The use of ICT in teaching tertiary physics: Technology and pedagogy

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Abstract

In the light of the education reform driven by Vietnam's government, information communication technologies (ICTs) are becoming integrated into education, while concurrently, teaching approaches are shifting from teacher-centred to student-centred in Vietnam's universities. The innovation is top-down and is being applied on a large scale. Emerging from this innovation are some important issues about technology and pedagogy that need to be investigated.

The aim of this research focuses on applications of ICTs and pedagogy underpinning these innovations in teaching Physics at a tertiary level. The research aim is specified in three research questions:
(1) What ICT applications do lecturers use in teaching Physics?
(2) How often do they use ICTs in teaching?
(3) What is the lecturers' pedagogy in using ICTs in teaching Physics?

The 45 Physics lecturers and the 12 students who participated in this research were from different universities and represented both gender, and a range of ages and experience in education.

The findings of the research show that the most popular and frequent application of ICTs is MS PowerPoint used to support face-to-face lectures. The pedagogy underpinning the use of MS PowerPoint appears to be helping students to understand Physics phenomena, and so assist their learning in Physics.

Keywords: information communication technology, technology, pedagogy, physics

Introduction

In recent years, Vietnam's government has been driving reform in education. An important goal of the reform is to promote innovative teaching and learning methods (Vietnam's Ministry of Education and Training, 2001, 2008; Vietnam's National Assembly, 2000, 2005). The teaching approach has been consequently slowly changing from teacher-centred to student-centred, and information communication technologies (ICTs) are becoming integrated in education (Vietnam's National Assembly, 2000, 2005).

According to UNESCO (2005), the process of educational institutions adopting and using ICTs follow four stages: emerging, applying, infusing and transforming. Southeast Asian Ministers of Education Organization (2010) categorises South East Asian countries into three groups based on the countries' stages of integrating ICTs in education: group one at infusing and transforming stages, group two mainly at the infusing stage and group three at the emerging stage. Generally, Vietnam belongs to the second group who have integrated ICTs into existing teaching, learning and administration (mainly at the infusing stage). The little literature about the use of ICTs in education at Vietnam's universities focuses on educators' access to ICTs and their concepts of learning, and generally use quantitative methods which provide

little deep insight into the pedagogical implementation of ICTs (Peeraer & Van Petegem, 2011). The literature review that was conducted did not reveal any research on the pedagogy associated with the use of ICTs in Physics at Vietnam's tertiary level.

The objectives of the current study are to investigate (1) the ICT applications that lecturers use in teaching Physics in Vietnam's universities, (2) frequency of application and (3) the pedagogy of the ICT use. Both quantitative and qualitative methods are employed in the research. Besides questionnaires administered to lecturers, interviews with students and lecturers were performed in order to triangulate the data and so enhance trustworthiness.

This paper first describes a theoretical background related to the research topic. Then the research method and findings will be discussed.

Literature Review

Information Communication Technology

Information and communication technology (ICT) is defined by UNESCO as forms of technology used for creating, displaying, storing, manipulating, and exchanging information (Meleisea, 2007). ICTs, in general, consist of computers, hardware and software, networks, learning management systems, e-mail, internet, telephone, television, radio and so forth.

In the 1960s and 1970s, schools and universities started to use printed material, television, radio, overhead projectors and movies in teaching. Since personal computers and the internet began being more widely used in the late 1980s and early 1990s, the use of ICTs in education has grown rapidly. The proliferation of personal computers and the Internet resulted in significant changes in the implementation of ICTs in education. ICTs included not only learning resources but also tools to facilitate interaction and collaboration (Caladine, 2008; Taylor, 1995). Learning management systems such as Blackboard and WebCT became widespread. Social networking sites (e.g. FaceBook, Flicker and Yahoo3600) permitted people to create profiles and upload information including text, photos, pictures, audio files and video files. The users could also add, edit and remove content.

Information and Communication Technology and Learning

The focus of ICTs in this study is the use of internet, software, multimedia resources, course management systems and computer-based testing systems in education. The applications of ICTs are categorised into the three groups represented in Table 1: learning resources, instructional organisation of learning and communication (Collis & Moonen, 2001)

The applications of ICTs in learning resources include educational software, distributed resources via the internet and video resources. Educational software is not only learning resources for students but also tools for instructional organisation of learning. Examples of physics education software are Physics Pro, Crocodile Physics and Andres Physics. Rich learning resources distributed via the internet and video resources are also considered important.

Table 1 The applications of ICTs in this study

Categories	**The applications of ICTs**
Learning resources	• Educational software • Distributed resources via the internet • Video resources
Instructional organisation of learning	• Software and technology tools supporting face-to-face lectures • Course management system • Computer-based testing system
Communication	• E-mail system • Websites offering communication options for the direct sending for e-mail and forms of structured communication • Software system for text-based chat

(Collis & Moonen, 2001)

The next category, instructional organisation of learning, contains software and technology tools supporting lectures, course management systems and computer-based testing systems. First, educational software and technology equipment are needed to assist in face-to-face lectures such as the teaching and learning software mentioned above. The tools supporting lectures in class comprise

LCD projectors, computers, speakers, over-head projectors, and so on. Another application of ICTs in instructional organisation of learning is course management systems (e.g. DOKEOS, Moodle, WebCT). Course management systems are sometimes called learning management systems, e-learning systems, content management systems, or learning support systems. Third, computer-based testing systems such as Maplesoft T.A. and Hot Potatoes are applied in the instructional organisation of learning.

ICT is also utilised to promote communication. The use of ICTs in this domain consists of e-mail systems and websites which offer variable communication options and software systems for text-based chat and other forms of communication.

In its broadest meaning, ICT embraces many forms of technology, and a limitation of this research is that it only explores ICT in terms of internet, software, multimedia resources, course management system and computer-based testing systems. The applications of ICTs are categorised into three groups relating to three vital factors of the education process: learning, teaching and communicating (student-student and student-teacher).

Cognitive Constructivist and Sociocultural Perspectives

A Cognitive constructivist perspective represents an explanation of cognition of human beings. According to Piaget, knowing involves constructing and reconstructing knowledge. To know also means to produce in thought. The cognition process is the optimizing equilibration which brings us from equilibrium to new equilibrium (Bettencourt, 1993). This process may result in confirming or changing existing knowledge. Piaget stated that *schemes* (concepts, models, or patterns) were created by *assimilation* and *accommodation*.

When confronting experience, human beings tend to judge the schemes, ignore the differences, assimilate and bring them under a category. Then the schemes become *assimilations*. When the assimilations are made, they are used many times. Three consequences of the repeated assimilations are the generalization and flexibility of the schemes, the integration of different schemes, and problems.

When the problems appear, human beings start to notice the differences and make consequent perturbations in cognitive activities. Based on concepts, models and patterns, they generate new solutions repeatedly until the new schemes give expected results. In this way, the schemes have been *accommodated*. Piaget stated that

assimilation and accommodation, which led to a new equilibrium of knowledge, were two opposite poles of interaction between human beings and their environment in learning processes.

From **a sociocultural perspective**, learning occurs in a social context (Tobin & Tippins, 1993). Individuals construct their understandings in social settings. The foci of sociocultural views are that learning occurs in a social and cultural context; and knowledge or cognition is distributed over the social context, both inside and outside individuals (Bell, 2005). Learning is facilitated by mediational tools (artefacts), such as signs, diagrams, language, experimental equipment, technical tools and technology (Daniels, 2008). The artefacts are powerful tools to enhance learning processes, and may direct thinking and shape actions. The tools help students to interact with the social settings and co-construct their knowledge.

Social interaction between learner-learner and between learner-teacher plays an important role in the learning process. Students should be provided with a supportive, open and interactive environment which helps them discover knowledge. This learning environment facilitates learners to generate as many of their own hypotheses, models and ideas as possible, including both affirmative and contradictory positions. Moreover, the learning environment encourages students to present, discuss, negotiate their points of view with community, test their hypotheses, models or their possibilities, and determine viable knowledge.

TPCK Model

A model which appears popular for integrating ICT in education is the *Technology Pedagogy Content Knowledge* (TPCK) *Model*. The TPCK Model (Mishra & Koehler, 2006) describes the inter-relationships between content, pedagogy and technology, and then emphasises the importance of the integration of the three areas in developing effective teaching for learning.

Knowledge of *content* (C) in the model is an understanding about subject matter (Shulman, 1986). Teachers must be knowledgeable about the field of teaching, including facts, concepts, principles, theories, procedures and the structure of knowledge in their disciplines. *Pedagogical* knowledge (P) is knowledge about teaching and learning. Teachers also need to know the nature of learning; for example, how students construct knowledge and what a cognition process is. Methods of teaching, student assessment, instructional design and classroom

management are also elements of pedagogical knowledge. *Technology* knowledge (T) involves the awareness of and skills in operating and applying technologies such as computer software, the internet and LCD projectors.

Pedagogical content knowledge exists in the intersection of content and pedagogy, and is the knowledge about teaching specific subject matter (Shulman, 1986). It is concerned with the arrangement of content, the representation and formulation of the subject, the analogies and demonstration of ideas in easily comprehensible ways for learners. *Technological content knowledge associates* with the application of technology in teaching about subject matter. An example of technological content knowledge is the understanding of statistical computer software (e.g. Stata, R, and SPSS) and their applications into the subject matter statistics. Technological pedagogical knowledge, an overlapped area between the technology and pedagogy circles, refers to abilities of using technology in a way that supports the pedagogical approach. An understanding about existing technologies such as MS PowerPoint, digital cameras, and WebCT as well as the capabilities of utilising them in teaching is illustrative of technological pedagogical knowledge.

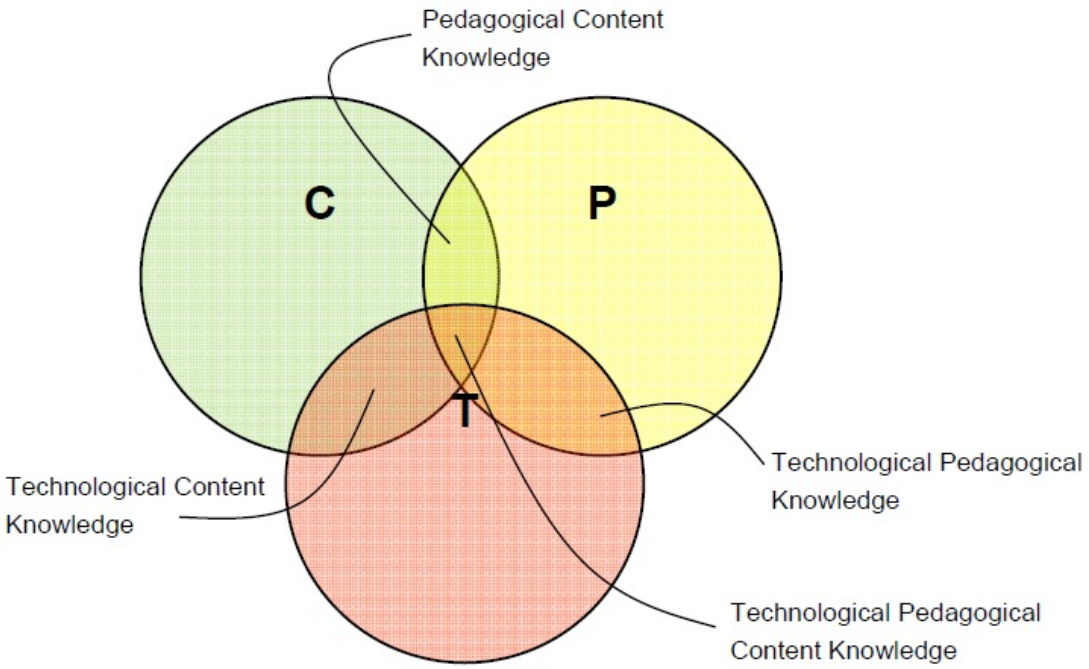

Figure 1 Pedagogical Technological Content Knowledge (Mishra & Koehler, 2006, p. 1025)

As illustrated in Figure 1, in the centre of the model, *technological pedagogical content knowledge*, an emerged form of knowledge, is essential for successful application of ICT in teaching (Mishra & Koehler, 2006) and is the focus of this study. It is the integration of teachers' understanding about the subject, knowledge about teaching and learning, and the ability of using technologies. Thus, technological pedagogical content knowledge is the knowledge of how to teach the content of subject matter using technology in a way that facilitates learning.

The TPCK Model is a valuable theoretical conceptual framework for teacher preparation and teacher professional development. The framework implies that the balance of technology, pedagogy and content knowledge are essential for success in effective teaching for learning.

The Research Method

Research Aim:

The aim of research is to investigate applications of ICTs and pedagogy underpinning these applications in teaching Physics at a tertiary level.

Research questions:

1. What ICT applications do the lecturers use in teaching Physics?
2. How often do they use ICTs in their teaching?
3. What is lecturers' pedagogy of using ICTs in teaching Physics?

Sample

There were 45 Physics lecturers and 12 students from universities involved in the research. The universities were chosen in order to provide a spread across three criteria: universities' size (the number of staff), years of establishment and the type of the university (public or private, funded by provinces government or ministry of education and training). Questionnaires were delivered to Physics departments of the universities. Physics lecturers were invited to answer the questionnaires. The lecturers who were interested in the research gave their feedback.

Students and lecturers were also encouraged to have interviews with researchers who managed to have interviewees from different age groups, gender, experience

in teaching/ learning capability and year of study. 50% of lecturers who were interviewed were female. Their ages were from 23 to 58. 25% of interviewed lecturers had more than 10 year teaching experience; 12.5% had only one year experience. The majority had teaching experience from 3 to 9 years. 50% of interviewed students were female, aged between 19 and 22, and they represented a range of learning ability.

Data Collection Methods

Both qualitative and quantitative methods interviews and surveys) were employed in the research. A questionnaire was administered to 37 Physics lecturers from different universities. The questionnaire included 15 items (9 Likert Scale items and 6 open questions). The nine Likert scale items presented nine applications of ICTs in teaching:

- Educational software as learning resources
- Distributed resources via the internet as learning resources
- Video resources as learning resources
- Software and technology tools supporting face-to-face lectures
- Course management system
- Computer-based testing system
- E-mail system
- Websites offering communication options for the direct sending for e-mail and forms of structured communication
- Software system for text-based chat

The items were classified into three groups: learning resources, instructional organisation of learning and communication. These Likert scale items inquired into the frequencies of use of the applications by the lecturers, requiring responses using five scales: one stands for not at all, two for less than once a month, three for once a month, four for twice a month and five for every week. Six open questions were to elaborate on the information gained from the Likert scale items. Frequencies and percentages of the answers were computed and analysed.

The lecturers and students from the universities were invited to have interviews with researchers in order to investigate which ICT applications were used by lecturers and the pedagogy underpinning the applications. Eight lecturers and twelve students accepted the invitations and were interviewed. The lecturer

interviews included four main questions, and based on the answers further discussions were stimulated. There were five main questions for the student interviews which sought to understand the student perspectives of the use of ICT and the pedagogy underpinning its use.

Data from the students' interviews triangulated the data from lecturers' interviews and survey. In addition, data from lecturers' interviews not only enriched but also triangulated the data from the survey with the lecturers.

Findings

As mentioned above, the research questions addressed three issues: the applications of ICTs in teaching Physics, its frequency and the lecturers' pedagogy of using ICTs. First, the applications and their frequencies will be examined, and then the lecturers' pedagogy will be discussed.

1. The Applications of ICTs - First and Second Research Questions Findings

Learning Resources

The ICT applications belonging to the learning resources category included educational software, distributed resources via internet and video resources. The lecturers did not favour using educational software as learning resources for students. 70% of the lecturers stated that they did not employ software at all, or used it less than once a month. The most frequently-used software was Crocodile Physics (19% of the lecturers use it), OriginPro (14%), MATLAB (8%) and MS PowerPoint (8%).

About two-thirds of the lecturers reported that they used websites as learning resources for students less than once a month or not at all. The most popular websites recommended to students by lecturers were www.thuvienvatly.com (10/37 lecturers recommended), www.vatlyvietnam.org (5/37) and www.vatlytuoitre.org (3/37). Vietnamese is the main language in the websites. In addition, Google and Wikipedia were also suggested by the lecturers.

Table 2 also presents the frequency of video utilization as a learning resource used by the lecturers. Video appeared not to be a popular learning resource with about 80% of lecturers participating in the research confirmed that they did not suggest, or just proposed videos to students less than once a month.

Table 2 Applications of ICTs as learning resources

	How often the lecturers use software as a learning resource for students		**How often the lecturers use websites as learning resources for students**		**How often the lecturers use videos as learning resources recommended to students**	
	Frequency	*Percent*	*Frequency*	*Percent*	*Frequency*	*Percent*
Not at all	12	32.4%	7	19.4%	11	33.3%
Less than once a month	13	35.1%	17	47.2%	15	45.5%
Once a month	4	10.8%	6	16.7%	3	9.1%
Twice a month	1	2.7%	3	8.3%	2	6.1%
Every week	7	18.9%	3	8.3%	2	6.1%
Total	37	100.0%	36	100.0%	33	100.0%

In general, ICT was not recommended regularly as a learning resource to students by the lecturers. More than 66% of the lecturers did not recommended the ICT applications to students as learning resources either not at all or less than once a month.

Instructional Organisation of Learning

The applications of ICTs in the instructional organisation of learning category embrace software and technology tools supporting face-to-face lectures, course management systems and computer-based testing systems. Figure 2 demonstrates that software and hardware supporting face-to-face lectures was the most frequently-used application of ICTs. About 60% of the lecturers implemented the software and hardware every week. Answers from an opened-end question (What software and technology tools do you use for your face-to-face lectures?) revealed that MS PowerPoint was widely used by the lecturers (83%), accompanied by MS PowerPoint and LCD projectors.

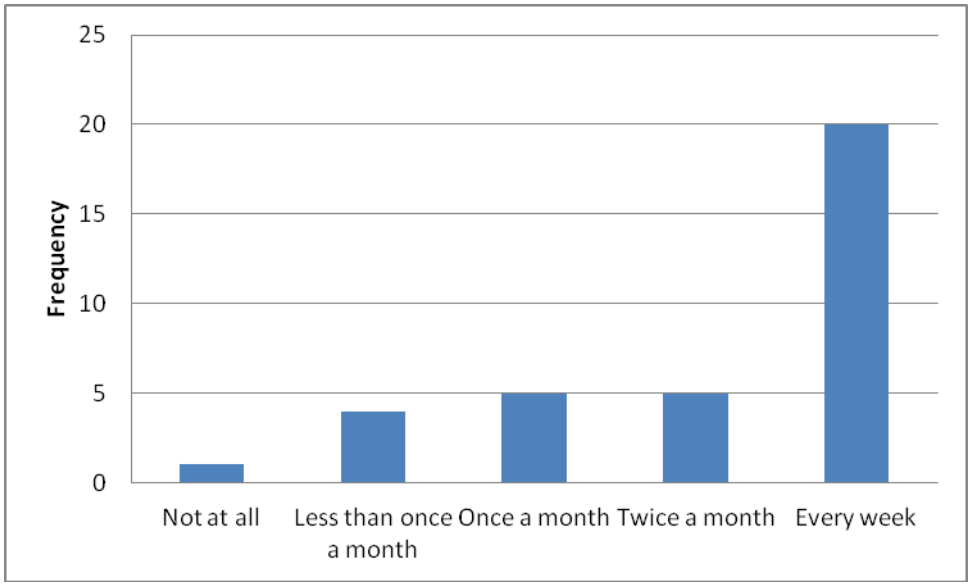

Figure 2 How often lecturers use software and hardware supporting face-to-face lectures (e.g. PowerPoint, LCD projectors, Over-head projectors)

The majority of university lecturers did not utilize course management systems and computer-based testing systems in their teaching. Nearly 70% of lecturers stated they did not use a course management system; about 13% said that they used the system less than once a month. About 85% did not use a computer-based testing system.

Software and hardware supporting face-to-face lectures dominated the applications of ICTs as instructional organisation of learning. The result from the qualitative data analysis also disclosed that MS PowerPoint was popularly utilized by the lecturers. Software supporting experimental simulation was the second most popular use; and photo-use was the third.

Communication

The applications of ICTs used as form of communication support learning consist of e-mail systems, websites offering communication options for the direct sending of e-mail and forms of structured communication, and software systems for text-based chat. Among the three applications, Table 3 indicates that e-mail to support learning was the most widespread used. More than a half of the lecturers said that they used e-mail to support students' learning every week. Social network and online chat systems to support students' learning appeared to be unpopular applications.

Table 3 Applications of ICTs as a form of communication

	How often the lecturers use e-mail to support learning		**How often the lecturers use online chat systems (e.g. Yahoo messenger, Skype) to support learning**		**How often the lecturers use social networks (e.g. Facebook, Flickr) to support learning**	
	Frequency	*Percent*	*Frequency*	*Percent*	*Frequency*	*Percent*
Not at all	0	0%	24	70.6%	23	65.7%
Less than once a month	8	23.5%	1	2.9%	3	8.6%
Once a month	3	8.8%	0	0%	2	5.7%
Twice a month	5	14.7%	6	8.8%	1	2.9%
Every week	18	52.9%	34	17.6%	6	17.1%
Total	34	100.0%	24	100.0%	35	100.0%

In summary, the applications of ICTs as learning resources did not have a strong focus by the Vietnamese Physics lecturers participating in the research. Software and technology tools supporting face-to-face lectures in the instructional organisation of learning category were the most frequently used by the lecturers. MS PowerPoint, software for simulating experiments and projectors were more prevalent among the software and technology tools. Among the applications of ICTs used as a form of communication to support learning, e-mail was commonly and regularly used by the lecturers. This section has clarified the types of ICTs popularly used in Physics courses at the Vietnam's universities. The next section will investigate the pedagogical foundations of the lecturers' ICT applications.

2. The Pedagogy behind the ICT use by the Lecturers - Third Research Question Findings

It is revealed from the interview data that there were three main pedagogical trends of using ICT. The most emerging trend was using MS PowerPoint, software, photos and other ICT applications to simulate and visualise Physics phenomena and

experiments. The trend of simulating and visualising to help students observe phenomena likely related to cognitive constructivist perspective. The other two trends appeared to be associated with a sociocultural perspective and other technology pedagogy knowledge.

Cognitive Constructivist Perspective

From the cognitive constructivist perspective, learning normally starts by observing or experiencing, and then continues with making meaning and relating current experiences to cognitive systems which learners have already developed. Learners then integrate or differentiate the new knowledge; and a new balance (accommodation) in their cognitive system is formed (Fosnot & Perry, 2005).

The striking feature that emerged from the interview data was that the lecturers implement ICTs to simulate and visualise Physics phenomena and experiments.

> For example, there are many issues in Physics which are very abstract. I want to make them visual by simulating them (such as optical phenomena, magnetic phenomena). There are many Mechanics phenomena which happen quickly and students cannot observe. In real life, we cannot make the phenomena happen slowly, only on computers we can retard the processes. For example, we make the oscillations happen slowly so that students can observe the process more carefully...Students cannot see how air molecules move in normal conditions. I simulate the motion of air molecules, how they collide and interact. It is more visual. It is abstract for students if we explain and ask them to imagine the air molecules motions. If they see the motion by their eyes, it is easier for them to comprehend. (Lecturer H)

> It [ICT] supports my teaching. For example, in some courses, it helps illustrating in details our lectures therefore, student understand the lectures better… For example, in Math for Physics, writing functions for wave carrying by strings, I use Mathlab to form the functions and also draw the diagrams of the functions. Students can see the form of the strings. (Lecturer G)

> Selecting some contents to teach by MS PowerPoint brings high efficiency, especially experiments which are difficult to perform (Lecturer D)

A lecturers' objective of using ICTs is to attract students' attention:

> Using ICT, by which lectures attract students' attention, helps them understand the lectures easier. If I keep talking without ICT, students are asleep and passive. Moreover, it is more vivid and attractive. (Lecturer H)

From a cognitive constructivist point of view, the lecturers used ICTs to attract students' attention and to visualise Physics experiments and phenomena. The lecturers believed that, as a result of drawing attention and visualising phenomena, students' learning were enhanced and they understood Physics better. This belief seems to dominate at the Vietnam's universities participating in the research.

Sociocultural Perspective

Another trend of pedagogy behind the ICT applications related to a sociocultural perspective. Of interviewed Physics lecturers, 25% used ICT to engage students in learning, seeking information, supporting group-work, group-discussion and co-constructing their knowledge. For example, two lecturers said:

> When lecturers use ICT in teaching and request students carry out learning tasks, students in general are very active. They cooperate with lecturers to build knowledge. Students also develop their problem-solving skills… While I give students learning tasks and they carried out the tasks, I can see that the students are very matured... They are gain more knowledge that they find out themselves. (Lecturer K)

> In a short duration of time, it is handy to use hyperlink to access to the content of lessons... The content is available on laptop. When a student has a question or a problem, I write the question/the problem on the board. I let students discuss first. My principles are to require students discuss in small groups about the issue and present their ideas in front of class... I let them explain and debate about the answers or solution for the problem. I may not give an answer because students have explained it to their peer... When we need to access to theory background for discussion... we find information from presentation by hyperlink. (Lecturer L)

In her discussion of learning in education, Bell (2005) presents three sociocultural views: learning as situated activity, learning as distributed cognition and learning as mediated action. Learning occurs in a social and cultural context; and knowledge or

cognition distributes over the social context, both inside and outside individuals. By employing the artefacts (technical tools and ICTs), students interact with the social settings and co-construct their knowledge.

Other Technology Pedagogy Knowledge

The result of the qualitative data analysis indicated that the lecturers considered the applications of ICTs to Physics content to be appropriate in some but not all contexts. Based on their content knowledge, the lecturers stated that the utilization of ICTs was highly effective with some Physics lessons; however, they felt that many Physics lessons such as those on Mathematics for Physics and Quantum Physics were not suitable for ICT applications. In addition, some lecturers believed that combining real experiments and simulation would facilitate learning:

> Selecting some content to teach by MS PowerPoint brings high efficiency, especially experiments which are difficult to perform. (Teacher D)
>
> It [ICT] is not efficient for specialized subjects such as Mathematics for Physics and Quantum Physics. (Teacher P)
>
> In the teaching process, we should not use e-lectures too much. We should use it alternatively. When it is necessary, we use e-lecture. Otherwise we read and students take notes. (Teacher H)
>
> I think the best way is combining real experiments, lecturing and simulation… After we perform real experiments, we simulate them on computers, make the processes happening on the experiment slow down and ask students give their ideas about the experiments. (Teacher H)

Discussion and Conclusion

Data triangulation (survey data triangulating interviews' data and lecturers' interviews data triangulating students' interviews data) was utilised in this research to disclose similar important findings. ICT applications as learning resources and communication to support Physics learning (except e-mail) were not regularly used by the lecturers. MS PowerPoint and some Physics simulation software, which belonged to the instructional organization of learning category, were very commonly and frequently used in Physics courses in the selected Vietnamese

universities. The pedagogy behind the use of MS PowerPoint and the software was to simulate and help students visualise Physics phenomena and experiments. This pedagogical view underpinning the ICT applications related to a cognitive constructivist perspective.

According to Peeraer & Van Petegem (2011), in the school year 2008-2009 when the data for their study was collected, the use of ICTs for teaching of lecturers was not quite regular. Among the applications of ICTs for teaching (e.g. presentation, electronic communication and classroom management), the application of ICTs for use in presentations was most common (16.8% of the lectures stated the use it regular; 83.2% of the lecturers never/rarely/sometimes used ICTs for presentation in their teaching). Other applications such as electronic communication and classroom management systems were less regularly used. For example, only 11% of the lecturers stated they used electronic communication regularly in their teaching, for applying ICT in classroom management only 4.8%.

The result of the current research showed that three years after the survey of Peeraer & Van Petegem (2011), the applications of ICTs in teaching practice seemed to become more frequent. Among the applications, ICTs for presentation was still the most popular application, with 60% of lecturers involved in this research claiming that they implemented software and hardware to support face-to-face lectures every week; 83% of them used MS PowerPoint for presentation 53% used e-mail to support learning every week, and about 10% for applying course management system (applying ICTs in classroom management). The more regular applications of ICTs into teaching practice might be explained by the top-down reform of the Vietnam's Ministry of Education and Training and the investment of the ministry on ICTs infrastructure and training human resources. After three years, the effort of the ministry on integrating ICTs in education (Vietnam's National Assembly, 2000, 2005) appears to be having some effect.

As mentioned in the introduction of this paper, the literature reviewed did not reveal any research about the pedagogy related to the applications of ICTs in Physics at Vietnam's tertiary level. The findings of this research indicated that the popular pedagogy underpinning the use of ICTs in teaching Physics at the universities was to simulate and visualise Physics experiments and phenomena. Lectures' goal of using ICTs seemed to focus more on students' individual learning (cognitive constructivist perspective).

The data from lecturers' and students' interviews revealed that lecturers applied ICTs, especially MS PowerPoint, software and hardware to support face-to-face lectures, to attract students' attention and to help students observe Physics phenomena carefully and clearly. From a cognitive constructivist perspective, observing and experiencing are the first stages of a cognitive constructivist learning process. The lecturers' applications of ICTs revealed in this study were more likely to enhance observing Physics experiments and phenomena, than to enhance learning.

In many institutions around the world, the applications of ICTs are moving toward enhancing interaction, communication and cooperation in learning Physics. According to Southeast Asian Ministers of Education Organization (2010), Vietnam's universities have integrated ICTs in existing teaching and learning, and are mainly at the infusing stage. The findings of this research showed that ICTs were implemented into physics learning and teaching at the universities. These findings agree with the work of Southeast Asian Ministers of Education Organization (2010). The pedagogy driving the ICT use at the universities is changing to be more student-centred. Although changes such as this take time, the research reveals a positive trend toward a sociocultural philosophy of pedagogy underpinning the ICT applications in teaching Physics.

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