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# Barriers to Effective use of Information Technology in Science Education at Yanbu Kingdom of Saudi Arabia

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## Abstract

This study examined the barriers to use of information technology (IT) in science education at the Yanbu school district in Saudi Arabia. Sub-domains investigated included: infrastructure and resources, policy and support, science teachers' personal beliefs, and staff development. This chapter is using a survey which shows common barriers encountered by the science teachers were identified. Demographic data enabled description of science teachers based on similarities and differences of gender, location of the school, training, years of teaching experience, and age. Science teachers rated the barriers limiting their use of technology in teaching on a scale ranging from 0 (does not limit) to 3 (greatly limits). We present results which showed that all four domains were highly significant barriers: infrastructure and resources ( $M = 2.06$ ,  $p < .001$ ); staff development ( $M = 2.02$ ,  $p < .001$ ); policy and support ( $M = 1.84$ ,  $p < .001$ ); and science teachers' personal beliefs regarding technology ( $M = 1.15$ ,  $p < .001$ ). The more barriers comes to face the teachers who are related to science and are experienced, the less likely they were to be IT users ( $r = -0.16$ ,  $p = .02$ ). To minimize the impact of these barriers and consequently improve the level of integration of information technology in science education in Saudi Arabia, a well-conceived strategic vision, adequate funding, and good implementation plan are of great importance.

## 1. Introduction and Related Research

Day after day, the importance of information technology becomes more evident and requires more of our attention. Today's world is one full of information. Through the use of information technology and the Internet, information is now more accessible than ever before. We are swamped with information and increasingly derive knowledge gained from information distributed by the Internet, newspapers, television, computers, magazines, books, radio, etc. Information technology penetrates every corner of our world and our

individual lives. What does that mean to us? How can we evaluate the legitimacy of the new “information technology era” and realize its promise of greater knowledge for the many?

The World Wide Web makes our world so small that it increasingly resembles a small village. Internet users tend to know what is going on in their cyber-neighbors’ lives; even when that neighbor is often living on the other side of the world! According to Becta (2003) and (Samman, 2003), new technologies might improve our lives in two ways: a) by enabling us to do things better, and b) by enabling us to do better things. Information technologies today significantly affect every society in the world, especially in the field of education.

Successful integration and/or adoption of information technology as well as its rejection depend on several factors. These factors could vary from one place to another depending on the environment where the technology is introduced as well as the purpose and timing of the introduction. Several studies have been conducted on this regard.

The purpose of this study was to examine the barriers that prevent science teachers from Yanbu education district in Saudi Arabia from using information technology in their teaching. This study investigated the degree of IT use and examined the barriers to its use in teaching science.

What are the unique barriers encountered by Saudi educators in the transition to IT-facilitated education? This study outlined an investigation into the barriers that prevent effective use of IT in science education in K-12 public schools in Saudi Arabia, specifically drawing from the perspectives of science teachers. Two research questions were considered:

1. Do science teachers encounter common barriers that prevent them from making effective use of IT in science education in the public schools at the Yanbu education district in Saudi Arabia? And
2. Do science teachers encounter unique barriers (other than the common barriers identified in the first research question) that may prevent them from making effective use of IT in science education in Saudi Arabia?

Weber (1996) surveyed three major themes related to IT barriers: (a) inadequate instruction; (b) inadequate computer systems; and (c) frustration. Examples of barriers that Weber identified include lack of administrative support, financial constraints, policy confusion, logistic limitations, conflicting purchasing decisions, support service deficiencies, and untrained personnel. In addition, he categorized groups of barriers to the use of technology that many researchers have also identified. These are: (a) anxiety; (b) stress; (c) feelings of stupidity, fear of the unfamiliar, and fear of dehumanizing effects; (d) the extreme of computer addiction (microcomputer mania); and (e) the extreme of computer phobia (cyberphobia), potentially involving active resistance, and sabotage.

Beggs (2000) posited that one critical barrier pertains to science teachers’ poor preparation and lack of confidence related to IT. While there is some evidence of a history of using technology in science classrooms, not all science teachers are ready to use IT in teaching science. Some instructors, even those well educated and highly competent in the field of science, have been documented as fearing technology, most particularly fearing looking

stupid in front of their students by failing in their use of IT. Fear of failure is a very legitimate problem. Ertmer (1999) pointed out that many teachers may ask themselves a hard-to-answer question: "What will I do if the technology fails and I can't complete the lesson as planned?" This may interfere with the adoption of technology in the classroom. Logically, to the extent that teacher training and technical support can answer teachers' questions of what happens when technology does not work, this barrier is reduced.

The U.S. Congressional report as cited in Corbin (2003) reported that the Office of Technology Assessment (OTA) suggested that the lack of experience using technology in the student teaching experience was a major concern. This report goes on to say that to overcome this problem, "K-12 and university educators must work together to integrate technology in the curriculum" (U.S. Congress, 1995, p. 165). Therefore, it is fair to say that the modest level of IT skills in teachers has been a barrier in its implementation in both education in general, and in science education, in particular (Corbin, 2003).

Al-Mohaissin (1993) listed some barriers that prevent effective use of IT in science teaching. The barriers he identified included the fact that poor consistency and compatibility existed between teacher training, available software, and hardware in schools. Most efforts undertaken were to supply hardware. However, the hardware that was delivered to Saudi schools was very limited; consisting of older and limited versions. The hardware installed supported very limited software applications produced by the hardware company. Often, this software did not serve the needs of the science teachers. There is a lack of availability of Arabic computer software for science and what is available is very expensive. Al-Mohaissin did not consider lack of funding a barrier but he indicated that lack of knowledge about IT at the purchasing level resulted in the performance and compatibility barriers experienced. He suggested generic software, like Word and Excel, to overcome the high price of the software programs.

Al-Oteawi (2002) found that there were not enough courses on IT in the colleges, particularly related to computer navigation and Internet skills. No programs existed in the colleges of education that allowed students to learn how to integrate IT in the curricula. Neither there were any in-service training programs in existence that permitted students and educators to develop their knowledge of IT processes.

According to the National Council for Accreditation of Teacher Education (NCATE, 1997), lack of training, knowledge, or familiarity leads to teachers' inability to independently integrate subject matter software with necessary computer hardware. A sizeable amount of literature exists that identifies overlapping barriers, lack of teacher knowledge, and inability to integrate hardware/software reliably. From this literature, a picture can be drawn of the perennial "vicious circle" that illustrates barrier relationships. Teachers' "fear of failure" is reinforced by failure to use IT successfully. The more a teacher internalizes previous failures, the less likely it is that he/she will be able to solve new compatibility issues. The more demands there are on teachers to make IT work in the classroom, the more fear of failure. These issues have implications for supporting science teachers in the IT implementation.

Corbin (2003) identified five barriers and grouped them into three areas: lack of experience in pre-service training, lack of access to computers at school, and lack of on-site technical support. He also stated that the most important barrier most teachers must deal with is lack of access to computers, either in a laboratory setting or in the classroom.

After gathering information through online questionnaires of 170 teachers, Becta (2003) discussed barriers to IT adoption. Arranged from the most to least frequent, these barriers included: lack of confidence, lack of access to quality resources, lack of time, lack of effective training, technical problems, lack of personal access, and age.

Brush (2003), studied what teachers themselves think are the barriers to IT-related instruction. Nine barriers included in his survey were: lack of hardware, lack of software, lack of network access, lack of time to develop courses, lack of support by department or school, lack of salary support during the development period, lack of students' preparation to handle technology, lack of facilities for student laboratories, and lack of central resources.

Al-Moussa (2004) discussed the barriers to integration of IT within Gulf Cooperation Council (GCC) countries. They are: lack of teachers' training programs in the use of the computer, high cost of computer peripherals, and lack of computer technicians in the schools to help teachers and administrators apply IT.

The chapter is organized as follows. In Section 2 we introduce our methodology which provides procedure to collect our data and shows the findings regarding barriers of IT education in Yanbu. In Section 3 we present the limitation of our analysis method. In Section 4 we present results and discussions. Finally we summarize the chapter with future discussion and recommendations.

## **2. Methodology**

The study was conducted in Yanbu education district in Saudi Arabia. The research designs used were descriptive, comparative, and correlational. Both male and female science teachers at the elementary, middle, and high school levels were asked on their use of IT in the classroom. Comparisons of their survey responses were made. The relationship between demographic information and science teachers' computer experience to their attitudes toward computers was also determined.

The study examined and identified the barriers that hinder the inclusion of IT in science education in Saudi Arabia. The research instrument was developed to replicate this study at future time intervals to monitor trends and the degree of the technology use in Saudi Arabia over a period of time.

Based on the findings from a preliminary focus group of 80 science teachers in Saudi Arabia, common barriers to IT adoption were identified and used to design the survey instrument.

## 2.1 Variables

There were three categories of variables in the study: (a) dependent variables, (b) demographic variables, and (c) independent variables. The dependent variables of this study were the scores related to degree and frequency of technology use. The instrument used scored measures of amount of technology use, skill levels, and conformity with technology.

The demographic variables came from questions included in the final segment of the survey. These questions include: (a) school location, b) participant's gender, (c) his/her years of teaching experience, (d) pre-service IT training, (e) in-service IT training, and (f) age.

The independent variables focused on four categories of barriers. Each category contained statements designed to test the frequency of the science teachers' responses to determine whether or not it should be considered a barrier. The four groups were: (a) infrastructure and resources, (b) policy and support, (c) science teachers' personal beliefs, and (d) staff development. Participants were asked to add any other barriers they considered important that were not mentioned in the instrument.

## 2.2 Survey Instrument

The survey consisted of two main parts. The first part investigated barriers to implementing IT in science education in public schools in Yanbu education district in Saudi Arabia. The second part focused on demographic factors.

The first part of the instrument consisted of four sections: (a) infrastructure and resources, (b) policy and support, (c) science teachers' beliefs, and (d) staff development. It also included barriers not previously mentioned in the instrument but added by study participants in response to an open-ended question. Participants evaluated each barrier and rated it according to the values defined in Table 1.

Description	Value
Does Not Limit	0
Slightly Limits	1
Somewhat Limit	2
Greatly Limits	3

Table 1. Limitations of Technology Scale

The second part of the survey contained 12 elements of demographic information. They included: (a) schools' location, (b) gender, (c) years of teaching experience, (d) training, (e) age, (f) grade levels taught, (g) number of classes taught weekly, (h) highest educational degree and year earned, (i) presence of a computer in their home or school, (j) where computers were used (at home or school), (k) where access to the Internet was available (at home or school), and (l) number of computers available in teachers' classrooms and in computer laboratories in schools.



### 2.3 Participants/Respondents

Study participants included teachers from all K-12 grade levels who were teaching during the School Year 2003-2004. According to the Department of Statistics (2003) in Yanbu Education District, there were a total of 284 science teachers in grades K-12. Survey questionnaires were sent to all schools at the Yanbu education district and distributed by the educational training department to all male and female science teachers who volunteered to participate in the study. About 176 questionnaires were returned back by 105 male and 71 female science teachers, constituting 60 percent and 40 percent of those solicited, respectively.

### 2.4 Statistical Methods

The first research question asked was "Do science teachers encounter common barriers that prevent them from effectively using IT in science education in the public schools at Yanbu education district in Saudi Arabia?" The null hypothesis for this question is: Science teachers do not encounter common barriers that prevent them from effectively using IT in science education in the public schools at the Yanbu education district in Saudi Arabia.

This was tested using the sample *t*-test. The domains were tested individually which include: (a) infrastructure and resources, (b) policy and support, (c) science teachers' personal beliefs, and (d) staff development (Table 2). In a Table 2 analysis the statistics and Intercorrelation Matrix describing barriers to integration of IT in Science education in Yanbu School as indicated by frequency of IT use.

The average of all participants in every domain was derived. Arranged by perceived importance, the participants reported that most barriers were associated with infrastructure and resources, staff development, policy and support, and the teachers' personal beliefs. SPSS was used to calculate the *t*-statistic and its significance at .05 level.

Variable	Intercorrelation							
	Mean	SD	SEM	IT	IR	PS	PB	SD
Frequency of use of IT	1.13	.78		.88				
Infrastructure and Resources (IR)	2.06	.673	.051	.04*	.93			
Policy and Support (PS)	1.84	.696	.052	-.18*	.48*	.86		
Teachers' Personal Beliefs (PB)	1.15	.682	.052	-.20**	.17*	.39**	.91	
Staff Development (SD)	2.02	.783	.59	-.16*	.67**	.77**	.67**	.92

Table 2. Descriptive Statistics and Intercorrelation Matrix

Note: Cronbach's alpha scores of internal consistency are reported in diagonal of correlation matrix

\*Significant at .05 level of significance

\*\* Significant at .01 level of significance

The second research question asked was , “Do science teachers encounter unique barriers (other than explicit barriers listed in the second research question) that may prevent them from effectively using IT in science education in Saudi Arabia?” All anticipated major barriers that may prevent science teachers from using IT were explicitly included in the survey. Acknowledging that important barriers may have been overlooked, an open-ended question was included to let the participants express their opinions and thoughts about barriers not mentioned in the survey. Analysis of their answers was conducted by calculating how many times each new barrier mentioned was repeated. After the data were collected, responses were summarized and classified based on location and gender.

### 3. Limitation

This study was focused only on science teachers from only one educational district covering School Year 2003-2004. Aspects of IT implementation can change over time. Based on the continuous evolutionary development of the computer industry, the degree of technology use this year may be different from that of next year.

This research was limited to a specific region in Saudi Arabia, the Yanbu district. It is hoped that these results could be generalized due to the inclusion of feedback from across Saudi Arabia which was used in the development of the survey instrument. However, one limiting factor of this research is that the results may not be generalized to non-science teachers. The barriers to the application of IT in other fields may be different from those in the field of science.

### 4. Experimental Results and Discussions

#### Barriers to IT Integration

Results of a one-sample t-test for all these subdomains of barriers to IT integration are reported in Table 3. All p values for the four subdomains are less than .05 indicating that these common barriers prevent science teachers from effectively using IT science education in the public schools in the Yanbu education district in Saudi Arabia.

	<i>t</i> Value	Significance	Mean
Infrastructure and Resources	40.52	.000*	2.06
Policy and Support	35.11	.000*	1.84
Science Teachers' personal belief	22.36	.000*	1.15
Staff Development	34.13	.000*	2.03

Table 3. Limitations of Technology Scale

\*Significant at .05 level of significance

Top ten barriers. To discern trends, specific common barriers were examined in terms of frequency of occurrence. Tables 4 and 5 show the top 10 and top five barriers by frequency of response, respectively.



#	Barrier	Mean	Std. Dev	Sub-Domain
1	No Specific IT Budget	2.48	.88	PS
2	Lack of Finding for Hardware	2.48	.88	PS
3	No Electronic, Science Text Books	2.31	1.01	IR
4	Lack of English Training needed for IT	2.27	.97	SD
5	Not enough Time in School for IT related activities	2.26	1.06	STPB
6	No instructional support for incorporating IT into teaching	2.24	1.13	IR
7	No vision or Strategic plan for IT	2.23	1.01	PS
8	Science Curriculum not compatible with IT	2.18	1.03	IR
9	No access to Internet during School	2.18	1.12	IR
10	Classroom Architecture not suitable for IT	2.17	1.09	IR

Table 4. Top Ten Barriers that limit the Use of IT in Science Education at Yanbu, KSA

Note: Scale runs from “doecn’t limit” (0) to “greatly limits”. N = 176.

Where

IR = Infrastructure and Resources

PS = Policy and Support

STPB = Science Teachers’ Personal Beliefs

SD = Staff Development

Five least frequently cited barriers. There were five statements in the survey that most participants considered to be the least limiting barriers to IT use (Table 6).

The following summarizes the additional barriers as submitted by participants in response to the open-ended question. Most of their responses were focused on the following:

1. No information technology resource centers in education districts and in schools;
2. No specialist trainers to train teachers and students;
3. Busy schedules leave no time;
4. Teaching more than one subject;
5. Shortage of short courses (in-service training); and
6. High cost of short courses.

	<b>Does Not Limit</b>	<b>Slightly Limit</b>	<b>Somewhat Limit</b>	<b>Greatly Limit</b>
	<b>Freq %</b>	<b>Freq %</b>	<b>Freq    %</b>	<b>Freq    %</b>
No specific budget for information technology in my school (PS)	9 5.1	19 10.8	27 15.3	121    68.8
The lack of school funds to get hardware (PS)	19 10.08	13 7.4	38 21.6	106    60.2
Students don't have access to the internet during the school day (IR)	25 14.2	21 11.9	28 15.9	102    58.0
The architecture of class rooms are not suitable for implementing IT	23 13.1	22 12.5	33 18.8	98      55.7

Table 5. Limitations to Technology integration imposed by Infrastructure and Resources  
Note. Where N = 176, IR = Infrastructure and resources, PS = Policy and support, STPB = Science teachers' personal beliefs and SD = Staff Development

It was found that some male teachers from industrial locations and some male teachers from urban locations agreed about the following barriers that prevented them from effective applications of IT. They reported that there was no IT center in the education district or in their schools and there were no specialized and qualified trainers to train teachers and students to use IT in the right way.

Many of the female science teachers from industrial locations experienced the same barriers that male teachers from suburban locations have experienced. These barriers were: busy schedules, teaching more subjects, and doing some work besides teaching. All of these barriers prevent them from applying IT to educational practice. In addition, female teachers from industrial locations have encountered some of the same barriers as male teachers from urban locations, including the shortage of short-course training on how to implement IT into the science curriculum and the high cost they would incur if they choose to pay on their own.

	Does Not Limit	Slightly Limit	Somewhat Limit	Greatly Limit
	Freq %	Freq %	Freq    %	Freq    %
My School's principal has negative attitudes towards application of information technology. (PS)	9 5.1	19 10.8	27 15.3	121    68.8
The Science supervisor doesn't follow up if I use information technology or not. (PS)	19 10.08	13 7.4	38 21.6	106    60.2
I am frightened of the consequences if I damaged the computer equipments. (PS)	25 14.2	21 11.9	28 15.9	102    58.0
There is no computer specialist at my School. (PS)	23 13.1	22 12.5	33 18.8	98    55.7
The lack of understanding of science supervisors about the important of the information technology. (PS)	23 13.1	22 12.5	33 18.8	98    55.7

Table 5. Bottom Five Barriers to Technology integration imposed by Policy and Support Relating them to gender and location.

## 5. Conclusion and Future Research

We investigate barriers that prevent teachers from making effective use of information technology in science education in K-12 public schools in the Yanbu education district in Saudi Arabia. Identifying the fundamental barriers encountered by the science teachers in integrating IT into the classroom is the first step towards a solution to the problem. Two related barriers are greatly limiting which are as follows:

1. No specific budget for IT in school; and
2. Lack of school funds to get hardware.

These financial barriers could be minimized by providing support and funds from the Ministry of Education and the Yanbu educational district. This study was not the first to identify these barriers. When Al-Mohaissin (1993) applied his study in Saudi Arabia, one of the barriers he identified was the shortage of computers in the schools. This finding is similar to that of Al-Mohaissin (1993) which revealed that funding is not the first problem that needs to be solved. Hendren (2000) declared that the three important factors affecting science teachers' use of technology in the high school classrooms are: lack of access, insufficient funds, and lack of vision. Carter (1998) found that the two most important barriers are lack of computers in the classroom and lack of time to learn how to incorporate IT into the curriculum. Of the five statements least considered as barriers limiting the use of IT into the classroom, all are related to the subdomain of policy and support. School administration is characterized by some participants as being relatively supportive of the effort to integrate technology into the classroom and not perceived as a primary barrier to technology integration. Barriers rooted in policies and funding require a well-conceived, strategic vision, adequate funding, and implementation plan before much change can be expected.

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## **E-learning Experiences and Future**

Edited by Safeeullah Soomro

ISBN 978-953-307-092-6

Hard cover, 452 pages

**Publisher** InTech

**Published online** 01, April, 2010

**Published in print edition** April, 2010

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Abdulkareem Eid S. Alwani and Safeeullah Soomro (2010). Barriers to Effective use of Information Technology in Science Education at Yanbu Kingdom of Saudi Arabia, E-learning Experiences and Future, Safeeullah Soomro (Ed.), ISBN: 978-953-307-092-6, InTech, Available from: <http://www.intechopen.com/books/e-learning-experiences-and-future/barriers-to-effective-use-of-information-technology-in-science-education-at-yanbu-kingdom-of-saudi-a>

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