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EDITORIAL

M. Fatih Taşar, Associate Editor
Gazi Üniversitesi, Ankara, TURKEY

Dear readers and contributors of EJMSTE,

We are now glad to release the second issue of the third volume. In this issue there are nine articles, again from a diverse set of topics and regions of the globe. In the past couple years EJMSTE has become known by almost every colleague in our field. Thus, we are receiving an increasing number of manuscripts every month. We would like to take this opportunity and thank all of our authors and diligent reviewers.

We also would like to welcome new editorial board members: Professors **Charles Hutchison** of The University of North Carolina at Charlotte, **Radhi Mihiri** of Université Tunis El Manar and **Ingo Eilks** of University of Bremen. Another development is that Professor **Anetta Gough**, a member of our editorial board, is now also assuming the associate editorship.

As you all know by now that EJMSTE is being published, starting with this volume, 4 times per annum in February, May, August and November. It is no doubt that the continuation of this journal and its quality will depend on all our efforts. We are doing our best in order to speed up the review process and publish the papers in a fast and timely manner to better suit your needs.

We are looking forward to receiving your valuable contributions in the coming issues.

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The Professional Preparation of Malaysian Teachers in the Implementation of Teaching and Learning of Mathematics and Science in English

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Malaysia is in the process of changing the medium of instruction for mathematics and science from Malay to English since 2003. To ensure the success of this transition, teachers have to be professional prepared to teach in English. This research aimed to survey the Malaysian science/ mathematics teachers' perception towards this professional preparation effort. An instrument called "Teachers Perception Towards the Professional Preparation to Teach Mathematics/Science in English" was developed. The samples were 72 Form One mathematics/science teachers in Malaysia. The research revealed that the teachers perceived that their pre-service training (M = 2.90, SD = .57) and the in-service training (M = 2.99, SD = .62) is adequate in their professional preparation. However, the teachers perceived that there is a need (M = 3.18, SD = .82) for enhancing their professional readiness to teach mathematics/science in English. Further analysis revealed that 44.3 % of the sample reported that their pre-service training could not develop their confidence in English speaking and after the in-service training 31.4% of the teachers still reported the same. About 84.7 % of the teachers also reported the need for training on helping students to learn in English. The findings showed that although the teachers perceived they are professionally prepared to teach mathematics/science in English, they still need more preparation in overcoming students' difficulties in learning the subjects in English especially for students who are weak in English or mathematics/science or both.

Keywords: Professional Development, Science, Mathematics, Teachers, Assessment

INTRODUCTION

In recent years, many factors have converged to steadily increase the momentum toward professionalization of the field of teaching mathematics and science.

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Recently, some of countries were initiating and implementing standards and accountability systems to better monitor the impact of mathematics and science education programs. The programs are being held to higher standards not only as measured by student outcomes but also in terms of program quality indicators. Given the centrality of teacher competence in both measures of program quality and in learning outcomes, many countries are investing in state-wide professional development efforts and some are beginning to experiment with various types of competency and credentialing mechanisms (Parke, 2000). Professionalization has been defined as the movement of any field towards some standards of educational preparation and competency. The term professionalization indicates a direct attempt to (a) use education or training to improve the quality of practice, (b) standardize professional responses, (c) better define a collection of persons as representing a field of endeavor, and (d) enhance communication within that field (Shanahan, Meehan, & Mogge, 1994).

Teacher education has always been a crucial and symbolically significant field of education development. A country's nation building lies in the hands of its teachers. No matter how good the curriculum, infrastructure or teaching aids, at the end of the day it is the teachers who make a difference. Teachers are valuable human resources that a nation can count upon to mould and nurture its young minds (Syed Azizi Wafa, Ramayah, & Tan, 2003). Teachers are at the heart of the educational process. The greater the importance attached to education as a whole-whether for cultural transmission, for social cohesion and justice, or for human resource development so critical in modern, technology-based economies-the higher is the priority that must be accorded to the teachers responsible for that education (OECD, 1989).

Teaching, like any other profession, has its own unique set of challenges. Many of these challenges exist because teaching and learning is rooted in the human dimension. This means we do not always act rationally, even when it might be in our best interest to do so. In addition, there are so many challenges we face such as, the lack of resources, overcrowded classes, and unmotivated students, uninvolved or over involved parents, unsupportive colleagues and insensitive administrators (Kottler & Zehm 2000).

Teaching is usually seen as a form of professional work, that is, a type of complex work requiring a great deal of specialized knowledge (Sykes, 1990). To become good teachers when facing challenges and complex work as well as constraints, teachers need positive attitude. According to Ferrett (1994), positive work attitude is the key for success at work. Employees with positive attitudes and enthusiasm at work become invaluable to institutions of today that have become more and more service-oriented. People with positive attitudes tend to: (i) have positive feelings about people and situations; (ii) have a sense of purpose, excitement, and passion; (iii) approach problems in a creative manner; (iv) have a resourceful, positive, and enthusiastic air about them; (v) make the best out of every situation; (vi) realize that attitude is a choice; (vii) feel that they have control of their thoughts; and, (viii) feel that they are making a contribution through their work.

In Malaysia. the role of English as a taught subject has been changed into a medium of instruction when the minister of education declared that mathematics and science will be taught in English in all fully aided government schools from 2003 onwards. This change has been implemented in attempting to prepare the generations with the abilities in facing the needs of this global era. The advances in science and technology demand new skills and abilities and have made an impact on the teaching and learning process.

This implementation raised many debates among the general public, parents, political parties and even teachers on the effectiveness as it is still in the transition stage. Many people are skeptical about its success citing reasons such as poor English language proficiency of teachers for these subjects and the lack of student interest towards learning English (Alwis, 2005). While discussions were being held with various groups, the government went ahead with its preparations to implement the policy. The Ministry of Education presented the necessary infrastructure to enable teacher readiness in implementing the change.

Pillay and Thomas (2004) reported that the ministry set up 14 working committees to implement the decision. These committees represented the areas of curriculum, textbooks, teacher training, teaching resources, supplementary resources, ICT, publicity, monitoring, assessment, special education, technical studies, matriculation programmes, promoting English language use and special funding for schools.

One of the major challenges in this implementation is the teacher's ability (Pillay & Thomas, 2004). The teachers involved had varying levels of competency in English as most of them completed their education beginning from the primary right up to the tertiary level in Bahasa Melayu. Starting from 1970, all the Government-aided English Medium schools were replaced by Malay-Medium schools, and by 1982, all national secondary and university education was conducted in the national language (Mauzy, 1985). So, these teachers who went through this education system have inadequate proficiency in English.

To face the problem, the ministry developed a re-training programme to enhance English language proficiency among mathematics and science teachers. It was designed to meet their specific needs and focused on the skills for teaching mathematics and science disciplines in English.

To add to this programme, the ministry also provided the continuous support programme at the school level such as the Buddy Support Programme that stressed the collaboration between Mathematics and Science teachers with their language counterparts. Competent English teachers were appointed as 'Critical Friends' to science and mathematics teachers in school. The teachers were also supplied with self-instructional material to facilitate their own learning.

There are 29 Teacher Education Colleges within Malaysia providing pre-service and –in-service programmes. Most of the Teacher Colleges are generalist in nature, although there are specialist languages institutes, vocational and technical colleges, Religious Colleges, Women's Colleges and one Science College.

There are two main types of pre-service programmes: The Malaysian Diploma of TeachingMDT) and the Postgraduate Diploma of Teaching (PDT). There are also a number of twinning programmes between local and overseas universities where selected students train to be teachers. Across Malaysia, about 4000 teachers graduate each year from the MDT and about 3000 from the PDT.

The curriculum is set nationally and consists of 5 major components namely Teacher Dynamics (English, Moral and Religious Education, Basic ICT etc.), Knowledge and Professional Competency (Psychology and Pedagogy etc.), Knowledge in subject specialization and Option (one major and three other elective areas), Co-curriculum activities; and Practicum. Assessment involves a combination of examinations, coursework assignments, journals and formative and summative evaluation of teaching practice.

The postgraduate diploma of teaching entry requirements include a Bachelors Degree from a local or overseas university or institution of higher learning and a credit in Malay Language at the School Certificate level. Malaysia is in the process of upgrading the qualification of its teachers. By 2005, all secondary teachers are expected be university graduates, and that by 2020 all teachers will be graduates. For teachers who have a three-year teaching diploma based on "O" level educational qualification, the pathway to the degree is through a pre-course 14 week in-service programme in the subject matter plus one full-time year at a teacher training college and three full-time years at a university.

The quality of teacher learning is no less important than the quality of student learning experiences. Teachers need to be rejuvenated with new ideas and challenges to promote renewed enthusiasm in their profession. Professional development should be aimed at meeting the needs of each individual teacher especially when implementing a new policy such as the teaching and learning of mathematics and science in English.

Staff development is more complex than ever before. It will require different techniques and serves a different purpose. What is needed is a dynamic, systematic professional development that is more comprehensive, better organized and more responsive than most of the existing in-service training. The more complex and diversified an educational organization becomes the more important it is to have a systematic in-service professional development because schools can no longer rely on pre-service preparations to develop the needed skills. So, to prepare teachers for implementating teaching and learning of mathematics and science in English, they need to acquire knowledge and skills appropriate with this policy.

According to Pillay and Thomas (2004), the task of re-training for this language conversion exercise was assigned to the Teacher Education Division of the Ministry of Education. The English Language Teaching Centre Malaysia (ELTCM), a teacher training college for in-service teacher development, was appointed to develop a national re-training programme aimed at enhancing English language proficiency of mathematics and science teachers.

ELTCM was thus confronted with this mammoth task of planning a nationwide re-training programme. Planners had to grapple with the reality that, "it is impossible to create a single, centrally administered and planned programme of professional development that will meet everyone's needs and desires" (Clark, 1992). However, despite this awareness, the challenge for ELTCM was just that, which was to develop one national level programme that could cater for all.

The training programme develop by ELTCM is known as English for Teaching Mathematics and Science (ETeMS). The planners had to take into consideration the range of challenges teachers would meet in the changing classroom. The Programme had to incorporate elements of activating teachers' English language proficiency as well as developing a specialist language to cope with teaching mathematics and science in English. Hence the aim of the programme is two-fold:

a. To enhance the English language skills of mathematics and science teachers for effective teaching using English as a medium of instruction.
b. To enhance teachers' continuing professional development.

Among the competencies to be developed in the ETeMS training programme are:

a. Language for accessing information
b. Language for teaching mathematics and science
c. Language for professional exchange.

Apart from the face training sessions, the ETeMS structure also integrates ongoing language support elements, namely, asset of instructional language materials, a teacher support system and programme for teachers with low language proficiency. The related Buddy Support Programme recognized the need for continuous teacher support at school level.

According to Altschuld & Witkin (in Veale, 2002), needs assessment has been defined as "the process of determining, analyzing, and prioritizing needs and, in turn, identifying and implementing solution strategies to resolve high-priority needs". Teacher's needs assessment includes both what teachers know and can do and what they want to learn and be able to do. Needs assessment of teachers should focus on what teachers want or believe they need to learn (Weddel & Van Duzer, 1997).

Some researchers like Cranton (in Susan, 1994) argued that through needs assessment, information about the amount and type of direction learners require can be obtained. Adults can identify their problem areas in relation to the course topics through needs assessment. It can become a starting point for their learning.

There are several aims of conducting needs assessment. According to Weddel and Van Duzer (1997, p.2):

A needs assessment serves a number of purposes:

- It aids administrators, teachers, and tutors with learner placement and in developing materials, curricula, skills assessments, teaching approaches, and teacher training.
- It assures a flexible, responsive curriculum rather than a fixed, linear curriculum determined ahead of time by instructors.
- It provides information to the instructor and learner about what the learner brings to the course (if done at the beginning), what has been accomplished (if done during the course), and what the learner wants and needs to know next.

There are many ways to assess the needs of teachers. Weddel and Van Duzer (1997, p.3,) described that "…. needs assessments with ESL learners, as well as with those in adult basic education programs, can take a variety of forms, including survey questionnaires on which learners check areas of interest or need, open-ended interviews, or informal observations of performance."

RATIONALE OF THE STUDY

Some emergent concerns within the Asian countries of late are the incorporation of Information and Communications Technologies (ICT) in the provision of education. More specifically, it is the challenge of incorporating ICT into classroom teaching and learning (SEAMEO Library, 2003). With the influence of technology which emphasizes the importance of some aspects of curriculum content and process, this implies that there is a fundamental shift in educational priority, that is from accumulation of knowledge to the management of information. Hence, this suggests that there is an increasing need for citizens who are informed, critical and capable as decision-makers in a technological world.

In 2003, the Malaysian government had implemented a national policy calling for the teaching of Mathematics and Science in English. This is in line with the increased importance of mathematics and science in the development of knowledge-based economies. Apart from the use of English language for instructional delivery, Mathematics and Science teachers are required to master ICT skills in operating the CD provided by the Ministry of Education during classroom instruction. Hence, educators being the forerunners in executing the national educational policy must abide by the needs to equip themselves with ICT knowledge and to deliver the mathematical and science content knowledge in English.

With the growing emphasis on technology, it is high time to strengthen pre-service teacher training and professional development in the use of ICT in the teaching of mathematics and science. Professional development courses enable Mathematics and Science teachers to develop themselves and be updated on the trends and techniques of integrating ICT in teaching Mathematics and Science. Strategies need to be developed in preparing the Mathematics and Science teachers professionally, and for making available teaching and learning resources which are tailored to teachers' needs (SEAMEO Library, 2003).

The effective use of technology encourages a shift from teacher-centered approaches towards a more flexible student-centered environment. A technology-rich learning environment is characterized by collaborative and investigative approaches to learning, increasing integration of content across the curriculum and a significant emphasis upon concept development and understanding (SEAMEO Library, 2003). Thus, the use of technological tools in teaching Mathematics and Science should enable the teachers and students to learn both these subjects more meaningfully.

Statement of Problem

Most Mathematics and Science teachers who teach in the Malaysian schools were required to attend the professional preparation course to enable them to teach Mathematics and Science in English and to operate the ICT tools effectively. Through informal interviews with the Mathematics and Science teachers from rural and urban schools, it was found that many of these teachers seek longer training in preparing themselves to teach Mathematics and Science in English and in using ICT tools. Teachers who are veterans may have mastered the English language and are competent to deliver Mathematics and Science lessons in English. However, these teachers might not be fully computer literate, thus hindering the use of ICT tools during Mathematics and Science lessons. As a result, though some Mathematics and Science teachers had undergone the training, they did not utilize the ICT tools in executing Mathematics and Science lessons.

Conversely, some teachers who are from the younger generation may be computer literate but may not be conversant in English. This leads to lack of self-efficacy in handling day-to-day lessons and the feeling of inferiority in handling students who have difficulty in learning Mathematics and Science. As a result, teachers who believe they lack professional preparation will opt to teach Mathematics and Science in English alternately with other languages.

Professional preparation encompasses strategies to equip Mathematics and Science teachers to master the English language and to handle ICT tools effectively. In addition, it also encompasses the strategies for teachers to help the students to learn Mathematics and Science in English more effectively. A general observation of students showed that many Mathematics and Science teachers failed to implement steps to help students in overcoming difficulties in learning Mathematics and Science in English, although some of the teachers did quite well in helping the students.

Objectives

The main objective of this study is to examine the professional preparation of the Malaysian teachers to teach mathematics / science in English. Specifically the study is aimed at:

1. determining the level of pre-service training professional preparation of the Malaysian teachers to teach mathematics / science in English.
2. determining the level of in-service training professional preparation of the Malaysian teachers to teach mathematics / science in English.
3. comparing between the level of pre-service and in-service training professional preparation of the Malaysian teachers to teach mathematics / science in English
4. identifying the level of the various needs teachers have for them to enhance their readiness to teach mathematics / science in English.

Research Questions

The main research questions investigated in this study were:

1. What is the level of pre-service training professional preparation of the Malaysian teachers to teach mathematics / science in English?
2. What is the level of in-service training professional preparation of the Malaysian teachers to teach mathematics / science in English?
3. Is there any significant difference between the level of pre-service and in-service training professional preparation of the Malaysian teachers to teach mathematics/science in English?
4. What are the levels of the various needs teachers have for them to enhance their readiness to teach mathematics / science in English?

METHODOLOGY

Research design: This study used the survey method to answer the research questions.

Population and sample: The population of this study was all Form One science / mathematics teachers in Malaysia. The samples selected for this study comprised of 72 teachers teaching Form One science / mathematics. To ensure that the sample will represent teachers teaching Form One science / mathematics in Malaysia, the teachers were selected from schools that were identified based on several criteria. These criteria will ensure that the sample will include teachers from all kinds of schools having the background characteristics representative of schools in Malaysia.

Location: The study was conducted at thirty three secondary schools in Malaysia. All the schools involved in the study are from the fourteen states in Malaysia.

Instrument: The instrument used in this study for the purpose of collecting data is a questionnaire developed by the research team. The questionnaire consists of four main sections: Section A of the instrument collected demographic information of the respondents; Section B comprised eight items where respondents have to respond to a four-point Likert Scale on their perception towards their needs for improving their professional preparation to teach science / mathematics in English; Section C is made up of twelve items where respondents have to respond to a four-point Likert Scale on their perception towards the result of pre-service training in their professional preparation to teach science / mathematics in English; and Section D is made up of twelve items where respondents have to respond to a four-point Likert Scale on their perception towards the result of in-service staff development programme in their professional preparation to teach science / mathematics in English.

Reliability and validity:A pilot study had been conducted to establish questionnaire validity and reliability. Reliability was determined through the reliability coefficient, Cronbach alpha. The Cronbach alpha value for Section B is .88, Section C is .97, and Section D is .91. Other members of the research team validated the instrument.

Data Collection: The data were collected from the samples using the questionnaire. The questionnaire was administered directly to the samples when the research team visited the selected schools from July 2005 to November 2005. The response to the questionnaire were immediately collected before the research team left the schools.

Data analysis procedure: The data collected from this questionnaire were analyzed using the Statistical Package for Social Sciences (SPSS) Version 13.0 software. Descriptive analysis of mean, frequency and percentage was conducted for all the items in the instruments. T-tests were also conducted for each item to compare the professional preparation from the pre-service courses and the professional preparation from the in-service courses.

RESULTS

This section describes the results obtained from analysis of the data collected from the questionnaire. It is organized into three subsections: first, presentation of results of descriptive analysis on professional preparation of teachers to teach science / mathematics in English from the pre-service and in-service courses; second, presentation of the results of comparison between the professional preparation of teachers to teach science / mathematics in English from the pre-service and in-service courses; third, presentation of the results of descriptive analysis on the training needs of the teachers to teach science / mathematics in English.

Teachers' professional preparation to teach science / mathematics in English

This subsection presents the result of analysis on professional preparation of teachers to teach science / mathematics in English from the pre-service and in-service courses. Table 1 presents the frequencies and percentages for the items on the teachers' professional preparation to teach science / mathematics in English from their pre-service training.

As shown in Table 1, a substantial majority of the teachers agreed that the pre-service training they received had prepared them to speak in English (78.5%)

Table 1. Frequencies and Percentages for the Items on the Teachers Professional Preparation to Teach Science / Mathematics in English from Their Pre-Service Training

Item No.	As a result of the pre-service training,	Strongly Disagree	Disagree	Agree	Strongly Agree
1.	I am ready to speak in English	5 (7.1%)	10 (14.3%)	33 (47.1%)	22 (31.4%)
2.	I feel confident to speak in English	3 (4.3%)	28 (40.0%)	31 (44.3%)	8 (11.4%)
3.	I am ready in understanding science / mathematics reading materials in English	1 (1.4%)	9 (12.9%)	42 (60.0%)	18 (25.7%)
4.	I am ready in writing science / mathematics instructional materials in English	2 (2.9%)	19 (27.1%)	41 (58.6%)	8 (11.4%)
5.	I am ready in constructing test items in English	3 (4.3%)	16 (22.9%)	41 (58.6%)	10 (14.3%)
6.	I am ready in delivering instruction of science / mathematics in English	1 (1.4%)	16 (22.9%)	42 (60.0%)	11 (15.7%)
7.	I am ready in guiding students to use English in learning science / mathematics	1 (1.4%)	12 (16.7%)	44 (62.9%)	13 (18.6%)
8.	I am ready in enabling students to understand my science / mathematics teaching.	1 (1.4%)	13 (18.8%)	41 (59.4%)	14 (20.3%)
9.	I feel confident in teaching science / mathematics in English	4 (5.7%)	21 (30.0%)	34 (48.6%)	11 (15.7%)
10.	I am ready in ensuring the science / mathematics instructional objectives are achieved	1 (1.4%)	5 (7.1%)	51 (72.9%)	13 (18.6%)
11.	I am ready to pose questions to students in English	1 (1.4%)	7 (9.7%)	48 (68.6%)	14 (20.0%)
12.	I dare to answer students' questions in English	2 (2.9%)	13 (18.6%)	45 (64.3%)	10 (14.3%)
13.	I am ready to handle learning problems of students who are weak in science / mathematics to learn science / mathematics in English	4 (5.7%)	19 (27.1%)	39 (55.7%)	8 (11.4%)
14.	I am ready to handle learning problems of students who are weak in English to learn science / mathematics in English	5 (7.1%)	21 (29.2%)	36 (50.0%)	8 (11.4%)

and to understand the science / mathematics reading materials in English (85.7%). They also reported being ready to pose questions to students in English (88.6%) and to answer students' questions in English (78.6%). However, a considerable percentage of teachers reported that their pre-service training had not made them feel confident to speak English (44.3%) and to teach science / mathematics in English (35.7%). They also reported that they are not prepared to write science / mathematics instructional materials in English (30.0%), and to construct test items in English (27.1%). About 36.3% of the teachers disagreed that the pre-service training had prepared them to handle learning problems of students who are weak in English to learn science / mathematics in English.

Table 2 presents the frequencies and the percentages for the items on the teachers' professional preparation to teach science / mathematics in English from their in-service training. As shown in Table 2, a significantly large majority of the teachers agreed that the in-service training they received had prepared them to speak in English (82.1%) and to understand the science / mathematics reading materials in English (89.6%). They also reported being ready to pose questions to students in English (83.6%) and to answer students' questions in English (80.6%). A lower percentage of teachers reported that the in-service courses had not prepared them professionally to teach science / mathematics in English. However, there are still some teachers reporting that the in-service training they received had not made them feel confident to speak English (31.4%) and to teach science / mathematics in English (32.9%). They also reported that they are not prepared to write science / mathematics instructional materials in English (21.4%), and to construct test items in English (19.4%). About 35.8% of the teachers do not agree that they are prepared to handle learning problems of students who are weak in English to learn science / mathematics in English even after the in-service training.

Table 2. Frequencies and Percentages for The Items on the Teachers Professional Preparation to Teach Science/Mathematics in English from Their in-Service Training

Item No.	As a result of the in-service training,	Strongly Disagree	Disagree	Agree	Strongly Agree
1.	I am ready to speak in English	1 (1.5%)	11 (16.4%)	33 (49.3%)	22 (32.8%)
2.	I feel confident to speak in English	1 (1.5%)	20 (29.9%)	33 (49.3%)	13 (19.4%)
3.	I am ready in understanding science / mathematics reading materials in English	1 (1.5%)	6 (9.0%)	40 (59.7%)	20 (29.9%)
4.	I am ready in writing science / mathematics instructional materials in English	1 (1.5%)	14 (20.9%)	37 (55.2%)	15 (22.4%)
5.	I am ready in constructing test items in English	2 (3.0%)	11 (16.4%)	42 (62.7%)	12 (17.9%)
6.	I am ready in delivering instruction of science / mathematics in English	2 (3.0%)	8 (11.9%)	40 (59.7%)	17 (25.4%)
7.	I am ready in guiding students to use English in learning science / mathematics	2 (3.0%)	7 (10.4%)	43 (64.2%)	15 (22.4%)
8.	I am ready in enabling students to understand my science / mathematics teaching.	2 (3.0%)	9 (13.4%)	41 (61.2%)	15 (22.4%)
9.	I feel confident in teaching science / mathematics in English	2 (3.0%)	18 (26.9%)	31 (46.3%)	16 (23.9%)
10.	I am ready in ensuring the science / mathematics instructional objectives are achieved	2 (3.0%)	7 (10.4%)	44 (65.7%)	14 (20.9%)
11.	I am ready to pose questions to students in English	1 (1.5%)	10 (16.4%)	41 (61.2%)	15 (22.4%)
12.	I dare to answer students' questions in English	1 (1.5%)	12 (17.9%)	38 (56.7%)	16 (23.9%)
13.	I am ready to handle learning problems of students who are weak in science / mathematics to learn science / mathematics in English	3 (4.5%)	17 (25.4%)	34 (50.7%)	13 (19.4%)
14.	I am ready to handle learning problems of students who are weak in English to learn science / mathematics in English	3 (4.5%)	21 (31.3%)	32 (47.8%)	11 (16.4%)

Comparison between the professional preparation of teachers to teach science / mathematics in English from their pre-service and in-service training courses

This subsection presents the *t*-test results of the comparison between the means of the professional preparation of teachers to teach science / mathematics in English from their pre-service and in-service training courses. From the t-test, the results show that differences between the professional preparation of teachers to teach science / mathematics in English from their pre-service training courses (*M*=2.89, *SD*=.56) and from their in-service courses (*M*=3.01, *SD*= .63) is significant, t(65)=-2.69, $p<.01$.

Table 3 presents the t-test results of the comparison between the means of the items in the questionnaire on the professional preparation of teachers to teach science / mathematics in English from their pre-service and in-service training courses.

As shown in Table 3, the *t*–test results show a significant difference at the level of $p<.01$ between the professional preparation of teachers to teach science / mathematics in English from their pre-service and in-service training courses for Item 2, Item 4 and Item 6. Table 3 also shows a significant difference at the level of

Table 3. The t-Test Results on the Professional Preparation of Teachers to Teach Science / Mathematics in English from Their Pre-Service And In-Service Training Courses by Items of the Questionnaire

Item No.	As a result of the training,	Pre-service Mean	Pre-service SD	In-service Mean	In-service SD	*t*-test *T*	*t*-test *p*
1.	I am ready to speak in English	3.00	.88	3.14	.74	-1.59	.118
2.	I feel confident to speak in English	2.61	.74	2.86	.74	-4.14	.000
3.	I am ready in understanding science / mathematics reading materials in English	3.11	.66	3.18	.65	-1.06	.279
4.	I am ready in writing science / mathematics instructional materials in English	2.77	.68	2.98	.71	-2.90	.005
5.	I am ready in constructing test items in English	2.82	.72	2.95	.69	-2.01	.049
6.	I am ready in delivering instruction of science / mathematics in English	2.89	.66	3.08	.71	-3.00	.004
7.	I am ready in guiding students to use English in learning science / mathematics	2.97	.63	3.06	.68	-1.43	.159
8.	I am ready in enabling students to understand my science / mathematics teaching.	2.98	.67	3.03	.71	-.554	.581
9.	I feel confident in teaching science / mathematics in English	2.74	.77	2.91	.80	-2.176	.033
10.	I am ready in ensuring the science / mathematics instructional objectives are achieved	3.08	.56	3.05	.67	.444	.658
11.	I am ready to pose questions to students in English	3.08	.59	3.05	.67	.406	.686
12.	I dare to answer students' questions in English	2.89	.66	3.03	.70	-2.01	.049
13.	I am ready to handle learning problems of students who are weak in science / mathematics to learn science / mathematics in English	2.73	.76	2.86	.78	-2.12	.038
14.	I am ready to handle learning problems of students who are weak in English to learn science / mathematics in English	2.67	.79	2.77	.78	-1.84	.070

p<.05 for Item 5, Item 9, Item 12 and Item 13. The *t*-test results show that the difference between the professional preparation of teachers to teach science / mathematics in English from their pre-service and in-service training courses for Item 1, Item 3, Item 7, Item 8, Item 10, Item 11 and Item 14 are not significant.

Training needs of the teachers teaching science / mathematics in English

This subsection presents the result of descriptive analysis on training needs of the teachers teaching science / mathematics in English. Table 4 presents the means, standard deviations, frequencies and percentages for the items on the teachers' professional preparation to teach science / mathematics in English from their pre-service training.

As shown in Table 4, the teachers reported they need training on all aspects of teaching science / mathematics in English. For every item in the questionnaire, Table 4 shows that the mean is greater than 3.00. Table 4 also shows that most teachers reported that they need training on speaking English (85.9%), training on conducting question and answer session with students in English (84.5%) and training in guiding students to use English in learning science / mathematics (87.1%). A large majority of the teachers reported they need training on writing science / mathematics instructional materials in English (77.4%), training on constructing test items in English (80.2%), and training on various strategies to teach science / mathematics in English (80.3%).

Our research has shown that the training for teachers involved in implementing the teaching of science / mathematics in English needs to be reviewed for greater efficacy. The need to improve teachers' ability in dealing with students who are weak in English is a priority. Further research with a bigger sample would help to confirm these findings. However, this preliminary study enables educational policy specialists to identify the present shortcomings in teacher professional preparation for the teaching of science / mathematics in English in Malaysia.

DISCUSSION AND CONCLUSION

This study has shown that the majority of Malaysian teachers are satisfied with the pre-service training they had received for preparing them to teach science and mathematics in English. The majority of teachers are also satisfied with the in-service training they had received for preparing them to teach science and mathematics in English.

However, at the 5% significance level, there is significant difference in the level of satisfaction towards the pre-service training as compared to the in service training for the following aspects of the teacher preparation: to feel confident to speak in English; be ready in writing science / mathematics instructional materials in English; be ready in constructing test items in English; be ready in delivering science / mathematics instruction in English; be confident in teaching science

Table 4. The Means, Standard Deviations, Frequencies and Percentages for The Items on the Training Needs of the Teachers Teaching Science / Mathematics in English

Item No.	Aspects of training	Not needed	Less Needed	Need	Very Needed	Mean	SD
1.	Training on speaking in English	5 (7.1%)	5 (7.1%)	22 (31.4%)	38 (54.3%)	3.33	.90
2.	Training on understanding science / mathematics reading materials in English	10 (14.1%)	10 (14.1%)	21 (29.6%)	30 (42.3%)	3.00	1.07
3.	Training on writing science / mathematics instructional materials in English	7 (9.9%)	9 (12.7%)	28 (39.4%)	27 (38.0%)	3.06	.95
4.	Training on constructing test items in English	4 (5.6%)	10 (14.1%)	29 (40.8%)	28 (39.4%)	3.14	.87
5.	Training on delivering instruction of science / mathematics in English	5 (6.9%)	7 (9.9%)	27 (38.0%)	32 (45.1%)	3.21	.89
6.	Training on conducting question and answer session with students in English	5 (7.0%)	6 (8.5%)	31 (43.7%)	29 (40.8%)	3.18	.87
7.	Training on various strategies to teach science / mathematics in English	3 (4.2%)	11 (15.5%)	27 (38.0%)	30 (42.3%)	3.18	.85
8.	Training in guiding students to use English in learning science / mathematics	4 (5.7%)	5 (7.1%)	25 (35.7%)	36 (51.4%)	3.33	.85

/ mathematics in English; be ready to answer students' questions in English; be ready to handle learning problems of students who are weak in science / mathematics in learning the two subjects in English.

The study also found that many teachers perceived they still need more training in preparing themselves to teach science and mathematics in English especially in: speaking in English; delivering instruction of science / mathematics in English; conducting question and answer session with students in English; devising strategies for teach science / mathematics in English; and guiding students to use English in learning science / mathematics.

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A Holistic Approach for Science Education For All

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This article suggests that a genuine reform endeavor towards the "Science for All" paradigm should adopt a holistic approach. There are several countries around the world that adopted the "Science for All" paradigm at the beginning of the 21st century. However, while looking closely at the amount of change that took place in schools following the new paradigm, it seems that like previous reforms, there is a gap between the rhetoric and the actual change. A series of studies indicate that Earth systems science approach is much effective than the traditional "science for all" approach. While implementing it correctly, it succeeds to attract students from both groups – the high achievers group and the much bigger group of students to whom the traditional science programs were frequently inaccessible. Both groups found the Earth System approach attractive and interesting and both gained a significant amount of knowledge and understanding. However, the earth systems approach alone will not be enough and in order to attract most of the students and in addition such programs should be based on a holistic approach that should also include the following characteristics: (1) Learning in an authentic and relevant context as much as possible. (2) Organizing the learning in a sequence that shifts gradually from the concrete to the abstract. (3) Adjusting the learning for variant abilities learners. (4) Integrating the outdoor environment as an integral and central component of the learning process. (5) Focusing on both the cognitive and the emotional aspects of learning.

Keywords: Reforms in Science Education, Science For All, Earth Systems Education, Long-Term Study.

INTRODUCTION

In 1990, the American Association for the Advancement of Science published the policy paper Science for all Americans (AAAS, 1990). This document was a part of the Project 2061, which calls for major reforms in relation to the goals and strategies required for teaching and learning science in schools. The new "Science for All" paradigm perceives the main goal of science education as preparation for the nation's new citizens and its implementation has grown rapidly during the last 15 years in several countries around the world. The most important aspect of this new paradigm was a change in the purpose of science education - from preparing future scientists towards the education of the future citizens. However, while looking closely at the amount of change that took place in schools following the new paradigm, it seems that like previous reforms, there is a gap between the rhetoric and the actual change in the classes. Orion (2003) reported a long-term study that followed the "Science for All" reform process in Israel from its beginning onwards from the 'storm eye'. It includes about 10 years of a qualitative and quantitative data collection, which covered broad components and processes of the reform system: science teachers, principals, superintendents, students, curriculum developers, the academic science education establishment, the ministry of education establishment, in-service training programs and pre-service teachers and programs. The findings indicate that some meaningful changes could be identified as well as effective models to lead and support them. However, in general, no meaningful change concerning the goals of

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the new curriculum was found. It is suggested that the three main groups that are responsible for the minor success of the "Science for All" reform so far are the science teachers, the science education leadership and the Ministry of education bureaucrats and politicians. It is also suggested that such outcomes are not unique to Israel. There are several reasons for the constant failure of educational reforms. A major reason in this case was the academic leadership of the implementation of the reform. Most of the leaders were grown and based their career on the previous paradigm and they themselves failed to undergo a genuine paradigm shift or do not agree with the new paradigm. They grew up in the traditional paradigm that views the main importance of science education lays in its contribution to a nation's strength in terms of economy and military through the study of only three scientific disciplines physics, chemistry and biology. However, the traditional approach fails to deal with or actually refuses to deal with a very crucial field – the environment. During the last few years we were able to watch in a live TV the tsunami in the Indian Ocean, Hurricane Katherine in USA, volcanoes and earthquakes in many places in the world. In addition, the media deals very frequently with topic such as the global warming, pollution of our atmosphere and hydrosphere and the availability of fossil fuel. There is no doubt that the understanding of these earth sciences environmental phenomena is crucial for our future citizens no less than the subjects that a traditional science education curriculum deals with. Therefore, earth and environmental sciences topics should be included in the core and to dominant any "Science for All" curriculum. However the profile of the earth sciences in school science curricula all over the world is ranged between low to negligible, even in countries like Turkey where millions of people live along a very active fault line.

Lovelock (1991) notes that the Earth is composed of several inter-related systems. He argues that only by developing a multi-dimensional perspective can one understand the global picture. In this light, he proposes that environmental research should be carried out with a multi-disciplinary holistic approach, as opposed to the reductionist approach, where each scientist specializes in a narrow field that does not relate to the entire picture. Mayer (1995) claims that the main constraint which prevents introducing a more holistic approach within the science curricula is the reductionist philosophy. This philosophy which rates the sciences according to a hierarchy of "importance", places physics at the top, and provided the basis for science education's main goal in schools, which was the preparation of a new generation of scientists. He contends that the "hard" science approach illustrates the severe limitations of the reductionist science for studying processes, as they occur in the real world. He therefore suggests to adopt an earth systems education framework for the development of integrated science curricula. Specifically, he refers to any physical, chemical, or biological processes that can and should be taught in the context from which the particular process was taken from in the earth systems.

Thus, the first step in the long process of implementing genuine "Science for All" curricula should include a paradigm shift of the academic leadership of science education. This shift requires the movement from a narrow perception of science education towards a more holistic perception in terms of social purpose of science education, scientific contents and educational approach. For example, a movement from teaching science as a tool to prepare the future scientists of a society towards the preparing the future citizens of a society; a movement from a disciplinary-centered towards a multidisciplinary approach; a movement from a narrow minded perception of science that includes only physics, chemistry and biology towards a broader perception which also includes the earth and environmental sciences; a movement from a classroom-based education towards the integration of multi learning environments including the lab, outdoors and computer; a movement from a perception that is mainly derived from the scientific world towards an authentic based perception that is derived from the real world.

It is suggested that any genuine reform endeavor towards the "Science for All" paradigm should adopt a holistic approach. In this paper I will concentrate on three components of such a reform: (1) A holistic framework for the science curricula. (2) A holistic learning environments (outdoors, lab, computer and classroom) component. (3) A holistic cognition-emotions learning component.

THE HOLISTIC FRAMEWORK COMPONENT

Orion & Fortner (2003) have argued that the earth systems approach is ideal as a holistic framework for science curricula. The starting point is the four earth systems that combine our natural world: geosphere, hydrosphere, atmosphere and biosphere. The study of cycles organizes earth systems education: the rock cycle, the water cycle, the food chain, and the carbon cycle. The study of these cycles emphasizes relationships among subsystems through the transfer of matter and energy based on the laws of conservation. Such natural cycles should be discussed within the context of their influence on people's daily lives, rather than being isolated to scientific disciplines. The earth systems approach also connects the natural world with technology: Technology transforms the raw materials that originate from earth systems. In contrast with traditional teaching approaches of science, the earth systems approach does not sequence the curriculum using topics from physics or chemistry. Instead, this approach organizes study in terms of systems and cycles as experienced in peoples' lives. It does utilize physics and chemistry as tools for understanding science at a deeper and more abstract level in this context.

The main educational goal of this environmental-based science education approach is the development of environmental insight. This insight includes the development of the following two principles: (a) We live in a cycling world that is built upon a series of sub-systems (geosphere, hydrosphere, biosphere, and atmosphere) which interact through an exchange of energy and materials; and (b) Understanding that people are a part of nature, and thus must act in harmony with its "laws" of cycling.

THE HOLISTIC LEARNING ENVIRONMENTS COMPONENT

One of the unique characteristics of the Earth systems is that it places the outdoor learning environment at the same level of significance with the indoor learning environments (classroom, lab and computer).

There is little doubt that starting the learning process from the students own point of interest, or at least with their understanding of why they should learn a specific topic, might serve as a powerful tool for a meaningful learning process. Thus, it is suggested that the learning process should start with a "meaning construction" session, where students could discover what interested them about a particular subject. Depending on the subject and the school's location, this stage could be conducted in a relevant outdoor environment or in a versatile indoor space. In the former environment the function of the teacher is to mediate between the students and the concrete phenomena. In the indoor environment the teacher's role is to motivate students' interest by exposing them to phenomena that are related to the subject through the using of pictures, video films, computer software, Internet sites, and written texts. Orion (1993) suggested that the main role of the outdoor learning environment in the learning process is direct experience with concrete phenomena. The uniqueness of the outdoor learning environment is not in the concrete experiences themselves (which could also be given in the classroom), but the type of experiences. The main potential of such concrete experiences is that it deals with phenomena and processes, which cannot be cultivated indoors. The outdoors is a very complicated learning environment, since it includes a large number of stimuli, which can easily distract students from meaningful learning. Thus, the first task of teachers and curriculum developers is to identify and classify phenomena, processes, skills and concepts which can only be learned in a concrete fashion outdoors, and those that can be learned in a concrete fashion indoors. In addition, it is important to identify those abstract concepts to which the outdoor contributes little in student understanding, In such cases, more sophisticated indoor tools (such as pictures, films, slides and computer software) must be substituted to provide a fuller explanation.

The guiding principle of this model is a gradual progression from the concrete levels of the curriculum towards its more abstract components. This model can be used for designing a whole curriculum, a course, or a small set of learning activities. Following the "meaning construction" stage, which can be conducted both outdoors and indoors, the first phase of a specific learning spiral starts in the indoor learning environment. The length of time of this phase is varied; it is whole dependent on the specific learning sequence. The main aim of this phase is to prepare the students for their outdoor learning activities. The preparation phase deals with reducing the "novelty space" of an outdoor setting (Orion & Hofstein, 1994). The novelty space consists of three factors: cognitive, geographical and psychological. The cognitive novelty depends on the concepts and skills that students are asked to deal with throughout the outdoor learning experience. The geographical novelty reflects the acquaintance of the students with the outdoor physical area. The psychological novelty is the gap between the students' expectations and the reality that they face during the outdoor learning event.

The novelty space concept has a very clear implication for planning and conducting outdoor learning experiences. It defines the specific preparation required for an educational field trip. Preparation, which deals with the three novelty factors, can reduce the novelty space to a minimum, thus, facilitating meaningful learning during the field trip. The cognitive novelty can be directly reduced by several concrete activities, for example, working with the materials that the students will meet in the field, as well as simulation of processes through laboratory experiments. The geographic and psychological novelties can also be reduced indirectly in the classroom, first by slides, films and working with maps, and second by detailed information about the event: purpose, learning method, number of learning stations, length of time, expected weather conditions, expected difficulties along the route, etc.

The next phase in this cycle is the outdoor learning activity; it was placed early in the learning process, since it mainly focused on concrete interaction between the students and the environment. The outdoor learning experience, together with the preparatory unit, can constitute an independent module, which might serve as a concrete bridge towards more abstracts learning levels. Thus, an outdoor learning experience should be planned as an integral part of the curriculum rather than as an isolated activity. It should be based on curriculum materials, which lead the students to interact with the phenomenon and not with the teacher. Hands-on interaction should lead the students towards two main educational objectives: a) construction of understanding and b) inquiry concerning questions related to the studied phenomenon. The teacher's role is to act as a moderator between the students and the concrete phenomena. Some of the students' questions can be answered on the spot, but only those, which might be answered according to the evidence uncovered in the specific outdoor site. Otherwise, time and resources, including the students' attention is wasted on activities that might be done elsewhere. Lectures, discussions and long summaries should be postponed until the next phase, which is better conducted in an indoor environment.

THE HOLISTIC COGNITION-EMOTIONS LEARNING COMPONENT.

The earth systems approach emphasizes simultaneously on the development of thinking skills and on the students' affective development (emotional intelligence). For this purpose, it focuses on the development of thinking processes and connections between the students and their physical (natural and non-natural) environment. The environment offers students an opportunity to deal with scientific issues through their senses, thereby creating emotional experiences and insights that are not culture-dependent. The sense of accomplishment that students experience is likely to serve as a springboard for the enhancement of their scholastic motivation and for the improvement in their learning skills. The relationship with the immediate environment begins with authentic questions that are related to the students themselves and enhances their awareness and insight regarding their environment. Later, the students experience their environment through activities that are based on intake of stimuli of all the senses.

For example, one of the schools that implemented such an earth systems "Science for All" program is situated near dunes. The first learning activity of the 7th grade classes was outdoors in the dunes, where they combined cognitive oriented tasks like observing geological and biological phenomena and asking questions with emotional oriented tasks like climbing the moderate slope of a dune and rolling down the steep slope. Following the first visit to the dunes the students were introduced to a realistic authentic question concerning the future of that dune area. At the time there was a debate among the citizens of this town whether to use this area for a new real-estate enterprise or to conserve the natural area for future generations.

The focus on the affective aspect of learning includes the response to the variance of students. For example, including activities that are based on the multiple intelligences approach (Gardner, 1992), the use of varied methods of assessment, mediated learning and development of motivation and emotional intelligence.

FROM THEORY INTO PRACTICE

The following are a few examples of an earth systems learning sequence that demonstrate the practical use of the above holistic principals. The first example is an Earth systems "Science for All" program that was developed for a junior high school in a town that is located in a dunes area. The learning sequence of this program starts in the 7th grade with an authentic and relevant question concerning the future of the dunes area that borders with the town. This question raises a need to know and understand the dunes area. This acquaintance focuses on the concrete visual geological and biological phenomena that exist there. Yet, soon enough the students find that an in-depth understanding of every concrete phenomenon leads them to raise questions concerning aspects that are not concrete at all. For example, when they study the quartz grains that build the dune, one of the questions is: "where did they come from?" This question opens a new learning cycle that includes also the studying of weathering of granite. Thus, in this context the students learn the chemistry that is needed in order to understand this process. While dealing with the process of the transportation of the quartz grain and the dune structure, the question that rises is what influences the direction of the wind. This question opens a new learning cycle which mainly deals with basic concepts in physics such as radiation, heat absorption, heat transformation, in the air, air pressure, etc.

The grainy structure characteristic of the dunes leads the students to the relationships between the geosphere and the hydrosphere. More specifically, it leads to the aquifer topic and from there to the question of what influence the quality of our drinking water and this of course opens a new learning cycle that goes deep to very basic concepts in chemistry. Following the understanding of the relationships between the geosphere and the hydrosphere the students ask about the interrelationships of these earth systems with biosphere. This aspect allows the students to study very basic concepts in biology and again to deal with other basic concepts in physics and chemistry that again were studied in the context of concrete biospheric phenomena.

The translation of the program's principles and key ideas are described in Table 1. It is important to emphasize that the earth systems "Science for All" program complies with the concepts in physics and chemistry that appear in the national curriculum and standards and in the same depth as the traditional

Tables 1. Principles of an earth systems-based program and their fulfillment

Principles	Actions
Learning in authentic and relevant contexts	The development of the learning units around environmental real-life issues. Using the outdoor as an integral and essential learning environment. Using the Earth systems approach as a platform for the "Science for All" curriculum. The learning revolves around authentic questions and authentic assignments.
The learning sequence moves gradually from the concrete to the abstract.	Each learning unit starts with hands-on activities in the lab and in the outdoors. Following the authentic questions that were raised and the understanding that was built students move to deal with more abstract concepts that could be built through concrete interactions with the natural phenomenon.
Adjustment of the learning for variance of learners	Each unit includes a variety of learning strategies and environments dealing with both cognitive and emotional aspects. Focusing on both the cognitive and emotional needs of the students. The program emphasizes the development of all seven intelligences defined by Gardner (1983, 1992).

Table 2. A comparison of the science knowledge and skills between the students who studied the traditional science program and those who studied science by the Earth systems approach

	Traditional program		Earth systems based program			
	M	SD	M	SD	*t*	*P*
Whole test	0.59	0.15	0.69	0.1	4.4	0.0001
Multiple choice part	0.57	0.2	0.67	0.15	3.3	0.001
Graphs analysis part	0.45	0.3	0.66	0.25	4.4	0.0001

program. However, it places them in a different order within the learning sequence in comparison to the traditional study program.

THE EFFECTIVENESS OF THE EARTH SYSTEMS "SCIENCE FOR ALL" APPROACH

There are several studies that indicate the effectiveness of Erath systems approach in development of both general scientific literacy and thinking skills (Orion & Fortner, 2003; Dodick & Orion, 2003; Kali, Orion & Alon, 2003; Ben-zvi-Assaraf & Orion, 2005). In a more recent study we compared between two groups of junior high school students from the same age and school who taught by same teachers according to their the scores of a national science knowledge exam. One group studied the science curricula according to the earth systems approach and the other one according to the traditional approach. Since the "traditional" group did not study any earth sciences topics or principals the calculation of the exam's scores included only those questions that were related to physics, chemistry and biology. Table 2 presents the comparison of the outcomes of the two groups. It reveals a significant difference between the achievements of the two groups. The advantage of Earth systems approach group in a general science test is very clear in both parts of the test, but much clearer in terms of the scientific skills of data analysis and graphs reading.

PROFESSIONAL DEVELOPMENT VERSUS PROFESSIONAL CHANGE

There are two limiting factors that should be overcome in order to move towards the Earth systems science education approach. The first and the most difficult to overcome is the science education establishment, which is usually combined of disciplinary oriented scientist science educators and educational bureaucrats. While overcoming or bypassing the first limiting factor there is a second limiting factor to overcome - the science teachers.

The teaching strategies of the Earth systems based science program are quite different from the traditional way of teaching science (Table 3). For many traditional science teachers all over the world, the implementation of the new "science for all" programs in general and the Earth systems approach in particular is not just a professional development. The meaning of professional development is that the subject of the development, in our case science teachers, have a very solid basis of their profession and from this professional core they can grow and expand. However, in order that teachers will move from the right column of Table 3 to its left column, even in relation to some of the six parameters, they have to change their goals, contents, ways and philosophy of teaching. Moreover, the shift presented in Table 3 is valid for any genuine "Science for All" teaching, however the Earth systems teaching demands on top of it two additional new aspects for teachers: (a) Teaching earth sciences subjects, which many science teachers in many countries have no scientific background in this area and (b) the using of the outdoor learning environment, which is also ignored by most of the traditional science teachers.

Thus, the shift from a traditional science teacher towards Earth systems teacher is not just a development rather it is a major reform or even a revolution – a professional change.

For the last 10 years we conducted several studies that explored strategies and models that might lead teachers towards teaching earth systems "Science for All" programs (Orion, 2003; Orion, Ben-Menacham & Shur, 2007). Our findings suggest that the in-school INST model is much effective in conducting professional change while it includes the following components:

1. At the first stage the teachers have to experience the new methods and contents as learners. Positive experiences as learners will help both to be convinced of the effectiveness of the new paradigm and later to deal with their students' learning difficulties on the basis of their difficulties that they experienced as learners.
2. The school's management should be an integral part of the INST and to take the commitment for facilitating the implementation of the new reform.
3. The first teaching experiences of the new methods of contents should be done with a close support of the INST experts.
4. The INST leaders should be equipped with psychological knowledge and skills to deal with reservation and oppositions, which are the result of a change fear.

Our findings also suggest that even the most powerful and effective INST alone cannot guarantee a long-term sustainable reform. Unfortunately, education in many countries is controlled by economic and political decisions and not by pedagogical decisions. Thus, in order to lead the teachers to such a paradigm shift a lot of resources should be invested during a long period of at least ten years. However, in addition to the unwilling of the policy makers to allocate the needed resources, a genuine conceptual change cycle is much longer than a political cycle (the time from election to election). Therefore, the process never comes close to maturation. It is suggested that the heart of the problem is the science education leadership. This leadership has the responsibility to educate the teachers and to convince the Ministry of Education to invest the needed resources. Thus, the failure of the science education reforms is primarily the failure of the science education leadership.

Table 3. A comparison between the traditional science teaching and the ES teaching

Traditional science teaching	Earth systems teaching
The main purpose is to prepare the future scientists of a society	The main purpose is to prepare the future citizens of a society
Disciplinary-centered teaching	Multidisciplinary teaching
A teacher-centered teaching	A child-centered teaching
Content-based teaching	Integration of skills within contents
The teacher is a source for knowledge/information	The teacher is a mediator for knowledge
"Chalk and talk" based teaching	Inquiry based teaching
School-based learning	Multi learning environments: Classroom, lab, outdoors and computer.
Teaching that is derived from the scientific world	Authentic based teaching that is derived from the real world
Traditional assessment	Alternative assessment

MYTHS THAT SUSTAIN THE DOMINANCE OF THE TRADITIONAL PARADIGM

The philosophy that establishes the dominance of the traditional paradigm of science education for generations is widely accepted among scientists and science educators all over the world. However, some foundations of this philosophy are not well supported. The followings are four examples of such myths.

Myth 1: Studying science from the earth and environmental sciences (the so-called "soft" sciences) perspectives will be on the expense of the "real" sciences - physics and the less "hard" science – chemistry.

Our 15 years study indicates that studying science from the Earth systems perspective was not on the expense of the other sciences. On the contrary, it raised students' interest in studying all the sciences and increased their learning achievements in physics and chemistry. Moreover, it elevated their learning achievements in these areas to a level which is higher than the level they reached while studying the sciences that are physics-chemistry oriented and do not include any earth sciences component.

Myth 2: If students will go outside the class for field trips then when will they really study?

Our 20 years study in this area indicates that integrating the outdoor learning environment was not a waste of precious teaching hours, on the contrary, both students and teachers found it as one of the major contributors for the students' high achievements.

Myth 3: Focusing on the preparation of students towards national and international test will increase their achievements.

Our 5 years study shows that students who studied science in the traditional approach and then were prepared for the national science test for a period of about six weeks had significantly lower achievements than those students who were not prepared for the test and studied science through the earth systems approach.

Myth 4: Practicing science teachers are incapable of making changes in the way they teach.

Our 10 years study in this area indicates that although it is very difficult to change teachers' habits and perceptions of science teaching, it is a possible task even for seniors with 20 years of teaching experience). We found that such teachers changed their science content focus and taught earth sciences subjects that were completely new to them. They began to teach in the outdoors learning environment. They changed their ways of teaching and changed their views on the purpose of science teaching. Such professional change was achieved through long term in-service training programs conducting in the schools with close support and assistance that included both professional and emotional backing.

SUMMARY

Our studies indicate that Earth systems science approach is much effective than the traditional "science for all" approach. While implementing it correctly, it succeeds to attract and advance students to whom the traditional science programs were frequently inaccessible. However, the success of the students, who usually do not find school in general and science learning in particular interesting, did not happen on the expense of those students who are considered high achievers. Both groups found the ESS program attractive and interesting and both gained a significant amount of knowledge and understanding.

There is no doubt that the traditional science programs are very useful for the selection of that 1%-5% of the population that could be the future physicists. Our studies suggest that an earth systems science program might serve as a much powerful platform for any science program that claims to be "for all". Yet, the earth systems approach alone will not be enough and in addition such programs should also include the following characteristics:

- Learning in an authentic and relevant context as much as possible.
- Organizing the learning in a sequence that shifts gradually from the concrete to the abstract.
- Adjusting the learning for variant abilities learners.
- Integrating the outdoor environment as an integral and central component of the learning process.
- Focusing on both the cognitive and the emotional aspects of learning.

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University Students' Knowledge and Attitude about Genetic Engineering

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Genetic engineering and biotechnology made possible of gene transfer without discriminating microorganism, plant, animal or human. However, although these scientific techniques have benefits, they cause arguments because of their ethical and social impacts. The arguments about ethical ad social impacts of biotechnology made clear that not only getting basic knowledge about biotechnology and genetic engineering, also ethical and social issues must be thought in the schools, because the level of knowledge and the attitudes of new generation is very important for the society. So, in this study it is tried to determine the university students', level of knowledge about genetic engineering and their attitude towards genetic engineering applications. For determining the students' level of knowledge and attitude about genetic engineering, a questionnaire, which include 2 open ended questions and Likert type attitude scale with 12 statements, is given to students and wanted to answer. Answers of the open ended questions in the questionnaire are subjected to content analysis and students' level of knowledge about this field is tried to determine. The statements in attitude scale with 12 subject is grouped under 3 titles; and to evaluate the answers to the statements in attitude scale, percentage values and group differentiations are calculated by SPSS. The results have shown that students do not have sufficient knowledge about basic principles of genetic engineering and their attitudes towards the applications change according to species of organisms and the objective of the study.

Keywords: Biotechnology Education, Ethics Education, Genetics education, Teacher Education, Attitude

INTRODUCTION

Scientific literacy requires citizens interested in and understand the world around them, to be skeptical about scientific matters, to be able to identify questions and draw evidence-based conclusions, and make informed decisions about environment and their own health and well-being. So, school science curriculum has to prepare students for their future roles as citizens among technologies which will have a significant impact on their lives like genetic engineering and biotechnology (Dawson & Schibeci, 2003).

Genetic engineering and biotechnology with the techniques of solving limits of genetic material and making changes on the genetic material can make possible of gene transfer without discriminating microorganism, plant, animal or human. Beside these techniques benefits, it has some uncertainties and risks in some issues about;

- Genetic screening,
- Eugenics,
- The use and production of embryos and embryonic stem cells,

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- Culture and consumption of genetically modified (GM) corps,
- Environmental effects of GM corps,
- Biodiversity,
- Selective aborts

Because of these issues genetic engineering has become the subject of ethical discussions. Supporters of the biotechnological revolution suggest that biotechnology will be capable of relieving problems of human disease, hunger and pollution. Opponents fear this field represents "a form of annihilation every bit as deadly as nuclear holocaust" (Rifkin, 1999). These arguments in social dimension make clear not only getting basic knowledge about this topic also social effects of using knowledge and application methods must be determined. Indeed, it is important that students continue to be provided with appropriate science content, but it must be recognized that this knowledge alone may not be sufficient for students to make rational decisions (Harding & Hare, 2000). There is strong consensus among educators that training in the ethical and social consequences of science is necessary for the development of students into the science professionals and well-rounded citizens needed in the future (Booth & Garrett, 2004). An increase in the public understanding of biotechnology could be used to balance the extreme views that often have no basis in fact or logic (Edmondston, 2000). So, in last years the studies about the knowledge level and attitudes of society and especially the students', to the ethical topics in genetic engineering and application fields of biotechnology become important, because genetic engineering and biotechnology will effect their future lives in many fields.

For example with this aim in 1999 the social structure and education programs different English and Taiwanese students (Chen & Raffan, 1999), and in 2003 Australian students (Dawson & Schibeci, 2003) knowledge level and their attitudes towards the applications about biotechnology and genetic engineering are tried to determined; beside these, it is tried to determine the level of ethical topics in genetic lessons at the universities that give biological education.

In this field, if the studies are examined, Turkey is in the beginning of this way. However, fundamental genetic engineering and biotechnology subjects, besides having scientific knowledge they have applications fields in different fields, become subjects of ethnic, religious and cultural discussions and because of these reasons they must be determined in the developing countries like Turkey. With the providing data, young people who will decide about applications results of the social topics in the future have to be educated with learned and conscious. To provide social knowledge and consciousness; the teachers must be educated with sufficient and actual knowledge and ability of getting new developments.

OBJECTIVE

The purpose of this study was to determine students' knowledge and attitudes towards genetic engineering. The participants were juniour and seniour students from science education program (S.E. 3rd year and S.E. 4th year), seniour students from biology education program (B.E. 4th year) and seniour biology majors (B.D. 4th year) from the Faculty of Arts and Sciences.

MATERIAL AND METHOD

Material

In this study, for determining the students' level of knowledge and attitude about genetic engineering, a questionnaire, which include 2 open ended questions and 3 of Likert type of attitude scale with 12 statements, is given to students and students were wanted to answer. Firstly the scale was applied to 70 people group that has some features with study group. With the help of the data which is obtained from the application, it is decided that some statements are not appropriate for research. The indelicate statements are quieted from the scale and the statements which need to be changed are corrected. As a result of this correction, 2 open ended questions and the attitude scale with 12 statements is taken into the questionnaire.

For reliability of the questionnaire, specialist's opinions are consulted for the statements in the attitude scale. The reliability coefficient of measurement results is calculated as $\alpha = .81$. In answering open-ended questions, to prevent students affecting from the statements in the attitude scale, the attitude scale is scattered after open ended questions are answered and collected.

Method

Answers of the open ended questions in the questionnaire are subjected to content analysis and the students' level of knowledge about this field is tried to determine. The student's answers to the questions are put in groups and their frequency (f) and percentage (%) values are calculated. The definition of "genetic engineering" term in the Dictionary of Biological Terms which is a publication of Atatürk Culture, Language and History High Institution, is used as a right definition reference (Karol, Suludere & Ayvalı, 1998).

The statements in attitude scale with 12 subject is grouped under these titles; "The statements about the studies of genetic engineering", "The statements about the studies of genetic engineering with animals", "The statements about the studies of genetic engineering with plants", "The statements about the studies of genetic engineering with microorganisms". To evaluate the answers to statements in attitude scale, percentage values and group differentiations (One Way ANOVA and Seheffe) are calculated by SPSS.

Study Group

In this study, the study group consisted of the students' of Gazi University Gazi Faculty of Education, Science Education (S.E.) Department, Biology Education Department (B.E.) and Faculty of Arts and Science, Biology Department (B.D) students. The dissociation of research students according to Faculty and Departments are showed in Table 1;

The students, who participate in the study, have chosen according to four groups to make comparison, according to their Faculty and Departments:

1. Students who did not take "Genetic" course (S.E. 3rd year students),
2. Students who took "Genetic" course (S.E. 4th year students),
3. Students who took "Genetic" course (B.E. 4th year students),
4. Students who took "Genetic" course and elective "Genetic Engineering" course (B.D. 4.th year students).

Table 1. The dissociation of research students according to faculty and departments

Faculty/Department/Class	N
Gazi Education/ S.E./ 3	47
Gazi Education/ S.E./ 4	36
Gazi Education/ B.E/ 4	43
Faculty of Arts and Science/ B.D/ 4	25
Total	**151**

RESULTS AND DISCUSSION

The Results about Students' Answers to the Open Ended Questions

While evaluating open ended questions the reference definition is used and the answers of students "use of genetic material in various applications" and "studies about genetic material for human benefit" are accepted as right answers.

As showing in Table 2, 29.3 % of S.E. 3rd year students, 33% of S.E. 4th year students, 28 % of B.E. 4th year students can make right definitions about meaning of genetic engineering. It is conspicuous that the teacher candidate's B.E. and S.E. answer rate to the question is very low. The other findings about other researches are showed that most of the students can not make right definition of genetic engineering (Wever, 1996; Chen & Raffan, 1999).

However, when Table 2 is examined, it is seen that 84 % of B.D. students can make right definition of genetic engineering. The reason of the high rate of B.D. students' answers according to the S.E. and B.E. students can be interpreted as these B.D. students take optional genetic engineering lesson beside genetic lesson.

Students' answers to questions are shown according to the groups of majors and years in Table 3.

When Table 3 is examined, all students in the research give example about the mediatic topics like copying, the diagnosis and treatment methods of hereditary diseases, forensic case in high rates. Moreover, it is seen that while the number of courses about the subject increases, the specific examples rate, like obtaining productive and resistant plant species, gene maps, obtaining drug, vitamin etc. products from bacteria with gene transfer increase too. For example, while S.E. 3rd year students and S.E. 4th year students can give the example of obtaining drug, vitamin etc. from bacteria, 9.3% of B.E. 4th year students and 20% of B.D. 4th year students can give this example. While most of (84%) of B.D. students who take genetic engineering lesson beside genetic course can make right definition about genetic engineering and at the same time they can give many little known examples about this field. When the answers of students who did not take Genetic Engineering are examined; it is seen that they give examples especially about the subjects take part in media.

There has got similar findings at the study with English and Taiwanese students about determining their knowledge and attitude about genetic engineering (Chen & Raffan, 1999). According to this study; English students with their examples of definition of genetic engineering and application of genetic engineering are found more successful than Taiwanese students. The basic reasons for this are listed like; English students can find more opportunity to discuss ethical subjects in their lessons, they can reach the literatures easily, Science man- teacher and also student cooperation in England is supported by many biotechnology center. Another study with 222 students in America, 7.2% of students, who focus on the subjects about Mendel genetics in spite of human genetic, can give right answer for genetic engineering definition (Wever, 1996).

The Attitudes of Students about Genetic Engineering Studies

Expressions asked to students about the engineering studies are divided into 4 sub group (see Table 4).

The f and % values of answers about revealing students attitude towards genetic engineering are summarized in Table 5. According to the expression group of the general statements about genetic studies answers in the attitude scale for revealing students attitudes about the genetic engineering studies, there is found no meaningful difference around the groups with One Way ANOVA test ($p > .05$). According to this, all

Table 2. Percentage values of answers to the question "what is genetic engineering according to the dissociation of majors and years"

DEFINITIONS	S.E. 3rd year		S.E. 4th year		B.E. 4th year		B.D. 4th year	
	f	%	f	%	f	%	f	%
It searches the genetic material's structure and function	27	25,5	12	33,3	29	67,5	3	12
Use of genetic material in different applications*	12	25	12	33,3	10	23,3	16	64
It examines heredity and variation	13	27,8	2	4,3	-	-	-	-
Offering the studies about the genetic material with technology for human benefit*	2	4,3	-	-	2	4,7	5	20
Other	32	8,5	2	4,3	2	4,7	1	4

* The answers which are accepted as right.

Tablo 3. Distribution of examples given by the students about the studies of genetic engineering according to majors and years

EXAMPLES	S.E. 3rd year		S.E. 4th year		B.E. 4th year		B.D. 4th year	
	f	%	f	%	f	%	f	%
Obtaining productive and resistant plant species	-	-	1	2,8	8	18,6	1	4
Gene maps	-	-	4	11	3	6,9	1	4
Gen transfer	2	4,3	-	-	3	6,9	6	24
Copying	27	57,5	17	47,2	13	30,2	10	40
Diagnosis and treatment methods of hereditary diseases	6	12,8	3	8,3	8	18,6		4
Obtain drug, vitamin etc. products from bacteria via gene transfer	-	-	-	-	4	9,3	5	20
Forensic cases	4	8,5	2	5,6	-	-	-	-
Watermelon without seed	1	2	1	2,8	-	-	-	-
Obtaining productive and resistant animal species	1	2	2	5,6	1	2,3	-	-
Other	6	12,8	6	16,7	3	6,9	1	4

Table 4. Distribution of statements in the attitude scale according to the groups

STATEMENT GROUPS	EXPRESSION NUMBER
The general statements about studies of genetic engineering	1, 2, 7, 10, 12
The statements about the genetic engineering studies with animals	3, 5, 6
The statements about the genetic engineering studies with plants	4, 8, 9
The statements about the genetic engineering studies with microorganisms	11

Table 5. Findings of the general expressions in about genetic engineering studies

STATEMENTS		S.E. 3rd year		S.E. 4th year		B.E. 4th year		B.D. 4th year	
		f	%	f	%	f	%	f	%
1. Genetic engineering makes human life easier	Y	37	78,7	28	77,8	39	90,7	23	92,0
	N.S	8	17,0	7	19,4	4	9,3	2	8,0
	N	2	4,2	1	2,8	-	-	-	-
2. Genetic engineering can provide opportunities for new discoveries	Y	44	93,6	34	94,4	43	100	25	100
	N.S	3	6,4	2	5,6	-	-	-	-
	N	-	-	-	-	-	-	-	-
7. The animal meats that obtained with genetic manipulations can be sold without giving any information to the consumer	Y	47	100	35	97,3	37	86,1	23	92,0
	N.S	-	-	1	2,8	6	14,0	2	8,0
	N	-	-	-	-	-	-	-	-
10. Transgenic organisms contain risks for nature	Y	-	-	4	11,1	2	4,7	5	20,0
	N.S	30	63,8	18	50,0	23	53,5	10	40,0
	N	17	27,2	12	33,4	18	41,9	10	40,0
12. Releasing GM organisms to nature without control contains risks	Y	15	31,9	8	22,3	8	18,6	4	16,0
	N.S	-	-	9	25,0	10	23,2	7	28,0
	N	32	68,1	19	52,8	25	58,2	14	56,0

Table 6. The findings of students answers to the statements about genetic engineering studies with animals

STATEMENTS		S.E. 3rd year		S.E. 4th year		B.E. 4th year		B.D. 4th year	
		f	%	f	%	f	%	f	%
3. The genetic engineering studies with animals are beneficial to people	Y	39	83,0	32	88,9	38	88,4	17	68,0
	N.S	7	14,9	2	5,6	5	11,6	5	20,0
	N	1	2,1	2	5,6	-	-	3	12,0
5. It is acceptable transfer genes that provide protein synthesis in sheep with the medical aim.	Y	1	2,1	-	-	-	-	-	-
	N.S	10	21,3	8	22,2	12	27,9	4	16,0
	N	36	76,6	28	77,8	31	72,1	21	94,0
6. Transfer of carcinogenic genes to mice with medical aim is acceptable	Y	-	-	-	-	2	4,6	-	-
	N.S	6	12,8	-	-	1	2,3	1	4
	N	41	87,2	36	100	39	93,1	24	96

the students, who join the research, have positive attitudes about the genetic engineering studies. However, 1st statement, which is one of the statements for revealing students general attitude about genetic engineering, is answered yes by 90.7 % of B.E. 4th year students and 92.8 % of B.D. 4th year students, while 78.7 % of S.E. 3rd year students and 77.8 % of S.E. 4th year students answer yes to the this expression. If the courses which are taken by students are determined; it is seen that while the students' knowledge level increase their risk perception and suspicion about the subject decrease.

If the answers of 2nd statement are examined; it can be thought that students perceive genetic engineering as a opportunity; on the contrary of general aspect in this field it is seen that all of the S.E. 3rd years students, 97.3 % of S.E. 4th year students, 86.1 % of B.E. 4th year students and 92 % of B.D. 4th year students think that the genetically changed organisms can be sold without giving any information to the consumers in markets.

If we examine the answers to the statement it is conspicuous that the answer rate of not sure is very high. This situation shows that students do not have sufficient knowledge about this topic. However, if the students answer to 10th statement and also to 12nd statement is examined; it is seen that most of the students think G.M. organisms do not have any risk for the nature.

Findings about students answer to the statement about their attitude about engineering studies with animals are summarized in Table 6.

Table 7. The findings of students' answers to the statements about genetic engineering studies with plants

STATEMENTS		S.E. 3rd class		S.E. 4th class		B.E. 4th class		B.D. 4th class	
		f	%	f	%	f	%	f	%
4. Gene transfer from animals to plants can cause plants to improve features like animals	Y	8	17,0	6	16,7	9	21,0	4	16,0
	N.S	18	38,3	8	22,2	22	51,1	9	36,0
	N	21	44,7	22	61,1	12	27,9	12	48,0
8. It is acceptable to produce plants with enrichment proteins	Y	-	-	-	-	-	-	-	-
	N.S	7	14,9	6	16,7	5	11,6	1	4,0
	N	40	87,2	30	72,3	38	88,4	24	96,0
9. It is acceptable to produce plants that synthesize substances with effective medical importance	Y	38	80,8	36	100	42	97,7	22	88,0
	N.S	6	12,8	-	-	1	2,3	1	4,0
	N	3	6,4	-	-	-	-	2	8,0

Table 8. The findings of students about Genetic engineering studies with microorganisms

STATEMENTS		S.E. 3rd class		S.E. 4th class		B.E. 4th class		B.D. 4th class	
		f	%	f	%	f	%	f	%
11. It is acceptable to provide lipase from the bacteria to use in detergents.	Y	17	36,2	19	52,8	25	58,2	17	68
	N.S	20	42,6	15	41,7	13	30,2	7	28
	N	10	21,2	2	5,6	5	11,6	1	4

If the students answer to the 3rd statement is examined; it is seen that without considering any distinction of students year and major, most of the students think use of animals in genetic engineering studies can provide benefits for people. However, if the answers of 5th and 6th statements are examined, it is seen that student oppose to using animals in genetic studies although it provide benefits to people.

Findings about students answer to the statements about their attitude about the genetic engineering studies with plants are summarized in Table 7.

If the findings about 4th statement are examined, it is seen that most of the students (approximately 80 % of them) answers about the statements are I am not sure and no, and there is not any difference between the groups ($p > .05$). If these rates are determined it appears that most of the research students do not have sufficient knowledge in this field. It is also interesting that the students who have optional genetic engineering course do not have sufficient knowledge about this statement too.

If the answers to the 8th statement are examined, it is seen that 87.2% of S.E. 3rd year students, 72.3% of S.E. 4th year students, 88.4% of B.E. 4th year students, 96% of B.D. 4th year students have negative attitude about production of plants with enriched proteins. However, 80.8 % of S.E. 3rd year students, all of the S.E. 4th year students find acceptable to the production of plants which can synthesize effective substances that have medical importance. This situation can be interpreted as students look positive to genetic changes in plants if it has medical importance (Table 8).

If the students answers to the 11th statement are examined; 36.2 % of S.E. 3rd year students, 52.8 % of S.E. 4th year students, 58.2 % of B.E. 4th year students and 68 % of B.D. 4th year students give "yes" answer. These rates show that most of students found acceptable of providing lipase enzyme from bacteria to use in detergents.

If students answers to the statements about using different organism groups for genetic engineering studies, are examined it is seen that students find less acceptable of genetic engineering studies with animals even if they have medical aims than the studies with plants and microorganisms. In Chen & Raffan (1999) and Lock & Miles (1993)'s studies there is encountered similar findings, it is established that students attitude show differences according to the objective and the type of organism that is used in application.

CONCLUSIONS AND IMPLICATIONS

Genetic engineering gets most of risks and disadvantages in spite of its advantages and benefits to human services. Because of this, today's young people, who will take obligation about social decisions in the future personally, have to be trained to have sufficient knowledge about this field is not sufficient at school level only and also at the social level (Moses, 2003; Schibeci, 2000).

If the findings of this study are examined, it is seen that the students who take courses about this field have more knowledge and they can give more examples about the studies than the students who do not take these courses. However, it is thoughtful that the answers given to the statements do not differ significantly between the students who take optional courses and the students who do not take any other courses than general genetic lesson. This result shows that genetics education does not focus enough on genetic engineering and its implications. From this point, to make lessons more meaningful and to provide more effective education, alternative teaching methods and strategies must take place frequently and the curriculum must be restructured to increase coverage of basic principles and applications of genetic engineering. Moreover, it is seen that students risk perception and negative suspects decrease while their knowledge level about this subject increase. This situation is made clear the importance of these lessons which will provide social conscious. Because of this besides giving basic knowledge; curriculum must be restructured to containing more about advantages, disadvantages and possible risks of the applications in different fields of genetic engineering, and programs that contain activities that will improve the student's ability to give a decision about ethical issues.

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APPENDIX

QUESTIONNAIRE

This questionnaire consists of 2 open ended questions and 12 statements about implications of genetic engineering and biotechnology. Please give a brief description for open-ended questions. You have totally 25 minutes to answer.

1. What is genetic engineering?
2. Can you give an example about the studies of genetic engineering?

Instructions: Please put a (√) for a response for each of the following statements.

1. Genetic engineering makes human life easier

YES	NOT SURE	NO

2. Genetic engineering can provide opportunities for new discoveries

YES	NOT SURE	NO

3. The genetic engineering studies with animals are beneficial to people

YES	NOT SURE	NO

4. Gene transfer from animals to plants can cause plants to improve features like animals

YES	NOT SURE	NO

5. It is acceptable transfer genes that provide protein synthesis in sheep with the medical aim.

YES	NOT SURE	NO

6. Transfer of carcinogenic genes to mice with medical aim is acceptable

YES	NOT SURE	NO

7. The animal meats that obtained with genetic manipulations can be sold without giving any information to the consumer

YES	NOT SURE	NO

8. It is acceptable to produce plants with enrichment proteins

YES	NOT SURE	NO

9. It is acceptable to produce plants that synthesize substances with effective medical importance

YES	NOT SURE	NO

10. Transgenic organisms contain risks for nature

YES	NOT SURE	NO

11. It is acceptable to provide lipase from the bacteria to use in detergents

YES	NOT SURE	NO

12. Releasing GM organisms to nature without control contains risks

YES	NOT SURE	NO

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Association between Brain Hemisphericity, Learning Styles and Confidence in Using Graphics Calculator for Mathematics

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This paper presents the preliminary results of a study conducted to investigate the differences in brain hemisphericity and learning styles on students' confidence in using the graphics calculator (GC) to learn mathematics. Data were collected from a sample of 44 undergraduate mathematics students in Malaysia using Brain-Dominance Questionnaire, Index of Learning Style Inventory, and Confidence in Using GC to Learn Mathematics Questionnaire. Statistical analyses revealed that the sample differ significantly in their hemispheric preference and learning styles. In addition, sequential-global and sensing-intuitive learning styles were found to associate significantly with brain hemisphericity. However, there was no significant association between brain hemisphericity with gender, race, and program of study. Finally, the study also revealed that GC confidence ratings are not significantly different across brain hemisphericity as well as learning styles.

Keywords: Brain Hemisphericity, Graphics Calculator, Instructional Tool, Learning Styles

INTRODUCTION

Hand-held technology such as the graphics calculator (GC) is increasingly used in many mathematics schools and colleges worldwide. Integrating GC in the curriculum has a huge potential and can make mathematics learning more enjoyable and more accessible. While it has been claimed that GC empowers students to visualize mathematics (Arcavi & Hadas, 2000; Cunningham, 1991), there is still a need to better understand the issues involved in terms of how the GC shapes the students' learning of mathematics and the interplay between the tool and the subject.

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In the teaching and learning process, cognitive neuroscientists noted that right-brain dominant people prefer visual, spatial and analogical processing while left-brain dominant people prefer verbal, logical, linear and sequential processing. Realizing the importance of the connection between brain and mathematical thinking, researchers are attempting to link learning styles with hemispheric dominance (Seng & Yeo, 2000). Sadler-Smith and Badger (1998) maintained that cognitive style is a fundamental determinant of an individual's behaviour in organizational processes and routines. They stressed that cognitive style can explain why people with the same abilities, knowledge, and skills performed differently in the organization. In order to explain the differences in performance between students in the same classroom when incorporating a new instructional tool, it is pertinent to explore the connection between brain hemisphericity, learning styles as well as technical confidence with the tool.

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Table 1. Characteristics of the learners, learning styles and brain hemisphericity.*

Types of learner	Learning styles	Brain hemisphericity
Active	Retains and understands information best by discussing in group, applying it or explaining it to others.	
Reflective	Prefers to think about and work out something alone.	
Sensing	Likes to learn facts, solve problems by well-established methods. Good at memorizing facts and doing hands-on (laboratory) work. Dislikes complications as well as surprises. Resents being tested on material that has not been explicitly covered in class. Doesn't like courses that have no apparent connection to the real world.	Left-brain
Intuitive	Prefers discovering possibilities and relationships. Likes innovation and dislikes repetition. Good at grasping new concepts and is more comfortable with abstractions and mathematical formulations. Doesn't like courses that involve a lot of memorization and routine calculations.	Right-brain
Visual	Remembers best what is seen in pictures, diagrams, flow charts, time lines, films, and demonstrations.	Right-brain
Verbal	Get more out of words from written and spoken explanations.	Left-brain
Sequential	Tends to gain understanding in linear steps, with each step following logically from the previous one in a logical stepwise paths in finding solutions.	Left-brain
Global	Can solve complex problems quickly or put things together in novel ways once he/she has grasped the big picture without seeing connections. May have difficulty explaining how he/she did it.	Right-brain

*Table 1 is an abridgment between Felder and Solomon's Learning Styles (2001) and McCarthy's (1987) 4MAT System

OBJECTIVES OF THE STUDY

This study is conducted to examine the differences in brain hemispheric processing modes and learning styles among 44 undergraduates who undertake the specialized mathematics course using the GC. The course was developed by the School of Mathematical Sciences at the Universiti Sains Malaysia (USM). In this program, the students were acquainted with the capabilities of the GC as an instructional tool. Specifically, the study aims to investigate the relationship of brain hemisphericity and learning styles on the students' confidence in using the GC to learn mathematics.

LITERATURE REVIEW

Cognitive neuroscientists generally held that brain hemisphericity or brain dominance is the tendency of an individual to process information through the left hemisphere or the right hemisphere or in combination. It was pointed out further that left hemispheric dominant learners are analytical, verbal, linear and logical, whereas those right-hemispheric dominants are highly global, visual, relational, and intuitive. Closely related to brain hemisphericity is the learning style or the preferred way in which individuals learn. McCarthy (1987) purported four types of learners (innovative, analytic, common sense and dynamic) in association with two different brain modes (left or right). Similarly, Felder and Solomon (2001) classified learners into four different domains according to their learning styles. The four domains consist of the active-reflective learners, the sensing-intuitive learners, the visual-verbal learners and the sequential-global learners. Table 1 summarizes the characteristics of the learners, their learning styles and brain hemisphericity in accordance to Felder and Solomon (2001) as well as McCarthy's (1987) proposition.

DESIGN OF THE STUDY

The special topic course in GC at USM is developed for final year pre-service teachers and students in mathematics. The course has attracted an overwhelming response from students since its inception in 2001. Amongst the course objectives are to acquaint students with computer algebra system (CAS) calculators and its capabilities, to understand the relevance of calculator technology in the teaching and learning of mathematics and sciences, and to familiarize students with the issues involved in the use of calculator technology in the classroom.

Table 2. Mean of GC confidence and T-tests for all domains

Types of domain	N	Mean	Std. Deviation	t	Sig (2-tail)
Left-brain	30	.8087	.43442	-.204	.839
Right-brain	10	.8391	.30884		
Reflective	18	.7874	.35413	-.529	.600
Active	24	.8533	.42942		
Intuitive	6	1.0145	.26327	1.277	.209
Sensing	36	.7935	.40778		
Verbal	1	1.0000	.	.443	.660
Visual	41	.8208	.39957		
Global	11	.8024	.41719	-.219	.828
Sequential	31	.8331	.39453		

The course content includes topics from calculus, linear algebra, differential equations, and statistics. Students were not required to purchase GCs; each student had a calculator checked out for the duration of the course. Alternating interactive lectures and in-class exploration activities are the primary teaching modes of the course. This is complemented with laboratory assignments. The course culminates with a group project designed to foster students' knowledge and critical understanding of principles in mathematics and statistics.

For the cohort of 2005/2006, data were collected using 15-item Brain-Dominance Questionnaire (Mariani, 1996), 44-item Index of Learning Style Inventory (Felder & Solomon, 2001) and 23-item Confidence in Using GC to Learn Mathematics Questionnaire (Ali & Kor, 2004). Brain-Dominance Questionnaire and Index of Learning Style Inventory were administered to the respondents at the commencement of the course. The GC Confidence questionnaire was administered at the end of the course after students had mastered most of the GC skills. All items are 5-point Likert scale, and each item receives a score in the range of –2 to +2. Thus a positive mean score indicates a favourable response. To carry out the analyses, Chi-square tests on goodness-of-fit and tests of independence as well as T-tests of means were conducted using SPSS.

RESULTS OF THE STUDY

From a total of 44 questionnaires administered, two were incomplete and were subsequently discarded. Analysis revealed that 71% of the sample were left-brain dominant (n=30) whereas 24% (n=10) were right-brain dominant and the remainders (n=2) were whole-brain learners. As the whole-brain learners were very small in number, statistical tests were not conducted on this group.

Results showed that the sample differs significantly in hemispheric dominance and learning styles at 1% level of significance. In particular, almost 66% of the sample belongs to slight to moderate left-brain category. Similarly, data showed that most of the samples belong to mild active, moderate sensing, strong visual, and mild sequential learning styles (Fig.1).

On the other hand, mean GC confidence ratings were computed across different brain dominance and types of learners. In Table 2, results showed that learners who are "reflective" and "sensing" scored the lowest in confidence in using GC to learn mathematics. Also, T-tests conducted on the pairs in each domain showed no significant differences in the means of GC for all domains at 5% level of significance. The results indicated that there were no significant differences in GC confidence across brain hemisphericity as well as learning styles.

Looking at Tables 3 and 4, further analysis found that brain dominance associates significantly with the sensing-intuitive (p-value=0.015), as well as sequential-global learning styles (p-value=0.013).

The results are in accordance with McCarthy's (1987) proposition that left-brain learners are "sensing" and "sequential" while right-brain learners are "intuitive" and "global". However, there was no statistical significant association between brain hemisphericity with active-reflective as well as visual-verbal learners. Furthermore, no statistical significant association between brain hemisphericity with gender, race, and program of study was reported.

CONCLUSIONS

The genesis of our research into brain dominance and learning styles was the result of our inquisition about whether the competency skill in mastering the GC is brain dominated. In response to Steen's (1999) query regarding the neural mechanism of mathematical thought, we seek to understand the biology of the brain which could scientifically improve an individual's mathematical performance.

Table 3. Chi-Square tests on brain dominance and sensing-intuitive learning styles.

		Intuitive-sensing		Total
		Intuitive	Sensing	
Type of Brain Dominance	left brain	2 (4.4)	29 (26.6)	31
	right brain	4 (1.6)	7 (9.4)	11
Total		6	36	42

Numbers in parenthesis is the expected count.

Table 4. Chi-Square tests on brain dominance and sequential-global learning styles

		Sequential-global		Total
		Global	Sequential	
Type of Brain Dominance	left brain	5 (8.1)	26 (22.9)	31
	right brain	6 (2.9)	5 (8.1)	11
Total		11	31	42

Numbers in parenthesis is the expected count.

To date, no related research has yet been conducted to integrate both brain hemisphericity and learning styles in a mathematics classroom that incorporate the use of instructional tool such as the GC. Although the preliminary results of this study showed that there was no statistically significant difference in the GC confidence scores and the brain hemisphericity as well as learning styles, there were evidences of association between learning styles and brain dominance. It was found that most respondents were left brain dominated. In addition, results revealed that left brain individuals tend to be sensing and sequential learners.

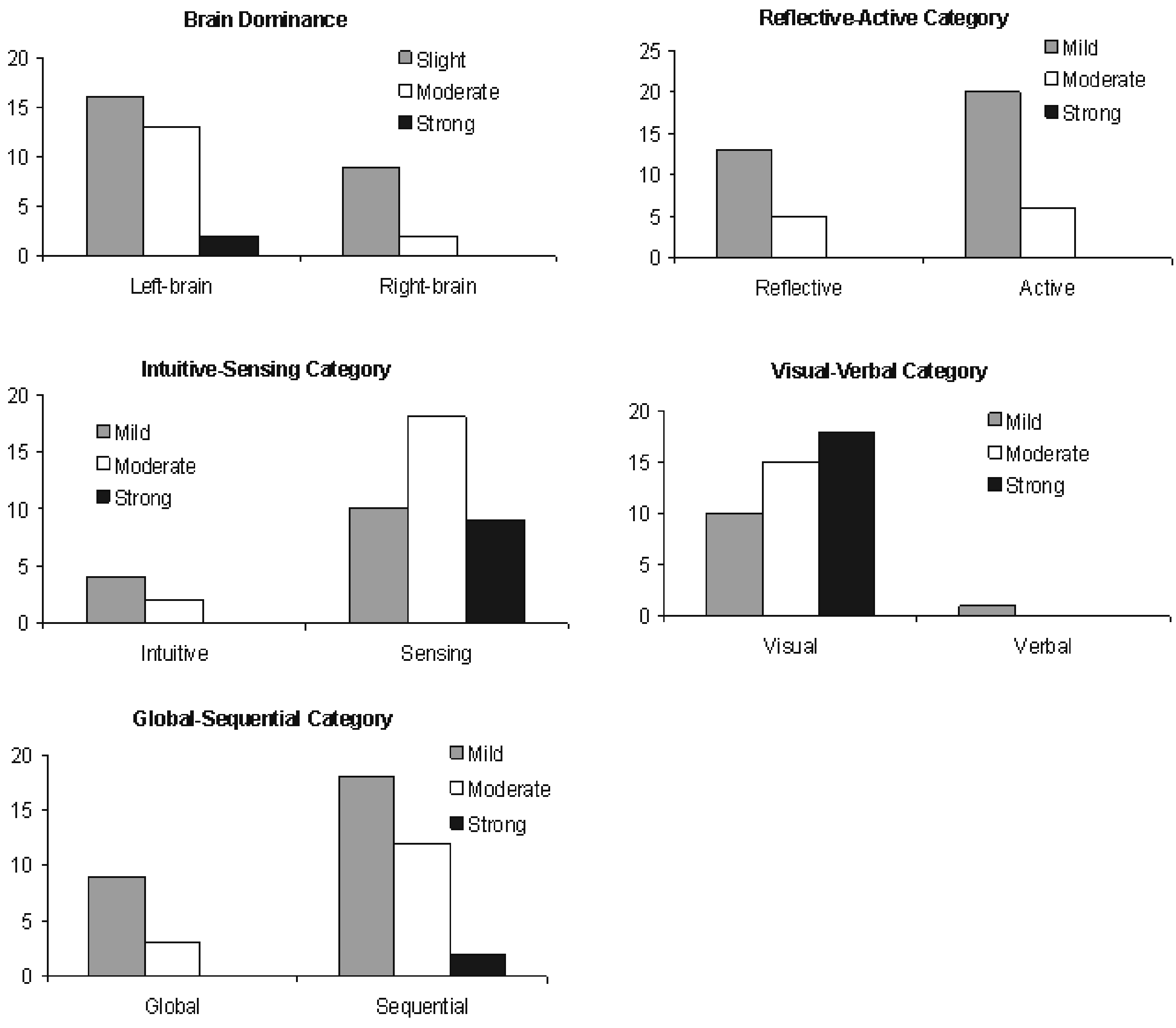

Figure 1. Frequency of categories in each domain

Lastly, we believe that the significance of our study could help enlarge the dimensions of research that examine the area of incorporating new technological tool in the teaching and learning of mathematics.

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Enhancing Technology Education at Surf Science: A Collaborative, Problem-Oriented Approach to Learning Design, Materials and Manufacturing of Surfboards

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This paper presents the results of a study on the influence of blackboard assistance and lecturer's initiative on student's achievements (measured via quality of individualised surfboards). In addition it looks at student attitudes to project related issues in technology education, derived from the pre-test and post-test experiments and surveys. The researcher employed a 2-group design with two pre-tests and one post-test experimental scenario. The results were analysed for homogeneity of variances and means by using Fisher test and t-test, respectively. It was found that the students from pre-test (blackboard-oriented) group achieved the 17% lower score and the 70% greater variations in score variances compared to the data obtained from the post-test (supervisor guided and video-enhanced) group. Furthermore, the students from the latter group believed they were better prepared for solving technically oriented problems in design and production. They also appreciated help from experienced supervisors and video-links, and reported more satisfaction with their individually designed surfboards.

Keywords: Technology Education, Surf Science, Problem-Oriented Approach, Learning Design, Materials, Manufacturing

INTRODUCTION

The Surf Science and Technology (SST) course is a unique one. It was established at Edith Cowan University (ECU) - Faculty of Regional Professional Studies (FRPS) in South West Campus Bunbury in 2002. It is one of only two such courses offered globally – with another one being conducted in Plymouth in England. When conducting this study, there were around 60 people enrolled at the ECU-SST course. All of them are dedicated surfers who are often concerned about influence of their surf-craft on the surfing performance. Consequently, they are 'searching' for the 'best' surfboard which would suit their surfing ability and style. Traditionally, improvements in the surf-boards are sought via changes in material and design features (Orbelian, 1987). Material changes were found (Warshaw, 2004; Wang *et al*, 1996; Manning *et al*, 1993; and Audy *et al*, 2005) to affect the mechanical properties (Warshaw, 2004; Wang *et al*, 1996; Manning *et al*, 1993) and the service life (Audy *et al*, 2005) while the design changes were shown (Orbelian, 1987; Warshaw, 2004; Hornung and Killen, 1976; and Haines *et al*, 2004) to affect the stability, buoyancy and manoeuvrability. Because of this, the balance between the material and design features is very important from both economic and performance point of view. Recent investigations at ECU (Audy *et al*, 2005 and Haines *et al*, 2004) have indicated that surfboard manufacturers and users did not reach the final agreement about the effects of particular design features and material on performance.

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Consequently it looks like 'the best' surfboard is the one that respond to the type of performance required by its surfer. Bearing the above in mind, over the past three years, a considerable attention has been focused on development of innovative technology education for collaborative team-oriented and problem-focused learning in practical work associated with surfboard design and manufacturing process. The driving force for it was to prepare an innovative teaching and learning module that would link the students' personal experiences with their individual needs. In addition, it was intended to give the students the opportunity to work individually and/or in teams to realize how to apply theory to real situation, and expose them to real life of research thinking and industrial working. In order to create such 'innovative' teaching and learning scenario a literature survey has been conducted. The most important findings from reported data on technology education are summarised below.

Reported Data on Technology Education Relevant to Experimental Research Design

The literature survey has shown that the considerable efforts made by technology education lecturers to identify and investigate actual technological practices of students required analysing the current models of design process (Williams, 1996; and Taylor 1992). It has been suggested that technology education should be based on innovative, and risk-taking real-life like problem scenarios (Mawson, 2003) that need to differ for low number of students in a group (McCardle, 2002). Some academics Losike-Sedimo and Reglin (2004: p.222), Oven (1998), Chou and Lin (1998), Burton (2005) warned that teaching and learning out-puts of students belonging to the same group may vary widely due to their diverse backgrounds and skills. There have been some suggestions to encourage team working skills in planned problem based learning scenarios with positive results obtained by Sayer *et al* (2006: p. 158) and Bennet *et al* (2000). Computer enhanced teaching and learning activities including e-learning seem to be frequently used in technology education as reported by Fletcher-Flinn *et al* (1999); Losike-Sedimo *et al* (2004); Reid *et al* (2005: p. 77); Jackson (2004); and Audy *et al* (2005). Literature survey confirmed that the use of computers and e-learning will *firstly* improve students' retention (Bray, 2004; and Hofstede, 1997), and *secondly* help to eliminate a need for empirical testing of product performance replacing this activity with computer enhanced modelling and predictions (Audy *et al*, 2005). The latter will also reduce students' workload and provide enough time to complete the task (Audy *et al*, 2005; and Inglis and Bradley, 2005). It has been suggested by Burton (2005) and Fritz (1996) that consistency in marking is important, and indicated that an assessment is reliable if a student's attempt is awarded similar grades by different markers or the same marker at different point in time. The literature survey has also shown that different questionnaires have been used by academics to evaluate students' research and teaching and learning progress. Some of them, Guilfoyle and Halse, (2004), and Wang and Webster (2004) appeared to experience some difficulties when analysing out-puts from an open type of questionnaires and leading questions. The most often used data evaluation methods were descriptive statistics and multivariable analyses of covariance for analysing group data with respect to more than one dependent variable. Bearing in mind the above information derived from a wide variety of reported sources, the experimental research design was set up as shown in the following Section 2.

Experimental Research Design

The experimental research design is shown in Figure 1. Participants in this study were the surf science students enrolled in the Surf Equipment Design and Materials course unit at ECU-South West Campus based in Bunbury. The task involved designing and producing a wide variety of individual surfboards according to surfing skill and needs of the students. Ten weeks -three hours a week- were allocated for this activity. The first five weeks were dedicated to the lectures/tutorials and demonstrations on design and production of different type surfboards. The rest of time was allocated for shaping-laminating and glassing of individually designed surfboards.

The students were assigned to the two treatment groups – A (control one) and B (experimental one). The former, A, consisted of 15 students, the latter, B, consisted of 13 students. The study was conducted in three stages involving two pre-test experimental designs (A_1) and (B_1), and one post-test experimental design (B_2). The pre-test experimental designs were based on verbal instructions, via three hours seminars (lectures/tutorials and demonstrations), delivered in four weeks, and written instructions distributed to the students through handouts and web-enhanced blackboard. For the pre-test experimental designs (A_1) and (B_1) the seminars were not compulsory and the students had a choice to relay on the information from both handouts and blackboard if they decided to do so. For the post-test experimental design (B_2) students were encouraged to attend all seminars, and to participate actively in researching and evaluating a wide variety of scenarios relevant to surfboard making activities *firstly* from four different videos and *secondly* from two – 3 hours - demonstrations each conducted by a different professional shaper. After this the students were asked

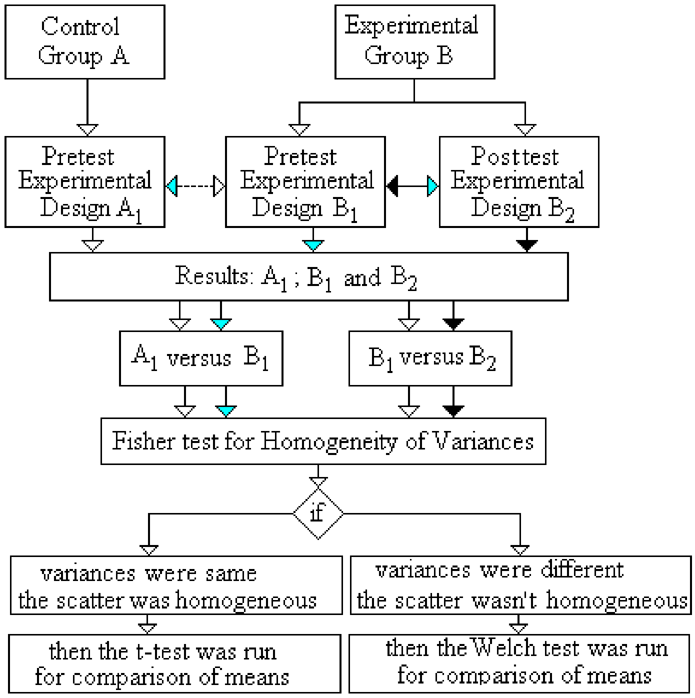

Figure 1. A key to experimental design and subsequent data analyses

to work individually or in group and share their ideas and knowledge when working on their surfboards.

The independent variables examined in this study were learning styles. The dependent variables were achievement scores and attitude scores. Achievement scores were the results (marks) that students obtained from their individually designed and manufactured surfboards including marks for their final reports. The main measures in assessment were: product quality (both intended and final), with comments on reported data on surfboard design and procedures and data analysis. The 50% was the highest possible mark to be achieved by a student for his/her surfboard and report. Other 50% were allocated for the exam.

The attitude scores were examined from a questionnaire designed in a way to allow studying a relationship between attitude achievement and motivation, if any, occurring in an open innovative and effective environment. It consisted of multiple choice questions and questions requiring written responses to a variety of issues relevant to individual learning. The students are asked to comment on (a) their designing, shaping, laminating and finishing skills (and improvements, if any), and (b) benefits gained from team work, handouts, DVD's and videos. Some additional questions were included in the questionnaire to investigate the students' interest in doing their honours, masters and PhD degrees at ECU in design and production (surfboards, fins and boats), materials (composites, laminates and recycling materials), testing (mechanical properties, failure modes, wear and service life), and modelling (simulations and prediction associated with product design and performance measures).

RESULTS

Table 1 shows variances, standard deviations, and mean – project assessment – scores including the results from comparison of variances and means across the two groups from the pre-test (A_1 and B_1), and one group from both the pre-test (B_1) and the post-test (B_2).

What follows are some examples of questions in questionnaire distributed to the students' and their responses to the survey.

Table 1. Results from descriptive statistics, *test* for equity of variances and *t-test* for equity of mean values on the results from pre-test and post-test experimental designs

Results	Variances	St. dev.	Mean
A_1 (dof=14)	65.2	8.1	37.4
B_1 (dof=12)	53.3	7.3	38.3
B_2 (dof=10)	19.9	4.4	44.8

A_1 & B_1	B_1 & B_2
F=0.81; $F_{critical}$=0.37	F=0.36; $F_{critical}$=0.34
Scatter different	Scatter different
t=0.28; $t_{critical}$=1.7	t=2.7; $t_{critical}$=1.7
Means similar, 37.85	Means different

(1) What follows are some examples of questions in questionnaire distributed to the students' and their responses to the survey.

Everything, from drawing out a template, cutting out, shaping laminating, sanding + finishing. There were so many facets involved it would have been a completely unsuccessful venture without Jaro's guidance + interaction with other students.

In comparing what methods i used from my first board i was able to refine my techniques across all areas

(2) Did you benefit from sharing information between the group members?

If yes HOW – able to work things out together, help each other and benefit from others' experience even if they are only 1 step ahead. Also helping others laminate their boards gave more experience therefore more confidence.

Learning there are many different methods adopted by various people. Everyone does it different.

yes by asking people what have already shaped boards. because I have not shaped one before

Sharing ideas and making templates with the help of others

(3) What did you learn from this teaching and learning activity?

Everything, from drawing out a template, cutting out, shaping laminating, sanding + finishing. There were so many facets involved it would have been a completely unsuccessful venture without Jaro's guidance + interaction with other students.

In comparing what methods i used from my first board i was able to refine my techniques across all areas

(4) What type of teaching activity and supporting material did you find most useful?

Watching proffesionals do what they do allows basic pick up of their techni

The DVD shaping & glassing 101 were great, most of the tips and tricks in the video I used in shaping my board

It was useful, however I found Jaro's guidance more beneficial as it was 'hands on' in a real working environment.

(5) What would you like o change if you could do this job again?

Go slower with glass job.

There is a need for surf science to invest in better equipment for the activity.

(6) Would you recommend these activities to your friend?

Yes- a really good learning experience

No. not at home but under supervision at UNI definately because chemicals are dangerous

(7) Do you think that what you learned would be useful in your further study or work?

Absolutely. because actively taking part make the learning process easier.

Hopefully. I would like to be a shaper

Yes helpful in 2nd semester of second year

If I went into shaping or glassing of boards it would definitely be useful

(8) Would the strategies used in this T&L program be successful in teaching, laboratory work etc?

Yes, however we benefited from the low numbers of students. A group of >10 would be difficult.

Some but not all, the 'experienced' members were not 'experienced' enough!

yes Team Work helped The Laminating process

(9) Describe the most significant difficulties you experienced when doing this project

The glassing process is very tricky I had lots of trouble with air bubbles

Finding some of the correct tools, eg. a sander w/ a soft pad to finish the board so not to sand too much off the finished project

Glassing the board on my own without assistance (everyone was busy) + making a few mistakes

Trying to help others with their questions when they seemed not to listen to the answer.

Obtaining a symmetrical board. (template, rails rocker etc equal on both sides)

(10) Would you be interested in doing a postgraduate degree at ECU in product design, material and testing?

probably Masters Design + production + testing

Materials testing + design of surfboards

boards fins boats materials history

The set of photographs in the following Figure 2 depicts the several stages in the surfboard making processes where the students experienced the major difficulties. The blank spaces in the photographs were used to protect identity of students.

Tables 2 to 5 show the percentage analysis for the two groups of students referring to the dimensional features of their individualised surfboards. Table 6 shows 'production' time data relevant to the shaping, laminating and finishing activities of the individually designed surfboards by the groups A and B in the pre-test (A_1 and B_1) and post-test (B_2) experimental designs.

Table 2. Tail shapes relevant to ECU surfboards produced by Group A and B

Tail Shapes	Swallow	Rounded Pin	Rounded Square	Diamond	All round	Swallow with wings	Square
Group A [%]	47	40	7	0	7	0	0
Group B [%]	44	11	11	6	6	6	17

Table 3. A type of surfboard design produced by Group A and B

Surfboard Design	Three fin fish/short board	Twin fin short board	Mini Gun	Mini-mal	Malibu	Bodyboard
Group A [%]	67	13	7	0	0	13
Group B [%]	71	6	0	17	6	0

Table 4. Some of the design data relevant to ECU surfboards produced in 2004 and 2003

6’2”x19”x2$^5/_8$	5’10”x19”$^1/_2$x2$^3/_8$	6’6”x19”$^3/_{16}$x2$^9/_{16}$	6’3”x18”$^1/_2$x2$^1/_4$	6’0”x18”x2$^1/_4$
6’4”x18”$^1/_2$x2$^1/_2$	5’11”x18”$^3/_4$x2$^1/_2$	6’2”x19”$^1/_2$x2$^1/_8$	6’0”x18”$^3/_4$x2$^1/_2$	6’3”x19”$^1/_4$x2$^2/_4$

(a) Cutting the shape
(~20%, mostly females)

(b)Skinning the blanks
(~30%, both genders)

(c) Shaping the rails
(~70%, both genders)

(d) Working with Glassed-in Ornaments (~60%, both genders)

(g) Drilling Holes
(~30%, mostly females)

(h) Positioning and Setting up the FCS and the Glassed-on Fins
(~40%, both genders)

Figure 2. Photographs showing some stages in a surfboard making production with percentage and gender of students experiencing most difficulties

DISCUSSION

Table 1 showed that the variances of the result 'score' data between the two groups in both cases (A_1 and B_1) and (B_1 and B_2) were not equal or homogeneous. In contrast, differences in mean values of score *i.e.* 37.4 for A_1 and 38.3 for B_1 were found to be not significant at 95 percent and higher confidence level. This suggested that one common grand mean of 37.85 will apply for the two groups from the pre-test experiments. The relatively small (but statistically significant) differences in variances, 65.2 and 53.3, and the same grand mean value of 37.85 for both Types $A_{1\ (dof=14)}$ and $B_{1\ (dof=12)}$ from pre-test indicated that students had diverse skills but same background. The post-test experiments (video assistance and lecturer's interactions) appeared to be very successful in improving students' achievements. The student scores improved (increased) by about 18 percent (from 37.85 in A_1 and B_1, to 44.8 in B_2). In addition the standard deviation in mean score was reduced from 8.1 for the pre-test A_1 and 7.3 for the pre-test B_1 to 4.4 for the post-test B_2. This improvement was found to be statistically significant at 95 percentage and higher confidence level.

From Tables 2 to 4 it is evident that a Type 'short' and 'swallow' tail - three fin - surfboards were the most popular in both groups. This is perhaps not surprising given that Simon Anderson – Sydney Shaper, presented his three fin surfboard design known as 'thruster' with a great success in "Bells Beach" in 1981. In addition, the most of ECU surfboards were those of a concave shape and had hard rails on tails and soft rails from middle to

Table 5. Templates used for shaping ECU surfboards by the Group A and B

Templates for shaping obtained	from 'reported' surfboard design features	from friends and/or shapers	by copying from an existing board	by designing and calculating
Group A [%]	55	25	6	12
Group B [%]	10	75	10	5

Table 6. Comparison of time (average and range in hours) needed for finishing individually designed surfboards by the groups in pre-test and post-test experimental design

		Surfboard making Activities [hrs]			
Group	Test Design	Shaping	Laminating	Fin Setting and Finishing	Total
A	pre-test (A_1)	$13^{\pm4.5}$	$5.4^{\pm2}$	$9.4^{\pm3}$	$27.7^{\pm6}$
B	pre-test (B_1)	$11.8^{\pm4}$	$4.8^{\pm3.5}$	$8.3^{\pm3}$	$24.9^{\pm6}$
B	post-test (B_2)	$7.9^{\pm3.5}$	$3.2^{\pm2}$	$5.3^{\pm2.5}$	$16.4^{\pm5}$

nose. Former was to reduce the surface tension in tail area, while the latter was to improve both stability and manoeuvrability.

From Table 5 it appears that about 55% students from Group A made templates for their surfboards by magnifying the design features of 'as published' surfboards in various magazines, while 25% of students got the templates from friends or shapers. The trend reversed a year later when 75% of students from Group B obtained the templates from friends or shapers and only 10% opted for those reported in magazines. Majority of the SST students opted to make a light surfboard. They did it by reducing the surfboard thickness features during shaping, and / or by using a light 135gsm cloth for laminating. Consequently, the total weight of the glassed surfboards with fins was low and it varied from about 2.8 to 3.3 kg. The production cost was about $230 for a complete surfboard (without fins) compared to around $600 for a commercial surfboard.

Finally, referring to Table 6, the total production time spent on shaping and laminating of ECU surfboards varied from three weeks to nine weeks. There was no big difference in the total average production time $27.7^{\pm6}$ hours and $24.9^{\pm6}$ hours between the two -A_1 and B_1- pre-test groups. However, the significant drop in production time (to $16.4^{\pm5}$ hours) was observed in the pre-test group B_2. This trend was evident in all three individual surfboard making activities that included *firstly* shaping, *secondly* laminating, and *thirdly* fin setting and finishing. The individual time factor for A_1 and B_1 (pre-test) designs was greater than that for B_2 (post-test) design.

Final Conclusions

This study confirmed that quality is rarely produced by chance but never produced consistently by chance. It appeared that two -A_1 and B_1- pre-test groups had the same background (because of statistically similar 'mean' score of 37.85) but diverse skills (because of statistically different variances being 65.2 and 53.3). The intervention had a significant effect on attitudes and scores (both mean and variances) compared to pre-test levels. The students from intervention group B, post-test design B_2, reported higher level of understanding and they also achieved much higher mean score of 44.8% from possible 50% compared to the pre-test designs from last two previous years (on average 37.85% from possible 50%) for both B_1 and A_1. They appeared to understand the interaction between surfboard design features and performance in deeper content and were able to link it together with production and material issues.

Their positive remarks in questionnaire indicated good reactions to the lecturer's initiative. In addition, the students from post-test group produced high quality work because of a real-time feedback from an independent observer *e.g.* teacher helping them to monitor and control the quality of their work in individual production stages. Such real-time feedback from the project supervisor and/or individual team members enabled the students to visualise, and understand, the contrast between theoretical and technical knowledge, and to alter a work-in-progress in order to improve the overall quality of their product. Consequently, each student was given opportunity of being an active member of a group with ability to produce, be self-monitoring, critical, and knowing how to compare his or her work against others not just by activities engaged in, tasks completed or work done, but by what they learned or mastered and can carry with them.

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Mathematics Teachers' Professional Development through Lesson Study in Indonesia

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Observable practices of mathematics teaching in the period of the year 2001-2003 also indicated that many teachers still have difficulty in elaborating the syllabus; a number of mathematics topics are considered to be difficult for teachers to teach; a significant number of children consider some mathematics topics as difficult to understand; teachers consider that they still need guidelines for conducting teaching process by using science process skills approach. Results of the initiated Lesson Studies significantly indicated that there are improvements of the practice of secondary mathematics teaching learning processes in term of teaching methodology, teacher competencies, students achievements, alternative evaluation, teaching learning resources and syllabus. However, in term of the longer term for teacher development program, the result of initiated Lesson Studies can be perceived as merely a starting point. There are still many things to be done in order that mathematics teachers develop their professional development.

Keywords: Mathematics Teaching, Professional Development, Lesson Study

INTRODUCTION

Lesson Study activities let the teachers to reflect and evaluate, in cooperation with lectures or other teachers, their paradigm of teaching. Herawati Susilo (2003) indicated that approaches of Lesson Studies covered (a) students cooperation with others in their learning, (b) contextual teaching and learning, (c) life-skill, (d) hands-on activities, (e) interactive process oriented curriculum and syllabi development, and (f) teachers and students autonomous. From those three sites of study, there can be produced the notions of educational improvement, in term of teacher, student and lecture.

The objectives of those Lesson Study activities were to contribute the improvement of secondary mathematics education by pursuing good practice of mathematics teaching (Marsigit, 2003). Lesson Studies for secondary mathematics were carried out by mainly Classroom Action Research approach. They carried out to improve the teaching learning practices and to find more appropriate methods for facilitating students learning. Teachers' experiences have been shared with other teachers and the lectures. The specific objectives of Lesson Study activities are:

(1) to develop instrument and equipment for teaching learning process,
(2) to develop teaching method and model for teaching learning process,
(3) to develop teaching material for teaching learning process, and
(4) to develop teaching evaluation for teaching learning process.

Isoda (2006) indicated that in the process of pre-service teacher education, it is important to develop teacher's perspectives; and, learning to listen is a key word for this approach. He added that, in the case of Japan, lesson study usually begins by developing a lesson plan in which teachers solve and pose problems from students' perspectives. Further, he claimed that:

By analyzing problems, teachers develop good ways of questioning. For writing the description of the VTR, it

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is very important to ask why? Why did students say this? Behind their words, there must be so many kinds of ideas. Why did the teacher say that? Through these questions, we can better know and understand the hidden features of the lessons being observed through VTR (Isoda, 2006)

Then, it is very important to add the format of such kinds of descriptions from the view points of original lessons from different context e.g. Indonesian context. Even if we add descriptions we should be critical because re-contextualization is done by VTR users.

METHOD

Teacher Professional Development Activities

Since the early of 2000, there are collaborations among universities, teacher training institutes and Ministry of Education of the Directorate of Secondary Education to improve teachers' competencies to support the implementation of the proposed competent-based curriculum (DGSE, 2002). The data of teachers' professional development coming up from various activities such as (Marsigit, 2003): Validation and Socialization of the Guideline of Syllabi and Evaluation System of Competent-Based Curriculum, National Workshop for Socialization the Development of Competent Based Curriculum for Junior High School Mathematics, National Level of Training of Trainer (TOT) for Basic Science, Monitoring and Evaluation of the Piloting of Competent-Based Curriculum for Mathematics in State Junior High School.

Case Study: Observing Japanese Lesson Study through VTR

In each of those activities, the author played the Japanese VTR of Lesson Study produced by CREAR (2000) of DIRECT NETWORK NICHIBUN, to reflect teachers' perceptions and to understand the extent it influences teachers' following activities. From the seven activities of workshops, there are totally 440 participants who observed the VTR and gave the inputs. In each of those workshops, there are some steps of reflecting those teaching: Firstly, observing the VTR without any comment from the trainer, Secondly, collecting the general comments from the audiences, Thirdly, repeating the observation of the VTR with some comments from the trainer, Fourthly, discussing the more specific aspects of the teaching

VTR : Produced by CREAR, Direct Network Nichibun
Lesson : Choosing Tasks according to Pupil's Interests (4th grade)
Teacher : SAITO, Kazuya
School : Ookayama Elementary School, Yokohama city
Unit : The area of plane figures

In the highlighting the VTR, teachers observe and reflect on how the teacher facilitate their students (Isoda, 2006): to appreciate the formulas for the area of figures and are willing to use the formulas in order to find the area; to find the area making the best use of their prior knowledge and experience; to formulate the methods to find the area of parallelograms; to find the area of fundamental Figures efficiently; to understand the methods of finding the area of fundamental figures.

Initiating Lesson Study

Under cooperation between Government of Indonesia (GOI) and JICA-Japan, three universities UPI Bandung, UNY Yogyakarta and UM Malang carried out project called IMSTEP-JICA for pursuing good practice of mathematics (and sciences) teaching by empowering and developing teacher education (Herawati Susilo, 2003). Starting in 1999 and lasting in 2005, the extending of the project resulting piloting activities through Lesson Studies for good practice of secondary mathematics teaching in three cluster site West Java, Central Java and East Java.

The piloting activities were carried out in three clusters i.e. West Java (Bandung), Central Java (Yogyakarta), and East Java (Malang). Table 1 below shows the number of classes, teachers, and lecturers in each site.

Table1. Three cluster sites of Lesson Studies of Mathematics Teaching (IMSTEP-JICA Project)

	West Java (Bandung)		Central Java (Yogyakarta)		East Java (Malang)	
	Year 2001/2002	Year 2002/2003	Year 2001/2002	Year 2002/2003	Year 2001/2002	Year 2002/2003
Classes (schools)	1	2	1	3	1	1
Teachers involved	1	2	3	3	1	1
Lecturers involved	4	4	4	3	4	4

The Lesson Studies were developed in which the teachers, in collaboration with Lecturers and Japanese Experts, tried out some teaching models at schools (Gorman, 2005). The Lecturers of Teacher Training Program and School Teachers worked collaboratively, composes some numbers of Lesson Studies. The grounds of the Lesson Study activities were reflecting and promoting the new paradigm of the secondary mathematics and science education, in which learning activities are not only perceived pragmatically and short-time oriented but also to be perceived as a long-life time purposes.

RESULTS

In general, the activities of reflecting Japanese context of mathematics teaching through VTR in the training program were perceived as good and useful by the teachers. The teachers perceived that such activities need to be socialized to other districts in order that more teachers can learn it. They perceived that the teaching reflected in the VTR was a good model that can also be implemented in Indonesian context. However, they perceived that it is not easy to implement it.

The teachers viewed that to implement good model of mathematics teaching, as it reflected in the VTR, there are some constraints coming from: lesson plans, students' worksheets, teachers' competencies, students' readiness, educational facilities and equipments, teaching methodologies, allocation of time, number of students and budgeting. Teachers need to improve their competencies of teaching and competencies of teaching contents. They perceived that they need to improve their competencies in preparing the lesson plans and producing students' worksheets.

There were strong evidences that Lesson Studies activities improved students' enthusiasm, motivation, activities, and performance. It also improved teachers' professionalism in terms of teaching performance, variation of teaching methods/approaches, collaboration. Lecturers got to know more about the problems faced by teachers. It was take time for teachers to shift from teacher-centered to student-centered. Teachers developed teaching methods based upon more hands-on activities and daily life utilizing local materials. Students were active learning and involved in discussion to share ideas among classmates.

Students enjoyed learning science and math during Lesson Study activities due to some reasons. According to students' respond, the lesson was not so formal, the contents were easier to learn, the students were able to express their ideas, the students got much time to discuss with their classmates, and the students got more experiences in science and mathematics. Further, the teachers developed alternative methods for letting their students to learn and to construct their own concepts. However, teachers needed more time to get used to develop teaching model by their own.

The Lesson Study project was proven to be very effective in lifting students' enthusiasm in learning mathematics, in helping students to develop their experimental and discussion skill, in giving opportunities to students in developing their own scientific concept by themselves. It was also documented that by employing constructivism approach, the students may find out their best style of learning. Competition rises among groups of students in presenting the results of their work and defending their presentations. This encouraged the students to learn more theory on their own. As a result of Lesson Study activities there were many teaching material has been developed either by lecturers or by teachers.

The results of Lesson Study activities and exchange experiences come to a suggestion that to improve mathematics and science teaching in Indonesia; it needs to deliver obvious messages to the government, teachers and head-teachers or schools. It learned from the study that to promote good practice of mathematics and sciences teaching, the teachers need to en-culture their efforts in inovating teaching learning processes which meet to academic students needs, encouraging students to be active learners, developing various strategic of teaching, developing various teaching materials, and in developing teaching evaluation. In developing teaching learning methods, the teachers perceived they need to: plan the scenario of teaching, plan students activities, plan teachers' roles, distribute the assignments, develop assesment methods, and monitor the progress of students achievements.

According to teachers, most of the students are not ready or not able to present their ideas; it takes time for them to accustom to do that. The teachers indicated that most of the schools are lack of educational facilities and teachers need to be able to develop teaching media. According to teachers, the most difficult to implement good model of teaching practice is about time allocation. They perceived that it is not easy to take in balance between achieving students' competencies and considering their processes of learning. Meanwhile, they claimed that a teacher still should facilitate a lot number of student i.e. forty students per class.

CONCLUDING REMARKS

This research lead to the conclusion that to develop teaching experiences, teachers need to participate frequently in Lesson Study activities. By developing teaching materials teachers may conduct the teaching and learning process more efficiently. In Lesson Study activities, the students enjoyed mathematics learning because they were involved in observing and doing things. Developed teaching materials also improved students' motivation and interest in learning mathematics. Although there are many kinds of teaching materials that have been developed through those Lesson Study activities, there are still more topics that need to be better equipped with teaching materials. This research concluded that lecturers from three universities need further collaborative work to develop more teaching materials in the future.

It was indicated in this research that the teachers hoped the schools and government to support their professional development including the chance to get training, to participate the conferences, to participate in teachers club. The teachers perceived that in the teachers' club they will be able to discuss and develop lesson plan and students worksheet. Teachers suggested that teachers' professional development programs should be based on teachers' need; and therefore, it needs such a need assessments prior the programs. They also hoped that the schools and government procure educational facilities and improve their salary.

The study also recommended that to encourage educational innovations, the head-teachers need:

(1) to make good atmosphere for teaching and learning,
(2) to promote to implement various teaching methods and teaching learning resources,
(3) to give the chances for the teachers and their students to perform their initiatives,
(4) to promote cooperative learning,
(5) to promote research class as a model for educational innovations (as Japanese teachers do),
(6) to support the teachers to be the developer/maker of the curriculum,
(7) to promote teachers' autonomy in developing model of teaching learning activities,
(8) to implement school-based management,
(9) to encourage students' parents participations, and
(10) to promote cooperation with other educational institutions.

Further, the study also recommended that to improve the quality of mathematics education, the central government needs to:

(1) implement more suitable curriculum i.e. more simple and flexible one,
(2) redefine the role of the teachers i.e. teachers should facilitate students' need to learn,
(3) redefine of the role of principals; principals should support the professional development of teachers by allowing them to attend and participate in scientific, meetings and trainings,
(4) redefine the role of schools; schools should promote school-based management,
(5) redefine the role of supervisor; the supervisors need to have similar background with the teachers they supervise in order to be able to do academic supervision,
(6) improve teachers' autonomy to innovate mathematics and science teaching and learning,
(7) promote better collaboration between school and university; communication among lecturers and teachers should be improved; these could be done through collaborative action researches and exchange experiences through seminars and workshops,
(8) redefine evaluation system, and
(9) extend project for promoting new paradigms and educational innovations.

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Biology Majors' Performance in a Biomathematics Course

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The recent considerable developments in the field of biology have necessitated the knowledge of mathematics and its applications in biology. Therefore; most of the universities, now, believe that it is essential to include mathematics courses in the curricula of biology departments. Taking this fact into consideration, this study aims at exploring to what extent biology department students are successful in comprehending mathematical concepts and applying these in biology problems. The test administered to achieve this aim revealed that biology department students were more successful in the application of mathematics in biology

Keywords: Biomathematics Course, Performances of Biology Students, Application of Mathematics in Biology

INTRODUCTION

The rapid developments in biology in the last 50 years have required an intensive collaboration between biologists and other fields. Due to computer-based analyses and experiment facilities, it is crucial that biology department students should be equipped with mathematical knowledge (May, 2004). It is a known fact that it is not adequate to learn about genes, proteins, virus, molecules and environmental factors only through biological methods (Nowak and May, 2000). It is quite difficult for biology department students to understand and improve today's biology without having knowledge about single or multi variable functions, differential equations as well as linear algebra (Newby, 1980). The use of related computer programs and the interpretation of the results require a considerable knowledge of mathematics. By taking these facts into consideration, Biology Department at Anadolu University, like many other universities, decided to introduce a biomathematics course into the syllabus starting with the 2003-2004 academic year. At first, a three credits course of this nature may seem to be irrelevant for biology majors. Although, presumably, the main reason for most students to prefer this department is their special interest in biology, some choose this department with an assumption that it is a science-related major with no or little mathematics. In other words, these students prefer to attend a science department which has no relation to mathematics.

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Indeed, if they wanted to attend a department using mathematics a lot, they would prefer a department from Engineering Faculty since such a department would be better for their future career and prosperity. In addition, it is a known fact that generally all the students in science departments are not successful in calculus courses and, therefore many studies have been conducted concerning this issue (Bloch, 2003; Cotrill, Dubinsky, at all., 1996; Eisenberg, 1991; Ferrini-Mundy, and Graham, 1994; Tall and Vinner, 1981). Thus, the lecturer teaching biomathematics in biology departments has to be motivating and also has to convince students about the place and importance of mathematics for the field of biology. As a result, lecturers should make use of samples from biology or closely related fields of science topic while explaining mathematical concepts. These conditions led the researcher to the following concerns about biomathematics course:

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- To what extent are biology department students successful in comprehending mathematical concepts?
- To what extent are biology department students successful in solving biology problems by using mathematical concepts?

On the basis of these concerns, this study aims at exploring to what extent are biology department students successful in comprehending and mathematical concepts and applying these concepts to biology problems.

METHODOLOGY

The first year students attending Anadolu University, Faculty of Science, Biology Department and having taken the biomathematics course were chosen as the subjects of this study. These students were first taught certain mathematical concepts such as function and its limit, continuity and derivation features, and then some applications of these concepts in biology were carried out in the classrooms. The total number of the subjects was 67. This group was administered an exam which consisted of four questions. Mainly, there were two types of questions; Type 1 included the first two questions testing mathematical knowledge directly, and other Type 2 questions were related to the application of mathematics in biology. Subjects were asked to provide expanded responses to questions in the exams.

The Exam Administered to the Subjects

Exam 1. $f(x) = \sqrt{x-1}$ and $g(x) = \dfrac{1}{x-1}$

functions are given

a) $(f \circ g)(x) = ?$

b) Find the domain of the function $f \circ g$.

Exam 2. Find the interval of the following function where it is increasing and decreasing $f(x) = x^2 e^{-x}$

Exam 3. A pharmacologist studying a drug that has been developed to lower blood pressure determines experimentally that the average reduction f in blood pressure resulting from a daily dosage of x *mg* of the drug is given by

$$f(x) = 2(1 + \frac{x-1}{\sqrt{x^2-1}})\ mm\ Hg.$$

(The units are millimeters of mercury (*Hg*).)

a) Determine the sensitivity of f to dosage x at dosage levels of 2 *mg* and 3 *mg*.

b) At which of these dosage levels would an increase in the dosage have the greatest effect?

Exam 4. A certain cell culture grows at a rate proportional to the number of cells present. If the culture contains 2000 cells initially, and 6000 after 20 minutes, how many cells will be present after a further 1 hour? ($\ln 3 \cong 1.0986$)

In the evaluation of this exam, the correct solution meant correct calculations with a correct answer. All other situations were considered as a "wrong answer." Statistical analysis of the results included percentages and frequencies.

RESULTS AND DISCUSSION

The performances of the students in the exams are shown in Table 1. According to Table 1, 21.5 % of the students gave a right answer to Type 1 questions and 59.5 % to Type 2 questions. When these two averages are compared, it is clear that students are far more successful with type 2 questions which require the use of mathematics in biology. It can be said that students find it difficult to find a solution to the problems testing the knowledge of mathematics directly.

This result can be interpreted as follows: "Biology department students find it difficult to comprehend an abstract concept, but they are more successful in solving concrete problems. This situation might be also the reason why these students have chosen biology department, a field not closely related to mathematics. Therefore, it might be more logical to teach this course in such a way that students can figure out the abstract structure of mathematics with the help of concrete problems.

In other words, we believe that students will be more successful when they are given the chance to discover mathematical concepts with the help of a "real life problem."

Another reason to fail to comprehend abstract concepts of mathematics is the inadequacy of 3 hours

Table 1. Student performance according to question types

	Type 1				Type 2			
	Question 1		**Question 2**		**Question 3**		***Question 4***	
	N	%	*N*	%	*N*	%	*N*	*%*
Correct Answer	***11***	***16***	***18***	***27***	***39***	***58***	***41***	***61***

mathematics instruction for the students that are not good at abstract thinking. Still another reason is the lack of interest due to the doubt about the importance of mathematics since they rarely have mathematics courses in vocational courses in their departments.

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The Impact of Motivation on Student's Academic Achievement and Learning Outcomes in Mathematics among Secondary School Students in Nigeria

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In our match towards scientific and technological advancement, we need nothing short of good performance in mathematics at all levels of schooling. In an effort to achieve this, this study investigated the impact of motivation on students' school academic achievement in mathematics in secondary schools using motivation for academic preference scale (α = 0.82) as a measuring instrument and achievement test in mathematics (ATM) Two hypotheses were tested for significant at 0.05 margin of error using t-test and analysis of variance (ANOVA) Results showed that gender difference were significant when impact of motivation on academic achievement was compared in male and female students. Also other result indicates significant difference when extent of motivation was taken as variable of interest on academic achievement in mathematics based on the degree of their motivation. Implications, suggestions and recommendations on students, parents, government, counsellors, educational stakeholders, etc were discussed.

Keywords: Motivation, Academic Achievement, Learning Outcome, Mathematics, Secondary School Students, Nigeria

INTRODUCTION AND BACKGROUND

In the contemporary Nigeria, greater emphasis is being placed on Industrial and Technological development. As a result students are being encouraged to take up science related subjects. One subject that cut across all the sciences is mathematics. Today, mathematical methods pervade literally every field of human endeavour and play a fundamental role in economic development of a country. In our match towards scientific and technological advancement, we need nothing short of good performance in mathematics at all levels of schooling. Unfortunately performance of students in mathematics at the end of secondary education has not improved in the past decade (Umoinyang, 1999).

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Various factors have been adduced for poor performance of students in mathematics. The interest of students in mathematics have been related to the volume of work completed, students task orientation and skill acquisition, students personality and self-concept (More, 1973), feeling of inadequacy (Callahan, 1971), motivation and self-confidence (Aiken, 1976), anxiety (Aiken, 1970), shortage of qualified mathematics teachers, (Ohuche 1978, Ale, 1989), poor facilities, equipment and instructional materials for effective teaching (Oshibodu, 1984, Akpan 1987, Odogwu, 1994), use of traditional chalk and talk methods, (Oshibodu, 1988, Edwards and Knight, 1994), large pupils to

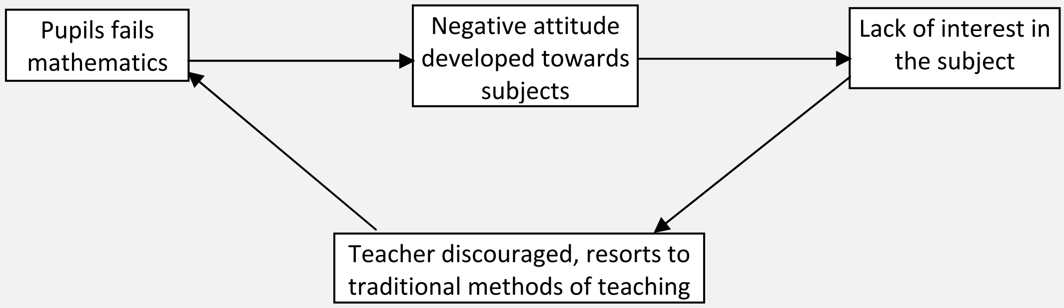

Figure 1. Illustration of factors affecting teaching and learning of Mathematics: Source- Aremu (1998)

teacher ratio (Alele-Williams 1988) mathematics fright/phobia (Georgewill, 1990) and so on. Wentzel (1998) stated that interest in activities tends to increase the likelihood that individuals formulate goals relating to that activity and invest time and effort to achieve them.

Moreover, individual characteristics such as intelligence, cognitive styles, and personality play an important role in learning and instruction as does the context of learning. Other research findings have shown that individual students' characteristics variables such as motivational orientations, self-esteem and learning approaches are important factors influencing academic achievements.

In the effort to improve students cognition and affective outcomes in mathematics and/or school learning, educational psychologists and mathematics educators, have continued to search for variables (personal and environmental) that could be manipulated in favour of academic gains. Of all the personal and psychological variables that have attracted researchers in this area of educational achievement, motivation seems to be gaining more popularity and leading other variables (Tella, 2003).

All the above stated reasons, for persistent failure in mathematics, which have been proffered, bear relevant in one way or the other to the poor performance of pupils in mathematics. This has lead to a cycle of events that could be illustrated thus:

When explaining the illustration above (Aremu, 1998) explained that; when pupils express lack of interest in the subject, it affects the way they react or listen to the teacher. And when many of the pupils believe that they cannot pass, the teacher is also affected. This is because aside of this negative response from the pupils, he/she as well is already being confronted by a lot of other factors (e.g., low income, low status in society, large teacher-pupils ratio) and so on. These may cause him or her to resorts to the easiest way of disseminating knowledge that is 'chalk and talk' without the use of instructional materials. He may not also bother to vary his teaching styles to suit individuals; therefore the cycle goes on (Aremu 1998). One unfortunate outcome of this is that, the negative attitude towards the subject is passed down from one generation of pupils to another and therefore the cycle keeps enlarging. What then could be done to break such a cycle of failure? This has been the question by many mathematics educators and researchers (Akpan 1987, Baya'a 1990). A lot of new and modified old methodologies have been proposed to improve performance in the subject (e.g., Ande, 1990; Akinsola, 1994; Broussard & Garrison, 2004) etc. Instructional materials have also been designed and developed to aid mathematics teaching and learning (Skemp 1989). All these are to help break this cycle of poor performance by motivating pupils to learn mathematics. This issued of motivating learners is seen as an important aspect of effective learning. In fact psychologists believe that motivation is a necessary ingredient for learning (Biehler and Snowman, 1986). They believe that satisfactory school learning is unlikely to take place in the absence of sufficient motivation to learn (Fontana 1981). The issue as relating to mathematics education would then be, is it possible to motivate pupils to learn mathematics? And how could it be done? One needs to therefore look at the effect of motivation on learning.

The issues of motivation of students in education and the impact on academic performance are considered as an important aspect of effective learning. However, a learner's reaction to education determines the extent to which he or she will go in education. The impact of motivation on education of mathematics of a child cannot be undermined. That is why Hall (1989) believes that there is a need to motivate pupils so as to arouse and sustain their interest in learning mathematics. "Motivation raises question on why people behave in the way they do it". An individual could therefore, from psychologists' point of view, be seen as politically, socially and academically motivated depending on the motive behind his or her activities.

Based on the foregoing, research on Mathematics academic achievement should be considered a continuous process until there is evidence of improvement in interest and performances of the learners in the subject particularly the secondary school students. Essentially therefore, the present study is an effort in this direction. Hence the study investigates the impact of motivation on student's academic achievement in mathematics.

The Purpose of the Study

The study sought to explain learning outcomes in senior secondary mathematics in terms of motivating students towards academic gains in the subject.

Hypotheses

In this study, two null hypotheses were tested for significance level at 0.05 margin of error. They are:

$H0_1$: There is no significant difference in the impact of motivation on academic performance of male and female students in mathematics.

$H0_2$: There is no significant difference in the academic performance of highly motivated and lowly motivated students in mathematics achievement test.

The experimental researches carried out by some researchers have tremendously improved the knowledge about the motive to achieve (Gesinde, 2000). Achievement motivation could be seen as self-determination to succeed in whatever activities one engages in, be it academic work, professional work, sporting events, among others. Gesinde (2000) posits that the urge to achieve varies from one individual to the other, while for some individuals need for achievement is very high whereas for others it may be very low. However, there are high achievers and low achievers. What is responsible for the variation could be the fact that achievement motivation is believed to be learnt during socialization processes and learning experiences. As a matter of fact this varies from one individual to the other. Gesinde (2000) asserts further that, those who have high achievers as their models in their early life experience would develop the high need to achieve, while those who have low achievers as their models hardly develop the need to achieve.

Human beings are said to be extrinsically or intrinsically motivated. Intrinsic motivation is said to be derived internally in the job itself. It is that which occurs while a person is performing an activity in which he takes delight and satisfaction in doing. Intrinsic motivation is seen as internal reward, while extrinsic motivation is incentive or reward that a person can enjoy after he finishes his work.

Okoye (1983) opined that motivation holds the key to the understanding of human behaviour. According to him, motivation explains why one individual dodges work, another works normally satisfactorily enough to reach the height, while yet others resort to illegal and unconventional methods of achieving social, academic, economic and political recognition. He added that motivation should be carefully manipulated whether in the work situation or study situation, so that our students are neither under motivated or over motivated but appropriately motivated so as to be useful to themselves in their society and the world at large.

Harju and Eppler (1997) investigated the relationships among college students' learning and performance goal orientation, drawing on questionnaire data from ages 17 – 22 of college students' total 312. It was reported that students who had a learning profile motivation had completed more semesters. They concluded that the younger students who were externally motivated tended to posses more irrational beliefs while other internally motivated students tended to be more involved in learning.

Cheung (1998) hypothesised that conceptions of success of achievement goal affect both the inclination to and actual performance. This was tested in a sample of 673 Chinese adolescents. Sex differences were found in the conception of success. As part of larger project concerned with motivation factors in educational attainment Siana et. al. (1998) focussing on Asian girls, 985 secondary schools students in London and England found that Asian students of both sexes rated parents and friends as more important in contributing to academic success.

Yoloye (1976) carried out a descriptive survey on the cause of poor academic achievement in Northern Nigeria. He reported that majority of the children who were labelled as backward or unintelligent to school were good, but they were handicapped by physical characteristics such as defective vision, learning defect and other preventable diseases. Bridgeman (1978) reported that standard school achievement test is somewhat predictive of later academic performance.

Bank and Finlapson (1980) found that successful students were found to have significantly higher motivation for achievement than unsuccessful students. Moreover, (Johnson, 1996; Broussard and Garrison, 2004; Skaalvik and Skaalvik, 2004; Skaalvik and Skaalvik, 2006; Sandra, 2002) revealed significant relationship between academic performance and motivation. In Nigeria, a study carried out by Ajayi (1998) on achievement motivation using 276 students revealed that there is an agreement between academic performance and motivation.

Motivation and Mathematics

In making instruction interesting in learning mathematics, there is need to use methods/strategies and material/media which will make the learning of mathematics, active, investigative and adventurous as much as possible. Such methods also must be ones that take into account, learner's differences and attitudes towards mathematics as a subject. Examples could be the use of programmed learning texts, use of concrete materials and other instructional devices, which are manipulated. Also, mathematics exercises in form of various pencil and paper activities should be used.

To enhance self-esteem of learners, which will in turn improve attitude of such pupils, it is recommended that varying activities (game activities), which has been designed to contain mathematics problems ranging from easy to very difficult, should be used. At least each pupil no matter their ability level should be able to answer some questions correctly. This would go a long way to motivate such pupils towards further learning.

When an activity is designed with its central feature being an admired situation, experience or individual, it would go a long way in motivating, pupils to learn mathematics. For example, in teaching addition at the primary school level, you could centre learning activities around foods like snacks (for example, I got two sweets from mummy and four from daddy how many sweet do I have and so on). It could as well be centred on a pleasurable experience (like going to see father Chrisman) or around an admired person (for example, a most liked character on the television) and so on. All these suggestions would help to motivate learners towards learning. However, one strategy, which has been observed to bring about motivation of learners to learn mathematics, is the use of game based strategy (Aremu, 1998).

Achievement Motivation

How do people differ in their motivation to achieve? In a classic study to assess the differences in strengths of people's achievement motives McClelland and Colleague in Aire and Tella (2003) developed a projection technique using selected picture cards from the Thematic Apperception Test (TAT). The technique assumes that, when asked to write stories about the pictures, respondents will project their feelings about themselves onto the characters in the pictures. Assessment of the responses involves noting references to achievement goals (concern over reaching a standard of excellence). Subjects who refer to achievement goals are often rated high in achievement motivation; those who rarely or never refer to achievement goals are rated low.

Achievement motivation is often correlated with actual achievement behaviour (Camara, 1986). The motivation to achieve, however may evidence itself only in behaviour that children value. For example, a child may be highly motivated to achieve, and this may be exhibited in athletics but not in schoolwork. Thus, different situations have different achievement-attaining values for children (Eccles, et. al. 1998; Harter and Connell, 1984).

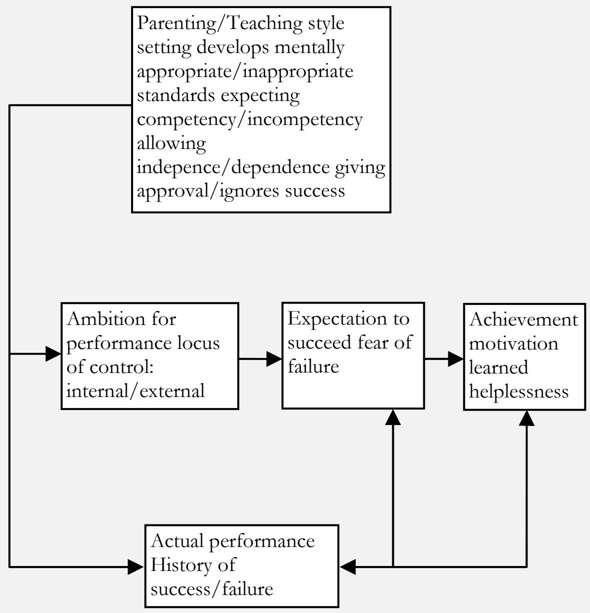

Figure 2. Relationship attribution and actual performance

Achievement Motivation, Child Expectations and Attributions

Individuals' actual achievement behaviour depends not only on their motivation to achieve but also on whether they expect to achieve and whether they fear failure. People are more likely to work hard when they perceive a reasonable chance to succeed than when they perceive a goal to be out of reach (Atkinson, 1964). Children's expectations of success can be measured by asking them to predict a certain grade, indicate how sure they are that they can solve a particular problem, and select the hardest task they think they can do from a collection of tasks varying by degree of difficulty (Philips, 1987).

Children with high expectation for success on a task usually persist at it longer and perform better than children with low expectations Eccles, 1983; Eccles et. al.1998). Researchers like (Carr et. al.1991) have found that children with high IQs and high expectations of success in school do, in facts get the highest grades. Children with high IQs and children with low IQs and low expectations receive lower grades than children with low IQs and high expectations. In addition to child rearing practices, reviewed previously, teaching styles and communication pattern affect children's attributions. When teachers are caring and supportive and emphasise the teaching learning process over the performance outcomes, and when they give feedback, children tend to be motivated to achieve and to expect success (Daniels, Kalkman, and McCombs, 2001).

METHODOLOGY

Design

This research is an ex-post facto design in the sense that the researcher does not have direct control over independent variables because their manifestations have already occurred or because they are inherently not manipulable. The investigator therefore examined the impact of motivation (independent variable) on secondary schools student achievement in Mathematics.

Population

The target population for the study comprised of all senior secondary 2 (SS2) students in Ibadan North-West and Ibadan South West Local Government areas of Oyo State of Nigeria.

Sampling Procedure and Sample

The study's participants were 450 secondary school students drawn from 10 schools in two local Governments areas in Ibadan. This sample of students was randomly drawn from selected secondary schools. Their age ranged from 15 – 22 years with a mean of 18.6 years and standard deviation of 3.6. The study includes male and female students. Other variables considered in the study are extent of motivation at two levels that is highly motivated and less motivated students.

Instrumentation

A modified instrument tagged Motivation for Academic Performance Questionnaire (MAPQ) was used to gathered data on the study. Items in the instrument were adapted from Motivation for Occupational Preference Scale (MOPS) by Bakare, (1977) and Motivation for Academic Study Scale by Osiki (2001). The instrument was divided into two parts. The first part require the participants demographic information like sex, age, class, name of school etc; while the second part contain the items. It was a thirty items scale of likert type format with response ranged from strongly agrees 5, to strongly disagree 1. To ascertain the reliability of the instrument after modification, it was administered on 50 respondents who were secondary school students selected from another two secondary schools which were not part of the study sample. The reliability coefficient yielded an r = 0.85 through cronbach alpha. All the items in the instrument were really very relevant to the content of the study.

Data on academic performance were gathered through achievement test in mathematics constructed by the researcher in the subject content area. The reliability coefficient of the instrument was found to be 0.82 using test re-test reliability method of two weeks interval.

Data Collection Procedure

All the 450 participants were administered the Motivation for Academic Performance Questionnaire. The mathematics teachers in the participating schools assisted during the administration of the instruments. Instruction on how to respond to the questionnaire was read to the participants. This ensures its proper filling. Data collection was done immediately after the administration and all the response sheets were retrieved from the respondents. Out of 480 questionnaires administered, 450 were valid for the analysis on the study.

Data Analysis and Results

Data collected on the study were analysed using inferential statistics which includes; student t-test and analysis of variance (ANOVA).

Specifically, the study provided answers to two research hypotheses. The sequence of the presentation of the results is in accordance with that of the hypotheses. In this study, two null hypotheses were tested for significance level at 0.05 margin of error. The results of the study were presented in tables below.

$H0_1$ states that there is no significant difference in the academic achievement of male and female students in mathematics. The result of the above hypothesis ($H0_1$) is presented in table 1 below:

Table 1: t-Test showing the Mean difference in the Impact of Motivation on Academic Achievement of Male and Female Students in Mathematics

Gender	N	X	S.D	Df	t-cal	t-crit.	Decision
Male	260	48.3	18.2				
Female	190	33.4	13.6	448	9.4	1.96	S*

S* - Significant at 0.05 probability level.

Table 2. t-test Showing Mean Difference Summary of Academic Achievement of Highly Motivated and Lowly Motivated Students in Mathematics.

Variables	N	X	S.D	Df	t-cal	t-crit.	Decision
Highly motivated students	150	39.3	25.8	448	8.05	1.96	S*
Lowly motivated students	300	10.3	7.8				

S* - Significant at 0.05 significant level.

Table 3. ANOVA Source Table of Summary of Gender Difference and Academic Achievement in Mathematics.

Source of variation	SS	Df	Ms	F-ratio	F-critical
Between	271174	1	90391	23.01	3.84
Within	15555	448	39.28		
Total	286729	449			S*

S* - Significant at 0.05 probability margin

Table 1 presents the results of the analysis conducted on the impact of motivation on academic achievement in mathematics based on gender. The result clearly reveals that significant difference exists in the academic achievement of male and a female student in mathematics with (t.cal.=9.4; t.crit.1.96; df=448; at 0.05 level), which means hypothesis ($H0_1$), is rejected.

The Table 2 shows academic achievement measured along side extent of motivation. The result reveals that there is significant difference in the academic achievement of highly motivated and lowly motivated students in mathematics with (t.cal.=8.05; t.crit.=1.96; df=449 and at 0.05 level).

The calculated f-ratio at (1,448) is 23.01, which shows a significant difference on gender and academic achievement as clearly stated in the table 3.

DISCUSSION, SUGGESTION AND RECOMMENDATION

The result of the first hypothesis, which compares the impact of motivation on academic achievement of secondary school students in mathematics using gender as a variable of interest is found to be significant. The findings show that motivation has impact on academic achievement of secondary school students in mathematics with respect to gender. This finding is in disagreement with Siana et. al. (1998) findings that Asian students of both sexes rated parents and friends as more important in contributing to academic success. The variation in the present result on this study and that of Siana et al., (1998) may be connected with the issue of environment. While the present study was conducted in Nigeria, Africa; the other was conducted in Asia. Meanwhile, one thing that should be very clear is the fact that success in school subject or academic generally depend on many motivating factors. The issue of gender is part of it likewise parental involvement/support and or peer influence. All these should not be underrated because they are factor that can make or mar student achievement in school.

The result of the second hypothesis shows that secondary school students differ significantly in their academic achievement based on the extent to which they are motivated. The results reveal that highly motivated students perform better academically than the lowly motivated students. This finding corroborates that of Bank and Finlapson's (1980) finding who stressed that successful students have significant higher motivation for achievement than unsuccessful students. Similarly, the report by John (1996) that academic achievement is highly correlated with student's motivation lends a good support to the present findings. With reference to the position of (Ayotola, 1998), that when pupils express lack of interest in the subject, it affects the way they react or listen to the teacher. It can be said therefore that interest and attitude of learner towards a particular subject matters a lot. This is because these two constructs according to the author are high motivating factor which can lead to better achievement on the part of the learner. Good attitude and better interest learners display particularly in Mathematics serve as an encouragement even to the teacher. And this can help the teacher a lot to disseminate his teaching to the best of his ability and knowledge making use of all available resources rather than resorting to the use of chalk and talk when learners show no interest or negative attitude. Moreover, when the students display good attitude and better interest in Mathematics, the teacher is motivated and this may cause him to forget whatever hindrances to the teaching of the subject from his own part. Good impartation of Mathematics knowledge on the part of the teacher; couple with student's interest in the subject and the display of positive attitude as earlier pointed out, are good motivating **factors** which when combine together is assumed will result to better achievement in Mathematics.

Suggestions

From all views, discussed in the literature review, some of the suggestions use can bring out as ways of motivating students to learn are:

* make mathematics teaching interesting.

* Individual differences in ability, background and attitude must be taken into consideration.

* enhance learners feeling of esteem by arranging varieties of learning experiences according to Biehler and Snowman (1986);

> *"Try to send your students away from your instruction anxious to use what they have been taught and eager to learn more by associating subjects with liked and admired situations, things or individuals and also arranging conditions so that students feel comfortable when in the presence of a subject".*

All these suggestion must however be transformed into actual practice within the framework of the school curriculum. More especially, with the case of mathematics education, these suggestions could be guidelines in deciding the types of methods/strategies or instructional materials/media, which could be used in motivating pupils to learn mathematics.

Implications and Recommendations

The findings reported in this study justify the importance of motivation to academic performance. The findings have implications for the teachers of mathematics that they should try as much as they could to motivate their students during the course of instructions. The parents as well as the government should engage in programmes that can motivate the students to improve their academic performance. It is therefore, hoped that these findings will serve as resource materials for mathematics educators, mathematicians, school authorities psychologists, counsellors, government, parents and significant others who are concerned with the academic progress of the students.

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Problems with Science and Technology Education in Turkey

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National and international indicators show that there is a big inadequacy in science and technology education in Turkey as compared to other countries. This important problem affects the young students' structure of thinking perspective and perceptions of nature in a wrong way. The problems in science and technology education will block creative and critical thinking, curiosity and positive attitudes towards nature. In order to determine attitudes towards science and technology education program and the reasons of low achievement in science education, a questionnaire with 20 items about science and technology lesson, has been prepared and applied to 84 science and technology lesson teacher in elementary schools in two different cities (Adıyaman and Malatya) of Turkey. According to the result of this research, the main problems with science and technology education are insufficient number of science and technology teachers' taking active role in the preparation of the programs, the insufficient in-service training of the science teacher in the transition state of a new program, the huge numbers of the students in the class, the informational education orienting students towards only exam achievement, the broken link with other lessons (e.g. mathematics program) and insufficient physical conditions of schools (less laboratory opportunities).

Keywords: Turkish Science and Technology Education, History and Philosophy of Science, Epistemological Role of Science.

INTRODUCTION

The Recent Problem

Turkey, with a population of 63 million, is a bridge between Europe and Asia. The country was established in 1923, after the Ottoman Empire collapsed at the end of the First World War. The schooling consists of three main components: basic education (primary and middle schools, age 6–14; 8 years), which is compulsory; secondary education (high lycees or senior high schools, age 14–17, 3 years); and higher education (colleges and universities). The Turkish Educational System was centralized by the Act of "Law of Unification of Instruction" in 1924. All schools throughout the country must use the same curricula, which are developed and implemented by the National Ministry of Education (Ayas, *et al*, 1993). Teachers, students, parents and all participants of education have groused about the science education in Turkey since 1924. A lot of science education program was developed and applied by Turkish National Education Ministry. All programs are tried to apply with a great excitement, but, unfortunately, science education problem was not solved completely.

There was no "separate" science course in elementary school programs from 1924 up to 1974. The science subjects were included to some degree in "Knowledge of Life" lesson in a heterogeneous form. Only after 1974 science courses became separate and given some importance.

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The Indicators in Turkish Science and Technology Education

The concrete indicator of science achievement is national and international central exam results. The average of science lesson questions answered correctly by the students was 4.79 questions from 25 science questions in "The Secondary Education Entrance Exam" called OKS in 2005. Out of 786,284 students in 2005 65,076 students scored zero in this exam. This means almost 8% of students have no idea about questions. Also in the same year there were 57,163 students scoring zero in "The University Entrance Exam" called ÖSS. The average of correctly answered science questions was 3.9 out of 45 questions.

International Association for the Evaluation of Educational Achievement (IEA) is an institute making international evaluation and assessment for countries. Thirty eight countries joined the Third International Mathematics and Science Study (TIMSS-R, 1999) in 1999. Turkey had lower scores in the science section and ranked 33rd among the 38 participating countries (Kılıç, 2002). All of the parameters above verify low achievement of Turkish science education program. Almost 70% students cannot solve any science questions in Turkey. This is very thought-provoking in terms of Turkish science education (Arslan, 2005). One of the important aims of science education in the USA is to teach "science for every one and to create scientifically literate citizens", according to the National Science Education Standards in the USA (1996), but escaping from science classes is still the norm world wide. For example, Baykul (1990) found that Turkish students' attitudes toward science and mathematics courses substantially decreased from grade 5 through grade 11.

The Relevance of Science Education (ROSE) is an international project that aims determining important factors with science education and technology as an universe. The main property of this project is to determine factors affecting students' motivation during science and technology instructions and analyze them. Some of these factors are variety of students' experiences about science and technology out of schools, attitudes towards different science and technology subjects, attitudes towards scientists and expectations in future. (Sjoberg, 2004)

According to the findings of this project about Turkish Science and technology lesson program, (Çavaş, 2004)

- Male students like science and technology lesson more than female students.
- Female students don't want to take science and technology lesson in schools; male students are undecided about this subject.
- Male students want to become scientist in future more than females.
- Both male and female students want to work in a technology related works.

METHOD

A survey method was used in this study. Details are of the employed method are given below.

Research Design and Procedure

This study intends to determine science and technology teachers' attitudes towards science and technology education program and the reasons of low achievement in science education.

According to Kobella (1988), the affective domain related to science education is mainly concerned with attitudes related to science. In order to determine attitudes towards science and technology education program and the reasons of low achievement in science education, It has been prepared a questionnaire with 20 items about science and technology lesson and applied to 84 science and technology lesson teachers in elementary schools in two different cities (Adıyaman and Malatya) of Turkey.

Participants

The participants of the present study were 84 elementary school science and technology teachers in two different cities (Adıyaman and Malatya) of Turkey.

Data Collection Instrument

Data were collected through "The Attitude Scale towards Science and Technology Education Program". The researcher has developed this scale by reviewing the literature and soliciting expert views in the area. The internal reliability of the survey was calculated by using Cronbach's Alpha Formula and found be high (α=0.87).

Data Analysis

Descriptive statistics were used to analyze data. Percentage was used to determine the science and technology teachers' attitudes towards science and technology education program and the reasons of low achievement in science education.

RESULTS

According to the result of this research (Table 1), the main problems with science and technology education are insufficient number of science and technology teachers' taking active role in the preparation of the programs, the insufficient in-service training of the science teacher in the transition state of a new program, the huge numbers of the students in the class, the informational education orienting students towards only exam achievement, the broken link with other lessons

Table 1. Percentages of agreement or disagreement to the presented problem statements in science and technology education in Turkey

Insufficient number of science and technology teachers' taking active role in the preparation of the programs.	Agree Disagree	% 74.6 % 25.4
The insufficient in-service training of the science teacher in the transition state of a new program.	Agree Disagree	% 82.7 % 17.3
The huge numbers of the students in the class.	Agree Disagree	% 78.9 % 21.1
The informational education orienting students towards only exam achievement.	Agree Disagree	% 93 % 7
The broken link with other lessons (e.g. mathematics program).	Agree Disagree	% 58.7 % 41.3
Insufficient physical conditions of schools (less laboratory opportunities).	Agree Disagree	% 55.6 % 44.4

(e.g. mathematics program) and insufficient physical conditions of schools (less laboratory opportunities).

Schwirian (1967) stated that attitude toward science is the basis of acceptance and support of science or the basis of rejection of science and scientific activities in a society. Therefore, the decline in attitude toward science may result in the decrease of scientific research support, for today's students will be tomorrow's scientists and decision making persons in their society. In other words, students who have a positive attitude toward science are more likely promote science and scientific research in a country (Gieger, 1973). Consequently, countries like Turkey, need scientifically literate citizens. To achieve this goal we must examine the attitudes of our science teachers (Türkmen, et. al, 1999). In his paper Machamer (1998) gives an overview of issues related to the nature of science. He defines science, epistemologically, as a method of inquiry about the things and structures in the world, and describes the concerns of the philosophy of science:

- Epistemological: Philosophy of science asks what the nature and essential characteristics of scientific knowledge, how this knowledge is obtained, how it is codified and presented, how it is subjected to scrutiny, and how it is warranted and validated.
- Metaphysically: Philosophy of science examines the kinds and natures of things in the world, in so far as science deals with them.
- Ethically: Philosophy of science directs questions towards the value system that scientists have and asks how these values affect the practices and conclusions of science.

According to him, for educational purposes the epistemological point of view bears the highest significance. He asserts that "science, as it is taught and practiced in an educational setting, should be concerned with questions about the nature and adequacy of knowledge." Further, he identifies epistemological key concepts to be addressed: aims and goals of science; limits of science; nature of scientific discovery; nature of scientific explanation; theory, law, model and hypothesis, paradigms and research traditions in science; evidence, test, confirmation, falsification, and prediction; experiments as types of empirical tests; and finally social, cultural, political and ethical implications of science (Taşar, 2003).

CONCLUSION AND DISCUSSION

The main problem with Turkish science and technology education is lack of research on epistemological knowledge and attitudes. The epistemological role of science and technology can not be comprehended well by the society. The use of history and philosophy of sciences could not defined and organized by all contributors in science and technology teaching. Program changes, curriculum and textbook about this lesson; ignore the epistemological role of science and the significance of history and philosophy of science. In 2006, Mettas et. al's research indicated that students' self-beliefs and attitudes are significantly related to science achievement and should be given consideration by instructional designers, when developing science materials and curriculum. These factors should be in mind of any science teacher in order to enable him promote the discussed positive attitudes and beliefs through teaching. Recently, a new program was developed and started to apply in elementary schools. The name and content of the lesson are changed. It is called "Science and technology" instead of science lesson. The present problems of Turkish science and technology education can be designated as follows in the view of many investigations (Eşme, 2004) up to date:

- The intensive curriculum (95% of all science education program) but insufficient time allocation for science education (87 hours per year).
- The instruction of lesson in an information level and students in passive position (only listening and writing), teachers in active position (writing on the board and teaching in a classical way).
- Evaluation of the lesson in information level by using multiple choice items.
- Insufficient usage of science laboratories.

R. Medupe (1999) has investigated problems of science education in South Africa and concluded the problems similar to the Turkish science and technology education problems. These problems were reported as lack of equipment and laboratory for science education, overcrowding in schools, improperly trained or under-qualified teachers and epistemological knowledge about science and technology.

In the other study, the main problems of science (especially physics) teaching in Germany are summarized as students' lack of interest and motivation in the subject, their poor understanding of scientific concepts, ideas, methods, and results, and their lack of comprehension of the social, political, and epistemological role of science by Riess (2000) similarly.

Besides these, there is a different study about the problems with Turkish science and technology education. Çavaş and Kesercioğlu (2004), reported that Turkish students have more positive attitudes toward science and technology than developed countries' students.

As a result, the literature based on epistemological knowledge and attitudes is insufficient and in a less amount. Scientific literacy for public understanding science and technology should be tested by the contribution of a high number of participants. According to the results, curriculum and textbook should be re-organized and the teachers should be educated effectively with a long term and detailed in-service instructions. Education faculties should be reorganized and teacher candidates should be provided with educational perspective of science and technology education. In addition to these, according to Akgül (2006), course instructors need to be well informed and equipped about the nature of science.

The assessment and evaluation items should be defined and used in a productive way. The system of assessment and evaluation should be reflected to the central exams (University and high school entrance exams).

In this paper, the problems of Turkish science and technology educations are presented. The lack of epistemological role of science is emphasized and the productive use of history and philosophy of science is proposed in science and technology education. Most of the science and technology education programs neglect the scientific literacy of the population, interest and the motivation of all participants. The programs should be prepared with the contribution of all participant and educators can find their perspective in the program.

Educational Implications

This study has some implications to help solving problems with Turkish Science and Technology Education.

First of all, the majority of science and technology teachers and others related to science and technology education should join all of the processes and take active role during the preparation of science and technology education instruction program. Besides this, the in-service training programs should be well organized satisfactorily in the transition state of a new science and technology education programs.

The crowded classrooms have been caused serious problems in science and technology education because, laboratory activities could not be performed efficiently with crowded classrooms. So, the number of students should be decreased for science and technology lessons. The crowded classrooms can be divided in to smaller groups for laboratory activities in different time intervals.

The achievement criterions should not be depended on only exam achievement. The achievement criterions should contain all of the activities in the school. For example, achievement scores for each semester should be considered.

The link with other lessons should be established and planned periodic group gatherings for collaboration. Especially, Mathematics and Turkish Language teachers should collaborate with science and technology teachers.

The laboratory conditions are very important for science and technology education. For this reason, laboratory conditions and materials should be provided. If there is no enough materials, the experiments or activities should be performed with alternative materials and equipments. Finally, the problems with Turkish Science and Technology Education can be solved by the contribution of all participants related to science and technology education.

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Book Reviews

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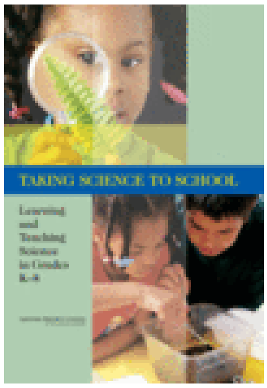
TAKING SCIENCE TO SCHOOL: LEARNING AND TEACHING SCIENCE IN GRADES K-8



by Richard A. Duschl, Heidi A. Schweingruber, Andrew W. Shouse (Editors)
2007
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This extensive monograph, now published as a book (but also available in individual chapters from http://books.nap.edu/catalog.php?record_id=11625) is a product of the work of the Board on Science Education of the US National Academies of Sciences. As an institution, this group has long taken an interest in the role of science education and commissioned these authors and their collaborators to produce a consensus report about what is known about teaching science to young children (age 14 or less) from the research that has been conducted in psychology, science education and other domains. The work of the committee was conducted through a series of meetings with extensive collaboration in between. The result is a very comprehensive review of what is currently known about the eponymous issue flagged in the title.

Some might ask what does this add to recent publications such as 'How People Learn' (Bransford, Brown, & Cocking, 2000) and 'How Students Learn Science' (Donovan & Bransford, 2005) which are both written from a psychological perspective. Or in the case of science, the extensive handbook summarising many years of research recently published and edited by Sandy Abell and Norm Lederman (Abell & Lederman, 2007). The answer is quite straightforward. This book represents a synthesis of research that has been conducted in both domains that examines not only what is known but what are its implications. No one book can attempt to capture all of the research that might be germane to any issue. Nevertheless, this book does manage to capture a lot of our current understanding in a lucid and clearly written form. Indeed, such is the depth and breadth of this report that it will stand as an authoritative statement against which others will be measured for a long time.

Why does it succeed where others have failed and where does it fall down? To turn to the first of these questions. The book begins by sketching out the path that science education has travelled, based in the belief that it helps to know how we got to where we are today and, also, that there is something to be learnt from both the successes and the mistakes of the past. This bit is brief though and others have attempted such work in much greater detail (DeBoer, 1991). This is not a criticism as its main function is to introduce the brief given to the committee which can be summarised as six questions:

1. What does research on learning, culling from a variety of research fields, suggest about how science is learned?
2. What, if any, are the critical stages in children's development of scientific concepts?
3. Where might connections between lines of research need to be made?

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4. Given a comprehensive review of research, how does it help to clarify how to teach science in K-8 classrooms?
5. How can this existing body of research be made useful for science educators and others?
6. What other lines of research need to be pursued to make our understanding about how students more complete?

Thus the book must be measured by the extent to which the report achieves these goals. Inevitably, given such a brief some answers were going to be addressed more systematically than others. In particular, perhaps, the answers to questions 1, 2 and 5. This is where the report is strong – particularly in the range of evidence that it draws to support its case. Readers will find that this is one of the most comprehensive reviews ever undertaken about how science is learned – something which everybody engaged in science education should read for the breadth and depth of what it has to say. Reading it was an illuminating experience seeing how the threads of various pieces of research had been carefully crafted into a coherent thesis. What is also interesting is that the range of sources drawn on is so extensive that this report will offer even the most knowledgeable in the field something to extend or challenge their perspective.

The review takes a very positive view of what children can achieve notably rejecting, either explicitly or implicitly, Piagetian developmental perspectives as being outmoded and no longer justified. In this it should be applauded. What it seeks to argue is that there is good evidence that young children can achieve levels of abstract thinking that Piagetians would have implied were unattainable. In doing so, however, the report is in danger of throwing the baby out with the bathwater as there is a sense that it has, perhaps, been blinded by the evidence it has chosen to present. It recognises, for instance, like one of its much cited authors (Metz, 1995) that children are different in their cognitive capabilities but denies that it is in their capability for abstract thought. The difference cannot simply be then that the adult knows more than the child – a view that was pervasive at the beginning of the last century – as the only obstacle to children's learning would be the acquisition of such knowledge. It is unfortunate that such an old-fashioned view of Piaget's ideas are presented here. A contemporary perspective would argue that such ideas have much to offer in explaining why certain ideas in science are difficult and that the function of school science is to accelerate a child's cognitive development not to place limits on it (Shayer & Adey, 2003). The denial of the value of this perspective becomes more problematic for the report when it later argues that there is a failure to construct curricula in 'developmentally informed ways' (Ch 8, p4). The answer provided by the report is the notion of detailed maps of how children's ontological and epistemological understanding develops in specific domains – what are termed learning progressions.

The report is also heavily influenced by contemporary philosophical perspectives on what it is that constitutes science and what, therefore, it would mean to learn science. In essence, it sees science as a rational process in which reasoning and argument are the means by which scientific knowledge claims are tested. In a similar fashion it argues, therefore, that such a process should be at the heart of learning science. That, in short, that a major element of science education for young children should consist of opportunities to engage in extended enquiry, collecting data, transforming that into evidence and critically examining any claims for its implication. As somebody who has argued in many ways e.g. (Millar & Osborne, 1998; Osborne, Ratcliffe, Collins, Millar, & Duschl, 2003) that science education should develop an understanding of how scientific knowledge is constructed it is difficult to disagree with this position. It is also gratifying to see that the report recognises the value of teacher directed instruction as well as opportunities for sustained exploration. Nevertheless, there is an implicit assumption here that the doing of science and the learning of science are one and the same thing. This is a dangerous elision as the two are distinct having as they do, different goals, different institutional structures and different mechanisms for accountability.

Where the report is very realistic is in documenting what we know about the gulf between current practice – what teachers commonly do now, and what societies might hope to achieve. The discussion of how teachers might be supported to develop the vision of best practice that is offered demonstrates what an enormous mountain, not just in the US but in most countries there is to climb. As it eloquently argues, teaching science is job that requires good subject knowledge, good pedagogical knowledge and an understanding of the practice of science itself. Never having been practising scientists, many teachers suffer from limited understandings of what scientists do. Not surprisingly it is difficult to represent that which they have never seen. The report is also good in making the case for assessments which match the goals of the curriculum – both of a formative and summative nature. The case for formative assessment and its value for learning is well-known (Black & Wiliam, 1998). The case for the significance of summative assessment is less well-developed and it is good to see a cogent case made here that, in an environment of accountability and high stakes testing, devoting significant energy to the improvement of such work should be a priority.

The major recommendation of the book is a call for the evidence of research to inform practice – in particular for the development of learning progressions which show how the construction of a scientific understanding, informed by research, is more likely to help students understand and use scientific explanations; generate and evaluate scientific evidence; and understand how personal and scientific knowledge are constructed. In short, to develop both students' understanding of the ontology and epistemology of science in ways which are informed by research. To exemplify what it means, the last chapter draws on the fairly extensive body of literature in the field of students' understanding of atomic and molecular theory to show how such learning progressions might take us from the concepts and reasoning of students entering school to those ideas which society sets as the goal for children of age 14 to understand.

Fundamentally, the report here is a call for research to inform the construction of curricula, and where the research is missing or rather thin, for more to be undertaken. All of us who work in research science education will support such an argument. After all, what is our work about if our ultimate goal is not to improve the experience and effectiveness of teaching and learning science in classrooms. My caveats here are twofold. First, the example given – atomic and molecular theory – is undoubtedly important. However, the manner in which it is presented is still redolent of the foundationalist approach to canonical science. My concern about such an approach is that if you fail to understand a key element the whole edifice, then its relevance and meaning collapses. Therefore, if we are to construct learning progressions, it is essential not only that we articulate the end point but that we start with the end point – a technique which is commonly used by those who are familiar with any of the better products of popular science. Only by laying out the grand stories that science has to tell can we hope to captivate the imagination and interest of young children to stay with us on this journey. So why do you look like your parents? Because there must be something in every little bit of you which tells your next incarnation how to make a copy. What happened to the dinosaurs? Why did they die out and how did we come to be? And my favourite – hold up your hand you are looking at stardust made flesh – over 95 percent of the matter was synthesised in a star millions of years ago. How do we know? Why we should believe these and other stories raise the epistemic aspects that this report rightly considers so important.

My second caveat is that it is one thing to set out the goals and the path by which a student must progress to get there. However, it is another thing to travel that road. Teaching and learning is a product of three aspects – curriculum (about which this report has a lot to say), pedagogy and assessment – about which it has less to say – although in its defence, this was not part of its brief having been addressed by a previous report (Wilson & Bertenthal, 2005). However, all of us working in this field need to be wary of emphasising the first at the expense of the other two, which are as central, if not more, to transforming practice.

Finally, some might find the book irritatingly parochial – a criticism that can be levelled in more than one way. The first is self-evident. This is an American report intended for an American audience. Hence, it is steeped in the language of the American educational system that the uninitiated will simply have to work their way around. More seriously is the fact that the literature on which it draws is overwhelmingly from the US. Even their Canadian colleagues do not get much of mention. The question this invites is whether the quality of American Educational research is so much better than that undertaken elsewhere? In one sense, the answer is yes. Anybody who knows anything about the American context cannot help be overwhelmed by the scale and quality of the academic enterprise. In part, despite their many protestations, this is because the extent of the funding available makes that provided by the EU or in the UK seem paltry. Nevertheless, there is good work that has taken place elsewhere and more recognition for it would have helped the wider credibility of the report.

These criticisms do not undermine, however, the impression that what this volume provides is a substantial contribution to the field. What it offers is a scholarly and rigorous summary of the current understanding of the capabilities that children can demonstrate; the goals of science education; and the ways in which those might be achieved. In short, it should be compulsory reading for all who have any interest in science education.

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SCIENCE LITERACY IN PRIMARY SCHOOLS AND PRE-SCHOOLS

by Haim Eshach
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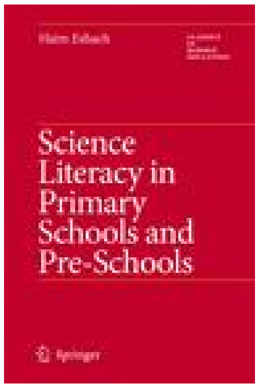

Science Literacy in Primary Schools and Pre-Schools offers theoretical and practical advice on teaching science to young children. This book should appeal to researchers, policymakers, curriculum designers, college students majoring in education and teachers for designing more effective teaching and learning activities and environments in primary and pre-schools. Dr. Eshach, with his considerable experience in early science education, outlines alternative rationales and a number of approaches to do a good science education by which he means one "that will nurture scientific thinking skills and inculcate in children the desire and passion to know and learn" (p. xii). Nevertheless, he warns that bad science education can sometimes be worse than no science education at all.

Dr. Eshach has a pleasant style, asking different and challenging questions that readers may want to ask when reading the book and answering these questions lucidly. In a sense, this book has an interactive feature. The book, consisting of 5 chapters, begins with a philosophical question, which is also the heading of chapter 1, *Should Science be Taught in Early Childhood?* Chapter 1 discusses why the typical reasons given by educators are problematic and insufficient for teaching science from early childhood. In this chapter, Dr. Eshach provides an excellent overview of his rationale for why science should be taught in early childhood. He offers six justifications for exposing young children to science as follows:

1. Children naturally enjoy observing and thinking about nature: 'A child's world is fresh and new and beautiful, full of wonder and excitement' (Carson, 1984, p.42). Because of their innate curiosity, children eagerly embrace all types of science activities. What makes children particularly ready for science is this intrinsic motivation which refers to doing an activity for its inherent satisfaction rather than for some separable consequences. Some may say children just play during these science activities; however according to Vygotsky, play is the leading factor for the development of relationships between objects, meanings, and imaginations. This is one of the most important arguments for including science in pre-schools.
2. Development of attitudes toward science starts at the early stages of life. Exposing students to science in environments where they can enjoy science develops positive attitudes towards science.
3. Early exposure to scientific phenomena leads to better understanding of the scientific concepts studied later in a formal way.
4. Since teaching science involves introducing the learner to the social language of school science (Scott, 1998), the use of scientifically informed language at an early age influences the eventual development of scientific concepts.
5. Children can understand scientific concepts and reason scientifically: Though there is no consensus on whether or not small children can think scientifically or whether they are mature enough to understand (abstract) scientific concepts, some research indicates that even younger children show the ability to think scientifically and they are able to think about even complex concepts (Metz, 1995).
6. Science is an efficient means for developing scientific thinking: It is essential to encourage students to develop scientific modes of explanations and modelling (Acher et al. 2007) and to develop the science process skills from the earliest school age.

Chapter 2, *How Should Science be Taught in Early Childhood?,* presents novel and creative ways of teaching science to young children: inquiry-based teaching, learning through authentic problems; preference of the Dewey's logical vs. psychological methods, designing teaching drawing on the notion of scaffolding and on the Vygotskian notion of the zone of proximal development (Scott, 1998); situated learning; project-based teaching; and non-verbal knowledge such as the use of visual representations and concept maps. This chapter offers both the theoretical underpinning and practical guidance to create an environment where the child is an active learner (e.g. conducting investigative work, being a scientist for a day). These approaches would help teachers to move away from traditional teacher-dominated activities to student-centered practices.

In Chapter 3, Dr. Eshach argues whether science and design and technology should be integrated in a curriculum. He believes that each approach to science, and design and technology education reviewed in the literature has some limitations. Accordingly, integrating these two subjects can result in ignoring some important aspects of each. Dr. Eshach suggests that "each of the subjects should develop its own activities with regards to the other…science can develop more design and technology activities which are relevant to science lessons and, on the other hand …design and technology might develop scientific activities" (p.83). Drawing upon these ideas, Chapter 3, *When Learning Science by Doing Meets Design and Technology*, addresses the need to implement the *learning by doing* approach in science education, and discusses the learning of science via technology, especially through designing, building, evaluating, and redesigning simple artifacts. Some case studies and illustrations are presented in order to clarify this approach. Wolpert (1997, p.21) pointed out that "science is a special way of knowing and investigating and the only way appreciating the process is to do it". Nevertheless, the current state of science education in primary schools suggests that this is not the case (Harlen, 1997). There are a number of reasons for the insufficient implementation of the *learning by doing* approach in schools. On the one hand, Schank (1996) claims that educators and psychologists have not fully understood why learning by doing works, and are thus hesitant to insist on it. On the hand, Dr. Eshach argues that teachers' lack of awareness of the effect of that *learning by doing* has on children and that teachers' lack of knowledge in order to implement such approach are the main reasons for this. In this respect, I believe this book offers a clear and helpful frame to change this situation.

Teachers' role is crucial in promoting science literacy in schools and society. Research on teachers' knowledge suggests that both teachers' subject matter knowledge and teachers' pedagogical knowledge are crucial to good science teaching and student understanding (Shulman, 1987). Unlike previous chapters, which are mainly concentrated on the children's needs in science teaching, Chapter 4, *From the Known to the Complex: The Inquiry Events Method as a Tool for K-2 Science Teaching*, focuses not only on the children's needs while designing teaching, but also on those of teachers. One such approach called the 'Inquiry Events' (IE) teaching method is presented in the first part of the chapter. The chapter then moves to a discussion of research which examined educators' changes in science teaching efficacy beliefs and science teaching outcomes after participating in a four-day workshop on IE. The participants included experienced 48 K-2 teachers, curriculum developers, and teaching-trainers from 20 different developing countries of Asia, Africa, Eastern Europe, and the Caribbean Islands. The results indicate that IE is a highly effective teaching method so as to improve science teaching efficacy beliefs of kindergarten and elementary school teachers. The research also suggests that significant changes in teachers' belief systems toward science teaching can be produced in a short period of time. The last part of the chapter continues the inquiry on the IE approach and discusses implementation and evaluation of this approach in two Israeli's kindergartens. The results showed that the IE helped two teachers in these schools to advance their both scientific knowledge and scientific reasoning.

Considering many benefits of out-of-school science learning environments such as science centers, museums and zoos, school trips to these places are not often conducted in a manner that could maximize the learning that can result from them, whether it be conceptual or affective (DeWitt & Osborne, 2007). There are some concerns that teachers do not fully understand the role of out-of-school learning and that non-formal science learning environments such as museums themselves need improvements for offering more effective learning environments. The final chapter of the book, Chapter 5, *Bridging In-School and Out-of-School Learning: Formal, Non-Formal, and Informal*, explores the nature of out-of-school learning and provides both theoretical and practical frameworks to bridge in and out-of-school learning. Dr. Eshach identifies four factors which influences out-of-school learning each containing cognitive and affective components: personal, physical, social, and instructional. This chapter makes a valuable contribution to the book in the sense that it offers numerous frameworks and examples for teachers and educators to construct bridges so that out-of-school learning is better connected to in-school learning. Research on the impacts of science fieldtrips and the effects of particular instructional practices on students' learning has resulted in a series of recommendations. As recommended by Dr. Eshach, as well as stated by DeWitt and Osborne (2007), teachers are encouraged to become familiar with the setting before the fieldtrip; to decide the purpose of the fieldtrip; to share the purpose and expectations of the visit with children, to present children the structure of visit; to plan pre-visit activities aligned with curriculum goals; to provide some tasks to be conducted in the fieldtrip, to encourage parents of kindergarten children to join the trip; to plan and conduct post-visit classroom activities to reinforce the fieldtrip experiences. It is also suggested to build a specific science center (what is called Scientific Kindergartens or Enrichment Centers) for small children in different part of a town or city. Such centers, that might even be part of science museums or schools, therefore, could offer a rich learning environment for children, parents, and teachers in the community. Most importantly, teachers' objectives for fieldtrips and effective instructional strategies used by teachers during the fieldtrip should be the focus of pre-service and in-service teacher-training courses in order to gain more benefits from out-of-school practices.

The book ends with 'matome', means 'summing up' in Japanese, in which the main points are summarized and a set of issues and questions which warrant further research attention is propounded. These questions are: why do some science activities work better than others with children? How can we prepare teachers for science education in kindergarten? How widely and in what way do teachers pass on their scientific knowledge and skills to their children? What kind of activities might advance executive control functions in children? What difficulties do children have in understanding scientific knowledge and in acquiring scientific skills? What activities are required to develop meta-cognitive operators in children? How can we analyze whether scientific activities efficiently scaffold scientific knowledge and scientific reasoning? How might educators best invest effort to build science curricula that take into account the points discussed in this book? (p.144-145).

Overall, Dr. Eshach's book offers a vigorous and reasoned argument to change the way policymakers, researchers, and teachers envision science education in early childhood. However, his research and I shall say some of his radical ideas offer interesting challenges and opportunities for further development and research. The most important requirement for this or any other approaches to science teaching is to develop and implement the teaching activity proposed, and to assess learning outcomes. In summary, justifications, approaches and methods for teaching science in early childhood offered in this book need further evaluation but are promising as effective teaching and learning approaches in primary schools and pre-schools.

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