Does technology hinder or enhance learning and teaching?

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Abstract

In higher education, many lecturers are facing the challenges of reaching excellence in both research and teaching. While some of them might admit that technology would be most useful if it could maximise their time for research and minimise their time for teaching, many are concerned with the quality of the outcomes of learning and teaching when technology is applied. This paper shows that the yardsticks for evaluating the effectiveness of technology in learning and teaching can be different and individualistic depending on our interpretation of the purpose of technology and our perspectives on learning and teaching. Different learning perspectives affect how technology can be applied and therefore lead to different outcomes. However, technology is a doubled-edged sword: when it is misused or abused, opportunities can turn into dilemmas. This paper includes examples of such opportunities and dilemmas in the areas of learning environment, content development, information access, task automation, and communication. Trends and commonalities are found, suggesting that we are going through paradigm shifts of user readiness in response to the changing technology and evolving perspectives on learning and teaching.

Keywords

Instructional technology, learning, teaching, effectiveness, opportunities and dilemmas.

Introduction

The question is no longer whether organizations will implement online learning, but whether they will do it well. (Rosenberg 2001:xviii)

In today’s higher education context, where there are increasing demands on lecturers for quality and accountability in both their research and their teaching, Rosenberg’s (2001) sentiment is shared by many of the lecturers at the Hong Kong University of Science and Technology (HKUST).

They feel that using technology in learning and teaching is not predominantly a debatable issue of ‘Should we do it?’, but rather an issue of ‘How well are we doing? How effective are the results?’. In other words, they need to identify in advance what the possible outcomes of technology are that may hinder or enhance learning and teaching in order to justify their efforts. As I am a practitioner of instructional design and instructional technology, supporting lecturers’ online instructional projects, their concerns become mine.

In this paper I aim to explore and discuss the following areas:
• ways to set premises to evaluate the effectiveness of technology in learning and teaching;
• opportunities and dilemmas as a result of using technology in learning and teaching;
• trends and commonalities that might affect results.

I also suggest some guidelines on how to maximise the opportunities and minimise the dilemmas in practice.

**My praxis**

The goal of an instructional designer is to integrate theory and practice in the process of learning and teaching enhancement (Gagne et al. 1992; Seels & Richey 1994), and this is no exception for me. I adopt this approach (Figure 1) in the following spiral process: (1) react to solving problems with actions that come from prior experiences; (2) analyse and reflect on the results of the action; and (3) research support for, or answer to, hypotheses or questions that might have been raised in the previous step. The end of one cycle then takes me to the beginning of the next to confront more problem-solving situations to apply my cycle of approach. This paper is a result of this approach which integrates practice with theory.

![Figure 1: My praxis.](image)

**Setting premises**

In order to evaluate whether or not learning and teaching are enhanced or hindered as a result of using technology, one needs to identify what the yardsticks for evaluating such a process are. Here I will refer to some mainstream interpretations of the purpose of technology, as well as perspectives on how we learn most effectively.

**Interpretations of technology**

To the layman, information technology and instructional technology are similar, in the sense that the user and the task are driven by the tools. However, in the context of teaching technology, Naughton (1994:8) reminds us that:

> Technology is the application of scientific knowledge to practical tasks by examinations that involve people and machines.

He implies that technology does not run by itself, but rather involves and depends on how users apply it. Technology could be evaluated subsequently on its applicability and practicability in
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relationship to user needs. From the instructional designer’s perspective, the application areas are more comprehensive and this can be seen in Seels and Richey’s definition of instructional technology as “the theory and practice of design, development, utilisation, management and evaluation of processes and resources for learning” (Seels & Richey 1994:9).

Interpretations on learning and teaching

Our personal interpretations of how we learn or teach are influenced by our unique epistemological beliefs. As individuals, lecturers or learners, we bring with us different epistemological approaches that stem from our past unique learning experiences and educational value systems (Rossett 1987; Laurillard 1993; Negroponte 1995). Therefore, we can have different yardsticks, or perspectives, for what are considered to be effective learning and teaching.

The behavioural perspective

According to the behavioural perspective, learning is not self-initiated, rather reactive. Learners learn by responding to external stimuli and corrective feedback (Piaget 1950; Skinner 1968). The responsibility for teaching and achieving correct learning outcomes would mostly belong to teachers or programme designers. Typical examples of technology that could be applied to achieve these perspectives are:

• programmed sequenced incremental learning procedures;
• built-in tutor or agent in the programme to guide each step;
• automatic positive reinforcements for correct answers;
• repeated drills to overcome errors until corrected.

The cognitive perspective

According to the cognitive perspective, learning is natural and hierarchical, and learners come with a certain background of experience and a value system (Gagne 1985; Kemp et al. 1997). As a result, knowledge and skills can be stored and transferred from the short-term memory of surface learning to the long-term memory of deep learning which can be retrieved later for application purposes (Ausubel 2000). The responsibility for learning lies mainly with the students, and teaching activities should be designed according to their different needs. Typical applications of technology are:

• hypertext-based hierarchical learning frameworks;
• interactive learning activities that address and guide the different hierarchical learning events;
• multimedia simulation of knowledge application;
• interactive self-assessment with customised constructive feedback.

The constructivist perspective

From the constructivist perspective, learning is also natural and self-initiated, and takes place as new information is transformed into building blocks that become part of learners’ existing schemata when they identify the relevance of the new information. Learning is most meaningful when achieved in a social context, and if the outcomes help them to solve immediate work or social challenges (Piaget 1950; Bruner 1971; McBeath 1992; Ausubel 2000). The responsibilities for
learning and teaching can be reciprocal between learners and teachers. Some examples of technology being used to implement these perspectives are:

- flexible interactive learning frameworks to hold independent learning modules;
- virtual collaborative projects;
- multimedia case studies with multi-perspectives and real world problems;
- online video broadcasts or conferences for asynchronous and/or synchronous discussions or Q&A periods.

**Opportunities and dilemmas of technology in learning and teaching**

Different learning perspectives or theories shape how technology can be applied. Technology can be used as a tool to implement a goal rather than being the goal itself. If one aligns one’s perspective of learning with one’s teaching methods and learning outcomes (Mager 1975), then one will have a good chance of using technology effectively to bring about opportunities. However, from my experience, users of technology do not always consciously have a particular learning or teaching perspective in mind, and their learning objectives for the course can be vague. In addition, opportunities in technology can be missed, misused, or abused in practice, regardless of the perspective of learning and teaching one might have, and consequently opportunities can turn into dilemmas.

The following sections list some typical examples of both opportunities and dilemmas with technology use in the areas of learning environment, content development, information access, task automation, and communication.

**Learning environment**

Broadly speaking the main opportunity provided by technology is one of freedom of choice. There is freedom in terms of entry and exit points into a learning programme and freedom over the path that can be followed between these variable points. There is freedom over when and where to study and there is freedom of choice over the medium of the content (text, graphics, audio and video). However, freedom of choice also leads to corresponding decision-making dilemmas for the learner. Table 1 summarises the opportunities and dilemmas in the online environment from the perspective of Hong Kong learners.

**Table 1: Opportunities and dilemmas in the online learning environment.**

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Dilemmas</th>
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</thead>
<tbody>
<tr>
<td>Learners have the freedom of choice to decide their own time, place, pace, or path to study.</td>
<td>The educational experience of most Hong Kong students is that of being ‘spoon-fed’ content; therefore, they tend to learn passively rather than actively.</td>
</tr>
<tr>
<td>Learning materials could be designed with various entry and exit points that allow the learners to formulate their own learning strategies.</td>
<td>Learners who are used to a teacher-centred environment can be weak in self-directing their study or formulating their own study strategy.</td>
</tr>
<tr>
<td>Learners can use the online materials as preview or/and review depending on their background and knowledge levels.</td>
<td>Learners visit the online materials or activities mostly only before examinations; therefore, they can find the learning experience overwhelming, unclear, and hard to digest.</td>
</tr>
</tbody>
</table>
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- Learners can enjoy the freedom to study at home and avoid early classes or commuting in heavy traffic.
- Some learners miss the physical congregation at a centralised place and the social need to elicit and validate learning experiences with peers.
- Multimedia learning materials provide learners with choices that can cater to their multiple intelligences and learning styles.
- When students are not clear about how to use the media to their advantage, they can end up having information overload and printing everything in attempts to cope with this.

These dilemmas remind us that providing greater choice to learners within a learning environment, with increased control of the learning processes and outcomes, does not guarantee that learners will take this up. We need to take into account their past learning experiences and their expectations of teachers, and of themselves as learners, in order for such dilemmas to be turned into opportunities.

**Content development**

In this area, the basic opportunity that technology engenders is one of the ease of content manipulation. This is encapsulated in the notion of ‘write once, reap many’ where content and tasks are broken down into learning objects that can be reused in multiple contexts or courses. Table 2 highlights some of the key opportunities and their corresponding dilemmas in terms of content.

<table>
<thead>
<tr>
<th>Opportunities</th>
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</thead>
<tbody>
<tr>
<td>Technology is becoming more open and versatile in overcoming the barriers of users’ different computing platforms.</td>
<td>Some users are not able to see and hear data that require special software or plug-ins.</td>
</tr>
<tr>
<td>When data are digital, content can be replicated easily.</td>
<td>Compatibility among different versions of Web browsers or operating systems, performance and availability of broadband delivery, etc. are still unstable.</td>
</tr>
<tr>
<td>Re-purposing a digital course could offer the following flexibilities:</td>
<td>If the target group of a specific course is changed and not the content, then the learning effectiveness will be lowered. The learning objectives and outcomes will probably not be aligned with the new user needs.</td>
</tr>
<tr>
<td>- Course enrolment is no longer bound by the physical limitations of lecture theatres.</td>
<td></td>
</tr>
<tr>
<td>- Off-campus students would benefit more from different geographies.</td>
<td></td>
</tr>
<tr>
<td>Offering a course online has significant cost-saving advantages as the enrolment base can be increased quickly.</td>
<td>One size does not usually fit all.</td>
</tr>
<tr>
<td>Lecturers who no longer have to meet their students regularly in the classroom could spend more time on their research.</td>
<td>Lecturers, who now become content providers, might find developing an online course that engages students requires more work than developing a face-to-face course.</td>
</tr>
</tbody>
</table>

Lecturers have to get used to the different roles such as developer in a team, e-tutor, e-facilitator, etc.
Monitoring online students does not require the same rank of teaching staff as lecturers and thus costs can be reduced.

Lecturers may perceive a potential for job cuts.

Lecturers do not realise their development efforts are not one-off but are ongoing.

Online communication of feedback to students is a key skill that needs careful development.

Whether an item is perceived as an opportunity or as a dilemma often depends on the perspective held by a particular stakeholder. For example, administrators, content providers, or developers, see a major gain in designing or re-purposing digital content as it can be used in different contexts.

**Information access**

The ease and speed of obtaining information on the Internet helps to empower users. However, as shown in Table 3, the same benefits might delude users into overlooking issues such as data validity, intellectual property rights, efficiency in locating relevant information, etc.

**Table 3: Opportunities and dilemmas regarding information access online.**

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Dilemmas</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Internet protocols allow individual hubs of computerised information and data to be connected and exchanged.</td>
<td>Exchanging information on the Internet could be unsafe through e.g. possible spread of computer viruses, unclear copyright, unhealthy content, etc.</td>
</tr>
<tr>
<td>The hypertext system and hyperlinks help users to explore information easily.</td>
<td>Hyperlinks in the course content that are designed with unclear objectives and destinations are likely to lead students into an endless journey in cyberspace.</td>
</tr>
<tr>
<td>Duplicating data such as printing, or digitally copying data on the Internet, could be reduced to just a couple of mouse clicks.</td>
<td>Information on the Internet is for the public to view, not necessarily to own and re-purpose.</td>
</tr>
<tr>
<td>The number of sites and topics of interest on the Internet are growing at a phenomenal rate. Students are able to find useful information for their fields easily.</td>
<td>The ease of copying on the Internet deludes users into ignoring copyright laws.</td>
</tr>
<tr>
<td>Many learners are not aware that data is not necessarily information, and information is not necessarily knowledge. The speed and ease of information access on the Internet could lead users to exercise less discrimination with respect to the quality and validity of their accessed data.</td>
<td></td>
</tr>
</tbody>
</table>

On the one hand, students need to learn about these issues, which digital information literacy has thrown into sharp relief, but at the same time it is time-consuming to locate relevant information intelligently. There needs to be a balance struck between access to pre-selected online information and student-selected online information. We can see from this table that although the Internet paves the way for access to information no longer constrained by location, time, or access mode (Negroponte 1995), experiences of instructional technologists remind us that:

The beauty of ‘anywhere, anytime, whenever you want’, too readily turns into ‘not now, maybe later, and often not at all’.  

(Rossett 2001: online)
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Task automation

As shown in Table 4, task automation brings self-reliance to lecturers and learners alike; however, if we are not careful, we can become slaves of the tools that originally were meant to empower us.

Being proficient in the use of a word processor does not guarantee that you’ll write the next best-seller. (Rosenberg 2001: xvii)

Table 4: Opportunities and dilemmas of task automation.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>• Users do not have to depend on a chain of division of labour by different people, and thus fewer mistakes might be made.</td>
<td>• This is only true if the users want to be in control and welcome extra work; otherwise, they might feel they are trapped in a chain of unfamiliar tasks, and thus more likely to make mistakes.</td>
</tr>
<tr>
<td>• Users are in total control of each task procedure, therefore they are in control of the time for delivery.</td>
<td>• Making changes digitally is so easy that users could become indecisive in making the final version.</td>
</tr>
</tbody>
</table>
| • Users could become professionals in certain tasks quickly with the help of advanced software.  
• Users are able to visualise their ideas on the computer more quickly. | • Sometimes, if users are not aware of their limited skills with the computer, their ideas could have been visualised differently if they had relied on professional help.  
• Novice users are easily deceived by professional grade software meant to empower professionals in the field. |

Communication

Communication on the Internet, or e-communication, enables learners to express themselves synchronously or asynchronously with their team mates or tutors, privately or publicly. The key opportunity here is that the technology allows the formation of groups which previously could not have formed because of either place or time constraints. Although the technology allows new groups to communicate with each other, it also creates unique communication problems for the people within such virtual groups. Table 5 sums up some of these opportunities and dilemmas.

Table 5: Opportunities and dilemmas in e-communication.

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Dilemmas</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Learners are able to compose their messages at their own pace and communicate to their audience selectively without pressure from their peers.</td>
<td>• Surprisingly, learners are not proactive in using e-communication. It appears that reticent students in class can also be reticent students online. If these learners are subject to peer pressure, then communicating on- or offline does not offer significant incentives.</td>
</tr>
<tr>
<td>• Learners are able to exchange ideas more personally and directly.</td>
<td>• The speed and ease of sending messages in discussion forums can also invite messages that are fragmented, irrelevant or irresponsible.</td>
</tr>
<tr>
<td>• Learners can communicate frequently and directly with their tutors.</td>
<td>• Some learners can become very dependent on their tutors, and expect a quick response regardless of the time of day or night.</td>
</tr>
</tbody>
</table>
Trends and commonalities

In order to be able to minimise these dilemmas and maximise the opportunities, the next step in my praxis is to observe and analyse these examples for underlying trends or commonalities.

Trends in user readiness with technology

Value systems, personal attitudes, routines of task operation, etc. cannot be changed easily unless either our work performance or survival are being challenged. Our value systems are deep rooted and affected by both intrinsic and extrinsic factors. New technology sometimes can inspire a user need, but actually most of the time it is the opposite (Rossett 1987; Richey 1992; Dirkx 1997; Harris 1997; Kempske 1998).

Technology compatibility

The interval between each new generation of technology will get shorter and shorter. This trend poses a constant threat to users who are not technologically savvy or motivated (Negroponte 1995; Rosenberg 2001).

The concepts of curriculum development and assessment

Curriculum design and assessment criteria have both become more learner-focused, and instructional design and usability become increasingly important issues (McBeath 1992; Seels & Richey 1994; Kemp et al. 1997; Rosenberg 2001).

The perspectives of learning and teaching in relation to needs of the workforce

Today our skill-based society has been transformed into a knowledge-based one, where human resources are valued for their ability to solve real-world problems. These skills are knowledge-driven and thus need to be sharpened continually, something both graduates and lecturers must not lose sight of (Laurillard 1993; Negroponte 1995; Kempske 1998; Rosenberg 2001).

Commonalities

After analysing the different trends, certain common factors emerge as follows:

1. User needs and user readiness will drive the means in technology.
2. Intrinsic factors will first determine the state of user readiness with technology.
3. Extrinsic factors will determine the duration and stability of user readiness with technology.
4. Learners are the centre of learning and teaching, and their role is becoming increasingly...
autonomous.
5. Learning is no longer limited to one subject, but rather it is becoming more comprehensive, integrated, and life-long.

Guidelines for enhancing learning and teaching with technology

In general, being aware of the above trends and commonalities will help us to gain a head start on our learning and teaching projects with technology. In addition, some guidelines discussed below will facilitate lecturers in maximising opportunities and minimising dilemmas during the analysis, design, implementation and evaluation process.

Envisaging the big picture

Before designing the details of the content, it is important to focus on macro issues that will help decide if the project is feasible, and whether collaboration with other team members is needed. The following procedures will help one see the big picture of the project.

1. Identify the stakeholders and their primary needs. These targeted groups might include the course tutor, the department, the teaching support team, etc.
2. Identify the major goals and requirements for the project such as time, scale, target audience, assessable learning outcomes, etc.
3. Identify quantitative as well as qualitative resources such as manpower, equipment, facilities, funding, and types of expertise.
4. Identify types of flexible and scalable support infrastructure that could react quickly to factors such as delivery platform upgrade, testing, modification and maintenance issues, etc.

After that, decide whether it is a do-it-yourself project, or a collaborative project; whether more financial resources are needed; whether the intended deadlines are realistic; and whether the project should be implemented at different levels and in different phases.

Adopting a development process

Next, adopt a development process or an instructional design model. Also, if collaboration in a team is needed, coming to an agreement on a particular type of process will also establish clear communication and expectations for all members from the beginning. A systematic development process usually consists of three major phases (Gagne 1987), each of which can be further broken down depending on the time and resources available (see the checklists below).

Plan

This phase is like preparing a blueprint of a dream house. The master plan will include major components of the general framework, stakeholders’ needs, definitions of the problems to be solved, project goals, sources of support and resources, and an estimated but realistic work schedule with room for handling contingencies.

Implementation

This phase resembles the design and building of a house according to the blueprint. The building process will include major tasks such as designing the detailed requirements for achieving the
goals and objectives, developing learning tasks and sequences, designing assessments for crucial learning points, utilising appropriate media to deliver the learning contents, and repeatedly testing the final implementation.

Evaluation

This phase is akin to having the building inspectors and tenants move in, and assessing whether the construction satisfies them externally as well as internally. The evaluation process consists of two stages: formative and summative evaluation. The former should be conducted while the content is developed and revised. The latter should be conducted when the product is finished and launched in the actual learning environment.

Formulating your personal learning and teaching checklists in advance

In developing an online course, one will need to accumulate content, determine instructional strategies for the content, and formulate the learner profile. All these take time and the following checklists could serve as a guide. They cover materials preparation, instructional activities design, learner proficiency requirements and assessment alignment.

1. Materials preparation checklist
   - The hierarchical course content structure should be expanded and enriched, both horizontally and vertically.
   - Content and learning tasks should be clear and explicit, especially if there is no body language or verbal delivery.
   - Data should be original and in digital format as far as possible.
   - Permission to publish ‘borrowed’ data should be obtained.
   - Various types of media should be used to form a database of multimedia elements.
   - The sources or credits of reference information should be recorded so that more advanced or curious learners can follow up on these. This is also good practice, to avoid infringing copyright.

2. Instructional activities design checklist
   - Two-way activities such as pre-test, post-test, random self-assessed quizzes, etc. should be designed to provoke inquiry and provide direct feedback throughout the course.
   - Examples, analogies, or stories for elaborating abstract or foreign concepts should be gathered to add relevance.
   - Incidental learning opportunities such as By the way, Did you know that, or Guess what stories or tasks should be designed to increase deep learning.
   - Real world What if? questions should be proposed to foster problem-solving skills in assignment or group discussion.
   - Different instructional activities such as opinion polling, short lectures, task-oriented discussion, short Q&A, etc. should be incorporated into the same session to engage students in learning.

3. Learner proficiency requirements checklist
   - The basic learning skills for the course should be identified.
   - The prerequisites for learners in the course should be set.
• The study habits of the learners should be identified or projected.
• A profile of the anticipated learners should be formulated, if possible.

4. Assessment alignment checklist

• The types of learning domains for the assessable activities and their relative weightings should be identified.
• The assessment types with the domains of learning should be matched.
• Different kinds of assessment should be incorporated into the course so that learners are assessed comprehensively.
• The assessment criteria should be aligned with the learning objectives and content design.

Summary

My journey to find out whether technology hinders or enhances learning and teaching has been both simple and complex. On the one hand, when setting premises for different interpretations of technology, learning, and teaching, I found we all have different yardsticks for evaluating learning and teaching which can shape not only how technology is applied, but also the resulting opportunities and outcomes. On the other hand, from the examples of opportunities and dilemmas, opportunities can turn into dilemmas if users are not aware of the double-edged sword of technology in learning and teaching. This paradoxical phenomenon of technology in learning and teaching seems to be related to common trends of user readiness versus the changes in technology that are affecting all of us. However, if we grasp the commonalities in these trends and apply them in practice, we can more accurately predict and engender a positive outcome in using technology.

As Gregory Felker of the School of Humanities and Social Science at HKUST, in a roundtable experience-sharing session with colleagues, on the topic of using technology in learning and teaching, commented,

If technology is the answer, then what is the question? ... One has to find out why can’t we do without technology before we can make technology add value to our teaching. ... Technology is neutral.

(IDEAS-OLT 2001)

In applying technology in learning and teaching, the 'how to do it' is just as important as the 'why do it'. However, without the why, there would be no purpose for the how, and thus evaluating whether the results hindered or enhanced learning and teaching would be difficult.
References


