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Developing a Reliable and Valid Instrument to Assess Technology Integration Units: A Collaborative Approach

Marge Maxwell, Cynthia Houston, & Jim Berger
Western Kentucky University

This paper describes the five phases of the Collaborative Analysis of Student Learning Model (CASL) and its adaptation for the development of an assessment of Technology Integration Units. The authors sought to develop a reliable and valid instrument that would provide a means of determining their students' specific weaknesses when it came to integrating technology into instruction. Results indicated that students were generally able to write four-part objectives, align post-assessments with their objectives and instructional strategies, and were able to successfully utilize Type II technology integration in their units. Students required more instructional support in aligning pre-assessments with their objectives and post-assessments. The authors strongly believe that they have benefited from engaging in the five phases of inquiry in the Collaborative Analysis of Student Learning model, which resulted in the development and implementation of the Technology Integration Unit assessment instrument.

Keywords: Collaborative Analysis of Student Learning, Technology Integration Unit, Instrument Development, validity, reliability, Teacher Work Sample, content alignment

INTRODUCTION

Collaboration is an essential component of the educational process at every level. Students, teachers, administrators, and teacher educators must learn to work together effectively to achieve their instructional goals and increase student learning. However, it is often the case that instruction remains primarily an activity that occurs between one teacher and a group of students. How to integrate a collaborative approach into the instructional process remains a challenge for educators in all settings. To add to this challenge, graduate level teacher education programs typically work with their students

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Marge Maxwell and Cynthia Houston are both Assistant Professors and Jim Berger is an Associate Professor, in the Educational Technology Program of Special Instructional Programs at Western Kentucky University in Bowling Green, Kentucky. Please contact Dr. Marge Maxwell at: marge.maxwell @wku.edu

for only one or two semesters and have limitations in addressing each student's learning needs, especially in an online environment. When faced which these issues as they design student learning experiences, graduate level teacher education instructors must be able to assess student work in a reliable and valid manner in a way that identifies overall patterns in student performance as well as individual learning needs. When it comes to evaluating Technology Integration Units, a common assignment in graduate level educational technology programs, instructors are at a loss because there is a dearth of reliable and valid measures of overall student performance. This situation is primarily due to the very specific requirements of the unit, which appear to vary from program to program.

The authors of this paper, all of whom are involved in teaching online graduate level educational technology classes at a southeastern university, suspected their students were weak in their ability to write four-part objectives and align objectives with assessments and instruction. This assumption was based on evaluating several semesters' worth of student work. However, with no valid and reliable instruments to measure these specific skills, there was no way to determine if this was an overall pattern of weakness in student performance or just isolated cases. For this reason, the authors of this paper set out to develop a reliable and valid instrument that would provide a means of determining students' specific weaknesses in developing Technology Integration Units.

Considering that the authors all needed to use such an instrument to assess their students' work, attempting to develop one that met each other's needs was no easy task. After examining several collaborative models, the authors decided to use a modified collaborative approach grounded in action research as the overarching framework for this process. Therefore, the purpose of this paper is to describe the use of a research-based model for developing an instrument for assessing graduate student technology integration units. The paper will discuss the following topics related to taking a collaborative approach to developing an assessment instrument for Technology Integration Units: use of the action research and the Collaborative Analysis of Student learning Model (CASL) to approach the problem, the features and requirements of the Technology Integration Units, the development and implementation of the technology integration unit assessment instrument, the implications derived from the analysis of student work using the instrument, and plans for future action research.

ACTION RESEARCH

Action research is an approach that allows instructors to gather data regarding their students and make changes without the necessity of developing a full-fledged research model. The goal of action research is "for practitioners to investigate and improve their own practices" by providing a framework for educators to study learning issues within their own learning communities (Hendricks, 2006, p.3). An important use of action research by educators is to improve student learning through the systematic analysis of student work, which involves identifying issues, collecting data, interpreting results and formulating practical solutions to instructional problems. This approach constitutes the fundamental framework for the Collaborative Analysis of Student Learning Model (CASL) proposed by Langer, Colton, and Goff (2003). The CASL model is based on the principles of the action research process of reflection, action and evaluation of student work in collaboration with other teachers. The use of collaborative inquiry for building learning communities in schools has been shown to be an effective method to foster changes in school culture (Goff, Colton, & Langer, 2000; Langer & Colton, 2005; Lieberman & Miller, 2000) and has also been incorporated into the National Board Certification process (National Board for Professional Teaching Standards, 2002).

COLLABORATIVE ANALYSIS OF STUDENT LEARNING MODEL

Different action research models propose different steps in the inquiry process. However, all of the models involve reflection, action, and evaluation of issues related to teaching and learning (Calhoun, 2002). In the CASL model, student work, in the form of homework, final projects and papers, is used to identify teaching and learning issues that arise during the classroom instructional process. According to Langer, Colton, et al. (2003, p. 74) the CASL model contains the following five inquiry phases:

Phase I. Define Target Learning Areas. The target learning area is identified, learning criteria are established using a performance grid, and performance levels of students are informally assessed.

Phase II. Analyze Classroom Assessments and Selection of Students. Student work is sorted by performance level and patterns in learning problems are identified; focus students are identified.

Phase III. Group Analysis of Students' Work. Teachers discuss student learning issues and promising strategies as a group.

Phase IV. Assess Whole Class Performance on Target Learning Area. Describe individual students' strengths, weaknesses and growths using student performance grid.

Phase V. Final Reflection. Reflect on student learning and teacher growth.

The five inquiry phases are designed to last from three to seven months. Teachers meet monthly throughout the process and spend from two to six months on the group analysis of student work (Phase III).

As every educational setting and professional development need in schools are different, some schools have employed adapted versions of the CASL model to work on school improvement projects and have also seen an increase in student learning. Although the CASL model promotes selecting individual pieces of student work for analysis, it has also been applied to the analysis of classroom sets of student work (Goff, et. al, 2000). Use of the CASL model to study classroom sets enables teachers to identify overall strengths and weaknesses in student learning on particular assignments.

For the purposes of this study the authors felt the CASL model offered more promise for assessing Technology Integration Units because the focus was on the collaborative approach to assessing student work and the development of learning communities. The authors were interested in this approach because the Technology Integration Unit assignment was developed collaboratively by the faculty. Every semester individual student performance on the unit is required to be evaluated by at least two members of the faculty. Therefore, the environment in which the assignment was developed was a collaborative one. Incorporating a more formal assessment instrument for analyzing student performance using this approach was the next logical step. Although the CASL model was initially a very attractive model to use for this study, the authors felt that one weakness of the model was its qualitative rather than quantitative approach to information analysis. In the CASL model, student learning is discussed in relation to a performance rubric (Langer, Colton, et al., 2003). However, formal analysis of student performance based on the rubric is not a required part of the process. The authors believed that analyzing large groups of student work using a qualitative approach did not yield information about the patterns in student learning that enabled the authors to identify specific instructional problems students were having. Additionally, incorporating quantitative measures through the use of a reliable and valid assessment instrument for data collection would provide the authors with a rich variety of information that could be used for the purposes of research, and potentially provide a means to assess similar student learning activities in other courses. The following sections describe the research process through the five CASL phases.

PHASE I: DEFINE TARGET LEARNING AREAS

As they engaged in Phase I of the CASL model, the authors concluded that even though all students do perform at the Proficient or higher level on the performance rubric after two to four revisions, there were still areas of student weakness on the Technology Integration Units where more information and analysis were needed. The authors found that, although analysis of student learning sections of the units indicated student learning increased as a result of instruction, measurements of student learning did not always match instructional activities or objectives. The authors wanted to determine if this was an overall pattern of student performance that was present from semester to semester. For this reason the authors decided to develop an assessment instrument and incorporate a quantitative approach to assessment within the CASL model. In this way the authors would be able to measure student performance on basic instructional design principles in the Technology Integration Units from semester to semester in a consistent manner. This assessment instrument would be used to collect data for the analysis of student work and would provide the authors with the kind of reliability and validity needed to be able to make generalizations regarding student learning based on the data collected.

PHASE II: ANALYZE CLASSROOM ASSESSMENTS AND SELECTION OF STUDENTS

THE TECHNOLOGY INTEGRATION UNIT

The assessment selected by the researchers for analysis was the Technology Integration Unit (TIU). The requirements for the Technology Integration Unit are to develop an authentic, thematic unit of instruction that integrates at least two original productivity tools (PowerPoint and either a database or spreadsheet) and Internet activities. Students select any authentic, thematic topic for their unit. The names of the sections for the Technology Integration Units are identical to the Teacher Work Sample required by pre-service teacher education programs at this southeastern university. The Teacher Work Sample is an accountability measure for demonstrating teachers' abilities to meet specific standards for teaching and learning based on best practices (Denner, Norman, Salzman, and Pankratz, 2003). The Teacher Work Sample is essentially a unit of instruction students develop, implement, and analyze following seven teaching processes shown to positively impact student learning. Research on the use of the Teacher Work Sample method indicates that this is a valid and reliable means for demonstrating that teacher education students can develop instruction to increase student learning (Denner, et. al., 2003; Hegler, 2003).

To adapt the Teacher Work Sample to a graduate level educational technology course, the Learning Goals and Objectives section of the Teacher Work Sample was modified for the Technology Integration Unit. In the Learning Goals and Objectives section students are required to develop four-part objectives using Bloom's Taxonomy. The purpose of four-part instructional objectives is to communicate and guide development of assessment, instructional methods, and content materials. Objectives communicate the focus of learning that enables instructors and students to work toward a common goal. The teacher can use objectives to make sure goals are reached. Students will understand expectations. Any skill is learned more effectively if the learner understands the reason for learning and practicing it (Botturi, 2003).

CONTENT REQUIREMENTS

A description of the required sections for the Technology Integration Unit is as follows:

1. Contextual Factors: description of the community, school district, school, instructional area, pupil characteristics, and factors which will influence teaching and learning in the unit.
2. Learning Goals and Instructional Objectives: create one content goal and two four-part instructional objectives (with Audience, Behavior, Condition, and Degree), create one technology goal and two four-part instructional objectives; correlate each objective with appropriate level of Bloom’s taxonomy and Gardner’s Multiple Intelligences, correlate each objective with appropriate state curriculum standards.
3. Assessment Plan: design appropriate pre-assessment and post-assessment for each objective; describe any adaptations needed for individual students.
4. Design for Instruction: design appropriate instructional activities aligned with objectives and assessments; describe collaboration with other educators in teaching each objective; give appropriate materials and resources; must include technology requirements.
5. Instructional Decisions: describe one event in teaching the unit that required a change in instruction; explain what was done and how it improved pupil performance and for which objective.
6. Analysis of Student Learning: select five pupils from varying performance levels; provide tables or charts to demonstrate their performance on pre- and post-assessments for all objectives; discuss these results; draw conclusions about student mastery of objectives; what were the major influences of pupil learning and conclusions in this unit?
7. Reflection and Self-evaluation: select the objective for which pupils had the greatest success and explain why; select the objective for which pupils had the least success and explain why; discuss two areas of professional growth to focus on; discuss how diversity of students in designing and teaching this unit was considered; discuss collaboration with other educators; discuss three teacher dispositions statements and how they were demonstrated in teaching this unit; describe the teaching experience; use the Technology Integration Unit scoring rubric and conduct a self-evaluation of your Technology Integration Unit.

TECHNOLOGY REQUIREMENTS

Another adaptation of the Teacher Work Sample incorporated into the Technology Integration Unit is the addition of Type II technology requirements for students engaging in unit activities. As described in Britten and Cassady (2006), Type I or "supportive" technology applications utilize technology, such as a prepackaged PowerPoint presentation, to be used as a support for the lesson but not necessary in the activity. Type II or "essential" technology applications are those required to analyze data, such as a database program, or to create a project, such as a presentation or web page development program and cannot be prepared without technology. The following Type II technology applications are required of graduate students in developing the Technology Integration Units:

1. Develop an instructional PowerPoint on the topic (15 or more slides, one template, art on most slides, each slide with title and 3-4 bullets, text information in presenter notes with APA citations, and APA references in the notes of the last slide.).

2. Develop either a database (create in Access with 10 fields, 4 numeric fields, 30 or more records, create worksheet with 10 sorting, 10 one-criterion, and 10 multiple-criteria questions and answer key) or spreadsheet (create in Excel with minimum of 5 different formulas, 20-30 detail lines, create worksheet involving higher level questioning with 20 questions and answer key).
3. Create an Internet activity: include at least one higher level learning activity which involves pupils in using the Internet.
4. Over the course of a semester students in the online Principles of Educational Technology Applications course develop the sections of the Technology Integration Unit based on these instructions. Students are provided with feedback and opportunities for revision of each of these sections throughout the semester. The projects are graded using a rubric that assesses student performance at the Novice, Apprentice, Proficient or Distinguished levels. Students are required to achieve Proficiency or better on these projects to complete the course.

PHASE III: GROUP ANALYSIS OF STUDENT"S WORK

In Phase III the CASL model promotes collaborative inquiry of two students' performance. Teachers discuss instructional strategies to improve student learning and assessment in the target learning areas. (Langer, Colton, et al., 2003) In this higher education setting two factors caused the researchers to deviate from the model in the practice of reviewing two students' performance. One, the graduate students only participate in a course for four months; therefore, there is not enough time for instructor collaboration, reteaching concepts, student revisions, and re-grading projects. Two, since it is an online course, all instruction and assignments are created before the course begins making it difficult to change instruction during a course without confusing students. Instruction can be modified for the next semester for a new set of students. Therefore, the researchers reviewed student technology integration units and feedback which had been given to students concerning their units for all students at the end of each semester over the last two years. After determining a common pattern that students were struggling with writing four part objectives, one of the researchers developed an online tutorial for writing objectives. After reviewing student projects in two more semesters, the researchers ascertained that student objectives did improve and most were written in the correct four-part format. Next, researchers encountered a more serious issue. Student instruction and assessments did not match their objectives. One researcher developed an online tutorial for creating and matching assessment to objectives. Realizing the need to further assess these critical components in the students' technology integration units after the above modifications in instruction, the researchers decided to create an online assessment instrument.

DEVELOPMENT OF THE INSTRUMENT

ESTABLISHING VALIDITY AND RELIABILITY

To assess specific areas of learning on the Technology Integration Units, the authors developed the Technology Integration Unit assessment instrument, which includes eight areas for data collection related to alignment of instructional objectives, assessments, instructional strategies, and technology integration.

Content and construct validity were established by conferring with a group of four experts about the following areas of the assessment instrument that aligned with the important characteristics of instructional objectives, assessment, and design of instruction in effective Teacher Work Samples: 1) the use of four part objectives, 2) use of Bloom's Taxonomy to identify learning levels, 3) the alignment of pre-assessment with instructional objectives, 4) the alignment of post-assessment with instructional objectives, 5) the alignment of pre and post assessments with the knowledge areas and skills to be measured, 6) the alignment of the instructional strategy with the objective, and 7) alignment of the instructional strategy with the post-assessments. In addition to assessing these seven areas, the authors also wanted to investigate whether the types of technology integration graduate students included in their units were Type I or Type II for the P-12 students engaging in unit activities.

As all four of the experts consulted to establish content and construct validity had gone through the Teacher Work Sample training process, they had already developed the inter-rater reliability required for evaluating the seven areas of the Teacher Work Sample. These same experts were also involved with implementing the Teacher Work Sample methodology at the pre-service level and were familiar with the characteristics of effective units of instruction. Three of the experts score up to 30 Teacher Work Samples each semester; one expert scores approximately 50 graduate-only Teacher Work Samples each semester. All of the experts agreed that the seven characteristics included in the Technology Integration Unit assessment instrument were valid characteristics of effective Teacher Work Samples with one difference. The four experts stated that the Teacher Work Sample focused on learning goals as well as objectives and did not require a rigorous four-part instructional objective. However, the inclusion of the four-part objective was one of the principle adaptations made for graduate students completing the Technology Integration Unit. After some discussion, the authors felt that this difference did not affect the content or construct validity of the instrument.

A pilot version of the Technology Integration Unit assessment instrument was developed to establish reliability. The pilot was deployed online using E Z Survey, a web-based application that allowed the authors to input data and compile results from distant locations. In collaboration, two authors and a graduate assistant who was hired to assist with the study, analyzed ten Technology Integration Units using the assessment instrument to ensure that there was agreement on how the sections of the unit should be assessed. To establish inter-rater reliability, the authors individually used the assessment instrument for data collection on ten of the same student Technology Integration Units. In the areas of identifying the components of behavioral objectives, Bloom’s Taxonomy level, and alignment of objectives with assessment and instruction, the inter-rater reliability among the authors was 94%. In all areas of the Technology Integration Unit assessment instrument inter-rater reliability was 99%. After discussing procedures and issues related to identifying Bloom’s Taxonomy levels and alignment of objectives, assessments, and instruction, the authors began the formal data collection process.

IMPLEMENTING THE INSTRUMENT

All completed Technology Integration Units used in the study were from three semesters: Spring 2005, Fall 2005, and Spring 2006. Students who audited the course or received an Incomplete for the course were not included in the study primarily because their Technology Integration Units were not completed within one semester. From each Technology Integration Unit, the authors chose one content objective and one technology objective. In each section, the authors chose the objective using the highest learning level from Bloom’s Taxonomy. The Bloom’s Taxonomy level was determined by the researcher and may or may not have been correctly identified by the student.

For the purposes of analysis, the number of projects was divided into two equal groups. Two of the authors identified two objectives (one content and one technology objective) from each project in their group. The two authors then reviewed each other’s selected objectives. In case of a disagreement about the Bloom level, the authors discussed their selections. Agreement on the selection of objectives and the Bloom’s Taxonomy level was calculated at 94%.

The assessment questions for each type of objective were as follows:

1. Select the components included in the four-part objective: Audience, Behavior, Condition, and/or Degree.
2. Select the Bloom’s Taxonomy Level that the objective correctly addresses.
3. Does the pre assessment test for the objective really measure the objective?
4. Does the Post assessment really measure the objective?
5. Do the pre-assessment and post-assessment for the objective measure the same knowledge or skill?
6. Is the instructional strategy for the objective aligned with the objective?
7. Is the instructional strategy for the objective aligned with the post assessment?
8. Is the technology objective for P-12 students Type I or Type II?

After the data collection phase was completed, data for the eight items above were exported to an Excel spreadsheet. Descriptive statistics were calculated for each item assessed by the instrument. The authors discussed the instructional changes which had occurred each semester and how this may have affected student performance and evaluated the usefulness of the assessment instrument.

PHASE IV: ASSESS WHOLE CLASS PERFORMANCE ON TARGET LEARNING AREA

From the 59 Technology Integration Units submitted in the Principles of Educational Technology Applications courses, 118 objectives were selected for analysis by the assessment instrument (59 content objectives and 59 technology objectives). A total of 48 or 81.4% of the content objectives were written in correct four-part format, while 49 or 83.1 % of the technology objectives were written in correct four-part format. A total of 82.2% of the 118 objectives were written in four-part format. High levels of Bloom’s Taxonomy were depicted in the content objectives with 81.4% of the content objectives at the Analysis or higher levels. Of the technology objectives, 54.3% of the 59 objectives were at the Analysis or higher levels. For the content objectives 28 or 47.5% of the pre-assessments assessed prior knowledge and skills of the objective. The data indicated lower alignment levels for the technology objectives with 22 or 37.3% of the pre-assessments evaluating prior knowledge of the objectives. Overall, only 42.4% of all 118 pre-assessments did align with their corresponding objectives. Forty-four or 74.6% of the post-assessments were aligned with the content objectives and 45 or 76.3% were aligned with the technology objectives. For the content objectives 33 or 55.9% of the pre- and post-assessments were aligned or measured the same knowledge or skill, while only 26 or 44.1% of the pre- and post-assessments were aligned or measured the same technology knowledge or skill. For content objectives, 48 or 81.4% of the instructional strategies were aligned while 51 or 86.4% were aligned with the technology objectives. A total of 83.9% of the 118 instructional strategies did align with their corresponding objectives. For the content objectives 45 or 76.3% of the instructional strategies were aligned with the post-assessment while 49 or 83.1% were aligned with the post-assessments for the technology objectives. Finally, 98% of the technology objectives represented Type II technology integration.

PHASE V: FINAL REFLECTION

The development and implementation of the Technology Integration Unit assessment instrument provided the authors with important information regarding overall strengths and weaknesses in their student's ability to write four-part objectives and align objectives, assessment, and instruction. The instrument enabled the authors to quickly identify areas of weakness where they needed to assist individual students and provide additional instructional support. This instrument not only allowed the authors to examine the skills for each student but also allowed the authors to draw comparisons across all students in the eight components of the Technology Integration Unit assessment instrument.

Use of the assessment instrument in the analysis of graduate student technology integration units led the authors to the conclusion that students are generally able to write four-part objectives, align post-assessments with their objectives and instructional strategies, and is able to successfully utilize Type II technology integration in their units. Over 75% of student work assessed with instrument show successful performance in these areas. This fact was not a surprise to the authors as they already knew that their students, most of whom were practicing teachers, possessed adequate skills in these areas.

Most importantly, the authors were able to use the assessment instrument to identify areas where student performance could be improved. One major weakness was that less than half of the students' pre-assessments did not measure the prior knowledge or skills that were a part of the instructional objectives. In concert with this finding, the authors also discovered weaknesses in students' abilities to align their pre and post assessments, with generally less than half of the students' being able to demonstrate these skills. As the ability to assess P-12 student's prior knowledge and skills regarding particular learning objectives before beginning instruction is crucial for developing an effective instructional unit, the authors realized that they needed to help students develop their skills in this area by providing additional instructional support.

In assessing student use of Type I or Type II technology integration, the authors were pleased that almost all of the students employed Type II technology integration as an essential component of their units. However, it was interesting to note that the level of Bloom's Taxonomy used in the technology objectives of Technology Integration Units were much lower than the levels used in the content objective of the unit. The authors determined that because a Type II requirement for every student technology integration unit was the development and use of a database, which most of the graduate and P-12 students had never used, the application level objectives students used were appropriate to their developmental levels.

The authors believe that the incorporation of the assessment instrument into the collaborative model they were using to assess student work provided them with vital information regarding their students' abilities that could not be found using a qualitative approach. Use of the Technology Integration Unit assessment instrument provided the authors with the key to finding the information they needed. At the core of this development process was the ability to use a collaborative approach to identify suspected weaknesses in student learning and develop a tool for looking across a body of student work to determine if a weakness actually existed.

TAKING THE COLLABORATIVE APPROACH INTO THE FUTURE

The paper described the five phases of the Collaborative Analysis of Student Learning Model and the adaptation of the model for the assessment of Technology Integration Units completed by graduate students at a southeastern university. As most successful action research projects are part of a recursive process of instructional improvement, the authors are now planning for the next cycle of collaborative activities. Based on the results provided through the use of the Technology Integration Unit assessment instrument, the authors believe it necessary to provide additional instruction in developing four-part objectives using Bloom's Taxonomy and creating pre and post assessments that effectively measure these objectives. One of the authors is currently developing online tutorials that will assist students with this process. Future research will use the assessment instrument to study the effect of these tutorials and student revisions to the Technology Integration Units on student performance.

This paper also provides a model for how this approach can be adapted and implemented in an educational setting different from the one intended by the creators of the model. The means by which the authors were able to develop an assessment instrument for the model demonstrates that this approach can also be adapted by others who teach educational technology and engage in related research. To do so, one may take any assignment where the professor, instructor, or teacher suspects a common weakness on the students' part and develop a list of questions that measures those weaknesses. This will allow for the analysis of a class set to determine if those suspected weaknesses exist. The strength of this proposed model is the collaborative aspect which allows for more than one set of eyes, discussion of components of the instrument, and developing a common interest in improving student performance.

The authors strongly believe that they have benefited from engaging in the five phases of inquiry in the Collaborative Analysis of Student Learning model, which resulted in the development and implementation of the Technology Integration Unit assessment instrument. As new models of educational leadership encourage teachers to become members of learning communities (Lieberman & Miller, 2000) and focus on the collaborative analysis of student learning, it is crucial that teacher education professionals adopt and model these approaches so their programs may continue to be relevant in a rapidly changing educational landscape.

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