamometers	25
Inclined plane boards	35	Mirrors and Optic Ray	25
Magnet	35	Chronometers	25

Beaker and Spatulas	25	Electrical Heating	18
Dissecting Cuvettes	25	Pens	18
Bunsen Holder	25	Barometers	18
Bulbs	24	Lancets	15
Burettes	22	Graduated Cylinders	10
Rheostats	22	Manometers and Ammeters	10
Compasses	22	Various Filter Papers	11
Litmus Paper	22	Thermometers	11
Lamp Sockets	21	Induction Coils	9
Glass Covers	21	Diapasons	0
Lamella Sockets	20	Pendulum	0
Bistouries	21	Oscilloscopes	0
Bunsen burner	19	Metal Gauses	0
PH Indicators	19	Gravzant Rings	0
Capillary Tubes	19	Sterilizers and Centrifuges	0
Droppers	19	Refrigerators	0

Majority of teachers often or always use *classical* educational technology resources. 100% (100) of teachers often or always use blackboard and 95% use books and practice books in their classrooms. Only a small percentage of teachers often or always use modern educational technology or computer technology. Even laboratory equipments which are essential in teaching science are not often used by the majority of teachers. Pendulums, oscilloscopes, refrigerators or thermometers are some of the examples that are not frequently used by the teachers.

RESULTS OF HYPOTHESIS TESTING

According to independent samples t-test results that were done for gender, all values (between 0.47 and 0.10) were higher than the standard value of α: 0.05. It indicates that there is no significant difference in teachers' responses about the use of educational technology based on their gender.

According to ANOVA test results that were done for age, almost all values (between 0.038 and 0.009) were smaller than the standard value of α: 0.05. This result reveals that younger teachers use educational technology tools more than the older teachers.

According to ANOVA test results that were done for years of teaching experience of teachers, almost all values (between 0.049 and 0.018) were smaller than the standard value of α: 0.05. It indicates that teachers who have an experience of 10 years or less agree more to use educational technology tools than those teachers who have an experience of 11 years or more.

According to ANOVA test results that were done for school location, almost all values (between 0.0428 and 0.019) were smaller than the standard value of α: 0.05. This result reveals that teachers from urban schools use educational technology more than teachers from rural schools.

According to ANOVA test results that were done for level of education of teachers, all values were higher than the standard value of α: 0.05. It indicates that there is no significant difference in teachers' responses about the use of educational technology resources based on their level of education.

CONCLUSIONS

According to frequencies, a small number of teachers agree to use educational technology resources. In addition, t-test and ANOVA test results indicated that there are no significant differences in teachers' perceptions about the use of educational technology based on gender and level of education of teachers. On the other hand, ANOVA test results revealed that there were significant differences in teachers' responses about the use of educational technology tools based on the location of schools, teaching experience and age of teachers.

The results of the study revealed that science teachers unfortunately are reluctant in using educational technology extensively in their classrooms and/or laboratories. Although there are some differences between groups of teachers according to their perceptions, they all need to change their views about educational technology resources. For example, younger teachers are more enthusiastic than older teachers but still most of them do not frequently use educational technology. Therefore, in-service training of **all** teachers is necessary to increase their

enthusiasm about integrating educational technology tools into their science lessons. Of course, further research is necessary to investigate the reasons why teachers are reluctant in using educational technology tools.

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