Student-Created Multimedia:
One road to higher-level learning outcomes

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for
ERA-AARE Conference, Singapore, 27 November, 1996

Overview

The acquisition by students of higher-level thinking skills (for example, the levels of analysis, synthesis, and evaluation of Bloom's Taxonomy) has of late become an increasingly important goal for educators and policy-makers. An article from Singapore (Petir, 1994) presents the views of Dr Aline Wong, Minister of State for Health and Education, on some emerging educational issues facing Singapore, in particular related to the rapidly expanding information technology environment, and states that, "Besides content learning, the curriculum will be constantly reviewed to ensure that pupils have opportunities to build up their analytical and problem-solving skills." With the rapid growth of readily available information on almost any topic area (eg, through the Internet), learning content alone may not be sufficient to meet the future needs but instead students should be taught and exposed to techniques to help them to think critically and creatively. This trend is further emphasised by Mr Goh Chok Tong, the Prime Minister of Singapore, who in his 1996 address to the nation's teachers said "Besides imbuing in our young a deep and abiding sense of commitment to the nation and to one another, our schools must give them the knowledge, skills and ability to think creatively, in order to succeed in the competitive global economy." The idea -- being pursued in all parts of the world, not just in Singapore -- is to prepare students to more effectively compete in the increasingly unpredictable global and local marketplaces.

The focus of this paper

This paper presents a model influenced by constructivist approaches to learning, new developments in assessment, and recent advances in educational technology, and presents some techniques teachers may be able to adopt to meet the goal of promoting more complex thinking skills in their students. Specifically, this paper will suggest the use of student-created multimedia projects as one technique which teachers can adopt if they wish to promote higher-level learning outcomes.

Teachers, of course, currently use a number of traditional approaches to teaching higher-level learning outcomes. As part of the instructional processes which lead to these goals, students typically will complete an integrative summary project at the end of a curricular unit. One of the most common examples of one of these integrative projects is a "term paper." The intention of these projects is that students will be expected to synthesise their learning and produce a

project which demonstrates a higher-level of learning than could be shown in a typical paper-and-pencil test.

With the increasing popularisation of multimedia software, however, a new and different type of final integrative project is possible for students to produce: a multimedia presentation. With this type of project students are still expected to demonstrate that they have explored and synthesised a complex topic by communicating their findings to an audience. However, in a multimedia presentation, students are able to assemble a variety of images (both still and motion), sounds, as well as text as part of their "report." While it may be fun for students to be involved with this new technology, educationists would raise a number of concerns regarding this approach to teaching. For example, what learning paradigm will this approach support, what types of learning outcomes will it help to achieve, what pedagogical considerations should a teacher be concerned with when using this approach, and how should the effectiveness of this approach be assessed?

These types of complex learning outcomes (synthesis, evaluation, etc.) have also recently received increased attention from scholars and academics who study learning and teaching. In particular, educational theorists concerned with studying higher-level learning and thinking skills have been developing supportive literature in two interrelated domains: learning theory and assessment. It is hoped that in the near future there will be a closer connection between educational theory related to the acquisition of higher-level learning outcomes and the practice of teachers.

Constructivist Learning

Learning theories in the past have been looking at how learners perceive and receive information. For example, in the behaviourist approach, the external conditions of learning (reinforcement) is central to the learning process. In cognitivism, the theory is used to explain how a learner perceives information and processes information through short- and long-term memory. Recently, a new emphasis in certain theories of learning is to look at ways the learners actually construct new knowledge, not just receive it. This approach, called constructivism (Jonassen, 1996), is concerned with how learners build their knowledge, and how such constructions depend on the learner's previous knowledge structures. Their previous knowledge is acquired through various kinds of experiences they have had, how they have organised the experiences into knowledge structures and their beliefs when they encounter with real events of the world. The demands on the learner in a constructivist environment are different from the more conventional learning environment. In conventional instruction, learners follow a path laid out by the teacher and any conflicts between their own personal beliefs and to what they are taught are depressed. Perkins (1991) termed this situation as a "conflict buried" learning situation. On the other hand, in a constructivist learning situation, a student with a naive mental model may be challenged to

construct a better model or to adopt a more useful model presented by the teacher. This is termed as "conflict faced" situation. One major implication of the use of constructive tools is that the demands on the learner have shifted with a greater emphasis on thinking skills.
With so much of personal experience and interpretation involved when constructing new knowledge, the teacher cannot map his or her interpretations of knowledge onto to the learner for they do not share the same and common experiences (Jonassen, 1996). If this is true then what is the role of a teacher in constructivist learning? In the constructivist viewpoint, the teacher's role is changed from a content provider in a direct instructional model to one who provides support in an apprenticeship model. Based on the old teaching paradigm of apprenticeship (master-apprentice model), it is the job of a teacher to provide a certain kind of support and guidance such as an "experience framework" to allow the learners to build their own knowledge and experiences around it. An example of this is the cognitive apprenticeship model of Collins, Brown and Newman (1989). An example from this cognitive apprenticeship model is coaching, a technique where the teacher observes the student trying to undertake a task and questions the learner to guide him to work like an experienced performer. Scaffolding, another cognitive apprenticeship technique, requires the teacher to perform a task when the student is unable to do it yet. The teacher intervenes and performs the task for the student before he/she gives up the whole task. These strategies will help students to construct knowledge within an "experience framework."
In the arena of learning theory, constructivist approaches (e.g., Salomon & Gardner; 1986) are also suggested as ways of promoting student acquisition of higher-level objectives. Although varying in specifics depending on the author, the defining characteristic of these approaches is the notion that students are seen as responsible for actively building their own knowledge structures and mental models. This is placed in contrast to more traditional educational philosophies which may see the student as the somewhat passive recipient of instruction and knowledge issued by the teacher. Because many higher-order learning objectives aim that the students develop analytical frameworks or integrative knowledge structures, the constructivist approach is viewed by many as offering a useful paradigm for designing instruction to meet these objectives.
"Student-Created Multimedia" - A constructivist approach
Jonassen (1966) suggests that student-created multimedia projects could be one of the cognitive tools that could be used for engaging and enhancing thinking in learners. He used the term "Mindtools" to describe various computer software such as spreadsheet, database, expert system shells, concept-mapping programs, multimedia and hypermedia. These software programmes are only considered as Mindtools when they are used as cognitive tools by students in a learning situation. When students are actively involved in constructing a system using the software they are engaged in many thinking tasks. For

example, when students are creating a database of animals found in a jungle, students have to identify the characteristics of the animals, identify categories, define fields, establish relationships between the animals and organise the whole database. By so doing, students are actively creating their own new knowledge. This constructivist approach is different from a direct-instruction approach where students are given the already-created database and they use it to find some information. In a direct-instruction approach, there is no construction of new knowledge. Rather existing information is intended to be assimilated.

Similarly, multimedia could be used in two different formats. As an instructional tool where students learn some content through a multimedia computer-based learning package or as a constructivist tool when the students themselves create their own multimedia program or presentation. The first approach is the most commonly used in schools, as shown by the many examples of commercial computer-based learning packages.

As an example of the second approach, perhaps a student (or group of students) have been doing a research project on the topic of AIDS. For their final project, students might produce a 15 or 20 minute multimedia presentation which includes text and graphs, photo images, audio narration and interviews, and perhaps even video clips from the nightly news. Certainly other possibilities for project ingredients exist as well, limited only by the students imagination and resources, and the guidance skills of the teacher. These extended types of data allows students a rich and creative source of communicative tools from which to fashion their summary theses. It is with on second mode of learning that this paper is focused.

However, the creation of such a multimedia project is not simply the gathering of resources by students and assembling them into a package with one of the many types of presentation software which exist in the market. Students need to learn the value of planning before they sit down and start copying multimedia data forms into a presentation package. As with a traditional written report, students need to be aware of important process elements such as data gathering, data organisation, creating a draft (called a storyboard or prototype in the world of multimedia), specifying an audience, and so on. That these features be absolutely linked with the learning of how to use multimedia tools is critical for students to improve their thinking and communication skills overall. Drawing from various sources (Carver, Lehrer, Connell & Erickson, 1992; Jonassen, 1996; Marzano, Debra, Pickering & Brandt, 1988), an integrated model of types of thinking skills involved when students create multimedia is given in Table 1. The table summaries some of the major thinking skills required by students when they design a multimedia project. The creation of multimedia by students involved many tasks and roughly they are divided into five sets of tasks namely, designing, researching, organising, developing, and evaluating. In addition to that, there is another task

which relates to the management of the whole project. Throughout the project, students have to manage the resources and timelines so that the project could be completed on time. Multiple thinking skills are involved in each set of task. For example, when students are researching into the topic of interest, various thinking skills are involved. They need to classify information into various categories, evaluate its usefulness, consider the different points of view presented by the author, and at times verify the information gathered.

Table 1: Thinking skills in student-created multimedia

Learning outcomes: Assessment

Traditional assessment modes based on objective forms of examination are used mainly to measure the amount of knowledge learnt and retained. In assessment, too, there have been developments which attempt to allow for the measurement of how well these complex learning objectives have been attained by the student. When it comes to complex learning outcomes there is a need to shift from the paper and pencil mode to other means. For example, a technique such as portfolio assessment is seen by some as a more accurate indication of how well students perform over a range of types of learning outcomes, rather than to focus microscopically on the measurement of low-level outcomes in isolation from each other. Another form to assess higher-order learning outcomes is project work and in the present case, the construction of multimedia presentation.

If constructing multimedia presentations could be a form of assessment of higher-order learning, we then have to ask the question of how to assess the constructive process. A number of issues arise when assessing student-created multimedia. For example, should a teacher just focus on the final project only? What about other supplementary materials to accompany the project? Should the teacher look at the process involved in the creation of multimedia, and if yes, then what should he/she be looking at? Should the teacher examine and assess drafts of the proposed project? Should the teacher be concerned with storyboards? How much emphasis should be given on the physical attractiveness of the project? These are some questions which a teacher will have to address when using student-created multimedia as a form of higher order learning tool.

Jonassen (1992) gives some suggestions on how to assess learning outcomes when students are working in a constructive environment using Mindtools. The following set of guidelines is adapted from Jonassen (1992) to focus it more on student-created multimedia.

∑The assessment of the project should be negotiated between students and the teachers and preferably a contract between the students and the teachers.

∑Tasks assigned to students should be directly related to the world situation which require them to integrate materials from across curriculum and of different complexities.

∑Tasks are broad-based with many different opinions or stands, and different groups of students could research into the various positions in which they believe.
∑The quality of the project should show a purposeful integration of media, content and context.

∑A well-designed project should have multi-modal and integrated representations of key points.
∑Students are required to construct new knowledge and not reproduce or copy/paste knowledge from external sources. The amount of synthesis by students will be an indication of the thought process that has gone into the project.
∑Teachers should develop a multi-mode assessment system at various stages of the project work. For example, teachers could assess development during the design phase, the depth of research done during the research phase, the integration of and production during the product development phase and finally looking at the presentation of the project. The final assessment is a consolidation of the various stages.

A pilot instructional module and the participating students

A pilot instructional module was developed which intended to explore some of the issues surrounding the constructivist paradigm presented in this paper. Approximately 80 teacher-trainees were involved in the module entitled "The Design of Computer-Based Instruction." They were from the cohort of students in the "Post-Graduate Diploma in Education (Primary & Secondary)" programme, meaning they all have previously received a baccalaureate degree and are completing a one-year course (two-year for Physical Education students) to prepare them specifically to become teachers. All students chose this module as an elective. Due to lab constraints, the group of students was split into four sections, two for primary and two for secondary school teachers. The module took place over six weeks, with instruction occurring in two two-hour blocks each week. Thus, each student received 24 contact hours. In practice, the time students spent at the computer far exceeded the allotted classroom time. Students were quite highly motivated and whenever there was space in the computer lab voluntarily spent many hours refining their projects.

Computer resources

All project work was completed on Apple Macintosh PowerMac computers. These types of computers were selected for this project work because of their ease of use, their relatively short learning curve, and their easy multimedia capabilities.

The software chosen was HyperStudio 3.0 (© Roger Wagner Software). Similarly, this software is very easy to learn, thus reducing learning time required to become competent creating multimedia presentations. Other more sophisticated software was considered (eg Authorware) but was rejected because of the necessity of spending more time learning to just operate the software. HyperStudio is also cross-platform (PC and Macintosh).

The instructional approach

The approach taken by instructors of this module was largely (but not wholly) constructivist. That is, students were given sets of problems and topics, and were expected to generate their own solutions. Specific issues were dealt with as they arose.

Certain types of information were communicated in a more traditional didactic manner. These topics included certain technical computing issues (eg, graphics formats, file conversion, network operating system), as well as some content associated with the design of computer-based instruction. Such didactic approaches were used primarily as a way to be efficient with the time allotted for the module. Given more time, the lecturers would extend the constructivist approach to these types of content as well, in the belief the resultant learning would be stronger and richer.

The goal of the module was absolutely NOT to make multimedia producers out of the teacher-trainees. The span of time given for completion of the module precluded that. Rather, the goal was that teacher-trainees would acquire the skills and strategies to implement student-created multimedia projects with THEIR students. That is, the ultimate goal is that the school students would be able to put their creative talents to use with these types of computer tools, and that our teacher-trainees would become facilitators of this process.

Module Outline

The module was laid out with the following specific objectives, weekly topics, and project specifications shown in Table 2.

Objectives:

Students will be able to do the following:

1. Describe the general process for designing CBI materials
2. Define some of the major components which make for effective instructional designs of CBI materials
3. Incorporate advanced features into an instructional project (e.g., multimedia, animation, scripting, customised buttons)
4. Create a project which can be used in a secondary school curriculum
5. Provide a rationale for the design of the CBI materials

Topics:

Week 1: Orientation; Introduction to Instructional Design; Introduction to HyperStudio
Week 2: Types of CBI; Storyboarding; Documentation; Interactivity in CBI
Week 3: Screen Design; Text & Graphics
Week 4: Using Internet; Student-created Multimedia
Week 5: Advanced Topics (e.g., scripting, customised buttons)
Week 6: Show and Tell

Project:

Students will work in pairs on a prototype project to be completed by

the last day of class. The topics will be your choice, but should belong
to a school curriculum area. The design of the project, the mode of instruction (tutorial, drill & practice, etc.), and the length are up to you,
but it is reasonable to shoot for something a student could complete in 15-30 minutes. Examples will be shown in class.

Additionally, each pair of students will produce a document which describes the rationale for the project and shows the instructional design
and storyboards. Included in each document is also a listing of tasks each student contributed to the project. Unless otherwise agreed to, students in a pair will receive the same marks.

Table 2: Outline of Instructional Module

Outcomes

At the conclusion of the module students presented their prototype project to the rest of the class. They turned in to the tutor their computer-based project plus an accompanying rationale report in which they clarified the particular processes they used during the planning and construction of their project.
Some sample screen captures of a few of the final projects are shown here:

How did it work?

Because of the pilot nature of this module, evaluations were conducted formatively and informally. In general, tutors felt that student did well on their projects given such a short period of time. They seemed to grasp the fundamental concepts and principles in the design of multimedia for instructional purposes, although the quality of this

knowledge varied somewhat.

Issues

Some specific issues are identified by the tutors as warranting further investigation, perhaps in a more formalised research environment:
∑Technical skills vs design skills. Which should come first? It became clear early into the progress of the module that there seems to be a sort of conflict about which skills should precede which other skills. Specifically, when we attempted to teach some of the necessary technical skills, there seemed to be missing the element of context, that is, prerequisite knowledge about the types of instructional problems which might need some specific computer-based solution. If students were not aware of these instructional design problems, we as faculty found it difficult to provide genuine situations where the technical solutions might be more appropriately applied.
However, the reverse order also presented its share of difficulties.

When we attempted to discuss the principles of instructional design as applied to computer-based instruction, there always seemed a need to reference some technical capabilities of the computer software at hand. Since all authoring softwares have their limitations, we found ourselves often addressing these shortcomings in the same breath as the conceptual design principles which related to those limitations. That is, we found ourselves saying things like, "Well, ideally a good instructional design should allow open responses by students to questions. However, the software we have does not permit extensive parsing of narrative text."

In general, the mutual roles and sequence of design and technical topics became a source of some confusion for the tutors as well as for the students. We still have not resolved the issue of which to teach first: design skills or technical skills.

∑Microviews vs Macroviews of the task. Due perhaps to the fact that students had a fairly limited mental model of the instructional design process, they tended to focus on rather small micro-problems during the development of their projects. That is, they would get focused on fairly trivial issues, spending inordinately long amounts of time trying to solve them. For example, students would go to great lengths to get "just the right" quality of digital picture from a scanner, taking valuable time away from other larger and more important design problems.

Tutors, on the other hand, were more interested in the larger design issues, and tried to dissuade students from focusing too narrowly on technical problems. The main concern for them was that students at least get the general boilerplates and larger instructional sections mapped out, and then fill in the details as time allowed.

The result was that students tended to lose site of the larger instructional design of their projects. Smaller, micro-level portions of their projects were usually carefully tended, but sometimes the larger, macro-level segments were neglected.

∑Assembling Information vs Synthesising Information. Related to the previous issue is the tendency some students had to see their project as merely the assemblage of various pieces of multimedia information. They saw the problem as one of collecting multimedia pieces (pictures, sound clips, etc.) and copying them into the designated slots in their designs.

Tutors, however, preferred to see students truly synthesising the information they collected into a more cohesive set of related ideas. This was intended to reflect a constructivist perspective, but somehow more attention needs to be given to instructional strategies to encourage this type of synthesis.

∑Assessment: Product vs Process; Unimodal vs multimodal. The final completed project was turned in to the tutors, together with a rationale document where the students justified the various instructional decisions they made during the previous six weeks. The software product was viewed only as a prototype, and was not judged as

a finished and polished piece of software might be. Tutors hoped the rationale statement would provide an accurate window into the thought processes of the students, and would allow an assessment of the level of sophistication of their instructional processes. However, this proved to be slightly more difficult than anticipated. Students statements of rationale were often naively stated and did not give a very clear indication of thought processes.

Also, the scheduling of the project and rationale statement at the very end of the course does not allow for the tracing of the students thought processes over time, a useful strategy for assessing thinking skills. That is, the lone marker at the end of the course (a unimodal assessment) might have been supplemented if there had been several points during the course of the instruction where tutors could chart the evolution of the students' thinking processes.

Of course, there is also the genuine and chronic concern about all assessments of thinking skills, that they are incredibly labor-intensive. The more journals, reports, portfolios, and other types of multi-modal assessment procedures are utilised, the greater the amount of time which needs to be spent by the tutor in scrutinising these data. This may be unresolvable, since it is hard to imagine assessing complex skills with anything short of a complex assessment mode.

Since the quality of assessment of thought processes is a central fixture underlying a constructivist teaching approach, it is clear that these issues need to be greatly clarified.

Where do we go from here?

As a result of completing the module, we are in a better position to put forth more formally structured research questions on the instructional issues which emerged. Specifically, it has become clear that the mental processes taking place in the students are those which reflect the student's transition from a "novice" instructional designer to an "advanced" designer. This "advanced" state is in turn a stage in the progression to an "expert" instructional designer.

We see the explication of this "novice" to "advanced" to "expert" as a central research issue. If we can understand how the learner's mental model is evolves as they move along the above progression, we might as instructors be in a position to facilitate that mental development.

A small but strong body of literature has surfaced in the last decade which views higher-level learning as a progression from a "novice" mental state to an "expert" state, and has attempted to describe that progression. Early papers by Lippert and colleagues (Lippert, 1988, 1989; Trollip & Lippert, 1987, 1988; Lippert & Finley, 1988;) provide suggestions for how students might acquire rich knowledge structures as a result of constructing their own knowledge databases, that is, of moving from a novice mentality about a subject toward something closer to an "expert." Others, too, have promoted the centrality of the "novice-expert" distinction in instructional models. They suggest many ways of promoting the development of "expert" skills (that is, moving away from "novice" behaviours) of teachers in general (Allen & Casbergue, 1995; Henry, 1994, Tan, et al., 1994) and instructional

designers in particular (Hong, 1992; Jones, et al., 1990; Perez, et al., 1995; Stepich, 1991; Taylor, 1994). Others have examined the approach specifically when related to instructional technology (Mitchell & Williams, 1993; Tucker & Dempsey, 1991).

In our setting, we see an opportunity to link these types of paradigms with that emerging from the constructivist school of thought. The idea of recasting paradigms entailing novice/expert distinctions in terms of a constructivist approach is fairly new, but seems to be a potentially rich source of practical and theoretical avenues toward the development of instruction for thinking skills and other higher-level learning outcomes.

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