Science Teachers' Acceptance towards Microcomputer-Based Laboratories

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ABSTRACT

A microcomputer-based laboratory (MBL) has shown that it enhances the learning of science students by offering various pedagogical and psychological advantages. With the use of MBLs, real-time data collection and analysis can be performed seamlessly in the laboratory resulting in meaningful learning, especially of abstract concepts. Research shows that the unique capability of MBLs is more than simply motivating students as MBL can also improve students' abilities such as graph interpretation and higher-order thinking skills. Despite the extensive use of MBLs in Western countries, the affective aspect of this technological application in school is still relatively unexplored. Therefore, a study was conducted to determine the level of acceptance of in-service teachers towards MBLs using the Technological Acceptance Model (TAM) with regards to the perceived usefulness of MBL in teaching and learning science, its perceived ease of use, and the likelihood of using MBLs. The survey involved 38 in-service science teachers. The outcome indicates that the in-service teachers have a positive view towards the usefulness of MBLs in learning science and are very likely to use the system in schools. However, perceptions towards the ease of use of MBLs are not as favourable. This implies that MBLs should be promoted in schools as it can potentially enhance the quality of science education in Malaysia. Thus, the use of MBLs among science teachers needs to be promoted through intensive professional development.

Keywords: science teacher, microcomputer-based laboratory, technological acceptance

INTRODUCTION

The microcomputer-based laboratory is a technology application in teaching and learning science. It is also used for scientific experiments in real-world applications. MBLs, also referred to as probeware, calculator-based laboratory or computer-based laboratory (CBL) or data logger, is said to be the most significant contribution of computer technology to science education (Tinker, 2000). MBLs are essentially ones where a microcomputer (or any device like a tablet or smartphone) is interfaced with laboratory sensors and actuators that enable users or students to conduct automated experiments and collect, process and represent data (Hartsuijker, Friedler, & Gravenberch, 1991). In practical science, this computer application differs from a multimedia application that provides presentations, explanations and explorations of scientific principles and processes using audio, video, animation, and simulations. The MBL application in the science laboratory consists of various sensors that measure temperature, pH and pressure which are connected to an interface that is an analogue-digital converter (see Figure 1 MBL Set Up). The interface is connected to a computer through the use of software that allows the programming of the frequency of measures and data format to be presented on the computer screen or print output (Tortosa, 2012).

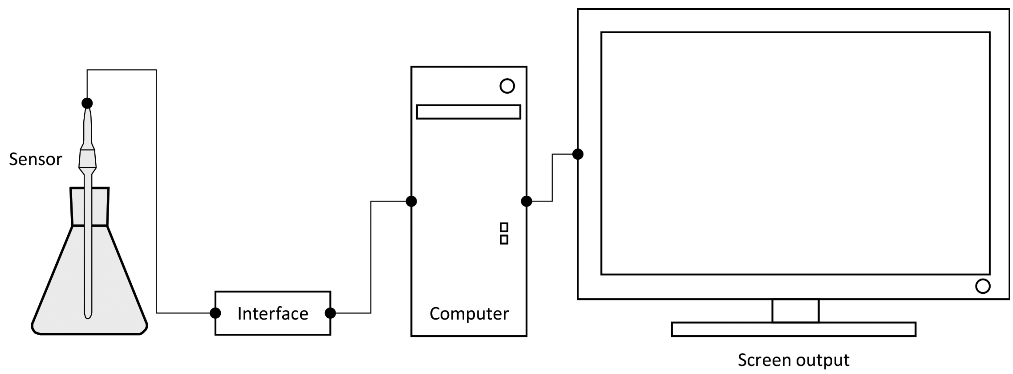

Figure 1 MBL Set Up

Initially, the main power of MBLs is the real-time data collection capability (Park, 2008). However, now with the advancement in computers and software, MBL technology offers various technological advantages. For example, the new generation of MBL systems enable users to watch events (through video capture) and collect data simultaneously; perform time and event-triggered data collection; and carry out live data presentation and analysis with the use of remote controlled sensors and wireless data interfaces (Hartsuijker et al., 1991; Park, 2008). With these capabilities, an MBL is seen to have advantages over the standard laboratory apparatus. MBLs provide opportunities to students to explore experiments that cannot be readily conducted in secondary school laboratories as MBLs can be used in micro-scaled reactions, fast or slow events, and with multiple parameters (Aksela, 2011). Through these opportunities, MBLs are also said to have many pedagogical benefits in science lessons. These advantages include encouraging students to become actively involved in science lessons, by making them engaged with ideas and processes rather than mere data collection. By reducing the routine work in laboratory, MBLs provide more time for students to discuss ideas, have more opportunities to suggest explanations for their observations, and also to test their ideas (Barton, 2004; Newton, 2000; Rogers, 2002).

For a successful integration of any new technology in education, there is a need to examine the readiness, acceptances, and mindset of all that are to be involved with the technology. So it is with MBL, especially the teachers. This examination is necessary for the proper preparation for teachers which includes training and attitude change. However, studies related to MBL integration are scant. The little literature related to this is reported by Heck (1990) which indicates that teachers reacted positively to the potential benefits of MBL in enhancing laboratory experiences for students. This finding is also echoed in other studies where pre-service teachers perceive MBL technology as a powerful way to facilitate learning, teach responsibility, and enhance problem-solving skills. (Gado, Ferguson, and van't Hooft (2006); Robert, 1998). Despite the positive acceptance of MBL, Heck (1990) also indicated the challenges for MBL integration in a curriculum, such as, using an MBL for traditional drills and practices, and limited resources. These challenges were also indicated in Gado et al. (2006).

Despite that, MBLs have been developing since in the 1970s and can be regarded as essential for secondary schools in the West. However, MBLs are quite foreign in many countries including Malaysia. With the current emphasis on Science, Technology, Engineering and Mathematics (STEM), there is a need for promoting the use of MBL in schools (Trumper & Gelbman, 2001). Therefore, this study is to explore acceptance of in-service teachers towards MBL integration in secondary schools in Malaysia.

METHODOLOGY

The teachers' acceptance of MBL was examined based on the Technology Acceptance Model (TAM) (Davis, 1986; Davis, Bagozzi, & Warshaw, 1989). This model consists of various variables including perceived usefulness, perceived ease of use, attitudes towards use, behavioural intention to use and actual system use. As the use of MBL in Malaysian schools is still limited, only three variables were explored to gauge teachers' reactions towards this technology: perceived usefulness, perceived ease of use and behavioural intention to use. Each of the variables were examined using questionnaire items which were modified from Gardner and Amoroso (2004). The response format of the questionnaire was the five-point Likert scale and the alpha Cronbach of the questionnaire was calculated as 0.88. The survey was administered to 38 in-service science teachers who are pursuing their postgraduate studies at Universiti Malaysia Sabah. The in-service teachers were introduced to the PASCO MBL system and were given the opportunities to utilise the system briefly. Most of them teach Science at secondary level.

RESULTS

Perceived Usefulness of MBL in Teaching and Learning Science

Table 1 Perceived usefulness of MBL in teaching and learning science shows the perception of in-service teachers on the usefulness of MBL in teaching and learning science. It indicates that most of the teachers strongly agree or agree that MBL can be useful in students' acquisition of scientific knowledge and skills. Only two participants disagree. All the in-service teachers agree that MBL provides fast and timely data collection.

Table 1 Perceived usefulness of MBL in teaching and learning science

Item n		Strongly agree		Agree		Neither agree or disagree		Disagree		Strongly disagree		Mean score
		%	n	%	n	%	n	%	n	%		
1	MBL helps students to develop data interpretation skills.	16	42.1	22	57.9	0	0.0	0	0.0	0	0.0	4.42
2	MBL helps all students learn scientific concepts.	14	36.8	20	52.6	3	7.9	1	2.6	0	0.0	4.24
3	MBL helps students learn new concepts.	14	36.8	21	55.3	2	5.3	1	2.6	0	0.0	4.26
4	MBL helps students learn scientific skills more effective.	16	42.1	21	55.3	1	2.6	0	0.0	0	0.0	4.39
5	MBL helps students develop higher order thinking skills.	17	44.7	20	52.6	1	2.6	0	0.0	0	0.0	4.42
6	MBL would enhance the quality of teaching of STEM in Malaysian schools.	24	63.2	12	31.6	2	5.3	0	0.0	0	0.0	4.58
7	MBL provides fast and timely data.	31	81.6	5	13.2	2	5.3	0	0.0	0	0.0	4.76
	Mean total score											4.44

Perceived Ease of Use of MBL

The responses on the ease of ease of MBL are shown in . Although the teachers regard the usefulness of MBL highly, they do not consider the ease of use of MBL in the same way, as indicated in the mean score of this domain (mean total score = 3.88). The lowest scored item is the elimination of preparation of practical work (mean score = 3.26). However, the teachers seem to perceive that setting up MBL equipment is easier than conventional practical work and that MBL is useful in the teaching of science.

Table 2 Perceived ease of use of MBL

	Item n	Strongly agree		Agree		Neither agree or disagree		Disagree		Strongly disagree		Mean score
		%	n	%	n	%	n	%	n	%		
1	Learning to operate MBL devices would be easy for me.	3	7.9	24	63.2	9	23.7	2	5.3	0	0.0	3.74
2	My interaction with MBL devices would be clear.	5	13.2	25	65.8	8	21.1	0	0.0	0	0.0	3.92
3	MBL would eliminate my preparation for practical work.	5	13.2	13	34.2	9	23.7	9	23.7	2	5.3	3.26
4	MBL is easier to set up compared to conventional practical work.	10	26.3	19	50.0	8	21.1	1	2.6	0	0.0	4.00
5	I find MBL equipment useful teaching science.	18	47.4	20	52.6	0	0.0	0	0.0	0	0.0	4.47
	Mean total score											3.88

Intention to Use MBL

Consistent with the very positive perception towards the usefulness of MBL, the teachers also indicate that they have a strong inclination to use MBL in teaching science. This dimension scored 4.49 on average. Most of the teachers (more than 90%) responded that they would use MBL in their school for different approaches to science teaching and learning such as project-based and inquiry-based learning. Similarly, they also responded that they are eager to change and enhance their teaching and learning by using MBL. So great are the teachers' enthusiasm about MBL that they also responded that they will share what they know about MBL with their colleagues.

Table 3 Intention to use MBL

	Item n	Strongly agree		Agree		Neither agree or disagree		Disagree		Strongly disagree		Mean score
		%	n	%	n	%	n	%	n	%		
1	I will use MBL in my school if it is available.	26	68.4	12	31.6	0	0.0	0	0.0	0	0.0	4.68
2	I want to use MBL for my student project-based learning.	23	60.5	15	39.5	0	0.0	0	0.0	0	0.0	4.61
3	I want to use MBL for student inquiry-based learning.	16	42.1	22	57.9	0	0.0	0	0.0	0	0.0	4.42

4	I will share what I learned about MBL with my colleague.	17	44.7	19	50.0	2	5.3	0	0.0	0	0.0	4.39
5	I want to use MBL for STEM instruction in school.	14	36.8	21	55.3	0	0.0	0	0.0	0	0.0	4.40
6	I want to use MBL to enhance my teaching.	21	55.3	17	44.7	0	0.0	0	0.0	0	0.0	4.55
7	I am eager to change my teaching by using MBL.	14	36.8	23	60.5	1	2.6	0	0.0	0	0.0	4.34
	Mean total score											4.49

DISCUSSION

The results indicate that the in-service teachers hold a positive view towards the usefulness of MBL in teaching science in school. This finding is consistent with a previous study that teachers perceive MBL as a very useful means in enhancing the teaching and learning of Science (Gado et al., 2006; Heck, 1990; Robert, 1998). The results were expected since the MBL offers various capabilities that enhance a science lesson. Real-time data collection, instant output display and flexibility are some of the main features of MBL that in-service teachers can identify as having great potential to enhance learning in practical science lessons. Besides that, these in-service teachers would also realise that MBL is not only a powerful tool in the laboratory but also allows students to conduct data collection in the real-world situations out of the typical Science lesson setting. This supports active learning and promotes higher-order thinking in science education.

Although the teachers are less partial towards the ease of use of MBLs, it still scored above 3.00 for all items. Despite being unaware of the existence of such technology before their postgraduate study, the in-service teachers agree that they would able to utilise the MBL system quite easily. Using current-generation MBLs does not require too much technical skill. The MBL "plug and play" feature and familiar software interface provided in the system are possible reasons for the teachers' positive perceptions on the ease of use. Moreover, the teachers also see an MBL as being easier to set up than a conventional laboratory, although teachers see that this does not necessarily equate to a reduction on the amount of preparation required.

Consequently, it is not surprising that most of the teachers want to use the technology for their teaching and learning. They consider an MBL as a very useful tool in teaching Science and it is, at the same time, easy to use. The positive acceptance of the MBL may not only be because of the features that it offers. The call to provide active and meaningful learning in their Science lessons by the Education Ministry in response to the demand to improve science education and STEM education is also a probable cause.

CONCLUSION

The findings suggest that the in-service Science teachers have positive attitudes towards MBL technology as indicated in their recognition and awareness of the opportunities offered by the technology. Therefore, something needs to be done to promote the integration of MBLs in schools in Malaysia for the enhancement of learning of science and STEM education. Besides training in the use of MBLs, it is also necessary to explore ways of reducing the cost of setting up an MBL system in schools.

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