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## BARRIERS TO ICT USE IN SCIENCE TEACHING: A COMPARATIVE ANALYSIS OF MALAYSIAN AND SAUDI SCIENCE TEACHERS

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### Abstract

*Despite the efforts expended by the governments of Malaysia and Saudi Arabia to promote science teachers' use of ICT in the classroom, the ICT uptake among these teachers remains slow and dismal. This article reports on a study undertaken to explore and understand the barriers that prevented science teachers in both countries from using ICT in their science instruction. A total of 282 science teachers from selected schools (53.5% Malaysian and 46.5% Saudi) responded to the survey. Principal components analysis (PCA) run on the data extracted four underlying factors that prevented the respondents from using ICT to teach, namely attitude towards ICT use, access to ICT at school, beliefs about ICT use and technical support provided by the school to promote ICT utilization. Among these four factors, attitude towards ICT emerged as the largest inhibitor, explaining about 25.5% of teachers' lack of ICT uptake in the science classroom. T-test results revealed significant differences between Malaysian and Saudi teachers in terms of access to ICT and technical support, but no significant difference in terms of attitude and beliefs about ICT use. The results corroborated previous findings that teacher factors tend to outweigh school factors in promoting or hindering teachers' uptake of technology.*

**Key words :** *ICT in Science Teaching, Teachers' ICT Adoption, Barriers to ICT Use, Malaysian Science Teachers and ICT, Saudi Science Teachers and ICT, Underlying Factors of ICT Barriers, Principal Components Analysis*

### INTRODUCTION

Advancement in science and technology is the dream of most developing nations as it promises quality development in various aspects of life. This scientific and technological development could be realized through sound education in schools and higher education institutions, in particular through the teaching of scientific subjects. This is because using technology is said to influence the understanding of all deductions in all science (Doering, 2003). Accordingly, the quality of science teaching in schools and universities is a priority for teachers, educators, and the government of developing nations. With the penetration of ICT into various aspects of education, integrating ICT into classroom teaching and learning has become a necessity. Although ICT integration may sound great and promising for teachers and students, barriers keep preventing a full integration. However, limited research on the most common barriers that hinder teachers' use ICT in the classroom has been conducted in the Muslim world, especially in the Kingdom of Saudi Arabia and Malaysia. For this reason, there is an urgent need for more research and studies in understanding these barriers which may assist in deciding strategies and ICT tools that teachers can use to help their students to comprehend science concepts more effectively (Beyerbach, 2000; Brandy, 1999).

In many Arab countries especially in Saudi Arabia, the teaching of scientific topics, i.e. mathematics, physics, chemistry, biology and general science, have been going through significant fluctuations. These fluctuations can be detected via a comparative look at the teaching in the past and in the present mostly resulted from changes that took place in the school curriculum and in the teaching styles, more so after the digital revolution affected most aspects of life, especially education. The situation in many other Muslim countries such as Malaysia may be similar to that occurring in Saudi Arabia, where the concern lies not only in tackling issues pertaining to the quality of teaching and learning science, but also in equipping teachers with the necessary skills to integrate ICT in the classroom. Research shows that Malaysia is confronted with the problem of inadequate implementation of ICT, especially in the teaching of scientific subjects such as Physics, Chemistry and Mathematics (Wee & Abu Bakar, 2006). In recent years, various programs have been implemented in Malaysia that seek to improve teachers' capacity to utilize ICT effectively in teaching, or that seek to improve teacher education via ICT utilization, such as: (i) the Malaysian smart school project started in 1997 that involved schemes and initiatives to improve Malaysian schools' ICT integration, and (ii) Smart School Qualification Standards which was launched in June 2006 and provides a set of criteria for achieving Smart School recognition as well as developing a system to measure ICT use in education. Many of these programs are innovative in that they have pioneered ICT training for teachers, as well as introduced new techniques and training procedures for the improvement of instruction (Wee & Abu Bakar, 2006).

### **Statement of the Problem**

Because of the complex nature of science as an academic subject, teachers of science need to be creative and innovative in the way they impart science contents to students. Science teachers in some developed countries, for example the UK, have been reported to use innovative techniques such as storytelling, story writing, inquiry, problem-based learning and visual learning, to augment students' understanding of scientific concepts and phenomena.

With the advent of advanced and sophisticated information and communications technologies (ICTs), science teachers can now use innovative tools like interactive whiteboards, animation, 3D models (digital), virtual lab, video clips (YouTube) and virtual worlds, like Second Life, to make students' science learning more meaningful and authentic.

Despite all these advances in digital technologies, science teachers' uptake of ICT remains slow and discouraging, especially in many parts of the Muslim world, such as Malaysia and Saudi Arabia. The factors that hamper Malaysian and Saudi science teachers' use of ICT are not well-understood, as not enough research has been conducted in the context of Malaysian and Saudi science education, especially one that is comparative in nature. The present study was an attempt to address this gap in the ICT barriers literature.

### **Research Objectives**

The primary objectives of this study were: (i) to profile ICT use among Malaysian and Saudi science teachers, (ii) to identify the underlying factors that could explain the slow uptake of ICT technologies among secondary school science teachers in Malaysia and Saudi Arabia, and (iii) to compare between Malaysian and Saudi secondary school science teachers in terms of the factors perceived to be the barriers preventing their use of ICT in the science classroom.

## METHODOLOGY

The study was a cross-sectional survey that involved 282 science teachers who were randomly sampled from selected secondary schools in Malaysia and Saudi Arabia. The primary instrument used to collect data was a self-developed questionnaire on possible ICT barriers. The questionnaire items were drawn from a review of selected ICT adoption studies (e.g. Mumtaz, 2000; Ismail, 2009) and several focus group discussions/interviews with Malaysian and Saudi science teachers. After content validation of the items with five experts in the field, the questionnaire was translated into Arabic and pilot tested with 31 science teachers (15 Saudi and 16 Malaysian). Results of the pilot test indicated that one problematic item should be removed, leaving the finalized questionnaire with 27 items. A total of 400 questionnaires were distributed to schools with the help of the school principals. Emails and smses were sent some time later to remind the respondents to fill out the questionnaire. Out of the 400 distributed, 302 were returned and from this number, only 282 were usable after data screening. The data were analyzed using descriptive statistics (to address research objective 1), factor analysis (to address research objective 2) and *t*-test (to address research objective 3).

### Findings

The findings are presented in the order that addresses the research objectives:

#### • Profile of ICT Use Among Malaysian and Saudi Secondary Science Teachers

Figure 1 presents a visual summary of the Malaysian and Saudi science teachers' use of ICT. A majority of the respondents are familiar with most of the various types of ICT use asked in the questionnaire, especially using the email, online news reading, preparing Power Point presentations. Respondents of both countries are least familiar with blogging and Skyping. Less than 15% on both sides reported to be familiar with blogging, while only 15% (Saudis) to 25% (Malaysians) are familiar with Skyping. In general, the reported ICT use among the Malaysian and Saudi respondents did not appear to differ markedly. Differences between them are marginal, except with respect to the use of spreadsheet (where twice as many Saudi teachers use spreadsheet compared to Malaysian teachers) and database (where less than 17% of Saudi teachers reported using it compared to more than 50% of their Malaysian counterparts). The findings suggest that using ICT is not uncommon among both teacher samples, and that these teachers do have the necessary skills to employ ICT in science teaching.

Figure 1

A Comparative Summary of ICT Use among Malaysian and Saudi Respondents

#### Underlying Factors that Represent Barriers to ICT Use among Malaysian and Saudi Secondary Science Teachers

Principal Components Analysis (PCA) with Varimax rotation was applied on the data to extract underlying factors that represent barriers to the respondents' use of ICT in the science classroom. The PCA procedures would allow the study to reduce the number of items or variables in the questionnaire down to their principal components, which constituted ICT use inhibitors. It was decided a priori that for an item to load on a factor, it must have a minimum absolute value of 0.35 and must not load on another factor at an absolute value of 0.35 or greater.

The data were first analyzed for the assumptions of PCA, namely adequacy in terms of (i) sampling and (ii) inter-correlation among the items. The Kaiser-Meyer-Olkin (KMO) measure was used to assess the study's sampling adequacy. This measure varies

between 0 and 1, and values closer to 1 are better. To fulfill the requirement for sampling drawn from the data in the study shows a value of 0.858, which met the sampling adequacy requirement of PCA. The correlation matrix shows the determinant to be 0.00004. Furthermore, Bartlett's test of sphericity produced a statistically significant inter-item relationship ( $\chi^2_{2351}=2.726E3$ ,  $P \leq 0.001$ ) with an overall MSA of 0.858. In summary, these results show factorability of the data hence justifying the use of PCA in the analysis.

The PCA results extracted six latent factors that constituted ICT use barriers among the respondents, which explained close to 57.5% of the variance (Table 1). However, factors 5 and 6 could not be retained in subsequent analysis due to crossloadings that resulted in insufficient number of items that could be retained to represent the two factors. Therefore, only four factors were retained in the final analysis. Altogether, the four-factor structure explained approximately 49% of the variance, which is considerably lower than the proportion of variance explained by the initial 6-factor structure.

Table 1  
The Six Extracted Factors and Total Variance Explained

Factor	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.881	25.484	25.484	4.002	14.822	14.822
2	3.242	12.008	37.492	3.250	12.036	26.858
3	1.589	5.884	43.376	2.910	10.777	37.635
4	1.427	5.286	48.662	2.135	7.908	45.543
5	1.278	4.735	53.397	1.772	6.561	52.104
6	1.107	4.100	57.497	1.456	5.392	57.497

Extraction Method: Principal Component Analysis.

The factors were then labelled based on the common idea shared by the items that loaded into them. Factor 1 was labelled *Attitude Towards ICT Use*. This factor accounted for 25.5% of the variance explained. Six (6) items loaded on this factor. They were (i) teachers not seeing how ICT helps students to understand science (0.76), (ii) teachers not interested in using ICT for teaching (0.744), (iii) teachers not having the required ICT skills (0.685), (iv) teachers not feeling confident to use ICT to teach (0.68), (v) teachers not knowing how to teach using ICT (0.633), and (vi) teachers believing that ICT doesn't improve their teaching (0.628). Factor 1 appeared to be the largest ICT use barrier among the respondents in this study.

Factor 2 was labelled *Access to ICT Facilities in School*. This factor explained 12% of the total variance. Items that loaded on this factor were the lack of ICT facilities in the class or lab (0.716), lack of computers for teachers (0.645), lack of access to computers at schools (0.69), and lack of Internet access at school (0.628).

Factor 3 was named *Beliefs about ICT*. This factor contributed 5.88% of the total variance explained. Items that loaded on this factor were ICT requires a lot of time (0.681), workload doesn't allow teachers to use ICT (0.697), lack of time to learn ICT skills (0.602), teachers can teach just as well without ICT (0.671), and students learn equally well without ICT (0.604).

Factor 4 was called *Technical Support for ICT Use*. This factor explained 5.28% of the total variance of the combined factors. Items that loaded on this factor were

hardware is outdated (0.652), software for science is not available (0.719) and lack of ICT training for teachers (0.481).

- **Differences Between Malaysian and Saudi Secondary Science Teachers with Respect to the Underlying ICT Barriers Factors**

Differences between the Malaysian and Saudi science teachers with respect to the four extracted factors (*Attitude towards ICT use, Access to ICT facilities, Beliefs about ICT and Technical Support for ICT Use*) were established by computing the factor scores and means of each teacher sample. Then four independent sample *t*-tests were run to investigate the variation in the four factors between the two teacher samples.

The *t*-test results show that Malaysian and Saudi secondary school science teachers did not differ significantly in terms of their attitude towards ICT use (Mean<sub>Saudi</sub> = 3.55 and Mean<sub>Malaysia</sub> = 3.54) and their beliefs about ICT use (Mean<sub>Saudi</sub> = 2.75 and Mean<sub>Malaysia</sub> = 2.83), but the differences between these two samples were statistically significant in terms of technical support for ICT use (Mean<sub>Saudi</sub> = 2.63 and Mean<sub>Malaysia</sub> = 2.98) and access to ICT at school (Mean<sub>Saudi</sub> = 2.37 and Mean<sub>Malaysia</sub> = 3.1). In short, Malaysian and Saudi teachers demonstrated similar attitude and beliefs about ICT use, but in terms of technical support and access to ICT at school, the Malaysian sample reported significantly greater technical support received from school and greater ICT access.

## CONCLUSION

The results have shown that the largest barrier to ICT use among the Malaysian and Saudi science teachers surveyed in the study came from within the teachers themselves. It is their not so favourable attitude about ICT use that is largely preventing them from using ICT in the science classroom. Their profile of ICT use does not indicate that these teachers lacked ICT skills; therefore it is reasonable to conclude that in spite of their existing ICT skills, these teachers are prevented from using ICT appropriately in the science classroom because of their unfavorable attitude towards its use. The second largest factor is *Access to ICT Facilities in School*, which explained about 12% of the science teachers' lack of ICT use in teaching, while the third and fourth largest barriers were *Beliefs about ICT Use* and *Technical Support for ICT Use*. In summary, the four barriers extracted from the data could be grouped into two major categories of barriers, namely teacher-level barriers (attitude and beliefs about ICT use) and school-level barriers (access to ICT at school and technical support for ICT use). The findings conform to Mumtaz's (2000) categorization of ICT use barriers and the results of similar studies on barriers to ICT adoption (Bigimlas, 2009; Birch & Burnett, 2009; Cuban, Kirkpatrick, & Peck, 2001). They are also quite consistent with Veen (1993) who documented that teacher factors tend to outweigh school-related factors in influencing teachers' use of ICT.

Based on the findings, some recommendations are made to improve science teachers' ICT uptake in school with a specific focus on school management and direction of future research:

### School management

In terms of the ICT facilities available at Malaysian and Saudi secondary schools, the directors should make some intervention to standardize the availability of ICT facilities across the schools. More efforts should be made to provide the technical support for ICT as well as the access to ICT facilities.

School managements may identify the ICT requirements of science teachers through an ICT needs analysis in which they can carefully assess and identify whether the

ICT facilities they wish to purchase would be relevant to what science teachers need to enhance their teaching performance.

### **Directions for future research**

The analysis in this study was accomplished under certain conditions and variables; other variables might be at play in inhibiting science teachers' ICT uptake, such as cultural norms, political intervention and other socio-economic variables. These variables should be studied since they may yield a better understanding of the underlying factors influencing ICT integration among science teachers. Additionally, ICT integration is highly affected by the way ICT might be employed in the classroom and whether teachers have previous knowledge to integrate it in the subjects they teach. Offering ICT facilities in schools alone is insufficient to empower teachers to use ICT successfully. Therefore future research should look into how the ICT is being used in classrooms and teachers' pedagogical content knowledge with respect to its use.

### **Future Plan of the Research**

Given the substantial number of problematic items found in the questionnaire (i.e. items with significant cross-loadings) which affected the number of factors to be retained and the proportion of variance explained, many items had to be revised and reworded to be more closely in line with the categories of barriers as delineated by Mumtaz (2000) and other established works on ICT adoption. The present study could be treated as a pilot test to establish the reliability of the data and refine the items that measure ICT adoption barriers among science teachers. Upon revision and improvement of the items, a new sample of science teachers could be surveyed from within and outside of Malaysia (for comparative analysis) to generate more comprehensive data that can better explain the reasons for science teachers' slow uptake of ICT.

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