Applying Case-Based Reasoning Principles Within A Technology Integration Learning Environment

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Abstract: Teachers and those who educate them are continually searching for innovative and effective tools to assist them in their task of learning to integrate technology. When teachers are seeking resources for solving a problem, they turn to databases, work groups, and communities of practice. They look for similar situations to see how problems were solved and then adapt the information that they find to fit their own situation. This type of strategy is called case-based reasoning (CBR). We have created a Web-based tool that supports the case-based reasoning process for learning how to integrate technology in instructional activities and teacher tasks. This paper will describe the process of designing the Technology Integration Learning Environment (TILE).

Introduction

Teachers and those who educate them are continually searching for innovative and effective tools to assist with learning to integrate technology. When teachers are seeking resources for solving a problem, they turn to databases, work groups, and communities of practice. They look for similar situations to see how problems were solved and then adapt the information that they find to fit their own needs. The Knowledge Innovation for Technology in Education (KITE) project, funded by a PT3 (Preparing Tomorrow's Teachers to Use Technology) grant from the U.S. Department of Education, seeks to assist teachers in learning how to integrate technology into their teaching by presenting cases containing technology integration stories collected from other teachers. The KITE case library is a knowledge repository with nearly 1000 stories or cases describing the real-life experiences of in-service teachers as they integrate technology into their teaching. Although KITE provides a wealth of knowledge that can be readily accessed, many users are not familiar with a case-based reasoning (CBR) retrieval system and how it differs from the typical keyword retrieval system. Therefore, it becomes necessary to create tools and strategies that will assist users in taking advantage of this alternative information retrieval system integrated in the KITE design. We have designed a support tool to utilize the CBR process for learning how to integrate technology in instructional activities and teacher tasks. This paper will describe CBR and its application to the design of the Technology Integration Learning Environment (TILE).

Case Based Reasoning

According to Jonassen and Hernandez-Serrano (2002), we can prepare professionals to deal with ill-defined and ill-structured problems by exposing them to stories generated in the workplace. People will naturally use what they have learned in a previous problem and apply it to a new problem (Ross, 1989). This is the essential principle for CBR, which is used extensively in everyday, common sense reasoning. It is a problem-solving approach that encompasses analysis, evaluation, synthesis, and conceptualization producing better judgment and decision-making.

From a CBR perspective, the problem-solving approach is "based on the retrieval and adaptation of cases, or episodic descriptions of problems and their associated solutions" (Bradley, 1994, p.40). A basic CBR assumption is that individuals have numerous experiences that have been indexed in their memory to make available to themselves and other people to be used in new situations. In addition, CBR assumes that community knowledge is stored and can be captured in the form of stories (Schank, 1990).

The KITE knowledge repository is a CBR system that embodies a library of technology integration cases. Each case contains a description of the problem, plus a solution and/or the outcome. The knowledge and reasoning process used by a teacher to solve the problem is not recorded, but is implicit in the solution. The four major CBR steps are: retrieve, reuse, revise, and retain. When solving a current problem, the user searches KITE for similar cases in the database. The retrieved cases are used to suggest a solution, which is reused and tested for success. If necessary, the solution is then revised. Finally the current problem and the final solution are retained as part of a new case.

When reusing the retrieved case solution in the context of the new problem, users must be able to focus on identifying the differences between the retrieved cases and the current problem, and identifying the part of the retrieved case that can be transferred to the new problem. Typically, most database users will try to utilize a solution directly from the retrieved cases. However, revising the solutions to fit the current problem is an important component of problem-solving. In addition, the revision of cases that reflect unsuccessful outcomes provides an opportunity for the users to learn from failure.

The CBR process cannot be effective without retaining the new solution. To retain a new case, the user must determine the information to recall and the format; how to index the case for future retrieval; and store the case into the case library. This process allows the user to retrieve all existing and new cases that can be compared and synthesized for future usage.

How Does CBR Apply to Learning Technology Integration?
When asked to solve a problem, humans typically search their memory for past experiences that can be reapplied in this new situation. They often describe their experience by telling a story. The major reason for recalling stories is to create new solutions by using knowledge and solutions from previous stories (Kolodner, 1993). Learning occurs when new cases are solved and stored in memory, along with the outcome of the solution. Learning also occurs when failed solutions are attributed to specific case features and those features are then added as indices.

The KITE project is using CBR in a novel way: to suggest adaptation of existing solutions to a current technology integration problem. It is important for teachers to utilize KITE as a resource, and also to use it for the last step in the CBR process, which is the creation of new solutions that can be retrieved from the library.

The CBR process encourages reflection in action by having the learner examine the differences and similarities of a case to a particular solution. This strategy improves problem-solving skills, which is critical for adapting to the technology situations that teachers will encounter in the classroom.

How Does CBR Relate to Teaching Technology Integration?
Historically, teacher education programs have offered a single technology integration course, designed to expose pre-service teachers to a variety of technology uses. It is not uncommon for this course to be a student's only requirement for learning technology integration. Once students become teachers, there is even less time, money and opportunities to learn how to appropriately use technology with instruction. A study by the National Center for Education Statistics, as discussed by Pope, Hare and Howard (2002), found that teachers believe that technology is vital to the success of the educational system's reform. However, only 20% of those teachers felt adequately prepared to integrate technology in their own teaching. And, of these teachers, 93% credited independent learning for their skills and knowledge.

So how can CBR be used to change the educational experiences for both pre-service and in-service teachers? Teacher education programs must begin to infuse their programs with opportunities to apply case-based reasoning principles to instructional problems. In addition, programs that offer continual exposure to a variety of technology situations, and provide a more open community of sharing practices may impact teachers' skill level and their attitude toward technology integration. Teachers who are given opportunities to practice solving problems in authentic cases and scenarios will be better prepared to solve problems that they encounter in real situations. As each

group is given more time to learn from the experiences of others and to share their experiences and solutions, the rate of success in technology integration will improve significantly.

Technology Integration Learning Environment

We have created the Technology Integration Learning Environment (TILE) as a Web-based support tool for: learning how to integrate technology in instructional activities and teacher tasks, providing an instructional resource for teacher educators, and supporting the case-based reasoning learning process. The target audience for the support tool includes teacher educators, pre-service teachers, and in-service teachers. This support tool will help teacher-educators, who teach technology integration courses, to easily integrate this Web-based tool into their classes in order to improve pre-service teachers' knowledge and skills regarding integrating technology into their future teaching situations. This support tool provides a structured environment that allows flexibility for in-service teachers to learn more about how to integrate technology at their own pace.

TILE Design Elements
Our pedagogy is based on the belief that learning is effective when situated in realistic settings wherein the learner is clear about the context and the reasons for the activities. This pedagogy can be also described as Goal-Based Scenarios (Schank & Cleary, 1995), which is essentially a simulation of an event. During the simulation, the learner's "goal" is to accomplish a mission or task associated with their role(s) in a scenario related to what the learner would encounter in a realistic setting. In order to achieve this goal, the learner needs to acquire particular skills and knowledge, which is where and when the learning takes place. A GBS therefore serves both to motivate learners and to give them the opportunity to "learn by doing."

The TILE design is based on three goal-based scenarios: teacher, principal, and technology coordinator (See Figure 1). These scenarios were chosen because of the basic assumption that individuals learn to perform their job better by 'playing the role' of people they would interact with in their work environment. The different scenarios provide multiple perspectives on the same goal – technology integration into the classrooms. When a pre-service teacher plays the role of a technology coordinator or a principal, the students learn from a different perspective and try to relate it to their reality. In the end, we are hoping to increase understanding among the different roles, which may improve the communication and expectations.

The KITE repository is used as an anchor for the instructional activities integrated within the environment. Some of the activities are as follows:

- Demonstrate how various technology standards can be manifested
- Analyze multiple cases given an instructional situation
- Synthesize best practices and lessons learned given an instructional context
- Select media for intended learning outcome
- Develop lesson plans based on the same thread of cases
- Plan a learning unit for a given situation

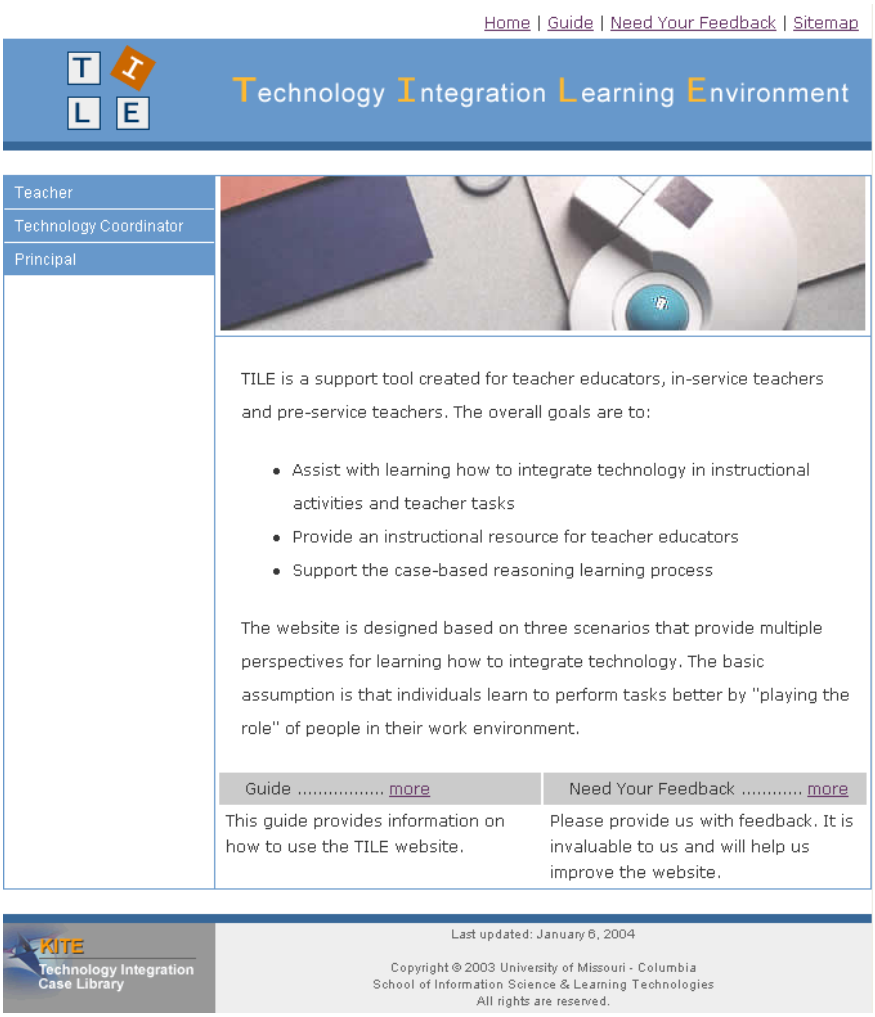

Figure 1: The TILE home page includes links to the three learning modules.

With each scenario, we provide activities for the learner to improve the case-based reasoning (CBR) and problem-solving skills by having them retrieve the KITE cases, determine the similarities and differences of the cases, describe the case elements used for the solution, and present the outcome. Each scenario consists of several modules that focus on a specific content. For example, the Teacher scenario has five modules: Technology Standards, Media Selection, Lesson Planning, Assessing Technology Integration Experiences, and Creating a Teaching Unit. The content in each Teacher module is a complete set of activities, which are closely related to teachers' everyday tasks for technology integration. Each module is organized with learning materials, user-activities (tasks) and a rubric with which the learners can determine the quality of the completed tasks. The goal is that the learner will practice and improve their ability to use CBR gradually by engaging in the tasks.

Each module begins by providing contextual knowledge, such as ISTE technology standards, that will assist with completion of the instructional activities. Next, we select and compare KITE cases that relate to the module activity. The case comparisons reflect important similarities and differences so that the learner will begin to realize how different case elements may be applicable to the current instructional problem. In addition, we discuss how each KITE case may be readily used or adapted for the instructional problem. To illustrate this process, the Media Selection module provides a good example. The first activity, "Considerations for Media Selection", includes various articles and Web sites that provide information regarding important factors and attributes to consider when selecting media. In the second activity, "Evaluating Technology Integration of KITE Cases," the learner reviews selected technology integration KITE cases. We provide an analysis of the media selection strategies in the cases by utilizing the media attributes content from the first activity. The analysis describes how the media is or is not

appropriate, determines how each case is similar and different, and presents solutions to improve the technology integration cases by adapting or revising solutions from other cases. For the final activity, "Selecting Technology for Intended Learning Outcomes", the learner assesses situational features presented in the given scenario, searches the KITE case library in order to find similar situations, and presents an appropriate solution either by adapting a solution from the retrieved case or revising the solution in the case to find a better solution. All of the module activities scaffold one or more of the CBR steps.

Although each module in the scenarios focuses on only one content area and is a complete set, we allow the user to choose modules without having to proceed through a specific order. Teacher educators also have the option to use either the entire site with all three modules, a specific scenario, or tailor it for their purpose and context.

Evaluation

Evaluation methods for teacher education courses will typically involve a portfolio containing a technology integration lesson plan, instructional materials, and reflection papers. Our evaluation revolves around two basic outcomes:

1. Learner can create a solution to an instructional problem that reflects technology standards and effective use of technology within instruction, and
2. Learner knows how to recall appropriate cases that relate to their current problem, modify, and then apply to solve problem.

Implementation of a technology-integrated lesson will provide valuable feedback regarding how well the lesson was designed, but many students do not have to opportunity or time during the course. An alternative evaluation method is peer evaluation from students within the course. This method allows for further enhancement of skills by analyzing other student lessons, which can lead to additional self-reflection of strategies used in their own lesson plan. Criteria that will be used to evaluate the first outcome are:

- The technology is appropriate for the learner characteristics
- The technology is appropriate for the learning task
- The technology is appropriate for the physical structure of the learning environment
- The technology is appropriate for the delivery of the instruction
- The technology usage meets or exceeds the technology standards

For the second outcome, we can measure the case-based reasoning and problem-solving skills by examining instructional artifacts, reflection exercises, and peer discussions. The instructional artifacts will present the learners final solution to an instructional problem, but it may not reflect an understanding of the reasoning process. Therefore, we must integrate reflection activities throughout the modules so that students can continue to reevaluate their strategies and we can analyze their reasoning process. When the learner retrieves KITE cases and provides a solution, they must provide a rationale for their choices and solution. Table 1 describes the reflection questions that address their case-based reasoning process for the instructional problem.

Student Question	Analysis
How or where was the case retrieved?	It is important to determine if the learner retrieved the case from their memory or searched the KITE database. If the learner retrieved the case from their memory or remembered parts of case they had previously retrieved from the KITE, then the learner reflects retention of problem solutions. Retention leads to the development of technology integration knowledge.
What are the case similarities and differences based on the KITE index terms?	During the comparison process, the learner identifies KITE index terms such as technology used or learning outcomes. The index terms provide a foundation for easier storage and recall of cases.
What case components are applicable to the current problem?	The learner identifies and synthesizes the case components to create the new solution. This represents problem-solving and case-based reasoning skills when the learner applies appropriate components to the current solution.
How does the proposed solution facilitate appropriate technology integration?	The learner applies the criteria from the first evaluation outcome to self-assess their proposed solution. This evaluation aligns the CBR process with the overall outcome of learning how to integrate technology.

Table 1: Evaluation of Student Reflections

Although we want the learner to create solutions that are effective and appropriate, learning also occurs from trying a solution that does not work. In addition, the peer discussions provide an opportunity for students to defend their solution and consider alternative ideas presented by their peers. Thus, student reflections are important activities for determining learners' understanding and if they are applying the CBR process.

Summary

The scenarios allow the user to focus on different learning outcomes without overloading one role and the tasks of one character in the environment. The scenarios are meant to provide an authentic context, and emphasize important elements that must be considered. Additionally, pre-service teachers learn that the integration of technology into the classrooms and the improvement of learning will not just happen through teachers, but through the whole environment and context of the school.

There are many Web-based databases of lesson plans that already support the retrieval of solutions but without understanding the different elements that are appropriate for a technology problem. By implementing a case-based reasoning structure to the instructional activities, our goal was to create a learning environment that goes beyond retrieval and application of solutions. We want to improve problem-solving and cased-based reasoning skills so that pre-service teachers will be highly adaptable and creative when integrating technology in the classroom. We believe that the TILE environment will meet this goal. Teachers would greatly benefit from the proliferation of these problem-solving and case-based reasoning skills.

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