Abstract

Information processing theory brought about changes in the way educational psychologists thought about how individuals creating meaning. In information processing, meaning was thought to be similar to a computer or information-processing machine where learning can be modeled and replicated. Situated cognition argued that people were not like computers. Situated cognition views learning as a manifestation of thinking that is connected to larger social interactions and everyday activities very much like a traditional apprenticeship model. In situated cognition, meaning is constructed by learning in context, culture and authentic activity. In this paper information processing and situated cognition will be briefly described to set the stage for the cognitive apprenticeship paradigm. A brief overview of the dimensions of designing learning environments will be investigated in order to better understand the framework for the cognitive apprenticeship paradigm. Finally, an example template from the University of New Mexico will be explored through its relationship to situated cognition and the cognitive apprenticeship paradigm. Discussion will be added concerning further research of this paradigm and its use in teaching technology integration to pre-service students in higher education programs.
Introduction

Information processing theory created changes in the way cognitive scientists thought about how people think. Computers were used as a metaphor for thinking. It was thought that meaning was formed in discrete pieces and then formed into schemas. The computer metaphor indicated that the thinking process could be reproduced and replicated.

Situated Cognition looks at creating meaning in a different way. Instead of creating meaning through discrete pieces of information as in the theory of information processing, situated cognition views constructing meaning as something that is relevant to the content, culture, and authentic activities in which meaning is created. This is much like the traditional apprenticeship model that has been used for centuries. The cognitive apprenticeship paradigm is based in situated cognition and traditional apprenticeship. Cognitive apprenticeship goes beyond the traditional apprenticeship model by developing the idea that learning is not only situated, but is connected to larger social situations and transferable beyond the activity.

The University of New Mexico has created a template based on the cognitive apprenticeship paradigm. This design template will be used with pre-service teachers as they learn to develop technology integration into the K-12 classroom. How does the University of New Mexico’s template fit with the cognitive apprenticeship paradigm in shaping how we teach pre-service teachers about technology integration in the K-12 classrooms?

The first part of this paper will give a brief overview of information processing theory and situated cognition. Cognitive apprenticeship will then be discussed as it relates to situated learning. A brief overview of the dimensions needed in designing effective learning environments will be explored. Finally, this paper try to answer the question of how cognitive
apprenticeship relates to the template used by the University of New Mexico in developing training of pre-service educators in technology integration for use in the classroom.

**Background**

Information processing theory was shaped from the cognitive science revolution in psychological thinking. Information processing (or symbolic cognition) exemplified the world through various memory structures. According to Wilson and Myers (2000), information processing viewed people much like computers (or information processing machines) “whose thinking and behavior can be modeled and simulated.” (p 64). Wilson and Myers also note that about the time that computers technology was growing, information processing theory was developing around the metaphor that” human behavior within that outside world was thought to be accounted for by internal processes and mechanisms.”(p.63). The principles of information processing theory are explained by Wilson and Myers (2000) in these stages: “Humans process information in stable, sequential stages, imputing sensory information into perceptual memory, then to working and long term memory, and finally to response generation.” (p.64)

In information processing “ two kinds of knowledge are fundamental” Wilson and Myers (2000). “These are declarative knowledge (knowing what) and procedural knowledge (knowing how)” (p 64). This knowledge and skills learning is gained though repeated practice until the steps are ingrained into a single unit of thought in which learning occurs. Situated cognition theory would argue that learning does not occur in discrete steps but rather in a more holistic manner that includes context, culture, tools and society as part of the learning environment.

Situated cognition is an alternative to information processing theory in how meaning is constructed. Situated cognition is learning knowledge and skills in the context to which they
apply to real life situations. Lave and Wenger, (1991) argues that naturally occurring learning happens when learners are involved in activity that is closely tied to the content and culture in which it happens. That means that it is “situated”.

**Situated Learning**

Situated learning is concerned with knowing “through teaching knowledge and skills in contexts that reflect the way the knowledge will be useful in real life” (Brown, Collins, Duguid, 1989). Knowledge is “situated” because what we learn is interconnected to everyday activities. These activities are inherently social because “knowledge is not a thing or a set of descriptors (Clancey, 1995, p.49)” but instead learned through a variety of contextual, cultural, and activity processes. Brown, Collins, and Duguid (1989) note, “knowledge is situated, being in part a product of activity, context, and culture in which it is developed and used” (p.32). Clancey (1995) defines Situated learning as being concerned with how learning occurs everyday.

It is not a recommendation that teaching be “situated” or “relevant”. It is a theory about the nature of human knowledge, claiming that knowledge is dynamically constructed as we conceive of what is happening to us, talk and move (sic). Especially, *our conception of the activity* within a social matrix shapes and constrains what we think, do, and say. That is, our actions are *situated in our role* as a member of a community. …The theory of situated learning claims that knowledge is not a thing or a set of descriptions or collection of facts and rules. We model knowledge by such descriptors. But the map is not the territory: Human knowledge is not like procedures and semantic networks in a computer program. Human knowledge should be viewed as a capacity to coordinate and sequence behavior, to adapt dynamically to changing circumstances. (p. 49)

Wilson and Myers (2000) described the main characteristic of situated cognition as:

“…the placements of individual cognition within the larger physical and social context of interactions and culturally constructed tools and intertwined meanings.”(p. 68)
What this indicates is that learning should be created in authentic activity. Researchers such as Collins, Brown, and Duguid (1989) and Collins, Brown, and Holm (1991) began to look at the authentic activity of traditional apprenticeship as it applied to situated cognition. From their research came the paradigm of cognitive apprenticeship.

Defining Cognitive Apprenticeship

The cognitive apprenticeship paradigm stems from the idea of situated cognition. Researchers began to look at traditional apprenticeship models in relationship to situated cognition. Traditional apprenticeship is “situated” in the context, culture, and authentic activities that describe apprenticeship in general. In traditional apprenticeship experts teach the apprentice how to do a task, by having the apprentice watch and then recreate the steps of that particular task. Collins, Brown, and Holm (1991) indicated three major components for traditional apprenticeship. These are modeling, scaffolding, and coaching. “In modeling, the apprentice observes the master demonstrating the task. …Scaffolding is the support the master gives apprentices in carrying out the task. …Coaching is the thread running through the entire apprenticeship experience.” (p. 2).

Collins et al (1991) further define the role of the coach in traditional apprenticeship as:

The master coaches the apprentice through a wide range of activities: choosing tasks, providing hints, and scaffolding, evaluating the activities of apprentices and diagnosing the kind of problems they are having, challenging them and offering encouragement, giving feedback, structuring the way to do things, working on particular weakness (p.2).

Coaching is of particular importance when looking at cognitive apprenticeship paradigm because it is the job of the mentor to create authentic learning environments that are related to context.
and culture. The next section will make distinctions between traditional and cognitive apprenticeship paradigms in the context of situated learning.

A Move From Traditional Apprenticeship to Cognitive Apprenticeship

The cognitive apprenticeship paradigm is designed for use in learning environments that are connected to larger social interactions and everyday activities. They appear to be more holistic in nature than the traditional apprenticeship model. Traditional apprenticeship is built within a particular set of parameters. Knowing is based within those parameters. In cognitive apprenticeship, knowing goes beyond the parameter by asking the learner to articulate the “why” of knowing. Traditional apprenticeship focuses on learning skills that can be observed, are innate to the task itself, and are learned, as they are needed for the apprentice. These learning skills are in a way, directed at learning a particular way of knowing. Collins, Brown, and Holum (1991) describe three major differences between traditional apprenticeship and cognitive apprenticeship.

In traditional apprenticeship, the process of carrying out a task to be learned is usually easily observable. In cognitive apprenticeship, one needs to deliberately bring the thinking to the surface, to make it visible, whether it’s in reading, writing or problem solving. …in traditional apprenticeship, the tasks come up just as they arise in the world….But in schools, teachers are working with curriculum centered around reading, writing, science, math, history, etc. that is, in large part, divorced from what students and most adults do in their lives. In cognitive apprenticeship, then the challenge is to situate the abstract tasks of school curriculum in context that makes sense to the students. … in traditional apprenticeship, the skills to be learned inherent in the task itself.….In cognitive apprenticeship, the challenge is to present a wide range of tasks, varying from systematic to diverse, and to encourage students to reflect on and articulate the elements that are in common across tasks”(p3-4).

Knowing in the cognitive apprenticeship paradigm focuses the connections between social interactions and concept learning through activities that are both situated and gradually
developed. Knowing is not just based in the activity, but also in context and in culture, that
is the “why” part of knowing. Brown, Collins and Duguid (1989) note that:

To explore the idea that concepts are both situated and progressively developed through
activity, we should abandon the notion that they are abstract, self-contained entities.
Instead it may be more useful to consider conceptual knowledge as, in some ways similar
to a set of tools (p34).

If we think of knowledge as though it were a “set of tools”, then a different way of
knowing can also be equated with this metaphor. According to Brown, et al. (1989):

People who use tools actively rather than acquire them, by contrast, build an increasingly
rich implicit understanding of the world in which they use the tools and of the tools
themselves. The understanding both of the world and the tool continually changes as a
result of their interactions. Learning and acting are interestingly indistinct, learning
becomes a continuous, life-long process resulting from acting in situations (p35).

Brown, et al. (1989) indicate that learning then becomes a process of
“enculturation” when conceptual tools are assimilated by a culture through individual
insights and experiences. When activities are authentic and based within a culture,
knowledge becomes a tool in which to problem-solve. This is important in the teaching
process.

Students need much more than just abstract concepts and self-contained
examples. They need to be exposed to the use of a domain’s conceptual tools in
authentic activity—to teachers acting as practitioners and using these tools in
wrestling with problems of the world (p36).

This thinking then changes the way in which learning environments are created for
cognitive apprenticeship. Instead of designing learning in the abstract, where ideas are
disconnected, cognitive apprenticeship designs learning that is connected and authentic to
the learner.
Designing Effective Learning Environments

In order to design effective learning environments, such as cognitive apprenticeship, Collins, Brown and Holum (1991) discuss four dimensions that make up a learning environment. These are content, methods, sequence, and sociology. Since this paper is concerned more with the framework of cognitive apprenticeship, these dimensions will be discussed briefly. They are important in understanding the underlying principles in the design of the template used by the University of New Mexico in training pre-service educators in the use of technology in the classroom.

The content dimension includes four major areas of thinking as in any learning environment. These are domain knowledge, heuristic strategies, control strategies, and learning strategies. Collins, et al (1991) as define them:

Domain knowledge is described as including the concepts, facts and procedures explicitly identified with a particular subject matter….Heuristic strategies are generally effective in techniques and approaches for accomplishing task that might be regarded as ‘tricks of the trade’; they don’t always work, but when they do, they are quite helpful. Control strategies” control the process of carrying out tasks….Learning strategies are for learning any of the other kinds of content described above.(p10-11)

These content dimensions define what is being learned. The method component defines how the learning will be created to afford the learners the opportunity to engage in, discover, and observe practiced strategies in content. Brown, Duguid and Holum (1989) would say that this approach “enables students to see how these strategies combine with their factual and conceptual knowledge and how they use a variety of resources in the social and physical environment.” (p11)

There are six teaching methods that fall under this category. These are (a) modeling, (b) coaching, (c) scaffolding, (d) articulation, (e) reflection, and (f) exploration; these are grouped
into three categories. Collins, Brown, and Holum (1991) further break these down as follows:

1. The first three teaching methods are the core of cognitive apprenticeship and are designed to help students acquire an integrated set of skills through processes of observation and guided practice.

2. Articulation and reflection are methods designed to help students both to focus their observations of expert problem solving and to gain conscious access to (and control of) their own problem-solving skill.

3. Exploration is aimed at encouraging learner autonomy, not only in carrying out expert problem solving processes but also in defining or formulating the problem to be solved. (p.11)

More discussion on each of these six teaching methods will be explored as they relate to the cognitive apprenticeship template designed by the University of New Mexico for technology integration in the pre-service education classroom.

The next dimension in designing effective learning environments as described by Collins et al. (1991) is sequencing. “In sequencing activities for students, it is important to give students tasks that structure learning but preserve the meaningfulness of what they are doing. This leads us to three principles that must be balanced in sequencing for students.” (p12). Collins et al. (1991) describes these sequence principles as:

1. Global before local skills. Students build a conceptual map before doing the task. In doing so, the learner is able to see how the individual pieces fit together and understand how the task should be completed. Scaffolding is important in this principle.

2. Increased complexity. Two devices used to increase complexity are sequencing of events and scaffolding. The sequencing of events demonstrate how to do the task. Scaffolding enables the learner to use the mentor to complete complex activities associated with the task.

3. Increasing diversity. As skills become learned, it is important to put these skills into a larger framework so that transfer can occur. This gives learners the ability to contextually understand the learning and apply it to other situated activities. (p.12-13)

The fourth and final area used to design a framework for learning environments is sociology. This dimension looks at learners in a collaborative environment. Collins, Brown,
and Holum (1991) relate four characteristics affecting the sociology of learning. These are (a) situated learning, (b) communities of practice, (c) intrinsic motivation, and (d) exploiting cooperation (p 13-14).

Situated learning refers to creating learning environments that are based in authentic activity, that are relevant to content and culture. Communities of practice refer to creating meaningful activities that are based in expert knowledge as a way in which to problem-solve and carry out the task. This is collaborative in nature, since learners are engaged in the same authentic activity within their community. Finally, intrinsic motivation refers to completing tasks beyond the extrinsic rewards such as grades. (p 13-14)

Each of these four dimensions are important when designing learning environments. They are interrelated and encompass the spirit of the cognitive apprenticeship paradigm.

University of New Mexico’s Cognitive Apprenticeship Template

The University of New Mexico template was designed as part of the Preparing Tomorrows Teachers to use Technology grant (PT3). Within the PT3 grant is the Shared Visions grant. The focus of this part of the PT3 grant is developed around the idea of creating self-sustained technology integration into the K-12 classroom. Six major goals encompass the Shared Visions grant. Three goals focus on creating self-sustaining technology implemented into pre-service classrooms via technology classes and faculty demonstrations. Another goal is designed to create a network of master technology teachers within public schools as a means of developing collaborative relationships for self-sustained technology growth with the university education faculty. The fifth goal is based in cutting edge technology research. The last goal of
the Shared Visions grant is to create a multimedia template that demonstrates “best practices” in the use of technology integration into the K-12 educational setting.

Shaw (1996) created the framework that was used to develop the University of New Mexico template. This model is based in the cognitive apprenticeship paradigm as it relates to problem solving technology. Notice that this model is based in the culture of teaching technology curriculum. The content used in this framework is specific to learning lesson development based in content standards. Even though this framework is constrained, it is open enough so that individuals may design any lesson that they deem appropriate for a particular grade level, but is within the parameters of technology integration educational content standards.

As Larry Shaw’s (1996) model shows, learning occurs through the six major areas of the cognitive apprenticeship paradigm. A master model or cognitive story is demonstrated through modeling and is then transformed so that the learners create their own version of the story. As the learner goes through the steps of the cognitive apprenticeship model they develop their own model of curriculum development with content assessment. This assessment is embedded into each step of the process. The plan that the learner develops is created with aid of a rubric. Learner support is also presented in the form of information banks, help screens, support programs, Internet and database access.

The University of New Mexico template is based in Shaw’s framework for problem-solving technology. Learning is modeled and coached, as scaffolding is embedded into the design. Ideally this template should be demonstrated and manipulated by a community of practice, in this case, K-12 pre-service teachers. Scaffolding is provided by a facilitator and within the template itself. The rubric for making the plan is the lesson design itself.
Figure 1. Cognitive Apprenticeship/Problem Solving Technology Model used in designing the University of New Mexico’s technology integration template.
Individuals look at the lesson design of the template and create their own, based on technology integration. The individuals then articulate this knowledge by creating their own lesson based on content standard for curriculum. Exploration enables the learner to transfer knowledge gained into other areas of the curriculum.

The University of New Mexico template is being used to create self-contained modules of activities centered on one lesson that integrates technology for the K-12 classroom. The particular model that is being investigated is based on a kindergarten classroom utilizing KidPix software into a lesson on animals. You may see this module and manipulate through it at http://www.unm.edu/~teched. This module is truly a “tool kit” to teach learners how to integrate technology within the context and culture (knowing) of the Kindergarten classroom. Screen shots of this KidPix template are incorporated to demonstrate the five major steps in the cognitive apprenticeship paradigm. Scaffolding is used throughout the template, but is not an independent piece of the template.

Figure 2 is the opening page of the KidPix lesson module. The learners are presented with a conceptual map of the cognitive apprenticeship module through a brief description of each of the steps they will be manipulating as they learn how to integrate technology into the K-12 classroom. This design is created in such a way that it implies that each of the “stages” increases in complexity. These stages are sequenced to give a global overview and increase in complexity. The template offers increasing diversity in helping the learner develop transfer of this knowledge to other areas of teaching. However, this template is non-linear in use. Users may click on any one of the “stages” within the open page module and begin exploring that particular piece of the module.
Learners on many levels may go between “steps” to review, learn, or develop lessons. Within this template are scaffolding devices that enable the student to gain a deeper understanding of the underlying principles of technology integration. Embedded in the template are tutorials on the software that is being used, and tutorials on computer use in general. There are national, states, and city educational content standards used in designing lesson plans for the K-12 students. There are lesson plan templates and example lesson plans. There are audio/video components that discuss the reflection questions as they relate to the presentation and coaching steps within this template.

The modeling portion of this template is called “Presentation”. This is where the learner is given an authentic look at expert teachers creating technology content in a classroom culture (See Figure 3). These experts will guide the learner through a sample of technology integration as a way in which to demonstrate the “best practices” of the conceptual tool of teaching technology integration.
When designing this particular step, effective learning environments as described by Collins, Brown and Holum (1991) were used. Included in the presentation portion of the template are content knowledge, teaching methods, sequencing, and sociology.

![Figure 3. Presentation stage of cognitive apprenticeship template](image)

Domain knowledge is most prevalent in this piece. The learners are given concepts and facts, which identify the authentic problem to be solved. In this case, the learner needs to know how to integrate technology into a Kindergarten classroom. Observation of the “master” is accomplished in the audio/video clip in which the presenter defines prerequisite skills needed to be successful in this particular lesson. The lesson is presented in a collaborative setting to engage learners in developing technology integration skills. Scaffolding is presented to the learners in database form as well. There are links to standards for content teaching as well as an overview of the cognitive apprenticeship paradigm in this step.

The Coaching module of this template is designed to look like the presentation module (see figure 4). In coaching, the master teacher is demonstrating how the technology is being integrated into the classroom. The audio/video component of this module discusses the how and why of integrating
with KidPix software. The learner is engaged in observation of the children as they develop the task with the instructor.

![Figure 4. Coaching stage in cognitive apprenticeship template](image)

The instructor is offering heuristic and control strategies to creating an effective lesson that integrates content with technology. In this stage the learners are actually acquiring the “tools” to create this lesson on their own. Here the instructor is acting as the practitioner by solving this authentic problem in her own way as the learner observers.

Scaffolding is presented in the form of databases and products. Learners can refer to the top ten list of management techniques for using the computer with students as well as a complete lesson plan on this particular module. KidPix tutorials are also offered for the learner to explore.

The articulation stage is the next component of this template. Here, the learners are asked to create their own lesson using KidPix software to fit the needs of their own classroom (see figure 5). This is another piece of the cognitive apprentice paradigm in which learners become aware of how to solve problems on an expert level. Learners are given heuristic strategies on developing effective lesson planning.
Scaffolding is provided with a lesson plan template that walks learners through each component piece of an effective lesson plan.

![Figure 5. Articulation stage in cognitive apprenticeship template](image)

The lesson plan may then be printed out for future use in the classroom. KidPix tutorials and content standard databases are also present in this stage. Learners have had the opportunity to observe, engage, and develop the cognitive strategies used in creating effective technology integration with a master teacher up to this point. The audio/video scaffolding has been removed in this portion so that the learners can ‘set out on their own’ and try to create their own lesson. The learner may return to any previous portion of the template at any time in order to receive more scaffolding. It is important to note that removing the scaffolding of the master instructor is done here on purpose. This is to encourage the learners to develop a collaborative environment with others working on the same problems as they are. It is meant to exploit others in the community of practice and to create intrinsic motivation to complete the task without the master technology teacher.
In the Shaw (1996) model, reflection should be the next stage. However, exploration is the next stage in this template (see figure 6). These were switched on purpose so that the learners would be able to reflect on their abilities to problem solve as experts. The reflection stage was created as a user satisfaction stage in the template and will be discussed next.

![Figure 6. Exploration in cognitive apprenticeship template](image)

The exploration stage is used not only to promote autonomy in learning, but also as a way in which to have the learners reflect on the process of becoming expert problem solvers in technology integration. Learners are asked to work in collaborative groups and answer the questions that are presented to them in this stage. These questions are designed to move the learner away from needing expert help to becoming autonomous in their problem solving abilities. Scaffolding resources are available that enable the learners to reflect on their knowledge gained in manipulating through this template. Technology journals and lesson plans help the learner develop a deeper understanding of why technology integration is an important component in teaching. Software tutorials are available to give
the learner the ability to develop other skills in computer use so that transfer can go beyond just the software presented in this template.

The last stage offered in this template is the reflection stage (see figure 7)

![Figure 7. Reflection in cognitive apprenticeship template](image)

This reflection stage is still under construction. The idea for the technology integration template was for the reflection stage to be used as a user satisfaction survey. This is one way in which the developers of this template can make changes in how the template is presented. Since this template has not been field tested yet, it is hard to say how effective it is in training teachers in technology integration.

**Conclusion:**

The cognitive apprenticeship technology template was specifically designed to give pre-service teachers an opportunity to gain problem solving ability in how to integrate technology into the classroom. Using the cognitive apprenticeship paradigm, Shaw (1996) created a model that explains how learning occurs in developing content standards to technology integration. The
University of New Mexico template has used Shaw’s model (1996) to create a template for use in disseminating the cognitive apprenticeship paradigm to pre-service teachers in order to have a more technology literate society. This template offers an alternative multimedia approach for pre-service teachers to develop skills in educational technology training.

The one question that remains unanswered is how effective is this template in training students to use technology? The reflection piece of this template is perhaps the most important in answering the above question. A user satisfaction survey is being created for this template. But is user satisfaction enough to create technology literate teachers for our classrooms? Research should be conducted based on user satisfaction. The user satisfaction piece would be beneficial for the designers as they create more lessons based in this template. I suggest some kind of field-testing to measure the effectiveness of using this type of evaluation for the template. Further research should be conducted to follow-up on the pre-service teachers that utilized this template in order to see if transfer did actually occur. It is important to note that the proof of transfer will occur in three to five years after the students have graduated from the University of New Mexico and are in the actual classroom conducting technology lessons based in content standards.