A Model of Evaluating Integrating Emerging Technology into Formal Technology Curriculum

LUNG-HSING KUO, HUEI-MEI WEI, LIN HSUEH-CHIH, MIAO-KUEI HO, HUNG-JEN YANG
National Kaohsiung Normal University
No.116, Heping 1st Rd., Lingya District, Kaohsiung City 80201
Taiwan (R.O.C.)
admi@nknucc.nknu.edu.tw, gracewei@nknucc.nknu.edu.tw, linsiaochih@yahoo.com.tw,
hmq0402@gmail.com, hjyang@nknucc.nknu.edu.tw

Abstract: - The purpose of this study was to recognize a formative evaluation model for integrating emerging technology into formal technology curriculum. For coping with new contents brought by fast advancing technology, education system should provide ways to integrating that new information of emerging technology into our curriculum for preparing students with up-to-date knowledge. There is a need to find out how to establish an evaluation system for effects of integrating emerging technology into formal curriculum. Several evaluation models were reviewed and compared. Upon the evaluation characteristics, a systematic approach was applied for designing evaluating standards for the context, input, process, and output. A model with fourteen stages was proposed and conducted for research purpose. The experience of creating evaluation system for high scope curriculum innovation was described for supporting the proposed model. The evaluation target was first identified based on the evaluation project, high scope curriculum development. Evaluating items of each category were also identified.

Key-Words: - High Scope Curriculum Development, Senior High, Emerging Technology, Evaluation System

1 Introduction
Technology education is a subject area of common education and provides learner the opportunity of understanding technology. New technology grows everyday and the information and knowledge of technology expands, too. Systems of technology in some areas are even exploded, such as energy & power technology and information & communication technology. In science education, how to integrating emerging technology into formal education becomes a concern. Education reform acts in Taiwan pointed out this trend and raised a “High Scope Curriculum Development” project to foster teachers to design teaching material and learning activities of emerging technology.

Evaluation is a mean for understanding how things going. Based on the evaluation goal, criteria should be identified before evaluation could be conducted. There is a need to create a system to pin point effects of integrating emerging technology into formal technology education, so can reveal the integral information and characteristics of curriculum innovation.

2 Problem Formulation
Evaluation is an integral part of instructional design. Formative evaluation, specifically, is a phase identified in many instructional design models and should be recognized as an important step for program improvement and acceptance. Although evaluation has many models and approaches, very few deal specifically with formative evaluation.

Further, no one set of guidelines has been found that provides a comprehensive set of procedures for planning and implementing an evaluation of integrating new content into formal curriculum.

2.1 Technology Education
Technology education is a subject of studying technology in which learners could learn about the context, process, and knowledge related to technology [1].

2.2 Formative Evaluation
Dick et al. [2] distinguish between formatively evaluating one’s own instructional materials and formatively evaluating externally selected materials. Many evaluation articles, strategies, and tools are
designed towards the end-user (instructor, teacher, etc.) to help to determine the effectiveness or appropriateness of a piece of instruction or instructional material once selected. “Although most evaluation theorists have said that their models are intended to influence and assist audiences, for the most part the nature and the role of these audiences has been given little or no special emphasis”[3] The author’s interest focused on the formative evaluation of instruction by the designer or developer within the context of the instructional design process. This study was helping designers and developers incorporate the step of formative evaluation of integrating immerging technology into formal into their design process for the purpose of improvement, not leaving it to the end-user to determine appropriate fit.

TenBrink [4] identifies three things that a model of the process of evaluation should do:
1. Clearly specify each step in the process of evaluation
2. Be applicable to all types of evaluation problems
3. Be easy to understand and easy to use

Tessmer [5] notes that all formative evaluations will follow these general steps:
1. Plan the evaluation
2. Introduce the evaluation to participants
3. Conduct the evaluation
4. Gather and organize data
5. Make data-based revisions
6. Evaluate revised version (if possible)

Most formative evaluations follow the same procedures. However, what was found when reviewing the literature to find the most comprehensive formative evaluation on which to base a tool was that no one model contained all steps that the author felt was necessary. Some steps might be considered optionally.

2.3 Evaluation
In this session, evaluation types, models, approaches are reviewed. Although the words “type”, “model”, and “approach” are quite of often used interchangeably, they are distinctly different aspects of evaluation.

2.3.1 Types
There are several basic types of evaluation: planning evaluation (discrepancy analysis), formative evaluation, summative evaluation, predictive evaluation, informal evaluation and formal evaluation.

A Planning Evaluation helps in determining a project’s goals, objectives, strategies, and timelines.

Formative evaluation is a systematic and empirical process. Formative evaluation is part of the instructional design process, and can be a “cost-saving measure to economically 'debug' instruction and increase client satisfaction. The formative evaluation process also gives the evaluator the opportunity to evaluate the evaluation instruments, as well as the instruction. Learners can pinpoint confusing questions and tasks, as well as point out problems on an attitude survey. The expert review is a phase conducted very early in the formative evaluation process, while the materials are in their roughest stages. There are several types of expert reviewers: subject-matter (content) expert reviewers; teacher, parent, or instructor expert reviewers; technical (production) expert reviewers; instructional design or learning specialist expert reviewers, and subject sophisticates. The purpose of the one-to-one evaluations is “to identify and remove the most obvious errors in the instruction, and to obtain initial performance indications and reactions to the content by learners” [2]. Small group evaluations answer use and implementation questions as well as effectiveness questions [5].

2.3.2 Models
Evaluation models either describe what evaluators do or prescribe what they should do. Generally, evaluators are concerned with determining the value or current status of objects or states of affairs.

The term ‘model’ is used in two general ways.
(a) A prescriptive model, the most common type, is a set of rules, prescriptions, prohibitions, and guiding frameworks which specify what a good or proper evaluation is and how evaluation should be carried out. Such models serve as samples.
(b) A descriptive model is a set of statements and generalizations which describes, predicts, or explains evaluation activities. Such models are designed to offer a practical theory.

The importance of studying evaluation models is shown in a number of ways.

Tyler’s Model outline the seven steps:
1. Establish broad goals or objectives
2. Classify the goals or objectives
3. Define objectives in behavioral terms
4. Find situations in which achievement of objectives could be shown
5. Develop or select measurement techniques
6. Collect performance data
7. Compare performance data with behaviorally stated objectives

“Evaluation was viewed as a cycle that involved not only clarifying and measuring objectives but adapting teaching methods and materials to make success more likely”[6]

The Metfessel and Michael Model identify the eight steps:
1. Involve the total school community as facilitators of program evaluation.
2. Formulate cohesive model of goals and specific objectives.
3. Translate specific objectives into a communicable form applicable to facilitating learning in the school environment.
4. Select or construct instruments to furnish measures allowing inferences about program effectiveness.
5. Carry out periodic observations using content-valid tests, scales, and other behavioral measures.
6. Analyze data using appropriate statistical methods.
7. Interpret the data using standards of desired levels of performance over all measures.
8. Develop recommendations for the further implementation, modification, and revision of broad goals and specific objectives.

This model was heavily influenced by the work of Tyler. Its major contribution was in expanding the possibilities regarding alternative instruments.

Hammond’s Model
Hammond [7] developed a three-dimensional cube that he called a “structure for evaluation”. The cube was designed to help the evaluator search for factors contributing to the success and failure of educational activities [8].

Alkin [3] identifies five areas of evaluation that attempt to provide information to satisfy unique decision categories:
1. Systems assessment (Similar to context evaluation in the CIPP Model).
2. Program planning
3. Program implementation
4. Program improvement (Similar to process evaluation in the CIPP Model).
5. Program certification (Similar to product evaluation in the CIPP Model).

Pace and Friedlander (1978, p. 7) organize Alkin’s Model this way:

<table>
<thead>
<tr>
<th>Decision Area</th>
<th>Type of Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem selection</td>
<td>Needs assessment</td>
</tr>
<tr>
<td>Program selection</td>
<td>Program planning</td>
</tr>
<tr>
<td>Program operationalization</td>
<td>Implementation evaluation</td>
</tr>
<tr>
<td>Program improvement</td>
<td>Progress evaluation</td>
</tr>
<tr>
<td>Program certification</td>
<td>Outcome evaluation</td>
</tr>
</tbody>
</table>

Stufflebeam’s CIPP Model
The CIPP Model (Context, Input, Process, and Product) can be used for both formative and summative evaluation[8]. Perhaps the most significant characteristic of CIPP is that it makes provision for holistic evaluation. Its elements are systems oriented, structured to accommodate universal evaluation needs. They also notes the rarity of an evaluation model that offers process evaluation, as this one does.

- **Context evaluation**, to serve planning decisions [8] – “is intended to describe the status or context or setting so as to identify the unmet needs, potential opportunities, problems, or program objectives that will be evaluated” [6].
- **Input evaluation**, to serve structuring decisions [8] – “the evaluator provides information to help the decision maker select procedures and resources for designing or choosing appropriate methods and materials” [6].
- **Process evaluation**, to serve implementing decisions [8] – “making sure that the program is going as intended, identifying defects or strengths in the procedures” [6].

The CIPP model deals with products or outcomes not only at the conclusion of the program but also at various points during the program. Outcomes are then related to objectives; differences are noted between expected and actual results; and the decision maker decides to continue, terminate, or modify the program.
Management Model of Evaluation

The Management Model of Evaluation [9] is cyclical in nature. One can enter the process at any point, although each stage builds on another. Harpel notes that the “iterative nature of the model is self-correcting”[9], because eventually all steps will be addressed.

Managers must take into account the resources available and whether or not those resources were used to their best advantage while also keeping in mind the goals of the parent institution or organization. Results of a management evaluation are primarily reviewed by external decision-makers rather than internal program staff.

Tessmer’s Formative Evaluation Planning Process

Tessmer [5] outlines 11 steps that are necessary when planning an evaluation. Although not graphical, the steps are prescriptive in nature and this model constitutes one of only a few formative evaluation models.

1. Determine the goals of the instruction
2. Determine the resources for and constraints upon the evaluation
3. Obtain a complete task analysis of the instruction
4. Describe the learning environment
5. Determine the media characteristics of the instruction
6. Outline the information sought from the evaluation
7. Choose parts of the instruction for evaluation
8. Select the stages and subjects for the evaluation
9. Select the data gathering methods and tools for each stage
10. Plan the report(s) of the evaluation
11. Implement the evaluation

2.3.3 Approaches

One of the few things these diverse approaches have in common is the idea that evaluation should determine the worth of the educational program. In the system evaluation approach, the program is compared with another. Three components are studied by the evaluator to find this information:

- Inputs (the incoming qualities of the students)
- Operations (the characteristics of the program or set of experiences that are intended to promote the students’ progress toward the desired aims)
- Outputs (the impact of the program on the participants’ attainments of its objectives)

3 Problem Solution

Based upon the evaluation characteristics of integrating emerging technology into formal curriculum, related literature were reviewed according to type, model and approach and organized as the proposed model.

3.1 Proposed evaluation model

The following is the proposed prescriptive formative evaluation model, using the systems approach. The model incorporates the steps identified by Tessmer as being general to all formative evaluations, and honors the three guidelines proposed by TenBrink for a good evaluation model. Many of these steps can also be found in other models. (The referenced models with similar steps have been listed below each step.) These 14 steps condense the formative evaluation process into one that is comprehensive and manageable.

Clarify product/program goals and objectives

Based upon reviewed literature: [Tyler Model (steps 1 and 2), Metfessel and Michael Model (step 2), Provas’ discrepancy Model (termed “standards”), Stake’s Cointenance Model (Step 1 – termed “program rationale”), Stufflebeam’s CIPP Model, Walker’s Evaluation Design Model (step 2), Tessmer’s Formative Evaluation Planning Process (step 1), Evaluation Overview (step 1)]

Define purpose of evaluation

a. Clarify evaluation type
b. Clarify evaluation goals and objectives

Based upon reviewed literature: [Walker’s Evaluation Design Model (step 1), Tips for Conducting an Evaluation (step...]}
1. Evaluation Overview (step 2), The Evaluation Process (step 1)

**Determine evaluation questions**
Based upon reviewed literature: [Walker’s Evaluation Design Model (under step 1), Tips for Conducting an Evaluation (step 1), Tessmer’s Formative Evaluation Planning Process (step 6), Evaluation Overview (step 3), The Evaluation Process (step 2)]

**Plan the evaluation**
- **a. Determine evaluator’s role(s)**
- **b. Identify evaluation design**
Based upon reviewed literature: [Walker’s Evaluation Design Model (step 6), Tips for Conducting an Evaluation (under step 2), Tessmer’s Formative Evaluation Planning Process (step 8), Evaluation Overview (step 5)]

**Select criteria, indicators, and data sources**
Based upon reviewed literature: [Tyler Model (steps 4 and 5), Stake’s Countenance Model (step 4), Walker’s Evaluation Design Model (steps 4 and 5), Tips for Conducting an Evaluation (under step 2), Tessmer’s Formative Evaluation Planning Process (step 9), Evaluation Overview (step 4), The Evaluation Process (steps 3 and 4)]

**Develop instruments**
Based upon reviewed literature: [Tyler Model (step 5), Metfessel and Michael Model (step 4), Tessmer’s Formative Evaluation Planning Process (step 9), The Evaluation Process (step 5)]

**Submit evaluation proposal**
- c. Determine time schedule
- d. Determine budget
- e. Submit evaluation plan, time schedule, budget, and instruments for feedback

**Make revisions to the evaluation proposal**
(optionally)

**Schedule appointments for evaluation**

**Conduct evaluation**
- f. Revise evaluation instruments (optionally)
Based upon reviewed literature: [Tyler Model (step 6), Metfessel and Michael Model (step 5), Stake’s Countenance Model (step 3), Walker’s Evaluation Design Model (step 7), Tips for Conducting an Evaluation (step 3), Tessmer’s Formative Evaluation Planning Process (step 11), Evaluation Overview (step 6), The Evaluation Process (step 6)]

**Organize and analyze results**
Based upon reviewed literature: [Tyler Model (step 7), Metfessel and Michael Model (steps 6 and 7), Walker’s Evaluation Design Model (step 8), Tips for Conducting an Evaluation (step 4), Evaluation Overview (steps 7 and 8), The Evaluation Process (steps 7 and 8)]

In addition to the steps outlined above, the following suggestions regarding formative evaluation are valuable to keep in mind. Four strategies are listed to ensure that evaluation activities are an integral part of any project.

- Establish a routine information system for the project, including inputs (time, resources), outputs (activities completed, student contact hours), and outcomes (student course grades, interim results of evaluation activities). Once established, a member of the project staff should be held responsible for keeping the information system up to date.
- Include evaluation activities in the project budget.
- Hold regularly scheduled monitoring and evaluation meetings for project staff. All those who work on a project should be familiar with the project objectives and how they will be evaluated.
- Encourage review and revision of the evaluation plan… Do not hesitate to revise aspects of the evaluation plan – to strengthen the research designs, select alternative indicators if the original ones are not sufficiently sensitive to project achievements, or incorporate the results of formative research.

**4 Conclusion**
This study proposed an evaluation model of integrating emerging technology into formal curriculum. An evaluation with determining information could be used for designing a well organized and effectively curriculum of emerging technology. The model includes total possible fourteen stages. Those are listed as followings.
1. Clarify product/program goals and objectives
2. Define purpose of evaluation
   a. Clarify evaluation type
   b. Clarify evaluation goals and objectives
3. Determine evaluation questions
   a. Determine evaluator’s role(s)
   b. Identify evaluation design
4. Plan the evaluation
   a. Determine time schedule
   b. Determine budget
   c. Submit evaluation plan, time schedule, budget, and instruments for feedback
5. Select criteria, indicators, and data sources
6. Develop instruments
7. Submit evaluation proposal
   a. Determine time schedule
   b. Determine budget
   c. Submit evaluation plan, time schedule, budget, and instruments for feedback
8. Make revisions to the evaluation proposal (optionally)
9. Schedule appointments for evaluation
10. Conduct evaluation
    a. Revise evaluation instruments (optionally)
11. Organize and analyze results
12. Report results
13. Revise instruction accordingly
14. Publish results

This formative evaluation model is a mean for understanding how integrating emerging technology content into formal curriculum is going. Based on the evaluation goal, criteria should be identified before evaluation could be conducted. The model is fulfill the needs of a system to pin point effects of integrating emerging technology into formal technology education, so can reveal the integral information and characteristics of curriculum innovation.

References: