Pre-Class "Incentive Homework" Transforms Learning

Assessment of a Pilot Study
involving 1,742 students enrolled in twenty-two courses
at Ubon Ratchathani University, Thailand

Leslie Richards, Utith Inprasit, and Hathaikarn Wattanataweekul

Abstract

The number one challenge encountered by university instructors is "students don't come to class prepared". Class-time primarily consists of information transfer (instructor) and memorization (learner). But the majority of students lack memorization skills….

This paper puts forward the argument that the majority of students due poorly lecture-centred instruction due to the fact they have difficulty with rote learning. This is the main factor restricting their ability to advance beyond their university entrance GPA (Grade Point Average). The number one challenge university instructors face is "their students don't come to class prepared". We show that by simply including pre-class time "incentive homework" is inspiring students to begin to develop their own learning strategies, becoming motivated and confidence in their ability to learn. This leads to higher grades on their mid-teams and final exams.

We carried out a pilot study, at Ubon Ratchathani University, Thailand (UBU) involved twenty-two courses in the fields of Biology, Chemistry, Computer Science, Information Technology, Mathematics, Physics and Engineering. Total enrollment was 1,742 students with the largest class size comprising 249 students. Each week, seven days prior to class-time, student would engage in "incentive homework" where they would receive marks based on the amount of effort, they put forward in their homework solution, their feedback to their peers solution and their contribution to their team's solution. The marks for effort would replace participation marks and they would receive additional marks within the weekly challenge was treated as a mini assignment.

Outcome: not only changed their motivation to come to class, but they also came to class with heightened confidence in their ability to learn as they began developing their own learning strategies This culminated with higher grades on their mid-teams and final exams.

indicated that pre-class "Incentive homework" encourages students to initiate the development of their own learning tactics. This approach instills a sense of motivation and self-assurance in their ability to learn, which subsequently results in better grades on both mid-term and final exams. motivates students to begin developing their own learning strategies, become motivated and confident in their ability to learn, leading to higher grades on their mid-teams and final exams.

Give student the confidence to begin the process of developing their own learning strategy so that during class they begin to challenge their current understanding of new knowledge and develop a deeper understanding of new knowledge.

The course design process, **ThinkSmith**, with its innovative learning environment, challenges and motivates students to engage in their own learning through independent discovery and collaborative construction of meaning. This results in a higher level of student participation and improved learning outcome, enabling all students to reach beyond their perceived academic abilities in their early university years.

ThinkSmith Pilot Study, at Ubon Ratchathani University, Thailand (UBU) involved twenty-two courses in the fields of Biology, Chemistry, Computer Science, Information Technology, Mathematics, Physics and Engineering. Total enrollment was 1,742 students with the largest class size comprising 249 students. Course instructors initially participated in a ThinkSmith course design program in May 2008. Instructors completed the re-design of their courses by the end of October 2008.The Pilot Study ran in UBU's second semester (November 2008-March 2009). Results of the survey completed and submitted by 684 of the 1,742 students involved in a ThinkSmith pilot course indicated a marked improvement in their attitude towards their learning. The results of the survey completed and submitted by thirteen of the twenty-two instructors demonstrated a marked change in their teaching philosophies and increased confidence in their ability to contribute to their students' learning.

Achieving change in students' attitudes is the first step towards the improvement of learning; but the big question with the Pilot Study was: would ThinkSmith method improve students' exam grades? For ten of the twenty-two courses, we were able to compare final exams marks between ThinkSmith methods and previously offered Lecture-centred method. The results showed that for 741 students enrolled in courses using ThinkSmith method, their final exam average was 17.31% higher than the 515 students enrolled in the traditional lecture courses.

This paper will also describe the learning design process, method of delivery and assessment of ThinkSmith - method.

ThinkSmith

Assessment of a Pilot Study
involving 1,742 students enrolled in twenty-two courses,
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Introduction

Traditionally, students' university entrance GPA (Grade Point Average) reflects their learning outcome potential as university students. "The GPA (Grade Point Average) is a testament of what you [students who are applying to a university] are capable of" (Jeanette Leach, 2009). To verify the anticipated outcome of this statement, ideally, universities would need to monitor students' input and output GPA averages, to ensure that no discrepancies exist between the ability of the entrance students and the quality of the university's academic programs. The registrar of a leading Canadian university stated that, "Universities do not create and maintain data that would allow one to analyze students' entrance averages versus their graduation averages." Some universities do however; implement a 'predicted GPA', derived from students' entrance GPA that, although traditionally lower, ultimately equates to their graduation GPA. Therefore, we can only assume that maintaining a student's entrance GPA is the standard that most universities aim for, or are capable of, and no more.

Ubon Ratchathani University (UBU), located in the North-East area of Thailand, does not enjoy the same advantage as universities that are able to set a high GPA entrance requirement (B+ to A) to their programs. Universities with a high (GPA) entrance requirement are virtually assured that their students will have the ability to better succeed in mastering a university lecture-centred teaching and learning system and will graduate with the same (B+ to A) GPA as their entrance GPA. However, if "a college is an institution that exists to produce learning" (Barr and Tagg 1995), then one would expect the GPA of a student, upon graduation, to be higher than their entrance GPA. UBU maintains a database (by program) of all students' entrance and graduation GPA. The combined average for all programs over a four year period (2005-2008), shows no significant difference between students' entrance and graduation GPA (with a standard deviation of -0.0036 GPA on a four point scale).

At UBU, instructors have successfully navigated their lecture-centered education. Therefore, it may appear reasonable for these instructors to assume that if they were able to learn within the traditional lecture-centered method, their students should also be able to learn by this method as well. However, the entrance GPA of UBU students is considerably lower than that of their instructors' undergraduate university entrance GPA, therefore, unlike their instructors, the majority of UBU undergraduate students are not absorbing, remembering and recalling the large volume of information being transmitted to them via lectures. Subsequently, if learning does not happen, instructors tend to fault the lack of positive learning outcome on the students.

In an attempt to rectify poor learning outcome, UBU, as well as other universities internationally, will replicate lecture-centred instruction in a variety of media to provide students with additional

access to lecture content outside the classroom. Although this generates little or no change in actual learning outcome, it does support traditional teaching and learning methodology. Barr and Tagg (1995) point out that "An instructor is typically evaluated by her peers or dean on the basis of whether her lectures are organized, whether she covers the appropriate material, whether she shows interest in and understanding of her subject matter….They do not raise the issue of whether students are learning, let alone demand evidence of learning…Many institutions construe teaching almost entirely in terms of lecturing."

Over the years, instructors have viewed the problem of poor learning outcome as learning challenges. The 'T5' Model, Salter, Richards & Carey (2004) talks about instructional challenges: "Students do not prepare for class time; No time to cover topics in depth; No time for discussion in class; Difficulty providing feedback to individual students in large classes; Students do poorly on tests/assignments...". When we focus on instructional challenges rather than learning challenges it provides a totally different perspective on the root of the problems associated with students' learning. Learning problems no longer point to the learner but to the teaching and learning strategies, the primary strategy being the lecture. Continuing to lecture or replicate the lecture in various forms of media only masks the learning problem and interferes with a students' ability to advance beyond their university entrance GPA. By moving away from the lecture-centred method and all its inherent instructional challenges, to a process that allows students to develop their own learning strategies, students are more motivated and build confidence in their ability to learn.

UBU offers excellent academic programs with highly qualified instructors who are dedicated to the improvement of learning and the quality and abilities of the students who graduate from their programs. However, improving or matching the graduation GPA of universities that pre-select students based on their high entrance GPA appears to be impossible within the established teaching and learning strategies at UBU. Like other universities, UBU has held the position that the lecture-centred method is central to learning. If the lecture-centred method of teaching impedes the possibility of improving students' learning outcome, the challenge for UBU is to make a radical change in their teaching and learning methodology. "Contemporary learning theory is based upon the notion that learning is an active process of constructing knowledge rather than acquiring knowledge….rather than a process of knowledge transmission." Duffy & Cunningham (1996).

ThinkSmith

To begin exploring different teaching and learning strategies at UBU, a new course design method, ThinkSmith was introduced to their academic teaching and learning strategies. ThinkSmith method of course design is based on Carey's T5 model; developed as an approach to instructional design at the University of Waterloo, Canada. The model emphasizes "*Tasks* (learning tasks with deliverables and feedback), *Tools* (for students to produce the deliverables associated with the tasks), *Tutorials* (online support/feedback for the tasks integrated with the tasks), *Topics* (content resources to support the activities) and *Teamwork* (role definitions and online support for collaborative work)", (Salter, Richards & Carey, 2004).

Students taking responsibility for their own learning is central to ThinkSmith method which transfers the responsibility for students gaining knowledge and skills *from* the instructor *to* the student. ThinkSmith method incorporates tasks, tools, tutorials, topics and teamwork to achieve ongoing student engagement, ongoing constructive feedback and ongoing measurement of learning outcome. Supportive learning environments motivate students by engaging them in higher level applications where they are asked to apply, analyze, evaluate or create, relative to defined course learning outcomes. The additional foundational knowledge, required in order to master the primary application, is acquired by the student on a need-to-know basis, or introduced by the instructor through feedback.

UBU took the following steps in assessing the value of ThinkSmith:

- Established a Learning Design Centre to support the Deans, Program Directors, Program curriculum teams and Instructors, to explore methods of improving learning outcome;
- Conducted ThinkSmith awareness sessions for instructors and program curriculum teams to guide their understanding and implementation of the new course design process;
- Announced a Pilot Study for ThinkSmith course design method;
- Conducted orientation for instructors involved in the Pilot Study;
- Re-designed pilot courses from lecture-centred instruction to ThinkSmith method;
- Developed ThinkSmith, Designing for Learning plus Portfolio (Sophakan, 2008), an online course development, delivery, monitoring, learning, authenticating and portfolio tool designed specifically to support ThinkSmith method;
- Monitored and authenticated learning outcome of pilot courses;
- Assessed Pilot Study learning outcomes of ThinkSmith

ThingSmith Method

Learning Outcomes:
Each academic program needs to define measurable learning outcomes, describing what the student will achieve upon graduation from the program. These measurable learning outcomes form the foundation for the type of courses offered within each program. Based on the program learning outcomes, each course must have specific, relevant, measurable learning outcomes defining what the students will achieve upon successful completion of their course. Authenticating learning outcomes at the program level is derived from the success of student learning across courses related to each of the programs' learning outcomes. This generates evidence of the correctness of each of the programs' learning outcomes, and the quality of learning within the program. Within ThinkSmith, there are two forms of assessment of learning outcome:

- Formative assessment: Marking for effort towards correctness / weekly tasks / providing and receiving constructive feedback (see ThinkSmith learning environment, Stages 1-5);
- Summative assessment: Marking for correctness / mid-term and final exam.

Learning environments to guide mastery of learning outcomes:

At the core of ThinkSmith is an innovative 'learning environment' that challenges and motivates students to engage in learning that builds confidence and enables the students to independently and collaboratively construct meaning in their learning. This results in higher levels of student participation and learning outcome. To attain the required learning outcome, a series of weekly learning environments allow the students to build towards mastery of the learning outcomes required for the course.

Each weekly learning environment consists of:

- A challenging learning task for the students to engage in;
- Any specified criteria (specific foundational knowledge) or conditions required as part of the students' solution;
- Course materials (which contain, the general foundational knowledge);
- Individual effort;
- Collaboration with peers;
- Ongoing feedback;
- Assessment based on effort towards correctness;
- A one hour class-time with the course instructor (face-to-face or virtual).

During class-time, the instructor provides feedback regarding the week's learning environment and addresses specific problems to provide students with a deeper understanding. Prior to class-time, it is vital for students to have engaged with the problem within the learning environment. Without students' prior engagement in the problem, class-time feedback is not possible. As a result, class-time no longer constitutes a lecture; class-time becomes engaging, constructive and time well spent, for the students and the instructor.

A learning task is an activity that requires students to engage with course materials. "Learning tasks pose an open question; students respond by engaging with course material. The single most important factor shaping learning outcomes is the way in which students approach a learning task …" (Jackson & Anagnostopoulou, 2001).

An open question allows students to express their understanding when:

- They are engaged in applying, analyzing, evaluating or creating (meaningful challenges motivate students to engage in their learning).
- They are applying specified criteria (foundational knowledge) to their solution.

According to Bloom's Taxonomy (1956), "The traditional learning paradigm implies a fixed order; before a learner can advance to higher order thinking, like applying, analyzing, evaluating or creating; they first need a solid understanding of fundamentals or a solid foundational knowledge." In comparison to the traditional learning paradigm, with ThinkSmith method, foundational knowledge is specified by the instructor as part of the criteria or conditions required in order for students to master a task. The instructor designs weekly tasks that challenge the students in applying, analyzing, evaluating or creating. This introduces entry level students to higher order thinking at an early stage and helps them to maintain their understanding and memory of foundational knowledge. As students move into advanced courses, they are better prepared to move directly into advanced applications. As Brownstein (2001) indicates, "Learners should constantly be challenged with tasks that refer to skills and knowledge just beyond their

current level of mastery. This will capture their motivation and build on previous successes in order to enhance the confidence of the learner."

The primary components of a ThinkSmith course are:

- Learner Engagement (50% of course time): Students engaging in challenging activities towards mastering the required knowledge and skills (for which they are required to make an effort).
- Constructive Feedback (50% of course time): Students giving and receiving constructive feedback to each other and the instructor giving constructive feedback to students in class-time.
- Learner Collaboration with Peers (2/3 of all learning activity): "Collaboration is a process by which individuals negotiate and share meanings relevant to the problem-solving task at hand." (Roschelle &Teasley,1993).
- Resources: formal lectures are eliminated and replaced with resources (textbook, etc.) to assist the students in mastering challenging activities.

The most important responsibilities for the instructor are: to monitor students' progress towards mastering the required knowledge and skills and; to guide students towards understanding and correctness through constructive feedback, culminating in a weekly one-hour class-time (face-to-face or online). Class-time is an opportunity for the instructor to focus on guiding the quality of learning outcome rather than knowledge transmission. Class time for the students is an opportunity to engage in learning outcome discussions. Assignments are replaced with weekly tasks that represent 20-40% of the students' marks. Formative assessment, as opposed to summative assessment, is based on *'effort towards correctness'* and is carried out by the student's peers - not the instructor.

Several UBU instructors indicate that in order for students to learn, especially new information, the instructor needs to "give" this information to their students in the form of a lecture. According to Alan Guskin (1997), "students retain less than 20 percent of what they were taught one week after the lecture." When you include the percentage of students who are absent or have their own 'agenda' during a lecture, the actual value gained during a lecture is questionable. An instructor spends a considerable amount of time preparing and giving lectures designed to transmit knowledge to their students. Class-time should be a time for the instructor to: give feedback that reinforces understanding and; receive feedback from students regarding any miss-understandings. This cannot happen unless the learner has made an attempt to understand the course concepts by independently and collaboratively engaging in learning tasks prior to class-time with the instructor.

How ThinkSmith scaffolds a learning task:

Within each learning environment, there are five stages in which students, individually and collaboratively, engage in mastering a weekly learning task that is managed by ThinkSmith online tool. Throughout the five stages, students are challenged and motivated to engage in learning. The process builds confidence and enables students to independently discover and

collaboratively construct meaning. With students' participation in weekly learning activities, higher levels of learning outcome are achieved. Students provide and receive ongoing feedback; develop and improve their listening and communication skills and; with a higher understanding of the problem, the students can engage in class-time discussion for deeper understanding. Class size and the providing/receiving of ongoing constructive feedback is no longer a concern for instructor or students.

Stage 1
The student is given a task, an open-ended question, requiring her to state what she believe is the correct solution to the problem. Working independently, the student needs to make an effort to master the learning task.

Stage 2
After submission of her task, the student will receive three submissions from her peers (classmates). She will not only see the solutions of her peers, but she can also re-think the problem by comparing her own submitted solution to that of three peers. The students must: review the three submissions and provide constructive feedback to each of the three peers and; rate the effort each peer made to produce the solution (5-point scale).
Note*: The identity of the peers is not disclosed to students.*

Stage 3
In turn, the student receives anonymous feedback from three of her peers on the task she submitted. The student must: review each feedback provided and; rate the effort each peer made in giving her feedback (5-point scale).
Note*: The identity of the peers who gave the feedback is not disclosed to the student.*

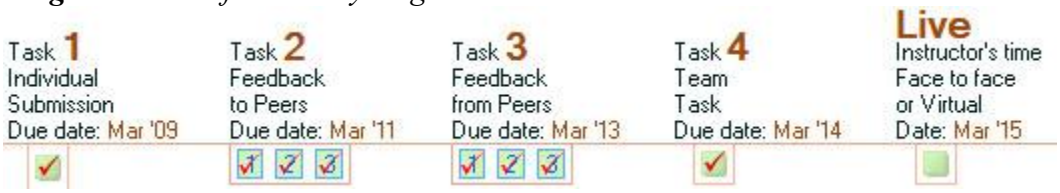
Stage 4
The student is then placed within a team of four and will know the identity of her team members. The team is assigned either the same task or one that is more challenging to work on collaboratively. Students must: engage with their team members to complete the team task and; rate the effort each team member contributed to the completion of the team task (5-point scale).
Note: *Although the identity of team members is known to students, they do not know how they were assessed by individual team members.*

Stage 5
The instructor and students engage in either face-to-face or online discussion of the week's learning task. The learning environment shifts the role of an instructor away from introducing new information to students in the form of a lecture to: guiding and responding to the students based on their independent and collaborative effort towards mastering a problem (stages 1-4). This instructor: reviews either all or some of the team submissions. The instructor then guides students through any misunderstandings/problems and discusses the challenges that individuals and teams encountered in preparing their tasks.

Typically, if an instructor lectures three hours per week, then two of these hours would be transferred to the students to work on Task 4 as a team, and the third hour would be for students'

class-time with the instructor. With ThinkSmith learning environment, an instructor is expected to spend three to four hours per week monitoring and one hour per week facilitating class-time for the duration of the course. The student is expected to spend three to six hours a week engaged in solving an application and one hour engaged with the instructor in class time. "The theory [that]…learners learn by becoming involved…seems to explain most of the empirical knowledge gained over the years about environmental influences on the learner's development." (Astin, 1985).

Diagram A: *The five weekly stages*



Formative Assessment:

Encouraging the students to make an effort for which they are subsequently provided feedback is the key to their mastery of learning. Within each learning environment, students are assessed by their peers on the effort they made towards mastering a particular competency. For each learning environment, the student will be assessed nine times. Two-thirds of the assessments are provided by peers who are anonymous to the student, and one-third provided by known team members. Peer assessment is based on effort towards correctness. This assessment by one's peers represents the student's learning outcome (effort=learning). Knowing their peers will be reviewing and providing assessment motivates and stimulates students to make their best effort. The criteria for peer assessment are defined by the instructor. "Experiences revealed that peer-assessment, as a formative assessment method and as a part of the learning process, can be valuable because students are more involved both in learning and in the assessment process and because they find it fair and accurate." (Sluijsman, Docky and Moerkerke, 1996).

Disadvantages of peer assessment, such as friendship marking and decibel marking, are resolved by the online tool, ThinkSmith, which conceals the identity of the peer a student is assessing and flags any discrepancy for the instructor to review.

Monitoring and authenticating students' mastery of learning:

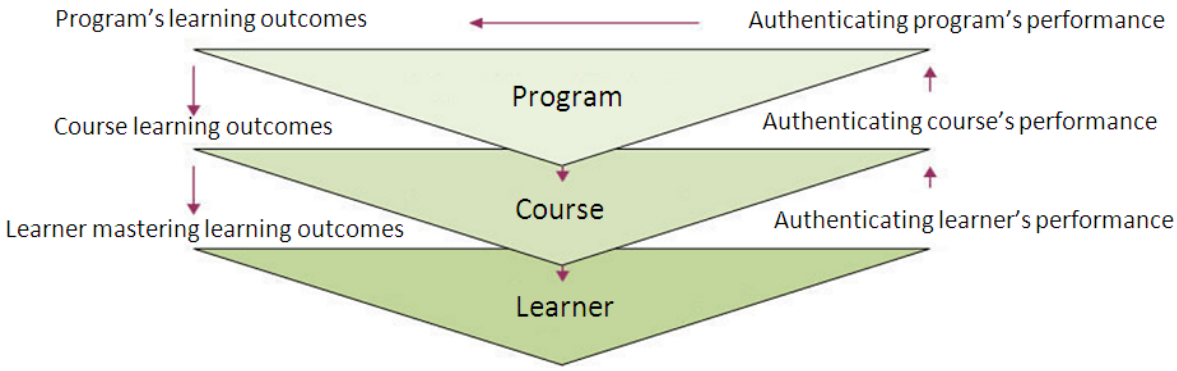
The students' mastery of the learning outcomes (for individual courses) and progress towards mastering their programs' learning outcomes are monitored and authenticated by ThinkSmith tool at three levels:

Program Directors'/Deans' Level
Define learning outcomes for graduating students and; monitor performance and quality of learning outcomes across programs and of individual courses within programs.

Instructors' Level
Define learning outcomes of students within their course; monitor performance and quality of learning outcome across their course and; monitor performance and quality of learning outcome of individual students within their course.

Students' Level
Monitor their performance within a specific course, comparing their performance with the established learning outcomes for that course and; monitor their performance within their program, comparing their performance with the established learning outcomes of their program.

Diagram B: *Flow of, monitoring and authenticating performance of program, course and student*



ThinkSmith Portfolio

The portfolio within ThinkSmith allows students to archive their authenticated, academic accomplishments. Authentication is no longer based entirely on marks alone as students need to be able to demonstrate their professional values and skills. To demonstrate mastery of their program, ThinkSmith portfolio is an invaluable resource when students are seeking to move into a professional program or career.

The UBU Pilot study: ThinkSmith

Phase I of ThinkSmith Pilot Study at UBU started in early 2008 with the re-design (using the ThinkSmith course design method) of a course in mathematics, Elementary Linear Algebra, that had previously been offered by the traditional lecture-centred method. When compared to the previous offering, ThinkSmith method showed an average increase of 8.86% in the midterms and

18.68% in the final exams. These results showed enough promise that the Pilot Study was expanded to twenty two courses (Phase II).

In Phase II, the majority of courses were within the Faculty of Science: Biology, Chemistry, Computer Science, Information Technology, Mathematics and Physics and; three courses were within the Faculty of Engineering. All twenty-two instructors attended ThinkSmith workshop in May, 2008 and completed the re-design of their courses by the end of October 2008. In November 2008, all twenty-two courses were offered with a combined enrollment of 1,742 students (largest class size was 249). At the end of term, March 2009, instructors and students were asked to complete a survey of ThinkSmith method.

Results of Student Survey

A summation of the survey completed by 684/1742 (39%) students indicated:

- 92.86% …Had a better appreciation for learning;
- 93.86% …Found the structure more rewarding then attending lectures;
- 92.86% …Took more responsibility for their own learning;
- 83.67% …Were more confident about their abilities to learn;
- 87.52% …Made better use of their time;
- 93.86% …Developed more critical thinking and problem-solving abilities;
- 89.29 %…Collaboration with other students proved stimulating and provided a rich learning experience;
- 89.39% …Were better prepared for writing exams;
- 89.29% …Developed better teamwork and communication skills;
- 96.43% …Found time spent with instructors was engaging and rewarding;
- 87.18% …Found course motivating.

Six of the twenty-two courses involved in the pilot were within with the Mathematics Department. Although UBU does not offer an undergraduate degree in mathematics, they have a strong Mathematics Department, servicing programs that have math as a requirement including Management Science, Engineering and Agriculture. Teaching mathematics to students where mathematics is outside their major can be extremely frustrating for instructors. Traditionally, the attitude of UBU students enrolled in mathematics service courses has impeded learning outcome.

A summation of the students enrolled in the six mathematics courses (161/413) showed a strong shift in students' attitude:

- 88.31% Had a better appreciation for learning;
- 85.16% Felt better prepared for class-time;
- 83.83 % Felt more confident about their abilities to learn;
- 91.14% Developed more critical thinking and problem-solving abilities;
- 86.17% Felt better prepared for writing exams;
- 96.34% Felt time spent with instructors was engaging and rewarding;
- 89.88% Found course motivating.

Results of Instructor Survey

A summation of the survey completed by thirteen out of twenty-two instructors indicated that:

- 100% Having the students engage in new information on their own and collaboratively, then using class-time for feedback, was more productive and better use of instructor and student time;
- 92.31% Assigning marks for effort towards correctness motivated students to engage in their own learning.
- 92.31% ThinkSmith method better prepared students for mid-terms and final exams.
- 84.61 % ThinkSmith method encouraged students to develop critical thinking and problem-solving abilities;
- 92.31% ThinkSmith method encouraged students to develop teamwork and communication skills;
- 76.93% Teaching was less stressful and more rewarding for instructor.

A summation of the survey completed by the ten Instructors who compared ThinkSmith method to previous offerings of their course (lecture-centred method) indicated that by using ThinkSmith method:

- 76.93% Overall learning outcome was better;
- 89.29% Overall attitude of this class was better;
- 89.29% Instructors felt better with their overall contribution;
- 76.93% Instructors were able to challenge students with more complex problems;
- 84.61% Students were more motivated;
- 92.31% Instructors did not have difficulty providing ongoing feedback to their students;
- 76.93% Instructors were able to spend less time on foundational knowledge and more time on deeper learning.

Learning Outcome

Initially, instructors questioned ThinkSmith method of providing marks for 'effort towards correctness'. It was viewed as giving away easy marks. Also, having students assess their class members was viewed as an opportunity for students to give high marks to their friends.

With ThinkSmith method:

- Before students see other students' work, they are required to make an effort on a task, on their own and submit their solution;
- 1/3 of the marks are available for the effort students make towards correctness in attempting the problem on their own. The peers who are assessing this effort do not know the identity of the student they are assessing. The average assessment given to students by their peers was 62.8%;

- 1/3 of marks are available for the effort students give in providing feedback to their peers. The student providing the feedback does not know the identity of the peers to whom she is giving feedback. The average assessment given to students by their peers on the effort they gave in providing them with feedback was 63.5%;
- 1/3 of marks are available for the effort students give working with their team members on their team task. The student providing the feedback knows the identity of her team members. The average assessment given by students to their team members was 67.5%. ***Note:*** *During the first two weeks, students' assessment of their team members averaged 91.85%, but starting in the 3rd week, students' assessment of their team members showed a noticeable change, ending up with an overall average of 67.5.4%. When comparing team members assessment and instructors' assessment, the difference is + or – 3.5% (after the 2nd week).*

The Pilot Study - Traditional Lecture-centred method versus ThinkSmith method:

Traditionally at UBU, the average entrance GPA of students would be reflected in their mid-term and final marks in the majority of their courses. A student entering UBU with a C- average will maintain that average throughout most of her courses and will graduate as a C- student. The big question was: would ThinkSmith method improve students' exam grades?

Ten of the twenty-two courses were previously offered with the traditional lecture-centred method prior to being offered, by the same instructors, with ThinkSmith method. This allowed comparison of the learning outcomes for both teaching methods and provided the answer to the big question.

Note: The percentages indicated comprise of mid-term and final exam grades only. They do not include marks attained by peers' formative assessment (ThinkSmith method).

Elementary Linear Algebra
Lecture-centred method: offered in 2006; enrollment of 45 students
ThinkSmith method: offered in 2008; enrollment of 47 students
With ThinkSmith method, there was an average increase of 8.86% in the mid-term and 18.68% in the final exam.

Calculus II: ***(two courses: Section 2 and Section 5)***
Lecture-centred method: offered in 2006 and 2007; average enrollment of 114 students
ThinkSmith method: offered *2008 (Sections 2 and 5)*; average enrollment of 108 students
With ThinkSmith method, there was an average increase of 13.14% in the mid-term and 17.21% in the final exam.

Calculus III: *(for students, who have previously failed Calculus III)*
Lecture-centred method: offered in 2008; enrollment of 24 students
ThinkSmith method: offered in Semester 2, 2008; enrollment of 20 students
With ThinkSmith method there was only one failure and four withdrawals compared with eight failures and three withdrawals with the traditional lecture method. In comparing both offerings of this course, the averages for the mid-terms were similar. However, with ThinkSmith method, the results for the final exam showed an increase of 27.62% over the Lecture-centred method.

Discrete Mathematics ***(two courses: Section 2 and Section 5)***
Lecture-centred method: offered 2006 and 2007, average enrollment of 43 students
ThinkSmith method: offered 2008; Section 2 (69 students) and Section 5 (69 students)
The Lecture-centred method showed an average deviation between the mid-term and final exam of + 6.1%. With ThinkSmith method, the mean of the final exam was 23.6% higher than the mid-term.

Computer Graphics and Design
Lecture-centred method: offered Semester 1, 2008, enrollment of 20 students
ThinkSmith method: offered semester 2, 2008; enrollment of 88 students
With ThinkSmith method, there was an average increase of 5.02% in the mid-term and 7.52% in the final exam. Plus, with ThinkSmith method, there was an increase of 16% in the number of students receiving a final grade of B or above, compared to the previous offering of the course.

Principle of Object-Oriented Programming II
Lecture-centred method: offered 2007, enrollment of 48 students
ThinkSmith method: offered 2008; enrollment of 70 students
With ThinkSmith method, there was an average increase of 2.13% in the mid-term and 6.47% in the final exam.

CNC-Computer Aided Design and Manufacturing
Lecture-centred method: offered Semester 2, 2007, enrollment of 78 students
ThinkSmith method: offered Semester 2, 2008; enrollment of 118 students
With ThinkSmith method, there was an average increase of 30.9% increase in the mid-term and 44.8% increase in the final exam. With ThinkSmith method there were 3 failures or withdrawals compared to the previous offering of the course with 10 failures or withdrawals.

Food Microbiology
Lecture method: offered 2004 to2006, average enrollment of 26 students
ThinkSmith method: offered 2007 and 2008; average enrollment of 44 students
This is the only course in the Pilot Study that showed no significant difference in learning outcome between the Lecture-centred teaching method and ThinkSmith method. However, the survey completed by students enrolled in ThinkSmith offering of the course showed an overall satisfaction rating of 93.5% compared with a 83.8% rating of satisfaction for the pervious offering.

Other courses in the Pilot Study

New courses:

Selected Topics in Manufacturing Engineering
ThinkSmith method: offered in 2008; enrollment of 17 students

Computer Programming
ThinkSmith method: offered in 2008; enrollment of 187 students

These two new courses, offered for the first time to Engineering students, showed strong results in both mid-term and final exams. The results of the students' survey showed strong support for ThinkSmith method of learning.

Split course with two different instructors:

Introduction to Biology II *(235 students):*
This course was taught by different instructors for each of the first and second-half of the course. For the first-half of the course, which was taught using ThinkSmith method, students gave an overall approval rating of 82.97% for this method of learning, with 92.6% indicating they found class-time engaging and motivating. The grade of the first-half mid-term exam was 7.9% higher than the second-half final exam. The instructor for the second half of the course did not implement ThinkSmith method.

New instructors:

Nine of the instructors involved in the Pilot Study were teaching for the first time. Therefore, we could not compare their courses to previous offerings. However, in all nine courses, the acceptance of ThinkSmith method by both the instructors and their students was exceptionally strong.

Summary of Outcome of Pilot Study

Change in attitudes
The students' survey results showed a substantial shift in their attitude towards learning and taking responsibility for their own learning. Without this change, we could not anticipate a change in students' learning outcome. The results of the survey completed by thirteen out of the twenty-two instructors showed a marked change in their teaching philosophies and increased confidence in their ability to contribute to their students' learning. Twelve of the thirteen instructors who completed the online survey indicated that, although ThinkSmith method initially required a lot of rethinking on the design and delivery methods of their course, they were looking forward to teaching with this method for the next offering of their course.
Of the students surveyed, 78.09% indicated that they would enroll in other courses taught by the

ThinkSmith method and 85.69% indicated that this method of learning was more rewarding than attending lectures.

Change in learning outcome

For 10 of the twenty-two courses involved in the Pilot Study, we were able to compare the final exam marks between ThinkSmith method of teaching and learning and these same courses when they were previously offered with the traditional lecture-centred method of teaching and learning. The results showed that for 741 students enrolled in courses using ThinkSmith method, their final exam average was 17.31% higher than the 515 students enrolled in the traditional lecture-centred courses.

Change in teaching and learning strategies

UBU is now expanding the application of ThinkSmith method to the following:

- A new program enabling 'advanced' high school students to enroll in UBU undergraduate courses
- A new master's program in science for teachers throughout Thailand
- A new master's program in Mathematics
- Working with the telecommunications sector of Thailand and building upon the results of ThinkSmith Pilot Study, UBU is in the initial planning and development stage of a new 'Mobile Learning Program'. This program merges on-campus students with students in remote areas (enrolled in the same courses), giving all students the flexibility to choose where, when, and how their learning occurs.
- UBU and STOU (Sukhothai Thammathirat Open University - the largest Open University in Thailand) signed a '*Memorandum of Understanding'*. Their shared focus is the implementation of ThinkSmith method for the improvement of learning outcome.
  Note: STOU has considerable experience with the implementation of ThinkSmith method for their distance courses, and are presently offering/developing Doctoral and Masters Degree programs and commencing application of ThinkSmith method to their undergraduate distance programs.

Conclusion

The Directorate for Education, within the Organization for Economic Co-operation and Development (OECD), is carrying out a feasibility study, Assessment of Higher Education Learning Outcomes (AHELO). The AHELO feasibility study explores four complementary strands referred to as 'The Four Strands'. Strand 4, 'The Value-Added Strand' states that "it is no surprise when an A+ student walks out the doors as an A+ graduate. But what about a B student who finishes with an A, his or her programs would have a higher added value than the programs at the top university."

UBU has the potential of offering programs that are academically more successful than similar programs offered at top universities that pre-select their students based on a high entrance GPA. It is possible to change C- GPA entrance students to C+ or B- or possibly a higher GPA upon students' graduation.

The Ubon Ratchathani University ThinkSmith project has encouraged instructors and university administrators to re-think their teaching strategies. The thinking that UBU students are lazy and unable to advance beyond their 'predicted' academic abilities is being questioned. For some instructors to appreciate the benefits of change, they need to experience it for themselves. Donald R. Woods of McMaster University, Canada stated: "In 1985, I cancelled lectures in a course and tried - with much trepidation – this form of PBL [problem-based learning]. Since then, my only question has been why I didn't do this sooner." An instructor who attended a T5/New Classroom workshop in 2000, at the University of Waterloo, Canada, made the following comment: "When I was first exposed to the T5model, I felt that I was being led along a path that was quite different from my initial goal. I was forced to examine my teaching at a very fundamental level, essentially dealing with the philosophy of teaching and the underlying principles of learning. This led to some initial irritation and resistance on my part as I felt my established classroom teaching methods (which until now had been moderately successful) were being threatened. After the first learning design session, I began to overcome my own resistance and initial aversion. I was able to look at the creative potential of adopting the T5 methodology to core engineering courses. I expect these insights to lead to better learning opportunities for my future students. Rob MacDonnell, Faculty of Engineering, University of Waterloo, Canada (2000). Instructors at UBU are beginning this process of re-thinking their teaching strategies in order to assist their students in developing their own learning strategies.

The 'Office of National Educational Standards and Quality Assessment' of Thailand stresses the need for universities to increase learning outcome and to implement a learning design strategy that emphasizes student-centred learning. Implementing a 'student-centred' approach to learning and/or introducing technology will have no effect in changing learning outcome if Thailand continues to cling to traditional lecture-centred education as the primary method of teaching and learning.

If, as Barr and Tagg (1995) suggest, "universities are about producing learning and not delivering instruction…", then UBU is heading in the right direction.

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