Inquiry- Based Teaching of the Life Sciences to Normal Technical Stream and Gifted Students using Interactive Whiteboard

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Abstract: Science education has the primary purpose to promote inquiry in learners in this new age. The role of the teacher is thus shifted from that of a presenter of knowledge to one who creates opportunities for students to be engaged in the learning process, invites his students to explore further and facilitates their understanding of key ideas through the process of discovery and guided questioning --- he is the champion of inquiry in the classroom. This strategy is increasingly challenging when promoting Inquiry in students with seemingly low attention span, such as those in the Normal Technical) Stream. In this paper, we present a strategy to engage students in the Normal (Technical) stream in the learning of the life sciences through the use of a series of software applications coupled with the interactive whiteboard. We will report the pedagogical framework on which these teaching applications have been developed and our observations of an elevated interest in the topic at hand (engagement) and increased level of understanding as demonstrated by the activation of selected Habits of Mind (Costa and Kallick, 2000).

Introduction

The Amdon Group (Singapore) and its education partners developed and delivered a series of enrichment lessons in the field of the Life Sciences for a group of Normal (Technical) students in the school. It is generally perceived that students in this academic stream prefer a more hands-on approach to learning and are more inclined against a more academic treatment of learning.

From our experience, we discovered the following learning patterns in students of this cohort:

- Generally, they may find learning science to be rather challenging and often have difficulty coping with the amount of facts and information presented within the Normal Technical science syllabus.
- These students tend to favour an activity-based method of instruction and often displayed limited attention span, especially during double-period lessons that extend 70 minutes or more.
- While they are keen in participating during activity-based lessons incorporating experiments, role-playing and games, they tend to focus their attention on the activities pre se than on the underlying concept to be taught through these activities.
- These students may not be engaged by multimedia presented through video clips and CD-ROMs on scientific topics. There could be many reasons for this observation, one of which could be the manner in which these multimedia content is structured: a discussion of which is beyond the scope of this paper.

In this paper, we present a strategy to develop and implement an inquiry-based curriculum for the teaching of life sciences for students in the Normal (Technical) streams. We will also take the opportunity to share our findings in a parallel investigation involving students in the Gifted Education Programme.

Defining Inquiry

Science education has the primary purpose to promote inquiry in learners in this new age. Inquiry in learners involves the posing of a researchable question and may be broadly categorised into 4 levels in varying levels of sophistication according to the following essential features of inquiry (National Research Council 2000)

- Learner engages in scientifically oriented questions
- Learner gives priority to evidence in responding to questions
- Learner formulates explanations from evidence
- Learning connects explanations to scientific knowledge
- Learner communicates and justifies explanations

An Inquiry-based curriculum may thus be characterized by the following (Lam, 2005):

- The learner is **engaged** in the learning process and the information presented to him
- The learner **understands** the key ideas presented to him

Put simply, we define inquiry-based learning as **active** learning that involves our students throughout the learning period. For the purpose of this discussion, we have broadly listed in the table below the key features of activities that may promote the various levels of inquiry in learners.

<table>
<tr><td colspan="4">Key features of Pedagogical Activities (Eick, Meadows & Balkcom 2005)</td></tr>
<tr><td>Level 1</td><td>Level 2</td><td>Level 3</td><td>Level 4</td></tr>
<tr><td>Data provided, students guided on how to analyse and make connections between evidence available and observed phenomenon</td><td>• Data provided, students NOT told how to analyse
• Predict-Observe-Explain (POE) based activities
• Simulation-based activities</td><td>• Lead-on from Level 2
• Begins with POE strategy then learners pose new explanations and test them
• Inherent feature of questioning one’s own assumptions and testing them further
• Simulation-based activities</td><td>• Student-initiated questions and methods to explore them
• Science-fair-based activities</td></tr>
<tr><td colspan="4">LESS --------------------------------- Amount of Learner Self-Direction ----------------------------------- MORE
MORE ---------------------- Amount of Direction from Teacher or MATERIAL -------------------------- LESS</td></tr>
</table>

As shown in the diagram above, the amount of learner self-direction is reciprocal to that of teacher-direction: with increasing levels of inquiry, the learner progressively takes charge of the learning process by initiating researchable questions, designing and implementing methods to answer them as part of the learning process.

To promote inquiry in the classroom, we believe that the modern educator needs to have in place teaching tools to support an inquiry-based pedagogy to engage his learners and to help them develop authentic and enduring understanding of concepts. These teaching tools go beyond merely posing complex problems to students and challenging them to solve them. In this paper, we present a series of content that is delicately framed in a manner that engages the learners and delivered through a medium that invites them to explore in a non-threatening fashion. The Amdon Group, working in collaboration with its education partners, carefully staged a series challenges to prompt the learners to explain, elaborate and evaluate certain scientific phenomena and in this way, promote understanding of important key ideas in science.

In this project, we applied a model proposed by Lam (2005) that integrates the 6 Facets of Understanding (McTighe & Wiggins, 1999) and the 16 Habits of Mind (Costa & Kallick, 2000) in a singular pedagogical framework. This method helps us shift the role of the teacher from that of a presenter of knowledge to one who creates opportunities for students to be engaged in the learning process, inviting our students to explore further and facilitating their understanding of key ideas through the process of discovery and guided questioning.

Framing Active Content For Teaching Purposes: Our Strategy

We believe that active content must go beyond sophisticated presentation of information to embody the following features:

- It should comprise of activities that the class can collectively participate and should focus the attention of the whole class on the location where information is presented.
- It should feature light-hearted and humorous moments that capture the attention of the learners and invite them to explore in a non-threatening fashion.
- It should pose manageable challenges to the learners and motivate them to take on these challenges.
- It should provide opportunities for learners to question assumptions and offer alternative predictions and hypotheses to a given problem.
- It should go further to allow learners to test their alternative hypotheses in a controlled fashion.
- It should be supported by a set of well-developed worksheets to reinforce the students' understanding of key ideas.
- Depending on the specific facet(s) of understanding that is required, the content should pose scenarios or questions that encourage the learners to display a specific thinking behaviour / Habit of Mind. In defining the type of questions or scenarios, we adopted a tagging model proposed by Lam (2005) that integrated the 6 facets of understanding to the habits of mind. Using this model, we worked backwards to tag each specific instructional objective to be achieved in the course of the lesson with the corresponding facet of understanding.

To achieve the desired outcome of an inquiry-based learning experience, we developed a series of teaching courseware for use on the interactive whiteboard for the teaching of life sciences, biology and chemistry (the i-board® Learning System & CoolScience! Courseware & Simulations). This method presents a highly interactive platform for students to be **directly involved in the learning process.**

During our field tests, we confirmed our hypothesis that the key driver for this benefit is not the hardware but the software that is purposefully-designed to promote classroom interaction with the content presented in a fun-filled and non-threatening fashion.

We also discovered that this method, when combined with a deliberate method of teaching, is highly effective in promoting up to Level 3 Inquiry in students.

Our Findings

We tested the effectiveness of this interactive suite on two groups of students:

a. A group of students in the Normal (Technical) stream for the teaching of life sciences
b. A group of students from the Gifted Education stream in a leading girls' school in Singapore

This method of instruction, coupled with the use of the i-board® learning system and an inquiry-based pedagogy that is designed around a single pedagogical framework, integrating the 6 Facets of Understanding and the 16 Habits of Mind (Lam 2005), was shown to produce very similar outcomes:

- Learners observed to be highly engaged throughout the lesson period. Seemingly low-attention span learners in the N(T) stream and selected students in the Gifted stream now find it fun to be able to make predictions, test their predictions and observe the results presented in a comical fashion. The use of the i-board® also focuses the attention of the class on what is being manipulated and not the person manipulating the variables of the 'experiment', thus effectively removing the stigma of embarrassment due to a wrong answer, thereby promoting greater level of involvement in a positive feedback. On some occasions, we also observed students deliberately making predictions on a scientific concept and applying them in the scenario presented by the software to bring about a highly comical outcome (such as choosing a series of activities to put a human being in an awkward situation when discussing homeostasis in biology).

- Promotes Levels Two and Three Inquiry (NRC 2000), with each round of analysis by the students. For example:

- Students were first invited to decide on specific characteristics of the skin cells in the human body and predict the consequences of their decisions before clicking the button to witness the result of their decisions (Level 2 Inquiry). A comical representation of such consequences engages the students and encourages them to suggest alternative hypotheses on the appropriate characteristics of skin cells. They are then invited to test these hypotheses by inputing them into the software and witnessing the consequences again (level 3 Inquiry)
- In each subsequent round, the class discuss in groups to predict the results of their peers' choices (Level 2 Inquiry).

On both occasions, we discovered that students became increasingly excited about the topic that is discussed and with increasing engagement, they tend to ask more questions with a framework, a context and a focus, thus demonstrating active learning in the classroom.

Our Conclusion

The underlying inquiry-based pedagogical approach is a very powerful tool in helping our students to become independent learners and it helps to develop a deeper and more meaningful understanding in them. While the interactive suite has been discovered to be highly effective in promoting inquiry-based learning in the classroom, we also discovered that constructing such lesson packages can be very time consuming and taxing on professional resources (such as animation and programming). As it involves multiple facets of expertise in the development of such resources, we conclude that it may be near impossible to structure similar lessons for all topics, even if it is a collective effort from multiple departments from the same school.

Thus we believe that with appropriate collaboration between the school and the private sector, we can implement the teaching of various topics in a more effective manner that will result in the type of positive learning experiences that we wish to see all our students exposed to.

References

National Research Council (NRC), 2000. *Inquiry and the national science education standards.* Washington, DC: National Academy Press

Eick, Meadows & Balkcom (2005) Breaking into Inquiry: Scaffolding supports beginning efforts to implement inquiry in the classroom. *The Science Teacher: 72(7): 49-53*

Eric Lam (2005) Inquiry-based Learning for Science: *A Practioner's Perspective, Conference paper presented in 'Rethinking Pedagogy & Practices Conference', National Institute of Education, Singapore, 2005*

Jay McTighe & Grant Wiggins: Understanding by Design (*Association for Supervision and Curriculum Development, 1999*)

Costa, A and Kallick, B (2000) *Habits of Mind: A Developmental Series.*