Abstract

Research on the nature of blended learning and its characteristics has led to a range of approaches to the practice of blended learning. As such, this paper provides an alternative practice model, the TSOI Hybrid Learning Model to develop integrated blended learning in science education. The Piagetian Science learning cycle model and the Kolb’s experiential learning cycle model are used to shape the theoretical framework of this model.

This research evidence-based model represents learning as a cognitive process in a cycle of four phases: Translating, Sculpting, Operationalizing, and Integrating. A major attribute is to support active cognitive processing in the learner for engaged inductive to deductive learning and cater to the learner’s individual learning style.

An application to develop integrated blended learning in science education is illustrated with an authentic example on understanding multimedia learning design in a blended learning environment for pre-service teachers. The design of the blended learning experiences involving participatory learning as well as asynchronous virtual collaboration such as blog and wiki is integrated and guided by this learning model. Outcomes, feedback and implications will be discussed in the context of blended learning in education.

Introduction

Research on the nature of blended learning and its characteristics has led to a range of approaches to the practice of blended learning. For example, the Kolb’s experiential learning cycle model has been used quite commonly in designing instructional materials for e-learning to cater to the different learning styles. Even so, there seems to be an inadequate research of the application of the Kolb’s experiential learning cycle model as well as the other models for learning, for example the Jarvis’s model of reflection and learning to the development of instructional materials for not only e-learning but also blended learning (Lisewski & Joyce, 2003; Oliver, 2002). As such, having this in mind, the TSOI Hybrid Learning Model™ & © 2005 All rights reserved. (TSOI HLM) can be used as an alternative pedagogic practice model for both effective design and pedagogical practice of blended learning.

Theoretical Framework of TSOI Hybrid Learning Model (TSOI HLM)

The theoretical framework of the TSOI HLM is progressed from the Piagetian Science learning cycle model and the Kolb’s experiential learning cycle model. The term hybrid will mean the mixing of two different things to give a better product which in this case is a learning model that is pedagogically more innovative and comprehensive than each of the original model namely, the Science learning cycle model and the Kolb’s experiential learning cycle model. The Piagetian Science
learning cycle model being inquiry-based represents an inductive application of information processing models of teaching and learning (Karplus, 1977; Lawson, 1995; Renner & Marek, 1990). It has three phases in a cycle: exploration, concept invention, and concept application as shown in Figure 1. The exploration phase focuses on “What did you do?” while the concept invention phase places emphasis on “What did you find out?”. The concept application phase entails the application of the concept.

The exploration phase (gathering of data) is often accomplished during a science activity or an experiment. During this exploration phase, learners learn through their own actions and reactions in a new situation and have the opportunity to explore new learning materials and new ideas with minimal guidance from the teacher.

The concept invention phase gives the opportunity to the student and/or teacher to derive the concept from the data through classroom discussion. This phase involves the introduction of a new term or terms. Ideally, learners are encouraged to discover as much of a new pattern as possible before the term is revealed to them. The third phase, concept application allows the student to explore the relevance and application. In this last phase, the learners apply the new term(s) to additional problems. This concept application phase is essential as it allows learners to extend the range of applicability of the new concept.

The Kolb’s experiential learning cycle (Kolb, 1984) as shown in Figure 2 represents learning as a process in a cycle of four stages, namely, concrete experience, reflective observation, abstract conceptualization, and active experimentation. The concrete experience stage is about “doing” while the reflective observation stage concerns the “understanding the doing”. The abstract conceptualization stage focuses on the “understanding” part and the active experimentation stage is about “doing the understanding”. The core idea in the Kolb’s experiential learning cycle is that learning requires both a grasp or figurative representation of experiences and some transformation of that representation. This experiential learning cycle model has also been used as a framework for organizing interactive multimedia learning activities (His & Agogino, 1994; Tsoi & Goh, 1999; Van Aalst et al., 1995).

Kolb also created four quadrants in his model of experiential learning. He named each quadrant a learning style as diverger, converger, assimilator or accommodator (see Figure 2).
For convergers, experience is grasped through abstract comprehension and transformed through action, which combines abstract conceptualization and active experimentation. For divergers, experience is grasped as opposite of convergers, that is, concretely through feelings and transformed through thought, which combines concrete experience with reflective observation. For assimilators, experience is grasped through abstract comprehension and transformed through thought, which combines abstract conceptualization and reflective observation. For the accommodators, experience is grasped concretely through feelings and transformed by action, combining the features of concrete experience and active experimentation.

The TSOI Hybrid Learning Model™ & © 2005 All rights reserved., represents learning as a cognitive process in a cycle of four phases: Translating, Sculpting, Operationalizing, and Integrating (Tsoi, 2008a; 2008b; 2007; Tsoi et al., 2006; 2005) One major feature is to promote active cognitive processing in the learner for meaningful and engaged learning proceeding from inductive to deductive learning. Besides, it is inclined towards constructivism. Figure 3 shows the four phases of this learning model.

The Translating phase is similar to the exploration phase of Science learning cycle model and the concrete experience stage of Kolb’s experiential learning cycle model. This is where interactive experiences are translated to beginning ideas or concepts to be further engaged in the Sculpting phase. The Sculpting phase parallels the concept invention phase of Science learning cycle model and predominantly the reflective
observation stage of the Kolb’s experiential learning cycle including partially the abstract conceptualization stage of the Kolb’s experiential learning cycle. This is where the beginning idea or concept still in its raw form is further molded to a concrete form that is meaningful to the learner.

The Operationalizing phase similar to predominantly the abstract conceptualization stage of the Kolb’s experiential learning cycle involves increasing the understandings of the relationship between thinking and concept acquisition. The Integrating phase parallels the concept application of Science learning cycle model as well as the active experimentation stage of Kolb’s experiential learning cycle. This is where the concept is applied to new domains in which the transfer of learning is practiced.

**TSOI Hybrid Learning Model (TSOI HLM) as a Practice Model**

The Translating phase emphasizes concept initial exposure for preliminary experience. The instructional learning activity though general in nature, is designed to have an initial relationship to the principle underlying the concept which is to be further engaged in the second phase, the Sculpting phase.

The Sculpting phase emphasizes concept construction for its critical attributes. The concept still in its beginning or raw form as taken from the Translating phase is logically sculpted or shaped to a more concrete form by a series of appropriate and relevant instructional learning activities that are designed meaningfully to assist the learner to identify the critical attributes of the concept.

The Operationalizing phase emphasizes concept internalization for its meaningful functionality. A more scientific view of the concept is formed and internalized for meaningful functionality. This important phase is crucial as it serves as the vital bridge connecting the Sculpting phase and the Integrating phase for not only concept formation but also concept internalization in which all the critical attributes of the concept are linked together so as to prepare the learner to be operationally ready for further applications in the Integrating phase. During the fourth phase, the Integrating phase, the just learned concept is applied to new situations as well as is integrated in different contexts in order for meaningful learning to occur. The Integrating phase emphasizes concept application for meaningful transfer of knowledge.

**Design for integrated blended learning (Translating phase)**

An example on understanding multimedia learning design in an e-learning environment for pre-service teachers of the PGDE (S) course (Postgraduate in Diploma in Education, Secondary) is used to illustrate the design of integrated blended learning using TSOI HLM as the practice model.

In the Translating phase, face to face interactions are carried out in 2 sessions of 2 hours each in the form of group discussion using cooperative learning strategies such as round table, number heads together and think and pair share. For example, responses to a question on “what do you understand by the term multimedia learning” are elicited and discussed. The idea is to give an opening experience to what does multimedia learning mean to them thereby having a beginning idea of this term. The next activity involves understanding of multimedia learning design principles (Mayer, 2001) followed by a focus on the fundamentals of TSOI HLM as the pedagogic model for design to prepare the trainee teachers for the Sculpting phase.

In chemistry education, stoichiometry, an abstract and difficult topic is used (Tsoi et al., 1998) to illustrate the understanding and applications of the hybrid learning
model. One of the subtopics used is molar volume and molar mass. This next section will provide insights on the design application of the TSOI HLM in multimedia learning.

**Design for integrated blended learning (Sculpting phase)**

There are 2 components to accomplish for e-learning namely, the molar volume and molar mass multimedia learning module, and use of blogs. The molar volume and molar mass multimedia learning module involves the learning of the following concepts namely Avogadro’s law; molar volume; and molar mass. A quantitative relationship between the mole and the volume of gas at room temperature and pressure is to be acquired. The module consists of four instructional learning episodes in accordance to the four phases of the TSOI HLM. These four instructional learning episodes are (a) Investigating gaseous reactions, (b) Relationship between mole and volume of gas, (c) Stoichiometry calculations, and (d) Gas stoichiometry problems.

The translating phase is illustrated to show part of the TSOI HLM since the focus is not on designing the multimedia learning module. Three activities in the Translating phase “Investigating Gaseous Reactions” are designed in accordance to the pedagogical design principles of the Translating phase of the TSOI HLM to explore the relationship between equal volumes of all gases and the number of particles. The multimedia experiences are translated into a beginning idea or concept of equal volumes of all gases containing the same number of particles which is considered basic and essential to understand molar volume in the second phase, the Sculpting phase. This takes place as a chain of logical events of content sequencing, learner guiding and reflecting in which active learning processes are involved as well. Findings from relevant research studies on the teaching and learning of stoichiometry (BouJaoude & Barakat, 2000; Dori & Hameiri, 2003; Sanger, 2005) are also taken into consideration in the design of the activities. Part of screenshot for designing multimedia learning that is meaningful and engaging is illustrated (see Fig 4).

During the first activity, the learner is given a general chemical equation for placing the correct number of flasks of equal size for the general chemical reaction of the ratio 1:1:1 in terms of one reactant reacting with another one reactant to give one product. This is then progressed to a second activity involving another general chemical reaction also of the ratio 1:1:1 in terms of one reactant reacting with another one reactant to give one product. However, this general chemical reaction is represented at the particle level. The question “What have you observed in terms of volume and number of particles?” is posed. The rationale is engaging the learner to use one’s observation skills and process the information cognitively with the aim of looking for a pattern relating the volume of the flasks of equal sizes and the number of particles in the flasks. This is further engaged into the third activity that involves another general chemical reaction of the ratio 2:1:1 in terms of two reactants reacting with one reactant to produce one product. Essential question for example “How are your observations for this reaction like the observations you made previously? is posed. The purpose is to elicit cognitive observational responses as a result of using thinking skills of abstracting and comparing by the learner. The response will be “I have observed that equal volumes of all gases contain the same number of particles”. The learner needs to grasp and master this essential relationship for understanding molar volume.

In essence, knowledge is built throughout the instructional learning activity on these two general chemical reactions involving gases only that progresses from a simple type, A + B \(\rightarrow\) C to a complex type, 2E + G \(\rightarrow\) D. This is designed for the learner to experience the multimedia learning activities and formulate cognitively that equal
volumes of all gases contain the same number of particles and that the stoichiometry
of a chemical reaction is not addictive in nature.

This beginning idea or concept of equal volumes of all gases containing the same
number of particles as Avogadro’s hypothesis experienced in the Translating phase
will be built upon in the second phase, Sculpting phase of the TSOI HLM, to expand
to a relationship between the mole and the volume of gas.

Figure 4 Molar Volume and Molar Mass Multimedia Learning Module (Translating
phase)
<table>
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<tr>
<th>TSOI hybrid learning model phase:</th>
<th>Section:</th>
<th>Reasons for classification:</th>
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| Translating                      | 6.1 & 6.2| · Exploration phase of the learning process.  
|                                  |          | · Interactive animations.  
|                                  |          | · Start off with concepts familiar to the learner.  |
| Sculpting                        | 6.3 (section 1) & 6.3a-e | · Guided multimedia present.  
|                                  |          | · Learner is exposed to a logical sequence of content and reflection.  
|                                  |          | o Learner needs to type in his own explanation based on what he learned earlier in section 6.3a. Although learner needs to input values, the problems posed are still guided as students need to answer one part before being prompted to answer another part.  |
| Operationalizing                 | 6.3f onwards | · Cognitive processes are involved as the learner moves towards more manipulative and abstract concepts.  
|                                  |          | · Questions involve multiple subtopics, which help the linking of critical attributes of concepts  
|                                  |          | · More in-depth analysis.  
|                                  |          | · Prepares the learner for section 6.4 as students are made aware of the problem solving processes, which can be applied to the integration phase.  
|                                  |          | · The meaning functionality is emphasized as students explore simple applications which help them internalize the concepts learnt.  |
| Integrating                      | 6.4      | · Extension of learned concepts to new situations. The knowledge is transferred from a ‘lesson context’ to a more ‘real-life context’  |

Figure 5 A sample of Blog Tool

The individual will observe how the multimedia learning module is developed based on the TSOI HLM and reflect on it using a reference article. After that, the group will discuss their observations using the blog tool and give a summary. The understanding of the hybrid learning model is constructed here besides the meaning of multimedia learning design principles. A sample of blog is shown in Figure 5.

**Design for integrated blended learning (Operationalizing and Integrating phase)**

In the Operationalizing phase, the Wiki tool is used for internalization. The individual is asked to reflect and provide up to 6 points its implication on teaching and learning of chemistry as well as think & describe briefly of how you as a teacher can apply this hybrid learning model as a practice framework to guide you in your teaching of chemistry concepts. Figure 6 shows part of the wiki.
Reflect & provide up to 6 points on its implications on teaching and learning of chemistry:

- It provides an organised way of teaching chemistry, which will help students to learn in a systematic manner as well.

- Prior knowledge of students is taken into consideration so as to help link the new knowledge with the old one. This also allows the teacher to correct any misconceptions the students may have.

- Teachers can make use of familiar problems that can help students begin their learning during the Translating phase so as to ease their learning. Animations can be brought in to engage the students.

- The teacher can introduce real-world problems for students to solve, so that they can link the knowledge they obtained to real-world scenarios. This can help them see the relevance of what they are learning.

- Activities planned for students are less teacher-centred, providing learning environments which encourage “teach less, learn more” during chemistry lessons.

Think & describe briefly of how you as a teacher can apply this hybrid learning model as a practice framework to guide you in your teaching of chemistry concepts.

This hybrid model can help me to organise my lesson plan in a systematic manner:

- I will start from simple concept teaching, during which I will ask questions to help students reflect and recall their prior knowledge.

- Next, I will bring in animations of the concept, which can introduce the students to the concept at a slightly difficult level. This animation will also help engage the students and interest them to learn more about the concept.

- Intermediate learning can then be executed whereby students learn more about the concept and apply to simple problems.

- Next, I will move onto posing higher-order thinking questions whereby students can apply the knowledge learnt to questions which may be more relevant and real to them.

- Lastly, I will allow students to reflect upon what they have learnt to ensure that they have thought through and assimilated the new knowledge with the old one. Assessment can be done by them coming up with a concept map to link all their ideas, old and new, together, as well as link to other concepts, if possible.

Figure 6 A sample of Wiki Tool

In the Integrating phase, the group members collaborate to provide the design of the chemistry lesson based on the hybrid learning model. At the end of the collaborative process, the group members take turns to present their works to the class for comments in a mode of gallery walk.
Discussions

Though the design of the research is not that of an experimental approach, the outcomes of the learning and collaborative processes involved as reflected in the contents of the blogs and wikis have been positive and encouraging. Indeed, this sets the groundwork for studying this alternative way of approaching the practice of blended learning. The various instructional activities be it face to face interactions or e-learning are integrated and connected within the framework of this practice model. The Translating phase of the TSOI Hybrid Learning Model is an important phase as it presents the learner an initial exposure of the concept to be learned. In other words, the experiences facilitated are translated to a beginning concept by the learner.

In the Translating phase of the TSOI HLM, active learning processes for example comparing, inferring and abstracting engage the learner during the process of learning. As such, it is essential to first identify the critical attributes of the concept to be learnt so that varied activities can be designed to assist the learner to identify these critical attributes and eventually leading to acquisition of concept mastery. The instructional activities experienced by the learner in the Translating phase should be familiar to the learner so that one can make connections to one’s existing knowledge structures. Following the realization of the Translating phase, the learner’s preliminary experience is then given more meaning in the Sculpting phase.

During the second phase, the Sculpting phase of the TSOI HLM, the beginning concept experienced still in its raw form is logically shaped to a more concrete form by a series of appropriate and relevant instructional learning activities that are “crafted” meaningfully to assist the learner to identify the critical characteristics or attributes of the concept to be learned. These instructional learning activities are also designed to encourage the learner to be actively involved in the appropriate thinking processes, for example, comparing and identifying patterns abstracting, and observing, predicting that the learner needs to achieve to determine the critical characteristics or attributes of the concept. The Sculpting phase focuses on concept construction for its critical characteristics or attributes.

The Operationalizing phase is the vital bridge connecting the Sculpting phase and the Integrating phase particularly in the aspect of concept internalization. There is an important need for the concept that is already constructed to be internalized for meaningful functionality. The learner has to experience meaningful functionality in the concept formed before applying the concept learned. Promoting concrete symbolic operations, controlling abstract symbols, using logic, and performing quantitative or qualitative analysis are part of the learning processes involved in this phase. Besides, a meta-cognitive approach of the problem solving processes is also established. The Operationalizing phase emphasizes concept internalization for its meaningful functionality.

During the fourth phase, the Integrating phase, the newly acquired concept already internalized is then applied to new situations thereby building external connections with other prior concepts as well. The concept is also integrated in different contexts in order for meaningful learning to occur. The Integrating phase emphasizes concept application for meaningful transfer of knowledge.

In this process of integrated blended learning, the learner will build on the concrete experience, and will learn how to create knowledge and integrate the knowledge with existing ideas and concepts in other context and more importantly, to be an active learner engaged in the various learning processes. Indeed, the TSOI Hybrid Learning
Model has the functional capacity to furnish the educator alternative such as this practice model for designing blended learning in science education that can engage the learner for active and meaningful learning.

References


