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Systematic Planning for ICT Integration in Topic Learning

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ABSTRACT

Integrating Information and Communication Technology (ICT) into teaching and learning is a growing area that has attracted many educators' efforts in recent years. Based on the scope of content covered, ICT integration can happen in three different areas: curriculum, topic, and lesson. This paper elaborates upon the concept of ICT integration, and presents a systematic planning model for guiding ICT integration in the topic area. A sample of an ICT integration plan is described in this paper to demonstrate how this model can be applied in practice.

Keywords

ICT, ICT integration, Systematic planning, Integration plan

Introduction

The rapid development of Information and Communication Technology (ICT) has made information ubiquitous and computers cheaper and more powerful. Much evidence indicates that technology has great potential to increase learners' motivation, link learners to various information sources, support collaborative learning, and allow teachers more time for facilitation in classrooms (Moallem, 2003; Roblyer, Edwards, & Havriluk, 2004; Wilson & Lowry, 2000). Integrating ICT into teaching and learning has therefore become a great concern for many educators.

Depending on the scope of content covered, ICT integration can happen in three areas: curriculum (macro), topic (meso), and lesson (micro), as shown in Figure 1. ICT integration into the area of a curriculum normally requires ICT to support a more substantial amount of subject content, such as a complete course containing a number of topics in a specific discipline like science. Examples of such ICT integration are multimedia curricula delivered in CD-ROMs (Wang, 2001) or web-based courses. In the topic area, ICT can be used to cover certain topics within a course. A topic usually involves a series of smaller pockets of knowledge, such as DNA or cell division, which are usually interrelated to elaborate concepts. At the micro level, ICT is used to help explain specific knowledge units, such as DNA within a single lesson.

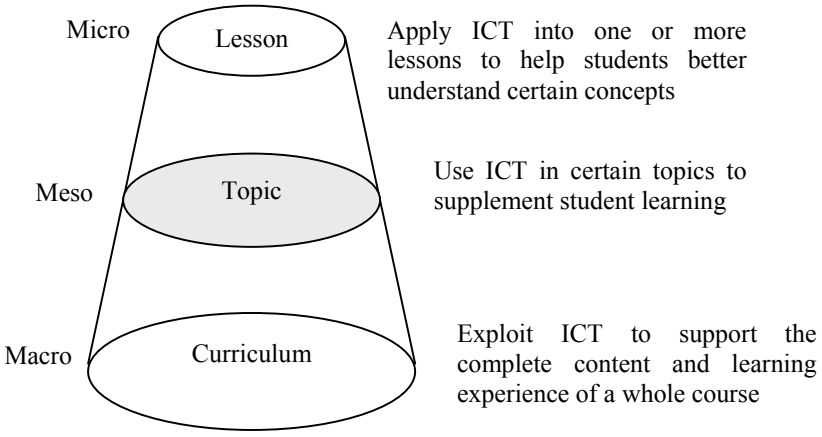

Figure 1: ICT integration areas

This paper demonstrates how a systematic planning model is used to guide teachers, who are called teacher-designers in the paper, in designing their ICT integration plans for a subject topic at the meso level. To help the teacher-designers better understand how to apply this model, a sample of an ICT integration plan that is built upon the systematic planning model is also provided in this paper as an appendix.

The Concept of ICT Integration

Integrating ICT into teaching and learning is not a new concept. It may be as old as other technologies such as radios or televisions. However, with the rapid development of emerging technology, such as web technology, ICT integration has increasingly attracted the attention of educators. In this section, we will elaborate on the terms of ICT and integration separately before giving the definition of ICT integration.

ICT is basically a tool. It can be hardware (such as computers, digital cameras), software (such as Excel, discussion forums), or both. In the educational context, it mainly refers to various resources and tools (software) presented on the computer. ICT is not particularly reserved for education; it is not a panacea for solving all educational problems either. However, it is "certainly a useful tool that enables us to link various learning communities together in new and different ways" (Taylor, 2000, p. 4). Research has indicated that the use of ICT can support new instructional approaches and make hard-to-implement instructional methods such as simulation or cooperative learning more feasible (Roblyer, Edwards, & Havriluk, 2004). Moreover, educators commonly agree that ICT has the potential to improve student learning outcomes and effectiveness if it is used properly (cf. Wang, 2001).

Integration has a sense of completeness or wholeness (Earle, 2002), by which all essential elements of a system are seamlessly combined together to make a whole. In education, simply handing out to students a collection of websites or CD-ROM programs is certainly not ICT integration. In a properly crafted ICT integrated lesson, ICT and other crucial educational components such as content and pedagogy are molded into one entity. As a result, the quality of the lesson would somehow be diminished if the ICT ingredient were taken away from the ICT-integrated lesson (Williams, 2003).

Putting these two words together, ICT integration in this paper is broadly defined as a process of using any ICT (including information resources on the web, multimedia programs in CD-ROMs, learning objects, or other tools) to enhance student learning (Williams, 2003). It is more of a process rather than a product. A simple placement of hardware and/or software will not make integration naturally follow (Earle, 2002). Numerous studies comparing traditional classroom-based instruction with technology-enhanced instruction have found insignificant differences in student satisfaction, attitudes, and learning outcomes (Johnson & Aragon, 2003). The primary factor that influences the effectiveness of learning is not the availability of technology, but the pedagogical design for effective use of ICT (Mandell, Sorge & Russell, 2002). The computer should be fitted into the curriculum, not the curriculum into the computer (Earle, 2002). Therefore, effective ICT integration should focus on pedagogy design by justifying how the technology is used in such a way and why.

Effective ICT integration into the learning process has the potential to engage learners. For instance, using multimedia to present authentic and ill-structured problems in problem-based learning can motivate and challenge students and hence develop their problem-solving skills (Boud & Felleti, 1991; Savery & Duffy, 1995). ICT can support various types of interaction: learner-content, learner-learner, learner-teacher, and learner-interface (Chou, 2003; Moore, 1989). These types of interaction make the learning process more interactive and learners more active and engaged.

Research evidence has also confirmed that effective ICT integration can promote student-engaged learning. For example, in a research study on the uses and effects of mobile computing devices in K–8 classrooms, Swan, Hooft, and Kratcoski (2005) reported that the students' motivation to learn and engagement in learning processes were improved by the use of mobile computing. In another study exploring the use of ICT tools to engage students in higher-order thinking in a Singapore school, Lim and Tay (2003) observed higher students' engagement in higher-order thinking by using ICT tools.

The Systematic Planning Model for ICT Integration

Many instructional design models are currently available to help teacher-designers plan their ICT integration into the curriculum. Some examples are the ASSURE (Analyze learners; State the objective; Select method, media and materials; Require learning participation; Evaluate and revise) model (Heinich, Molenda, Russell, & Smaldino, 2001), the WebQuests model (Dodge, 1997), and the ICARE (Introduction; Connect; Activity; Reflect; Extend) model (Hoffman & Ritchie, 1998). These models show guidelines for incorporating various resources and tools into teaching and learning. However, they do not explicitly encourage teacher-designers to think and justify why these resources and tools are used the way they are.

Figure 2 presents a systematic model for designing ICT-integration plans. It is systematic because it follows a logical flow and has components organized in a rather linear manner. Development of each component in the model depends very much on the completion of its previous components. This model essentially provides an easy-to-follow structure, where designers move to the next component only after they have completed the current component. Most importantly, this model requires teacher-designers to explicitly justify why the technology is used (the Rationale component), and how to effectively incorporate the technology (the Strategies component). The key components of this model are to be explained in detail below.

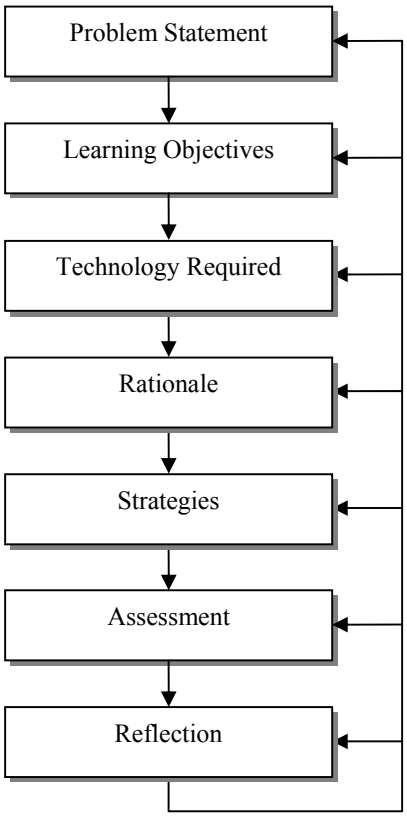

Figure 2: A systematic model for ICT integration

Problem Statement

This systematic model starts with a problem statement, which describes the major problems or issues to be addressed in a topic. For example, in the topic of "Energy," shown in the Appendix, the major problem is "what can we do to

prevent energy crises in Singapore in the future?" The problem statement serves as a starting point for the ICT-integration plan. The problem should be authentic, ill-structured, and challenging (Boud & Felleti, 1991). Also, the problem should be relevant to the intended target learners rather than to the teacher-designers. It is too often that the teacher-designers assume that students will understand and buy into the relevance and value of the problem. Unfortunately, the students do not simply take ownership for the problem if it is irrelevant to them (Savery & Duffy, 1995).

Learning Objectives

Learning objectives specify the intended learning outcomes at the end of the topic. Teacher-designers may write learning objectives based on the ABCD model (Reiser & Dick, 1996), where A is Audience; B is Behavior; C is Condition; and D is Degree. For instance, a complete description of a learning objective following the ABCD model might be: *At the end of the topic, the two secondary students should be able to verbally describe the present energy situation in Singapore on a mind map with 100% accuracy*.

In this example, A is "the secondary two students"; B is "verbally describe"; C is "on a mind map"; and D is "with 100% accuracy." It is worth mentioning that the behavior in a learning-objective statement should be observable and measurable. Vague verbs such as "understand," "do," or "brainstorm," are unsuitable for learning-objective statements. It is sometimes acceptable to omit or simplify one or two of the requirements mentioned. For instance, the D part ("with 100% accuracy") in the above example may be omitted; the A part can be simplified to "students" if the readers know who the intended audience is.

Technology Required

In order to address the problem and achieve the learning objectives, teacher-designers need to carefully compare all possible technologies that can be used for learning this topic. The technologies in this model may include software such as multimedia courseware, web-based resources, communication tools (such as voice chat, textual discussion forums, or video conferencing), mind tools (such as concept mapping tools and multimedia authoring tools), or any other possible ICT tools.

Rationale for Using the Technology

Technology should be used not because it is available or it has been shown effective in some cases. It should be used to enable the process and enhance learning. Inappropriate use of technology can lead to negative effects (Johnson & Aragon, 2003; Russell, 1999). Teacher-designers need to choose proper technology and justify i) why it is needed for the topic; ii) what added values the technology can offer; and iii) how the technology can support the instructional process. Moreover, Roblyer, Edwards, and Havriluk (2004) suggest the following for rationalizing the use of technology: i) high motivation; ii) unique instructional capabilities such as helping students visualize data/problems or tracking learning progress; iii) support for innovative instructional approaches such as collaborative learning and problem-based learning; and iv) increased teacher productivity and student knowledge construction.

Strategies for Implementation

After determining what technology is needed and why, teacher-designers must now decide how to effectively and meaningfully incorporate the selected technology into the topic learning. Since a topic is usually composed of several lessons, details on ICT integration should be provided separately for each lesson as well as for the entire topic. For each lesson, the teacher-designers should clearly answer the following questions:

- What ICT-based resources such as web sites, CD-ROM programs, or learning objects will be used?
- How will the ICT-based resources be used in various settings such as a full-lab, where each student uses a computer, or half-lab environment, where two students share a computer (Wong & Wettasinghe, 2003)?
- Why should we use these resources this way?
- What tasks/activities will the students do during the lesson?

- Are any handouts or instructions provided?

In addition, for the whole topic, the teacher-designer needs to specify how one lesson connects to the next lesson and the reason for doing so.

Furthermore, when designing an ICT-integration plan, the teacher-designers also need to consider whether:
- The activities can promote students' critical thinking or other higher-order thinking.
- The students understand what they are supposed to learn.
- The expectations and assessment criteria, such as rubrics, are stated clearly.
- There are opportunities for students to take control over content, pace, and sequence.

Student Assessment

Usually at the end of the topic, the students will be assessed on how well they have mastered the topic. The assessment often reflects both the process and the product (Jonassen, 1991). The assessment on the process examines how the students complete the learning activities or tasks, work together to complete the final product, or construct knowledge collaboratively by using the ICT. Methods used for the process assessment include writing online reflection journals, peer evaluation, or e-portfolios (Barret, 2006). The assessment on the product aims at investigating the quality of the final outcome, such as solutions to the problem, or software programs developed. Usually, there are two forms of assessment: ICT-based and non-ICT based. The ICT-based assessment includes computer-based testing, multimedia program development, PowerPoint presentation, Weblog writing, or concept map construction. The non ICT-based assessment involves writing a paper-based essay or a reflection journal, or answering short questions on paper.

Reflections and Further Suggestions

A plan is never good until it is executed and proven right. In the planning process, very often teacher-designers are faced with many constraints and restrictions that limit their choices and strategies. After conducting the ICT-integrated lessons, the teacher-designers need to reflect upon their learning experiences of the ICT integration. The reflections can focus on the appropriateness of the technology used, strengths and weaknesses of the technology, and possible improvement. Additionally, the teacher-designers can also provide further suggestions on how other teachers can use the lessons for different target students in different contexts. These suggestions may include alternative technology, instructional methods and activities, assessment approaches, and ways to improve the integration of ICT. Below are some points to help a teacher-designer reflect upon an integration plan:
- Are the major questions involved in the topic answered?
- Are the activities planned towards achieving the learning objectives?
- Does the technology support the instructional process?
- Is the rationale for using the technology sound?
- Can the implementation process be further improved?
- Are the methods for student assessment valid?
- How can we further improve the use of ICT in the topic?

A Sample ICT Integration Plan

Based on this systematical planning model, a sample of an ICT integration plan is designed as shown in the Appendix. This topic is about energy in the subject of science for the "secondary two" students in Singapore. It is to be completed over two double periods and one online session. Each double period lasts for seventy minutes, and the online session takes about three days.

The main purpose of studying the topic is to make the students realize the current energy situation in Singapore and propose a solution for preventing any possible energy crises in the future. It employs five ICT tools: Internet browser, PowerPoint, Mind Manager, Discussion Forum, and Email system. The reasons for choosing these tools are

explained in the rationale section. For instance, the Internet browser allows students to search for and locate the most current information on the Internet; Mind Manager is used to organize and present information.

The learning process is as follows: The students carry out two tasks in the first double-period lesson. The first task is to browse the given website, discuss it in groups, and create a concept map using Mind Manager. The second task is to search for information about possible energy crises for Singapore in 20 years and discuss it in the same group. After the first double-period lesson, an online session is organized, during which the students share their findings regarding both the current energy situation and future energy crises. In addition to participating in the online discussions, the students within a group can also make further clarifications through emailing. In the second double-period session, the students have a face-to-face debriefing on the online discussions, and this is followed by an activity of preparing a presentation on their energy crises prevention solution. Each group gives a presentation during the following week. The detailed description of the ICT-integration plan is attached in the Appendix.

Conclusion

ICT integration is a comprehensive process of applying technology to the curriculum to improve teaching and learning. Its success depends not only on the availability of technology, but also heavily on the pedagogical design. Other factors such as leadership, professional development, time, and evaluation also have a great impact on the effectiveness of ICT integration (Honey, Culp, & Carrigg, 2000). The systematic planning model for ICT integration introduced in this paper is developed to facilitate teacher-designers' producing effective-ICT integration plans for topics in their teaching subjects, and provides rationales and strategies applied in the plans. We hope this paper will inspire some new thoughts into ICT integration for the curriculum of the new era.

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Appendix: A sample of an ICT Integration Plan

Subject: Science	**Student stream/level**: Express/S2
Topic: Energy	**Duration**: Two double periods of 70 minutes each and one online activity outside class hours
Problem Statement	The scarce energy resources we have in Singapore have posed a threat to our long-term survival. What can we do to prevent an energy crisis in the future?
Learning Objectives	At the end of this topic, students should be able to: 1. Visually describe the present energy situation in Singapore on a mind map. 2. State the potential energy crises in Singapore in 20 years. 3. Present in class, using PowerPoint, a solution to prevent energy crises in Singapore.
Technology Level	Intermediate
Technology Required	1. Internet browser for searching information 2. Mind Manager for organizing ideas 3. Presentation tool: PowerPoint 4. Collaboration tool: Blackboard discussion forum 5. Communication tools: Blackboard discussion forum and Email
Rationale for Using the Technology	▪ The most current information on local energy profiles can be found on the Internet. ▪ Ideas can be better organized and presented using Mind Manager. ▪ Collaboration can be done through discussion forums and email. ▪ Ideas and concepts can be more effectively illustrated by PowerPoint
Strategies for Implementation	**Lesson 1 (70 minutes): Knowing the Energy Sources in Singapore** The lesson starts by asking individual students to visit the website http://www.eia.doe.gov/emeu/cabs/singapor.html, where they will find current information that describes the energy situation together with information regarding the development undertaken by both private and governmental agencies to address energy issues in Singapore. Also, students are encouraged to search for other supporting information on the Internet about what will happen to our energy supply 20 years down the road. After searching for information, students are to share and discuss in groups of four their findings about the present energy conditions and any potential energy crises that can happen in 20 years' time. Following the discussion, each group creates a mind map on the present energy conditions by using Mind Manager. Students will discuss their findings on potential energy crises online. **Post Lesson 1 Activity (online): Online Discussions** After Lesson 1, students will take part in online discussions in Blackboard. Each group will post their findings on potential energy crises as a new thread and their mind map as an attachment. Members from other groups are to comment and make critical suggestions. The online discussions will last three days. The teacher will moderate the discussions and may clarify specific issues or problems that individual students have via email. **Lesson 2 (70 minutes): Presentation** In this lesson, students are to come up with a solution for preventing the energy crises from happening in 20 years' time. To connect the last lesson to this lesson, the teacher first gives a debriefing on the students' online discussions and gets the students to discuss their solutions among group members. The teacher will not supply any solution but provide scaffolding instead. The solution files will be showcased in the class "Home Site," which is a repository of students' past assignments. Students are to present their solutions in PowerPoint the following week.
Student Assessment	Students will be assessed on: 1. The mind map. 2. Content, the number of relevant connections, the quality of explanations of their argument, and any examples used to substantiate their ideas. 3. the online discussions

	4. The quantity of postings, clarification, creative thinking, and critical thinking. 5. The PowerPoint presentation. 6. The rationale, practicality, and effectiveness of their solutions.
Reflections and Further Suggestions	For classes which do not have a Home Site, the plan may be modified to allow submission of PowerPoint presentation via soft copy. The teacher may then showcase works that are of exemplary nature in future classroom discussion.