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An Evaluation of a CD Provided to Schools to Enhance Learning in Marine Biology for Senior Primary School Children

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ABSTRACT

In this study we evaluate a digital marine science resource presented to primary schools for senior children. A quasi-experimental semi-quantitative methodology was employed. It was found that control, semi-control and experimental groups all showed significant improvements in attainment scores. However the experimental group (the group taught the topics using the digital resource) showed the greatest relative increase. We note gender differences: boys appeared to perform better; and an unaccounted for difference in the age groups. The study highlights the need for further research into evaluation of digital resources in schools and adopting 'quality control' measures were real learning should be demonstrated before they are adopted in schools.

KEYWORDS: *Digital resource, Senior primary, Improving attainment*

INTRODUCTION

Researchers in the field of science education have iterated that information and communications technology (ICT) can support the investigative (skills and attitudes) and the knowledge based (concepts) aspects of primary science and this has obvious benefits for the holistic development of the child (Murphy *et al.,* 2003). The government of Ireland invested considerable funds to improve the ICT infrastructure (18 million euro for broadband roll-out to all schools in November 2004) and the launch of awards to signify competency in ICT, *i.e.,* Digital Schools Award in 2006. The main aim of these strategies would appear to be to equip young people with competency in ICT to survive in an ever-emerging knowledge-based society. However, there are many recognised difficulties in achieving the aims set out above. These include: inadequate practical, financial and time resources, inadequate training for teachers, ambiguity in some of the objectives of the curriculum and lack of support in implementing these objectives – especially in the case of incorporating ICT into the curriculum (NCCA, 2005).

The ICT application used as a resource tool in the study was an internet-based website called 'Something Fishy' (http://www.somethingfishy.ie) which is designed as a teaching module for 5th and 6th classes and is relevant to the Social, Environmental and Scientific Education (SESE) and Social, Personal and Health

Education (SPHE) syllabi in the curriculum for primary schools in Ireland (NCCA, 1999). This educational resource is available online and as a teaching pack for use in the conventional way in classrooms *i.e.,* book-orientated, albeit with experimental activities but without ICT as a resource. The pack comprises of nine double-sided activity-based cards for pupils which explore different aspects of aquatic life, *e.g.,* water, fish, the life cycle of the salmon, fish stocks, angling, conservation of our rivers and lakes and fish as a part of the food chain. The interactive course includes all the material in the pack as well as photos, animations and links to other websites. The module is set out in eight lessons but the researcher decided to split each lesson in two in an effort to cover every aspect of the module in detail as some entailed experiments, field trips or art activities. Both the semi-control and the experimental groups did the exact same lessons differing only in the fact that they had different teachers and the experimental group used the interactive course as a resource in their lessons.

METHOD

The present research is a semi-quantitative evaluation of an intervention programme for primary school students in South West Donegal. An quasi experimental-type design was employed. The present research is a non-equivalent control group design using non-probability, convenience sampling **(**non-probability refers to the fact that not every person in the population has an equal chance of being a participant in the research (Cohen, 1977) and convenience sampling refers to the method of selection of participants i.e. it involves the enrolment of available/easily accessible subjects until the desired sample size is reached (Kane & O'Reilly-De Brun, 2001)).

We chose non-probability, convenience sampling for the following reasons:

- Time, work and financial constraints made it unfeasible to use probability/random sampling
- Nature of work (teacher) meant that direct access to participants was facilitated
- The researcher was not capacitated to omit elements from the study on ethical grounds
- The researcher did not have access to a sampling frame i.e. a list of all elements in the target population (Cohen 1977) because of time constraints, volume involved and data protection issues

The participants of the study were recruited through a convenience sampling method as some were enrolled in the primary school where the researcher works and others were enrolled in a neighbouring primary school. All participants were in either 5th or 6th class in rural schools and all were studying the science curriculum for primary schools in the Republic of Ireland. There was a mix of male and female students and no attempt was made to employ such strategies as matching – where attempts are made to match factors such as age, intelligence or gender of one participant in one group with a participant in another - or quota sampling – where a set amount of participants with particular characteristics or traits is required for

the research, *e.g.,* age, sex or intelligence. Below is a participant profile table of the 60 research subjects. See Table 1 for participant profiles of specific groupings within the study.

Table 1. *Participant profiles*

Categories	Participants	Control	Semi-control	Experimental
6th Class	34	12	10	12
5th Class	26	8	10	8
Age 11	23	6	8	9
Age 12	33	12	11	10
Age 13	4	2	1	1
Male	31	10	12	9
Female	29	10	8	11
Learning disability diagnosed	29	10	8	11

A questionnaire was designed to acquire an attainment score in the conceptual knowledge presented in the resource. Reliable questionnaires must be used where possible so that the veracity of the findings can be acknowledged and accepted by the research community. However, as no questionnaire exists that would examine conceptual development based solely on the use of the ICT application used in the research or any specific ICT application, it was decided following discussion with the research supervisor, to devise a questionnaire to suit the research. The threats to internal and external validity are acknowledged. We endeavoured to ensure that all questions related directly to the main objective of the research question and this was rigorously adhered to in the design process. As the research concentrates on the effect of the intervention on conceptual development, all questions were designed to examine development of all concepts as identified by Murphy *et al*., (2003). The list of concepts possible to develop through science education is: time, life cycles, weight, interdependence of living things, length, change, volume, adaptation, energy and properties of materials. All questions were designed in relation to the content of the ICT application in use during the research, see Table 2 for question linkage to concepts.

Table 2. *Question linkage to concepts*

Concept being tested in question	Question No. related to concept
Adaptation	1, 2, 3, 13, 27, 28, 30
Time	17
Life Cycles	10, 15, 21
Weight	18
Interdependence of living things	4, 12, 22, 25, 29
Length	16, 24
Change	9, 14
Volume	7, 8, 20, 26, 27
Energy	5, 19
Properties of materials	6, 9, 11, 23

The pilot study for this research was carried out in February 2006. Permission was sought and granted from another school principal and 5th and 6th class teacher in that school to pilot the questionnaire. The 5th and 6th classes combined numbered fifteen, seven boys and eight girls, aged between eleven and thirteen in a rural school. This was representative of the study sample. The researcher also piloted the questionnaire with ten teachers in other schools, one being a secondary school science teacher. The questionnaires were distributed by hand by the researcher and collected the same day. Problems identified by the pilot scheme were minimal. Some teachers advocated re-wording of some of the questions but all subjects welcomed the design of the questionnaire, its layout and its visual accompaniment. Some changes were made to the identified questions with no alteration being made to the visual design or layout of the questionnaire.

Sixty eleven to thirteen year olds from 5th and 6th classes in primary school were split into three groups; a control group who were given teaching on the topic at all, a semi-control group who were taught using the traditional method and an experimental group who were taught with the aid of ICT as a resource tool in the lessons. The control group was from a different school to the semi-control and experimental groups and thus was not exposed in any way to any of the experimental conditions.

The study was conducted over an eight week period. The control, semi-control and the experimental group participants were assigned to their groups and a particular teacher for science lessons only. Single lessons lasted an average of forty five minutes but some were longer as small field trips and experiments were sometimes necessary.The lessons on the topic were then taught over eight weeks. This consisted of two lessons per week for the eight weeks which numbered sixteen lessons in total. Each group was given a pre-test questionnaire to provide baseline data for the analysis of the study. The questionnaire consisted of closed questions (multiple choice) where there was only one correct answer. The participants were instructed by the teacher on how to complete the questionnaire which was to circle the letter opposite what they deemed to be the correct answer. At the end of the eight weeks, all three groups were given the same questionnaire again in the post-test.

RESULTS

In order to ascertain whether there were any significant differences in the results obtained by the participants in the different research groups, it was necessary to carry out comparative tests on results of selected sub-groups within the study. These sub-groups are participants' age, gender and school class level and have been identified as being variables, which could affect the overall conclusions of the research. Thus they must be analysed separately. A total of 60 children participated in this study i.e. 20 in each group. A total of 120 questionnaires were given out (60 pre-test and 60 post-test) Every questionnaire consisted of 30 identical questions. No questionnaires were withdrawn, as all children were present on the days of the tests. A mark was given for each correct answer. The results were

then analysed on the basis of percentage improvement from pre-test to post-test within the groups and t-test were conducted on selected groups to find out whether the improvements were significant or not. As previously mentioned, the statistical software package used during this analysis was Microsoft Excel.

General analysis of Control Group

The general analysis here indicated a 10.8% improvement with no experience of the teaching programme being used in the research. (42.7% questions correct pre-test – 256/600, and 53.5% correct post-test – 321/600).

General analysis of Semi-Control Group

This overall analysis shows that a 13.8% improvement in scores occurred in this group, who had the programme taught to them but without the aid of ICT as a resource. (45.0% questions correct pre-test – 270/600, and 58.8% correct post-test – 353/600)

General analysis of Experimental Group

The experimental group, who had the use of ICT as a resource in their lessons, indicated that they experienced a 19% improvement in performance from pre-test to post-test. (47.2% correct pre-test – 283/600, and 66.2% correct post-test – 397/600)

This clearly shows that both groups of students who had experience of the teaching programme had a greater improvement than those who did not *i.e.* the control group. The teacher only instructed group – the semi-control group – shows a further 27.8% improvement over the control group improvement (3 / 10.8%). However, the group with access to ICT resources – experimental group – shows a further 75.9% improvement over the control group improvement. (8.2 / 10.8%). These results are presented below in Table 3 and Figure 1.

Table 3. *General analysis summary*

	Questions Correct		Percentage Correct		Improvement %
	Pretest	Post-test	Pretest	Post-test	
No Teaching (cont)	256	321	42.7	53.5	10.8
Normal Teach (semi)	270	353	45.0	58.8	13.8
Comp. Assisted (exp)	283	397	47.2	66.2	19.0

In order to ascertain if the above learning gains within each group were significant, t-test were conducted on the before and after results of the groups.

T-TEST RESULTS

A one-tailed paired t-test (Table 4) was conducted to test the hypothesis that there was no significant difference between the pre-test and post-test means of the control group. The calculated t-value was 3.01. As this exceeded the critical (tabulated) value of 2.025 at a 5% level of significance and 38 degrees of freedom, the null hypothesis was rejected. This shows that there was a significant difference

between the pre-test and post-test scores of the control group. There is, therefore, evidence to suggest that the control group has made significant improvement without the experience of the taught programme.

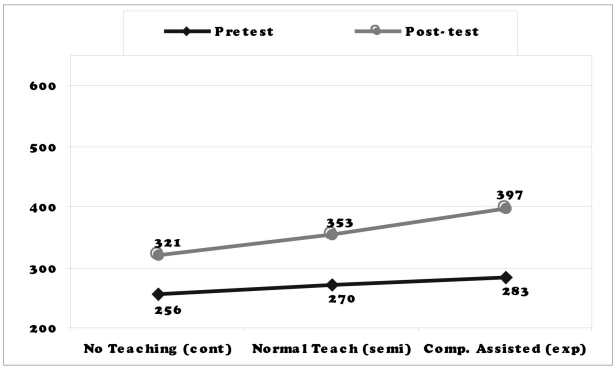

Figure 1. *General analysis graphed*
Scores (out of 600) of the three groups

Table 4. *Paired T-Test results*

Experimental		Semi-Control		Control	
SD	**S_{err}**	**SD**	**S_{err}**	**SD**	**S_{err}**
3.16	0.78	3.03	0.74	2.44	0.58
3.79	0.78	3.59	0.74	2.76	0.58
	SD_p		SD_p		SD_p
	3.49		3.32		2.61
	$S_{err}diff$		$S_{err}diff$		$S_{err}diff$
	1.25		1.22		1.08
	t		t		t
	4.92		3.40		3.01
	v		v		v
	38		38		38
	@ 0.05		@ 0.05		@ 0.05
v=38	2.025	v=38	2.025	v=38	2.025

Similarly, a one-tailed, paired t-test was carried out to test the hypothesis that there was no significant difference between the pre-test and post-test mean scores of the semi-control group. The calculated t-value was 3.40. As this exceeded the critical value of 2.025 at 5% level of significance and 38 degrees of freedom, the null hypothesis was rejected. This shows that there was indeed a significant difference between the pre-test and post-test scores of the semi-control group. The implication is that traditional teaching methods contributed to improvement in performance of this group.

Again, a one-tailed paired t-test (Table 4) was carried out to test the hypothesis that there was no significant difference between the pre-test and post-test means of the experimental group. The calculated t-value was 4.92. As this exceeded the

tabulated value of 2.025 at a 5% level of significance and 38 degrees of freedom, the null hypothesis was again rejected. This shows that there was a significant difference between the pre-test and post-test scores of the experimental group. Therefore, there is ample evidence to suggest that the experimental group has made significant improvement due to the use of ICT resources.

Besides examining the relative improvement in attainment of conceptual knowledge, other factors were investigated such as gender (Figure 2.); school size (Figure 3.); and student age (Figure 4.).

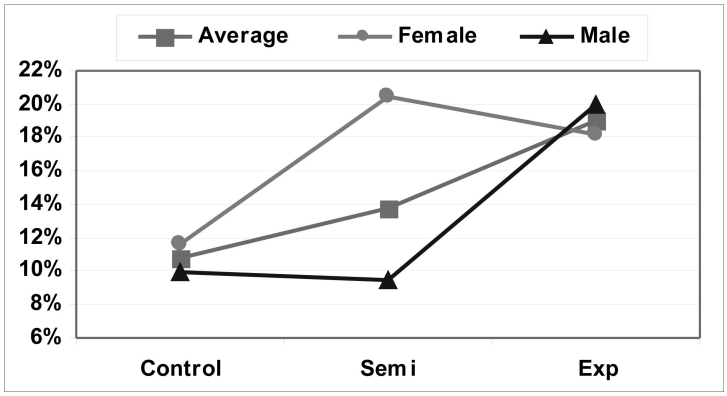

Figure 2. *Improvement of scores according to gender*

The general trend (average line) indicates improvement from the control group to the semi-control group and subsequently to the experimental group. However, the males respond very differently to the females. The males showed no improvement from the control group to the semi-control group but responded greatly to the ICT assisted learning in the experimental group. On the other hand, the females responded very well to the traditional teaching approach of the semi-control group but less so to the ICT assisted lessons in the experimental group. These results indicate that the boys responded better to computer/ICT-assisted learning than traditional teaching methods and that the girls experienced no benefit from the ICT assisted learning.

Boys and girls from two class levels (5th and 6th) were employed in the study but which displayed the greatest improvement? Basically these results indicate that both 5th and 6th class students benefit from the teaching of the science lessons in the research programme. As can be seen from the graph above, the 6th class students showed improvements in all three research groups. Although the 5th class students demonstrated similar overall improvements when compared to the 6th class students, the 5th class semi-control group showed no such improvement when compared to the control group.

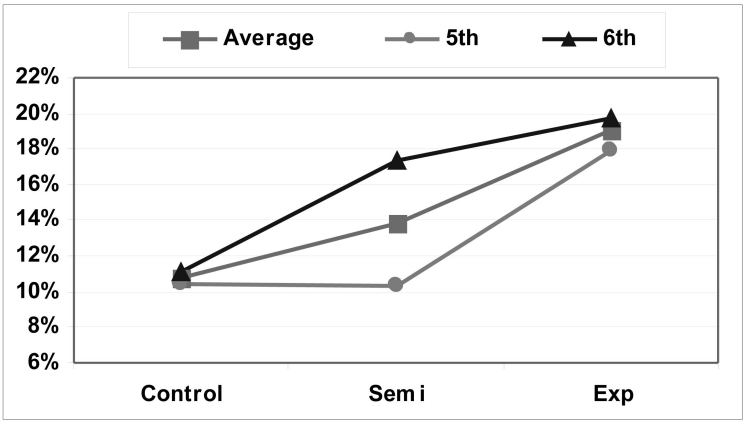

Figure 3. *Improvement of scores according to the school class*

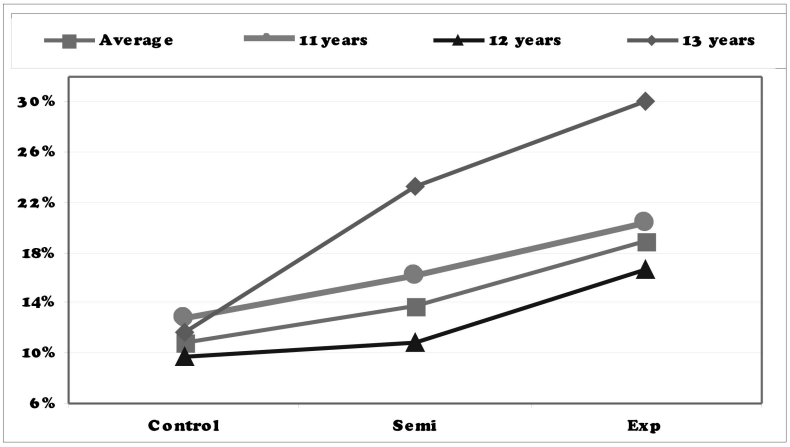

Figure 4. *Improvement of scores according to age of the students*

The preliminary analysis showed that all the groups observed in improvement in performance from pre-test to post-test levels. Here we identify which group improves the most with regard to their exposure to the specific conditions of each group. As can be seen from the graph above, the 12-year olds in all three groups appear to perform consistently below average, while the 11-year olds perform above average in all three research groups. The greatest improvement is in the 13-year old age group. However, due to the small number of 13-year olds in the study (4/60) the 13-year olds have little impact on the overall average performance of the research group as a whole.

CONCLUSIONS

- No significant difference was detected between the control, semi-control and experimental groups and all showed a significant improvement in attainment scores. However, the experimental group had the greatest relative increase.
- It was noted that boys responded better to computer-assisted learning than traditional teaching methods and that the girls experienced no benefit from the ICT assisted learning.
- We found that 5th and 6th class students benefited in real terms from the teaching of the science lessons in the research programme.
- As can be seen from the graph above, the 12-year olds in all three groups appear to perform consistently below average, while the 11-year olds perform above average in all three research groups. The greatest improvement is in the 13-year old age group. The preliminary analysis showed that all the groups observed in improvement in performance from pre-test to post-test levels. Here we identify which group improves the most with regard to their exposure to the specific conditions of each group.

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