CULTIVATING REFLECTIVE THINKING:
THE EFFECTS OF A REFLECTIVE THINKING TOOL ON
LEARNERS’ LEARNING PERFORMANCE AND METACOGNITIVE
AWARENESS IN THE CONTEXT OF ON-LINE LEARNING

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ABSTRACT

The purpose of the study was to explore the effects of using a reflective thinking tool designed to prompt students to think reflectively about their learning goals, motivation, understanding, learning strategies, and interaction with peers and instructors on students’ learning performance and metacognitive awareness in an on-line learning context. Specially, this study investigated 1) if the use of a reflective thinking tool was effective in enhancing students’ learning performance and metacognitive awareness, 2) if there was any difference in learning performance and metacognitive awareness by level of students’ reflective thinking, and 3) how the students perceived the reflective thinking tool in its use for their learning.

Two research studies were conducted. Study 1 used a cohort research design in an agricultural business management course in a land-grant university in the northeastern United States. Thirty seven college students who received the treatment, an on-line reflective thinking tool, for two weeks in a course of the 2003 Fall semester were compared with a cohort group of 50 students who did not receive the treatment in the previous semester. Also, the learning performance and pre and post metacognitive awareness of the 37 participants in the treatment group was analyzed by level of reflective thinking.

Study 2 was carried out with college students in a statistics course that provided both a classroom-based and an on-line learning environment. Students in the treatment group (N=84) used a reflective thinking tool during the two-week study, whereas students in the control group (N=73) only wrote an essay about what they learned without the help
of the reflection tool. The two groups were compared in terms of their learning performance. Also, students’ performance and metacognitive awareness in the treatment group were compared with respect to the level of their reflective thinking.

The results of study 1 and 2 showed a significant difference in problem solving performance between those who used an online reflective tool and those in the control group who did not. However, there was no significant difference between the treatment and the control group on comprehension. These findings indicate that the reflective thinking activity may be effective for problem solving, but not for comprehension.

From the analysis of learning performance by level of students’ reflective thinking, the results from study 1 and 2 do not support the hypothesis that students who have a higher level of reflective thinking will perform better than those who have a lower level of reflective thinking on their learning performance because of inconsistent results between the two studies. Both study 1 and 2 showed that students’ metacognitive awareness was significantly enhanced by the activity of reflective thinking.

Finally, the results of this study indicate that students who have a higher level of reflective thinking show a higher regulation of cognition. However, the relationship between reflective thinking and the component of knowledge about cognition was not significant.
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CHAPTER 1

INTRODUCTION

Problem Statement

Cultivating students’ ability to think has been an important theme for redesigning and reforming traditional instructional and learning systems (Jones & Idol, 1990; Tishman, Jay, & Perkins, 1993). Traditional teaching-centered systems have been criticized for failing to emphasize the development of student thinking (Baron & Sternberg, 1987; Hannafin & Land, 1997; Onosko & Newmann, 1994). As a result, creating more thoughtful learning environments reflecting contemporary theory and research in instruction and learning has been recommended. These learning environments have focused largely on prompting students to develop various thinking skills necessary to successfully perform learning tasks by engaging them in generating questions, representing their understanding, solving complex authentic problems, arguing different perspectives, and reconstructing their own thinking (American Psychological Association, 1996; Bonk & King, 1998; Duffy & Cunningham, 1996; Grabowski, 1997; Mayer, 1991; Reigeluth, 1999; Sternberg, 1998; Tishman, Perkins, & Jay; 1995).

Research on thinking has indicated that facilitating meaningful thinking by the student in the learning process helps them enhance awareness of their own thinking, attitudes towards thinking processes, organization of thinking processes, flexible and effective use of knowledge and cognitive learning strategies, and their learning
performance and cognitive growth (Ertmer & Newby, 1996; Paris & Winograd, 1990; Rogoff, 1990; Swartz & Perkins, 1990). Research also has identified various types of thinking, such as critical thinking, creative thinking, reasoning, decision making, problem solving, metacognition, or reflective thinking, as the important capabilities of students that should be cultivated in both instructional and learning situations and everyday life (Mayer, 1991; Tishman, Jay, & Perkins, 1993).

Diverse Perspectives on Reflective Thinking

Reflective thinking has been explored by many scholars of diverse traditions and perspectives in education, such as John Dewey (1933), experiential learning theorists (e.g., Boud, Keogh, & Walker, 1985; Kolb, 1984), researchers of professional education and development (e.g., Schön, 1983), and educational psychologists studying metacognition and self-regulated learning (e.g., Brown, 1987; Flavell, 1987; Zimmerman, 2002). These diverse approaches to the study of reflective thinking have led to various definitions and roles of reflective thinking and the interchangeable use of the terms reflective thinking, reflection, self-reflection, metacognitive reflection, or critical reflection in the literature (Ertmer & Newby, 1996; Grimmett, 1988; Moon, 1999a; Rogers, 2002).

Dewey (1933), who introduced the idea of reflective thinking in education, views it as a specialized form of thinking that arises from a state of doubt, uncertainty or difficulty that the learner has experienced in their learning. According to Dewey (1933), reflective thinking is a process of solving the “perplexity”, triggered by a learning
experience. He defines reflective thinking as “an active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and further conclusions to which it leads… it includes a conscious and voluntary effort to establish beliefs upon a firm basis of evidence and rationality” (Dewey, 1933, p.9). His view of reflective thinking appears to be central to the study of reflective thinking in experience-based learning and professional education and development (Grimmett, 1988; Moon, 1999a).

Reflection in experiential learning is considered as an essential activity for making meaning and creating new perspectives about the learning experience (Boud, Keogh, & Walker, 1985; Kolb, 1984; Lewis & Williams, 1994). In Kolb (1984)’s experiential learning cycle, for instance, “reflective observation” is addressed as a process of what learners add to the “concrete experiencing of an experience” by reflecting on the experience in order to create generalizations in the next stage, “abstract conceptualization” that guides further action, called “active experimentation.” Researchers of experiential learning emphasize that learners cannot learn from experience without reflection. Reflection enables learners to learn from their learning experience in such a way that they are cognitively and affectively changed (Boud, Keogh, & Walker, 1985; Boyd & Fales, 1983; Kolb, 1984; Moon, 1999b).

Reflective practice of practitioners has also been seen as an important element in professional education and development, especially teacher education. According to Schön (1983), practitioners’ professional knowledge is constructed by two main forms of reflection, reflection-in-action and reflection-on-action. Reflection-in-action occurs in
response to unexpected consequences during learning activities that the learners are currently doing, while reflection-on-action, as the activity of stop and think, occurs after an activity has been completed in order for the learners to extract meaning from their experience and improve future action or performance (Schön, 1983). Both types of reflection are regarded as a process in which practitioners reorganize and construct personal and practical knowledge that leads to new understanding of self as a professional within the context of the activity.

Other accounts of reflection or self-reflection have been discussed extensively within the study of educational psychology, especially within the study of metacognition and self-regulated learning. In general, metacognition refers to one’s ability to be aware of and to have control over the cognitive processes engaged in learning (Brown, 1987; Flavell, 1987; Sternberg, 1998; Swartz & Perkins, 1990). It involves two major components: knowledge about cognition (i.e., knowledge about self, task, and strategies) and regulation of cognition (i.e., planning, monitoring, and evaluating the learning process) (Schraw & Dennison, 1994; Schraw & Moshman, 1995). From the perspectives of metacognition, reflective thinking is believed to be associated with the component of regulation of cognition (e.g., Davidson & Sternberg, 1998) or serves as the link between two components of metacognition, knowledge of cognition and regulation of cognition (e.g., Ertmer & Newby, 1996). Therefore, reflective thinking can be interpreted as an integral process of metacognition in that reflection can make it possible for students to be metacognitively aware of their cognitive process and to monitor, analyze, and evaluate their learning processes and performance. In addition, Zimmerman (2000, 2002) proposes a model of self-regulated learning consisting of three cyclical phases: forethought,
performance, and self-reflection. According to Zimmerman (2002), self-reflection involves self-judgment (i.e., comparison of self-observed performance, beliefs about the cause of one's errors or successes) and self-reaction (i.e., feelings of self-satisfaction). Self-reflection, therefore, can be seen as a continuous process that learners evaluate their motivational, cognitive, and metacognitive activities engaged in performing a learning task and learning outcome.

The Importance of Reflective Thinking in Learning

As illustrated above, reflective thinking can be seen as a fuzzy construct because there has been no clear common definition, roles, or process of reflective thinking in students learning making it is difficult to distinguish reflective thinking from other thinking skills such as metacognition. Moon (1999a) points out that reflective thinking has been initiated or guided differently or used and applied for different purposes in a variety of fields of education. In spite of being a construct that is theoretically vague, however, many researchers from diverse traditions and perspectives argue that reflective thinking is an important capability or cognitive behavior that should be developed in students (Dewey, 1933; Ertmer & Newby, 1996; Perkins, Jay, & Tishman, 1993; Schön, 1983). The assertions of researchers about the importance of reflective thinking in instruction and learning are described below.

First, reflective thinking encourages learners to make deep understanding of a domain by articulating and monitoring what they have learned and to better use their cognitive process skills by evaluating whether cognitive process skills that they have used
do work or don’t work (Schraw, 1998; Walters, Seidel, & Gardner, 1994). Second, reflecting on learning experience can make students transform negative experience associated with their feelings or motivation (e.g., discomfort, anxiety, difficulty) that they have experienced into positive learning experiences (Boud, Keogh, & Walker, 1985; Boyd & Fales, 1983; Moon, 1999a). Third, students’ reflective activities can lead to changes to the way (e.g., belief, value) of dealing with their learning in the future by extracting inferences or meaning from their learning experience (Dunlap, 2002; Ertmer & Newby, 1996; Lin, Hmelo, Kinzer, & Secules, 1999; Moon, 1999a). Finally, students’ reflection can provide teachers with valuable information about their students, such as students’ learning processes, understanding, feelings, and even beliefs or values in working on their learning tasks (Walters, Seidel, & Gardner, 1994).

**Strategies for Supporting Reflective Thinking**

Journal writing has been commonly used as a strategy to encourage learners to reflect and articulate their learning processes and strategies in professional education and development, especially teacher education. Journal writing refers to written material that is based on reflection on one’s learning (Moon, 1999b). The purposes of journal writing in instruction and learning situations, in general, are 1) to capture and record learning progress and experience, 2) to enable learners to understand their own learning process, 3) to increase active involvement in learning and the ownership of learning, 4) to enhance
the ability to reflect and improve the quality of learning, and 5) to enhance thinking skills and improve learning performance (Cole, 1995; Dunlap, 2002; Moon, 1999b).

Although researchers of teacher education have investigated those educational potential benefits of journal writing, most of them have concentrated mainly on qualitative research approaches to explore pre-and in-service teachers’ perspectives on their teaching and learning practices, methods and attitudes toward teaching. These studies have indicated that journal writing is a powerful tool to capture student teachers’ reflective activity, perceptual change, and understanding of teaching practice and can help student teachers to reflect on their own teaching experience, beliefs, attitudes, issues in teaching, and their roles as future teachers (Cole, 1995; Dunlap, 2002). Only few research studies, however, have provided empirical evidence of learning effects regarding the use of journal writing in students’ learning. The study of McCrindle & Christensen (1995), for instance, examined how journal writing affects college students’ cognitive and metacognitive processes and learning performance in a biology course. Their results indicated that students who were trained how to write a journal and asked to write it during laboratory classes performed better than the students who wrote a report on the material they were learning without training. They also reported that the journal-writing group showed better awareness and control of cognitive and metacognitive processes. However, there is a need to extend the study of journal writing to investigate its effects on different levels of students’ performance in learning situations (Moon, 1999b).

Another way to support reflective thinking is the use of instructional strategies such as questions, self-explanation, and self-monitoring. These strategies prompt learners
to answer questions about domain-specific knowledge and to explain their domain-specific understanding, thinking process or problem solving strategies while engaging in or after completing a learning task (Chi, Leeuw, Chiu, & Lavancher, 1994; King, 1990; Lin, Hmelo, Kinzer, & Secules, 1999; Palincsar, 1986; Palincsar & Brown, 1988).

Question prompts as a form of reflection, for example, have been used to support learners to articulate their understanding in a domain, to explain learning processes and actions, and to evaluate their performance in a variety of learning domains. The effectiveness of question prompts has been demonstrated in many research studies. These studies reported that question prompts enhance students’ domain-specific understanding and problem solving performance (Brown, 1987; Chi, Leeuw, Chiu, & Lavancher, 1994; Ge, 2001; King, 1991; Lin, 1999; Palincsar & Brown, 1989).

The research conducted by Lin (1999), for instance, investigated the effects of metacognitive, cognitive, and motivational question prompts on college students’ problem solving performance. Metacognitive question prompts were used to ask students to plan ahead of time, monitor the process, and evaluate the results. Cognitive question prompts focused on asking students to explain specific rules, goals, and strategies associated with the content of problems; and motivational question prompts asked students to explain their feeling about their learning process. The results of this study showed that students who responded to metacognitive question prompts performed better on a far transfer test of problem solving; and metacognitive question prompts encouraged students to ‘stop, think and reflect’ on their problem solving processes.
Another way to support students’ reflection is to use technological tools embedded in technology-supported learning systems. A number of technology-supported learning systems have integrated technological tools to support students’ reflection [e.g., KIE (Bell, 1997), CoVis (Edelson & O’Neill, 1994), STAR Legacy (Schwartz, et. al, 1999)]. These tools are embedded in programs to capture a learner’s thinking and actions, to allow them to monitor the processes they use for inquiry, and to enable them to evaluate their performance. For example, STAR Legacy (Schwartz, et. al, 1999) provides students with a technology function, called a notebook tool that enables students to store their ideas while learning for subsequent reflection and to reflect on the products at the end of the learning cycle. These research studies have investigated the learners’ perspectives on the use of these tools.

A few researchers have reported the effects of these technology tools on the actual learning processes and performance. White & Frederiksen (1998), for instance, found that a reflective-assessment tool to support students to evaluate their learning progress had a strong positive effect on middle school students’ inquiry performance. The effect of this tool was also greatest for students who had low scores on a standardized achievement test (White & Frederiksen, 1998). They indicated that supporting students to reflect on and evaluate their learning progress and products affects students’ products, especially low-achieving students who lack the metacognitive monitoring and reflecting skills. These learning effects, however, may be attributed to a combination of several learning tools within a technology-supported learning system, such as a scaffolding tool, an authoring tool, a reflective assessment tool, and so on. Also, the learning effects described in this
research may not be generalizable to college level students. Therefore, the effects of those tools for supporting students’ thinking need to be tested under more controlled conditions and to examine their use in college learning situations.

In summary, the research on reflection and metacognition emphasizes the importance of cultivating learners’ reflective thinking in instruction and learning situations. However, learners’ reflective thinking does not occur spontaneously. Research on metacognition has indicated that learners lack conscious and purposeful reflection to evaluate the results of their own learning efforts, learning processes, and performance (Schraw, 1998; Tishman, Jay, & Perkins, 1993; White & Frederiksen, 1998). Dewey (1933) argues that learners have to learn how to think, especially how to construct the habit of reflection. Therefore, instructional and learning strategies for cultivating students’ thinking ability in a learning environment should be developed and tested.

On-line learning has been largely used in higher education and has potential for supporting and prompting students’ learning. Most on-line learning systems such as WebCT and ANGEL provide instructors and students with various technology tools to support instructional and learning activities. However, there is a limitation in terms of capturing what students do, how they make their learning progress, or what kinds of learning difficulty they have had (Choi, 2002). Therefore, an effort to make technological tools to support students’ thinking activities in on-line learning environments should be made by integrating results of research studies that have investigated the learning effects of learning strategies in traditional classroom situations. This study was driven by this
need and by the demand to explore how to design effective learning tools to support learners’ reflective thinking in an on-line learning context.

**Purpose of the Study**

The purpose of the study was to explore the effects of using an electronic supported reflection tool designed to prompt students to think reflectively about their learning goals, motivation, understanding, learning strategies, and interaction with peers and instructors on students’ learning performance and metacognitive awareness in an on-line learning context.

To examine the learning effectiveness of students’ reflective practice using an electronic tool, a definition of reflective thinking was established from researchers’ perspectives from diverse traditions. Reflective thinking refers to the process of one’s purposeful and conscious activity to monitor, analyze, and evaluate one’s own learning in terms of achieving learning goals, sustaining motivation, making deep understanding, using appropriate learning strategies, and interacting with peers and instructors in order to construct new perspectives of learning that directly lead to improve learning process and performance.

As shown in Figure 1-1, the assumptions of this study were based on the previous research on reflective thinking. First, reflective thinking support can make students aware of their learning activities during or after learning by providing an external tool for reflection. It can also guide students to reflect on their own learning effort and actions, in
terms of their learning goals, understanding, motivation, learning strategies, and interaction with peers and instructor. These six targets for reflection have been noted as important factors that influence students’ learning processes and performance (e.g., Kyza, Golan, Reiser, & Edelson, 2002; Walters, Seidel, & Gardner, 1994; Zimmerman, 2002). Therefore, these targets for reflection function as a foundation for explaining students’ reflective thinking in this study. It was hypothesized that by having students reflect on those targeted areas, they have an opportunity to analyze, evaluate, and reflect on their own learning experience. Second, through conscious and purposeful reflective activity enhanced by a given reflective thinking tool, students can reconstruct or construct new perspectives or understanding of learning that guides the improvement of learning actions and performance. Third, reflective thinking should be continuous, with new perspectives from their previous reflection being transferred to future learning situations. and reflective thinking should be continuous for better learning activities and performance. Students’ habitual use of reflection, therefore, is expected in every learning situation.
Research Questions

The overarching research question of the study was: What are the effects of using a reflective thinking tool for prompting college students to think reflectively about their learning experience in the context of on-line learning?

More specifically, the study investigated the following research questions.

Question 1: Does the use of a reflective thinking tool affect students’ learning performance in comprehension or problem solving?
**Question 2:** Is there any difference between comprehension or problem solving scores by level of students’ reflective thinking?

**Question 3:** Does the use of a reflective thinking tool increase students’ metacognitive awareness, as measured by Metacognitive Awareness Inventory (MAI) before and after on-line learning?

**Question 4:** Is there any difference in their metacognitive awareness by level of students’ reflective thinking?

**Question 5:** How do the students perceive the reflective thinking tool in terms of its usefulness in and contribution to their reflection and on-line learning?

**Research Hypothesis**

Based on research purposes and questions, it is hypothesized that:

*Hypothesis 1:* Students studying with a reflective thinking tool will perform significantly better on comprehension and problem solving than those who do not.

*Hypothesis 2:* Students who have higher levels of reflective thinking will perform significantly better than those who have lower levels of reflective thinking on comprehension and problem solving.

*Hypothesis 3:* Students studying with a reflective thinking tool will significantly increase their metacognitive awareness.

*Hypothesis 4:* Students who have higher levels of reflective thinking will demonstrate a higher metacognitive awareness than those who have lower levels of reflective thinking.
Definitions of the Terms

*Reflective thinking*: refers to the process of one’s purposeful and conscious activity to monitor, analyze, and evaluate one’s own learning in terms of achieving learning goals, sustaining motivation, making deep understanding, using appropriate learning strategies, and interacting with peers and instructors in order to construct new perspectives of learning that directly lead to improve learning process and performance.

*Reflective thinking tool*: refers to a learning tool for supporting students’ reflective thinking in an on-line learning. This tool is embedded in an on-line learning system. This tool consists of six targets for supporting students’ reflective thinking: learning goal, understanding, learning strategies, interaction with peers and instructor, and motivation. These six targets for reflection function as a focus for students’ reflective thinking. The tool employs a self-assessment form and a question prompt form. A self-assessment form serves as a starting point for supporting students’ reflection and asks student evaluate their learning experience using a 5-point Likert scale (i.e., 1=not at all, 5= very well) in terms of how well they have performed. A question form serves to help students reason and reflect deeply as they assess their progress in each targeted area (See Appendix B).

*Metacognitive awareness*: is one’s awareness of knowledge and skills being used to control one’s cognitive processes in learning.
**Comprehension**: “… the lowest level of understanding. It refers to a type of understanding or apprehension such that the individual knows what is being communicated and can make use of the materials without necessarily relating it to other material” (Bloom et al., 1956, p. 204).

**Problem solving**: students’ abilities to use several rules in combination to solve new or novel problems (Gagne, 1985). In this study, well-structured problems were used to evaluate students’ problem solving performance. A well-structured problem has one correct answer that students can attain by applying a procedure or ski that they learned. (Frederiksen, 1984).
CHAPTER 2
LITERATURE REVIEW

The purpose of the study was to explore the effects of using an electronic supported reflection tool designed to prompt students to think reflectively about their learning goals, motivation, understanding, learning strategies, and interaction with peers and instructors on students’ learning performance and metacognitive awareness in an online learning context. In this literature review, diverse perspectives on reflective thinking from different traditions and contexts of education are first discussed. Instructional and learning strategies that have been applied to enhance learners’ reflective thinking in face-to-face and technology-supported learning environments are then explored. Finally, effects of these instructional strategies for supporting reflective thinking on learners’ learning performance such as comprehension and problem solving are also examined through a review of previous research studies.

Perspectives on Reflective Thinking

In this section, the nature or meaning and roles of reflective thinking in education, especially in instruction and learning situations, are discussed through the review of the diverse perspectives of John Dewey, experiential learning theorists, the researchers of
professional education and development, and cognitive psychologists of reflective thinking.

Dewey’s Perspectives on Reflective Thinking

Dewey (1933) introduced the construct of reflective thinking with a philosophical point of view to education in his book, *How We Think*. He focused on the nature of reflective thinking and how it occurs. He viewed reflective thinking as a specialized form of thinking that stems from a state of doubt, uncertainty, or difficulty which one experiences in a situation. The experienced perplexity leads to purposeful inquiry to resolve it through reflective thinking. He stated that “the function of reflective thinking is to transform a situation which there is experienced obscurity, doubt, conflict, disturbance of some sort, into a situation that is clear, coherent, settled, harmonious” (Dewey, 1933, p.100-101). On this basis, reflective thinking can be viewed as an intentional and conscious activity to resolve problematic situations. Dewey (1933) defined reflective thinking as “active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and further conclusions to which it leads…it includes a conscious and voluntary efforts to establish belief upon a firm basis of evidence and rationality” (Dewey, 1933, p.9).

Dewey (1933) described the process of reflective thinking as having five phases: (1) suggestions, in which the mind leaps forward to a possible solution, (2) an intellectualization of the difficulty or perplexity that has been felt (directly experienced)
into a problem to be solved, a question for which the answer must be sought, (3) the use of one suggestion after another as a leading idea, or hypothesis, to initiate and guide observation and other operations in the collection of factual materials, (4) the mental elaboration of the idea or supposition as an ideas or supposition (reasoning, in the sense in which reasoning is a part, not the whole, of inference), and (5) testing the hypothesis by overt or imaginative action (p. 107). On this basis, the process of reflective thinking is a process of transforming a perplexing situation into a settled one by suggesting a tentative resolution to the initial problem.

Dewey (1933) believed that reflective thinking requires attitudes that value the personal and intellectual growth of a person. According to him, the attitudes of open-mindedness, whole-heartedness, and responsibility are essential to reflective thinking in education.

Open-mindedness is an attitude in which one actively tries to remain free of prejudice and partisanship which both tend to close the mind to new ideas, new problems, and seeing alternatives. “It includes an active desire to listen to more sides than one; to give heed to facts from whatever source they come; to give full attention to alternative possibilities; to recognize the possibility of error even in the beliefs that are dearest to us” (Dewey, 1933, p. 30).

Whole-heartedness is an attitude in which one continually strives to understand his or her commitment and makes efforts to see situations from difference perspectives (Zeichner, 1996). Dewey (1933) describes whole-heartedness as having an absorbed
interest in intellectual development, which creates an energy, enthusiasm, and persistence in the holder of the attitude.

Responsibility is “to consider consequences of a projected step; it means to be willing to adopt these consequences when they follow reasonably from any position already taken…Learners must ask for the meaning of what they learn, in the sense of what difference it makes to the rest of their beliefs and to their actions” (Dewey, 1933, p. 32). Responsibility helps to bind whole-heartedness and open-mindedness. Dewey believed these three attitudes need to be cultivated, as does the whole of reflective thinking.

In summary, Dewey’s approach to reflective thinking can be considered as a holistic way of making meaning which leads to the intellectual and moral growth of the individual by evaluating or interpreting a learning experience, especially problems felt in a situation. On this basis, reflective thinking can serve to generate knowledge in a learning situation. Dewey’s view of reflective thinking has been adopted by experiential learning theorists and the researchers of professional education and development as a backbone of their studies.

**Experiential Learning Theorists’ Perspective on Reflective Thinking**

Lewis & Williams (1994) noted that experiential learning focuses on the importance of learners’ experience they are constructing in a learning situation and on encouraging reflection about learners’ experience to develop new skills, new attitudes, or
new ways of thinking. As shown in Figure 2, Kolb (1984) proposed learning as the process whereby knowledge is created through the transformation of experience. In his model of experiential learning, true learning is depicted as a four-part process. Learners have “concrete experiences”; then they reflect on the experiences from a variety of perspectives. From these “reflective observations” learners engage in “abstract conceptualization”, creating generalizations or principles that integrate their observations into theories. Learners then use these generalizations as guides to engage in further action, called “active experimentation,” where they test what they have learned in other more complex situations. This in turn leads to another set of concrete experiences and another round of learning at a more sophisticated level. Kolb theorized that learning increases in complexity through this process and thus the learning cycle is transformed into a learning spiral of ever-increasing complexity (Kolb, 1984).

![Figure 2-1. Kolb’s model of experiential learning.](image-url)
Moon (1999a) pointed out that the reflection in Kolb’s model of experiential learning serves to make sense of experience and to make change in the quality of the learning activity and outcome. According to Moon, the characteristics of the phases of reflective activity in the experiential learning cycle include (1) development of a need to resolve something, (2) clarification of the issue, (3) review and recollection, (4) processing of knowledge and ideas, and (5) eventual resolution and possible action and transformation.

One team of experiential learning theorists, Boyd and Fales (1983) saw reflective activity as the key element in learning from experience, saying that it is “the core difference between whether a person repeats the same experience several times…or learning from experience in such a way that he or she is cognitively changed or affectively changed” (p. 100). They defined reflection as “the process of creating and clarifying the meaning of experience (present or past) in terms of self (self in relation to self and self in relation to the world)…the outcome of the process is changed conceptual perspectives” (p. 101).

Boud, Keogh, and Walker (1984), who extended Dewey’s view of reflective thinking and Kolb’s experiential learning, argued that reflection is an important human activity in which people recapture their experience, think about it, mull it over and evaluate it. They defined reflection in the context of learning as “a generic term for those intellectual and affective activities in which individuals engage to explore their experiences in order to lead to new understandings and appreciations” (p. 19).
The perspectives of experiential learning theorists imply that reflection is an important activity in a learning situation that enables learners to make meaning from their learning experience and to construct new perspectives that lead to improved learning actions and performance in future learning.

**Schön’s Perspectives on Reflection**

Schön (1983) argued that practitioners’ professional knowledge could be constructed by their reflective practice. Reflective practice involves the dialectical examination between theory and practice in determining what actions to take or why a certain action was taken and the results of these actions (Schön, 1983). “Reflective practice is a challenging, focused, and critical assessment of one’s own behavior as a means towards developing one’s own craftsmanship” (Osterman, 1990, p. 134). Through the questioning of one’s action and reasoning, practitioners can reflect on the effectiveness of these action choices, and they use the new perception as a means of developing alternate strategies. Through this dialectic process of thought and action, the practitioner takes an active role in shaping his or her own professional growth.

Schön (1983) proposed two main forms of reflection: reflection-in-action and reflection-on-action. According to Schön, reflection-in-action (Moon, 1999a) occurs in association with action and guides the process of action via knowledge in use, which is derived from theory in use. Reflection-in-action only occurs in situations where the
action yields unexpected consequences. Reflection-on-action is the form of reflection that occurs after action and relates, via verbalized or non-verbalized thought, to the action that the person has taken. In other words, it is a relatively narrow concept that is retrospective and has a role in learning, in informing action and in their building (Moon, 1999a). Both types of reflection involve some form of experimentation in which practitioners attempt to create meaning of the problematic aspects of a practice situation through problem setting and problem solving (Grimmett, 1988). This reframing of a problem situation enables practitioners to make use of their existing repertoire of examples, images, understandings, and actions. Reflection, thus, engages practitioners in a conversation with the problematic situation. The cyclical nature of this conversation is a fundamental aspect of reflection for new understandings of the situation (Grimmett, 1988).

Schön’s view of reflection is regarded as the reconstruction of experience. Experience including one’s past and present learning practices and one’s personal biography is shaped by reflection. Reflection, then, is regarded as a process in which practitioners structure and restructure their personal and practical knowledge. The context of Schön’s conception of reflection was constituted by action settings which precipitate puzzles or surprises for the professional practitioners. His focus was on how practitioners generate professional knowledge in and appreciate problematic features of actions settings (Grimmett, 1988).
Cognitive Psychologists' Perspectives on Reflection

Cognitive psychologists have emphasized that metacognition is one of the important abilities of the students that should be developed (Garner & Alexander, 1989; Gourgey, 1998; Paris & Winograd, 1990). Most cognitive psychology researchers agree that metacognition is one’s knowledge and skills about awareness of, and control over one’s cognitive activities and process (Schraw & Dennison, 1994; Sternberg, 1998; Swartz & Perkins, 1990). Schraw and Dennison (1994) described metacognition as consisting of two major components: Knowledge about cognition, and regulation of cognition. According their perspective, knowledge about cognition refers to what learners know about their cognition and includes three sub-components: “declarative knowledge (e.g., knowledge about self, strategies), procedural knowledge (e.g., knowledge about how to use strategies), and conditional knowledge (e.g., knowledge about when and why to use strategies)” (p. 460). Regulation of cognition refers to one’s cognitive activities to control his or her learning and includes sub-components such as planning (e.g., setting goals, selection of appropriate strategies, allocation of resources), monitoring (e.g., monitoring cognitive processes and learning progress), and evaluation (e.g., evaluating learning goals and learning performance) (Schraw, 1998; Schraw & Dennison, 1994). The two main components of metacognition are closely interrelated and all sub-components of two main components are also intercorrelated (Schraw, 1998).

Research on metacognition showed that students who were stronger in using metacognitive knowledge and skills in their learning process perform better than weaker students (Lin, 2001; Sternberg, 1998). However, there has been no clear description
about the relationship between metacognition and reflective thinking. From the perspective of metacognition, it can be inferred that reflective thinking is a component of metacognition in terms of monitoring and evaluating learning process and the results of one’s own learning efforts. In this sense, reflective thinking may be associated with regulation of cognition in metacognitive activities. Ertmer and Newby (1996) argue that reflective thinking serves as the link between knowledge about cognition and regulation of cognition. In other words, a learners’ reflection on the learning process can lead to increased metacognitive knowledge (knowledge about cognition) and skills (regulation of cognition). Ertmer and Newby (1996) state that “as a powerful link between thought and action, reflection can supply information about outcomes and the effectiveness of selected strategies, thus making it possible for a learner to gain strategy knowledge from specific learning activities…reflection allows learners to consider plans made prior to engaging in a task, the assessment and adjustments made while they work, and the revisions made afterwards” (p. 14). From the perspective of metacognition, therefore, reflective thinking can be interpreted as a cognitive activity to rethink one’s metacognitive knowledge and metacognitive control engaged in the process of learning.

Reflection or self-reflection has also been discussed within the study of self-regulated learning. As shown in Figure 2-2, Zimmerman (2002) proposed a model of self-regulated learning. This model consists of three phases: forethought, performance, and self-reflection. The forethought phase refers to processes and motivation that occur before learning. This phase has two major components: task analysis and self-motivation. The performance phase refers to processes that occur during learning and involves self-
control and self-observation. The self-reflection phase refers to processes that occur after learning and influences a learner’s self-judgment of and self-reactions to learning experience. In this model, self-reflection is an integral process that learners evaluate their own learning performance and attribute causal significance to the results. The self-reflective process of self-evaluation and attributional self-judgment leads to self-reactions (i.e., self-satisfaction, adaptive inferences, defensive inferences). These self-reactions influence forethought processes in a cyclical self-regulated learning model.

Figure 2-2. A self-regulated learning model. Adapted from B.J. Zimmerman (2002). Becoming a self-regulated learner. Theory Into Practice, 41(2), 64-70.
Defining Reflective Thinking for This Study

Diverse perspectives on reflective thinking from different traditions and contexts of education were explored above. From these perspectives, a definition of reflective thinking for this study was established. Reflective thinking refers to the process of one’s purposeful and conscious activity to monitor, analyze, and evaluate one’s own learning in terms of achieving learning goals, sustaining motivation, making deep understanding, using appropriate learning strategies, and interacting with peers and instructors in order to construct new perspectives of learning that directly lead to improved learning processes and performance. This definition of reflective thinking is similar to not only cognitive psychologists’ perspective in terms of a cognitive activity engaged in the learning process, but to Dewey’s view in terms of reflective thinking transforming new perspective or understanding of learning that lead to change in the students.

Instructional and Learning Strategies for Prompting Reflective Thinking

In this section, various instructional and learning strategies used for scaffolding students’ reflective thinking are reviewed. Specifically, the use of journal writing, question prompts for self-explanation and self-evaluation, and learning tools integrated in technology-enhanced learning environments are discussed. Also, the effects of these strategies on learners’ learning are examined through the review of previous research studies.
Prompting Reflection Using Journal Writing

Journal writing as a vehicle for encouraging learners’ reflection has been used in a wide variety of educational settings. Journal writing, in general, refers to written verbal material that is based on reflection on one’s learning (Moon, 1999b). While there are a variety of types or forms of journal writing based on their purposes and uses in diverse contexts, it is agreed that journal writing is an instructional and learning strategy that encourages learners to reflect on their learning and thinking (Cole, 1995; Moon, 1999b). Moon (1999b) argues that journal writing is an effective learning tool to “(1) record experience, (2) to facilitate learning from experience, (3) to support understanding and the representation of the understanding, (4) to develop critical thinking or the development of a questionable attitude, (5) to encourage metacognition, and (6) to increase ability in reflection and thinking” (p. 40).

Research on journal writing has been conducted in higher education. Most of research studies on journal writing focused on how journal writing can be used to help students’ learning. For example, Dunlap (2002) investigated how journal writing could be used to capture and track college students’ perceptual change and to encourage them to reflect on their learning and accomplishments by using a qualitative research approach. The journal writing in this study consisted of specific questions focusing on self-directed skills (e.g., setting goals, identifying resources, analyzing skills and strategies used in learning) and metacognitive skills (e.g., taking control of learning, monitoring and evaluating learning process and strategies). She reported that the journal writing gave students an opportunity to reflect on and articulate their learning process, reinforcing the
development of and use of self-directed learning metacognitive skills. Research on journal writing in teacher education has indicated that journal writing helps student teachers reflect on their teaching activities and experience, beliefs, attitudes, and issues related to teaching and their roles as future teachers.

Only a few research studies have provided empirical evidence of learning effects regarding the use of journal writing in students’ learning. For example, in the research conducted by Cole (1995), which used a quantitative and qualitative research method, journal writing was used as a learning tool to support college students’ understanding in a literature course for 15 weeks. The results of this study indicated that the journal writing supported students in attending to details, asking questions, and answering their own questions. However, journal writing in this study was not significantly related to students’ achievement (e.g., reading comprehension). The study by McCrindle & Christensen (1995) investigated the effects of journal writing on college students’ metacognitive awareness and learning performance. This research reported that the journal writing group performed better and showed better awareness and control of cognitive and metacognitive awareness than the control group who just wrote a report on the learning materials they studied.

**Prompting Reflection Using Prompting (Question, Self-explanation)**

Questions or self-explanation as instructional and learning strategies have been used extensively for a variety of instructional and learning purposes. In general, these
strategies guide students to generate effective questions that elicit meaningful interaction between students or between students and teachers. They focus on encouraging students to articulate domain-specific understanding that they are constructing and even articulate thinking processes such as a problem solving (King, 1990; Lin, Hmelo, Kinzer, & Secules, 1999; Palinscar, 1986; Palinscar & Brown, 1988). Most studies have indicated that questioning strategy fostered students’ reading comprehension.

Questions for prompting reflection on a problem solving process were used by King (1991) and Lin (1999). In the King study, questions were categorized into three levels—planning, monitoring, and evaluating. These questions were developed to support students to identify the problem, foster greater access to known strategies, monitor problem solving, and evaluating the results of problem solving in math. These question prompts help students to articulate the steps they have taken and decisions they have made and to reflect on their problem solving process. King (1991) reported that this question prompt influenced students’ math problem solving performance.

Lin (1999) used three different question prompts to support college students’ problem solving performance in her study: metacognitive, cognitive, and motivational question prompts. Metacognitive questions such as “where is your plan for solving the problem?” “how did you decide that you have had enough data to make conclusions?” focused students’ activities in planning, monitoring, and evaluating their learning process and products. Cognitive prompts focused on asking students to explain specific rules, goals, and strategies associated with the content, and motivational prompts asked students to explain their feeling in their learning process. The results of this study showed that
students who responded to metacognitive prompts performed better on far transfer tests of problem solving and the metacognitive prompts encouraged students to ‘stop, think and reflect’ on their problem solving processes.

Self-explanation prompts have also been used to guide student attention to conflicting thoughts and to build coherent understanding of the domain tasks. For example, in Chi et al.,’s study (1994), a group of middle-school students were prompted to explain what each line of a passage on the human circulatory system meant to them immediately after reading each line. The researchers found that the prompted group had a greater gain from the pretest to the posttest. Moreover, the prompted students who generated a large number of self-explanations learned with greater understanding than did the low explainers.

Overall, prompting (e.g., questions, self-explanation) supports students to articulate the learning process they have followed and decisions they have made, facilitating their understanding of the reasons behind actions. Most prompting used in previous research studies were closely related to an activity that students articulated and reflected their understanding of content-specific knowledge. In other words, prompting has been used to facilitate students’ cognitive and metacognitive activities in order for them to gain deep understanding of a domain-specific knowledge.

There are a number of technology-enhanced learning systems for supporting students’ learning activities. Most of these learning systems include a certain technological tool for supporting students’ thinking processes or reflective thinking. For example, a Collaborative and Multimedia Interactive Learning Environment (CaMILE) has been developed to support college students’ collaborative thinking (Guzdial et al., 1997). CaMILE provides students with an authoring interface such as “New idea,” “Revision,” “Question,” “Alternative,” “Comment,” and “Rebuttal.” This interface guides students to articulate their thinking process.

The Collaborative Visualization (CoVis) environment was developed to enhance students’ science learning (Edelson & O’Neill, 1994). This learning environment provides a technological tool that can effectively organize on-line discussion. This tool supports community-based reflection while students are engaging in sharing their learning experience through reflective discourse. However, the learning effects of this tool were not reported.

Another technological tool to support reflection is Progress Portfolio (Kyza et al., 2002). This learning system was developed to promote the following cognitive activities: (1) identifying important information, (2) planning, (3) process monitoring, (4) synthesizing, interpreting, and analyzing, and 5) communicating. The Progress Portfolio program provides tools for students to create a record of their scientific inquiry activities by capturing snapshots of their work. Using various tools such as notes, text fields, and
graphic interfaces, students can record their thinking, questions, learning processes and reflective activities. In other words, through technological tools, students reassess their thinking around the captured artifacts, revisiting and revising their conclusions, and identifying gaps and mistakes.

In the Knowledge Integration Environment (KIE) for science education developed by Linn and her colleagues (Linn, 2000), several learning strategy tools (e.g., knowledge organization tool, visual scientific inquiry process prompt, and argumentation tool) were provided to support students’ scientific inquiry and thinking process. For example, this technology-enhanced science learning environment provides an argumentation tool called SenseMaker to support students to make scientific arguments. This tool supports students to effectively build and reflect on their arguments by providing a visual interface (e.g., Look at Theories, Create Evidence, and Plan for Debate) and real examples of experts’ arguments as a model that the students were asked to follow. Davis and Linn (2000) reported that this argumentation tool helped students to develop better scientific explanations.

Even though these technological tools that were used for various purposes (e.g., supporting thinking process, organizing knowledge, and argumentation) in technology-enhanced learning environments were not directly related to a function for supporting students’ reflective thinking, these studies imply that providing on-line prompts could direct students’ thinking and facilitate reflection.
Summary

In summary, instructional and learning strategies for prompting reflective thinking reviewed in this chapter are summarized in Table 2-1 in terms of their major functions and features. Also, the features of a reflective thinking tool that were used for this study are described to emphasize differences between this tool and other strategies used in previous research studies.

In terms of instructional and learning strategies that provide an opportunity for students to reflect on their own learning process and performance include journal writing, questions prompts, and a technological and reflective thinking tool used for this study are similar. However, the reflective thinking tool for this study is different in terms of a target or focus of students’ reflective thinking, a form that guides students’ reflection, and when a strategy for reflection is used (See Table 2-1).

Table 2-1

Major Functions and Features of Strategies for Prompting Reflective Thinking

<table>
<thead>
<tr>
<th>Strategies for prompting reflective thinking</th>
<th>Major Functions/Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal Writing</td>
<td>Major Functions:</td>
</tr>
<tr>
<td></td>
<td>• record students’ reflection on the content of their learning, the process of learning, and learning performance.</td>
</tr>
<tr>
<td></td>
<td>• provide opportunities to keep written records of personal reaction and comments on a particular issue, their performance, field trips, or projects and state opinions, ask questions, and make predictions about their performance.</td>
</tr>
<tr>
<td></td>
<td>Forms:</td>
</tr>
<tr>
<td></td>
<td>• a variety of forms based on the purposes and use of journal writing in diverse disciplines and contexts</td>
</tr>
<tr>
<td></td>
<td>• in general, unstructured form (e.g., free writing) and structured form</td>
</tr>
<tr>
<td>Prompting (Questions, Self-explanation)</td>
<td>Major Functions:</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td></td>
<td>• direct students’ attention to important information.</td>
</tr>
<tr>
<td></td>
<td>• help students elaborate and articulate their understanding of a particular domain knowledge.</td>
</tr>
<tr>
<td></td>
<td>• facilitate students’ thinking processes such a problem solving process or metacognitive thinking consisting of planning, monitoring, and evaluating while learning.</td>
</tr>
<tr>
<td></td>
<td>• enhance comprehension or recall of information and even problem solving performance</td>
</tr>
<tr>
<td>Forms:</td>
<td>• questions can be generated by students or provided by instructors.</td>
</tr>
<tr>
<td></td>
<td>• generic question prompts (e.g., what is main idea of this passage? why do you think this information is important to decide…?)</td>
</tr>
<tr>
<td></td>
<td>• metacognitive question prompts (e.g., plan, monitor, and evaluate problem solving process)</td>
</tr>
<tr>
<td>Findings:</td>
<td>• questioning strategy fostered students’ reading comprehension (King, 1990, Palinscar, 1986).</td>
</tr>
<tr>
<td></td>
<td>• metacognitive question prompts helped students perform better on problem solving (King, 1991).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technological Tools</th>
<th>Major Forms &amp; Functions:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• learning process prompts: provide various technological tools such a visual learning process map (e.g., display scientific inquiry process), a notebook tool (e.g., students can record important information and pose a question or answer a given question), argument tool (e.g., guide to students to make their arguments during problem solving process).</td>
</tr>
<tr>
<td></td>
<td>• social discourse prompts: provide a particular discussion or conversation tool for learners (e.g., provide multiple perspectives on content or process) This tool can be used for review and reconsideration by the learners.</td>
</tr>
<tr>
<td></td>
<td>Findings:</td>
</tr>
</tbody>
</table>
|                     | • few research that reported empirical evidence on the effects of technological tools: A reflective assessment tool were helpful for students who had low scores in an achievement test (White &
students’ perceptions on the use of technological tools: They helped students to articulate their thinking process and to make their thinking more visible (Guzdial et al., 1997; Kyza et al., 2000; Linn, 2000).

<table>
<thead>
<tr>
<th>Reflective Thinking Tool for this Study</th>
<th>Major Functions:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>promote students to think reflectively about six targeted areas: learning goals, motivation, understanding, learning strategies, and interaction with peers and instructors in order to improve their learning process and performance after students have completed their learning tasks in an on-line learning context.</td>
</tr>
<tr>
<td></td>
<td>these targeted areas focus students’ reflective thinking.</td>
</tr>
<tr>
<td>Forms:</td>
<td>consist of a self assessment and question form as a structured reflection form.</td>
</tr>
<tr>
<td></td>
<td>a self-assessment form serves as a starting point for reflection on each theme.</td>
</tr>
<tr>
<td></td>
<td>a question form functions as a prompt to help student make their reasoning and deep reflection based on their self-assessment in each theme.</td>
</tr>
<tr>
<td></td>
<td>this tool is embedded in an on-line learning system.</td>
</tr>
<tr>
<td></td>
<td>students record their reflection and retrieve them for their review or consideration.</td>
</tr>
</tbody>
</table>
The purpose of the study was to explore the effects of using an electronic supported reflection tool designed to prompt students to think reflectively about their learning goals, motivation, understanding, learning strategies, and interaction with peers and instructors on students’ learning performance and metacognitive awareness in an on-line learning context. Two experimental research studies were conducted. Participants, the context of the study, research design, and procedures were different in each experiment. The treatment, instruments, and data analyses were the same. In study 1, all components of the research are described in detail. In study 2, only the differences from study 1 are described in detail.

Study 1

Participants

The participants for study 1 were college students enrolled in an agricultural economics course, titled Introduction to Agribusiness Management (AGBM 200), during the 2003 Fall Semester in a land-grant university in northeastern United States. These subjects were selected because they were engaged in an on-line learning environment that was the learning context for this study.
In compliance with the university’s regulations, the purpose of the study, a brief
description of the procedure, and the benefits for participating in the study were
explained to all 49 students in the class in order to obtain their consent (See Appendix A).
All 49 students agreed to participate in the study. However, only 37 students’ data were
used for this study because 12 students did not complete all of the requirements needed
for this study. The demographic data of the participants is described in Table 3-1.

A comparable group of 50 college students who took AGBM 200 in the 2003
Spring semester in the same university served as a control group for the study. The
demographic data of 50 students is described in Table 3-2.
Table 3-1

Demographic Data of the Participants (Treatment Group) of Study 1

<table>
<thead>
<tr>
<th>Category</th>
<th>Variable</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>22</td>
<td>59.45</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>15</td>
<td>40.54</td>
</tr>
<tr>
<td>Class Standing</td>
<td>Sophomore</td>
<td>8</td>
<td>21.62</td>
</tr>
<tr>
<td></td>
<td>Junior</td>
<td>21</td>
<td>56.75</td>
</tr>
<tr>
<td></td>
<td>Senior</td>
<td>8</td>
<td>21.62</td>
</tr>
<tr>
<td>Age</td>
<td>18-21</td>
<td>24</td>
<td>64.86</td>
</tr>
<tr>
<td></td>
<td>22-25</td>
<td>12</td>
<td>32.43</td>
</tr>
<tr>
<td></td>
<td>26-30</td>
<td>1</td>
<td>2.70</td>
</tr>
<tr>
<td>Race</td>
<td>Caucasian</td>
<td>33</td>
<td>89.18</td>
</tr>
<tr>
<td></td>
<td>African</td>
<td>1</td>
<td>2.70</td>
</tr>
<tr>
<td></td>
<td>American</td>
<td>2</td>
<td>5.40</td>
</tr>
<tr>
<td></td>
<td>Hispanic</td>
<td>1</td>
<td>2.70</td>
</tr>
<tr>
<td></td>
<td>Asian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Take the Course</td>
<td>Required</td>
<td>27</td>
<td>72.97</td>
</tr>
<tr>
<td></td>
<td>Interested</td>
<td>4</td>
<td>10.81</td>
</tr>
<tr>
<td></td>
<td>Recommended</td>
<td>4</td>
<td>10.81</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>2</td>
<td>5.40</td>
</tr>
<tr>
<td>Online Course</td>
<td>Yes</td>
<td>5</td>
<td>13.51</td>
</tr>
<tr>
<td>Experience</td>
<td>No</td>
<td>32</td>
<td>86.48</td>
</tr>
<tr>
<td>Reflective</td>
<td>Yes</td>
<td>8</td>
<td>21.62</td>
</tr>
<tr>
<td>Thinking</td>
<td>No</td>
<td>29</td>
<td>78.37</td>
</tr>
<tr>
<td>Writing Experience</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3-2
Demographic Data of 50 Students (Control Group) of Study 1

<table>
<thead>
<tr>
<th>Category</th>
<th>Variable</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>34</td>
<td>68.00</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>16</td>
<td>32.00</td>
</tr>
<tr>
<td>Class Standing</td>
<td>Sophomore</td>
<td>12</td>
<td>24.00</td>
</tr>
<tr>
<td></td>
<td>Junior</td>
<td>35</td>
<td>70.00</td>
</tr>
<tr>
<td></td>
<td>Senior</td>
<td>3</td>
<td>6.00</td>
</tr>
</tbody>
</table>

Research Design

A cohort research design (Vockell & Asher, 1995) was employed for study 1. It is designed to use existing data from a cohort who did not receive the treatment to compare with a cohort receiving a treatment. This cohort design, was intended to explore research question 1 (Does the use of a reflective thinking tool affect students’ learning performance?). It compared the performance of the cohort who took AGBM 200 course and received the treatment during the 2003 Fall semester with the performance of the cohort who took AGBM 200 course in the 2003 Spring semester and did not received the treatment. The cohort design is diagrammed as follows:
O₁: A cohort who did not receive the treatment and took AGBM200 course in the 2003 Spring semester
X: Treatment, which is a reflective thinking tool
O₂: A cohort who received the treatment and took AGBM 200 course in the 2003 Fall semester

The independent variable in this study was the use of a reflective thinking tool. The dependent variables were comprehension, problem solving, and metacognitive awareness.

The Context of the Study

AGBM 200 Course

AGBM 200 was an undergraduate course designed to explore general principles of agribusiness management in both a classroom-based and on-line learning environment. This course was designed and organized based on the principles of case/problem-based learning by the instructor who had more than 25 years of teaching and research experience in the field of agribusiness management. For on-line learning of this course, an on-line course management system, called ANGEL (A New Global Environment for Learning), was used (see Figure 3-1 for the course syllabus screen).
The Context for the Study for the 2003 Fall Semester Students of AGBM 200 (Treatment Group)

For the purpose of the study, all instruction and learning activities occurred fully on-line through the ANGEL learning management system for two weeks. In other words, there was no face-to-face instruction in the treatment group. The students had access to the on-line course site on Monday, Wednesday, and Friday each week from a place that was convenient for them to use Internet. During the two weeks of on-line learning, students participated in six on-line learning sessions that were designed by the instructor and the researcher based on the course schedule (See Table 3-3).
Table 3-3

Six On-line Learning Sessions and Learning Activities

<table>
<thead>
<tr>
<th>On-line learning session</th>
<th>Learning topics</th>
<th>Primary learning activities</th>
</tr>
</thead>
</table>
| 1                        | The basic accounting documents: Balance sheets & P & L statement | Read all assigned learning materials  
                             |                                                                     | Case study: “Lil’s Place”, “Fred’s financial phobia” |
| 2                        | Comparative Statement analysis  
                             | Sources of net working capital                                   | Read all assigned learning materials  
                             |                                                                     | Answer questions |
| 3                        | Ratio analysis                                         | Read all assigned learning materials  
                             |                                                                     | Case study: “Ratio analysis” |
| 4                        | Cash flow budgeting                                    | Read all assigned learning materials  
                             |                                                                     | Case study: “Cash flow budgeting” |
| 5                        | Capital budgeting I                                    | Read all assigned learning materials  
                             |                                                                     | Answer questions |
| 6                        | Capital budgeting II: NPV/The Benefit/Cost Ratio/IRR    | Read all assigned learning materials  
                             |                                                                     | Case study: “Financial management exercises” |

As shown in Table 3-3, each on-line learning session had two primary learning activities. First, individual students studied all assigned learning materials associated with each learning topic, including on-line materials provided in the on-line course system and the textbook of the course. Second, students were engaged in a case study or answering questions assigned by the instructor (see Figure 3-2 for the case study). This learning activity provided students with an opportunity to apply what they learned to a real agricultural business issue. For this activity, student worked with their peers using a
discussion board. Students’ responses to case studies or questions were submitted and stored in angel, the on-line course management system. After completing each on-line learning session, students used the reflective thinking tool to reflect on their own learning experience, wrote and posted their reflection on-line in ANGEL. The instructor and teaching assistant of the course monitored students’ learning process and activities and assisted them by providing feedback via email and discussion board throughout two weeks of on-line learning. However, they did not provide any feedback on students’ reflective thinking.

Figure 3-2. Sample screen of a case study page in AGBM 200 online course.
The Context of the Study for the 2003 Spring Semester Students of AGBM 200 (Control Cohort Group)

The students who took the AGBM 200 course in the 2003 Spring semester and did not receive the treatment had the same instructor as those who took the 2003 Fall semester course. They were given the same learning content and activities that were provided to the 2003 Fall semester students. All instruction and learning activities occurred in both a classroom-based and on-line learning environment.

Treatment: Reflective Thinking Tool

A reflective thinking tool (Appendix B) for this study was developed to prompt students to think reflectively about their learning goals, understanding, motivation, learning strategies, and interaction with peers and instructors in order to improve their learning process and performance in an on-line learning context. The perspectives of previous research on reflective thinking and learning strategies for enhancing metacognitive knowledge and skills (King, 1991; Lin & Lehman, 1999; Moon, 1999a; Schraw, 1998; Sternberg, 1998; Swartz & Perkins, 1990, White & Frederiksen, 1998) have been incorporated in this tool.

This reflection tool consisted of six targets for reflection: learning goal, understanding, learning strategies, interaction with peers and instructor, and motivation. According to other researchers (e.g., Kyza, Golan, Reiser, & Edelson, 2002; Walters, Seidel, & Gardner, 1994; Zimmerman, 2002), these six targeted areas for reflection have been noted as important factors that influence students’ learning processes and performance. This tool employs a self-assessment and question prompt format. The self-
assessment serves as a starting point for supporting students’ reflection on each theme by asking students to evaluate each theme using a 5-point Likert scale (i.e., 1=not at all, 5=a great deal) in terms of how well they have performed. The question format helps students reflect deeply and assess why they responded as they did on the self assessment in each of the six targeted areas. For example, a self-assessment form in this tool asks students “how well did you understand what you learned in today’s learning?” and a question form asks students “why do you think this”, as shown in Figure 3-3.

Figure 3-3. Sample screen of reflective thinking tool page.
The reflective thinking tool was embedded in the on-line learning course management system, ANGEL, for the AGBM 200 Fall 2003 semester. Students used this tool for their reflective activities, for storing their reflection reports and retrieving them for their review and consideration during two weeks of on-line learning.

**Instruments**

*Metacognitive Awareness Test*

To investigate whether the use of a reflective thinking tool influences students’ metacognitive awareness (research question 3 & 4), Schraw & Dennison (1994)’s Metacognitive Awareness Inventory (MAI) (Appendix C) was administered in the treatment group. According to their reports, MAI consists of a 52 items self-report instrument to assess students’ awareness of knowledge of cognition and regulation of cognition, two main components of metacognition. Knowledge of cognition includes three components: declarative knowledge (i.e., knowledge about one’s skills), procedural knowledge (i.e., knowledge about how to use strategies), and conditional knowledge (i.e., knowledge about why to use strategies). Regulation of cognition contains five components: planning (i.e., goal setting), information management (i.e., skills and strategies sequences), monitoring (i.e., assessment of one’s learning process), debugging (i.e., strategies for correcting one’ learning performance errors), and evaluation (i.e., assessment of one’ learning performance and strategy effectiveness) (Schraw & Dennison,
MAI uses a 7-point Likert scale (1=not at all true of me, 7=very true of me). Schraw and Dennison (1994) reported that the Cronbach alpha reliability coefficient of this test was .90 for college students. The Cronbach alpha reliability coefficient of the pre-MAI test was .84 and that of the post-MAI test was .92 in Study 1.

**Comprehension Test**

As one of the posttests, a comprehension test (Appendix D) was designed to assess students’ comprehension of knowledge of agricultural business management that the participants learned during two weeks’ on-line learning. This instrument consists of 20 multiple-choice items. All items of this instrument were developed by the instructor, who has been teaching the course, AG BM 200, Introduction to Agribusiness Management. Each item was given 5 points. According to Bloom et al. (1956), comprehension as a learning outcome is a type of the lowest level of understanding or apprehension. This test asks if students know or understand basic concepts about agricultural business management. The reliability, Cronbach $\alpha$, of this instrument in this study was .80.

**Problem Solving Test**

This posttest (Appendix E) was designed to assess students’ abilities to solve well-structured mathematical problems that have one correct answer that they can attain by applying rules or procedures that they learned during two weeks’ on-line learning. This
instrument consists of 2 large items. The first item consists of 4 sub-items that each sub-item was given 5 points and the second item consists of 39 sub-items that each sub-item was given 2 points. This test focuses on students’ ability to apply mathematical formulas or rules. All items of this instrument were developed by the instructor. The Cronbach alpha reliability coefficient of this test in this study was .75

A Rubric System for Assessing Level of Students’ Reflective Thinking

To assess each student’s level of reflective thinking, a rubric system (Appendix F) was adapted from Hatton and Smith (1995) because its assessment criteria were generally applicable to this study. According to Hatton and Smith (1995), the rubric system was originally developed to assess the level of student teachers’ reflective thinking on their teaching skill development in teaching and classroom management. This rubric system includes 4 different levels of reflective thinking:

Level 1: descriptive writing (not reflective, but reports events or actions that occurred in learning)

Level 2: descriptive reflection (reflective, provides reasons based on personal judgment)

Level 3: dialogic reflection (provides discourse with one’s self, an exploration of possible reasons)

Level 4: critical reflection (provides events or actions that are located in and influenced by historical, social, and/or political contexts)
Level 1, descriptive writing, is the lowest level of reflective thinking, and Level 4, critical reflection, is the highest level of reflective thinking in this rubric system (See Appendix F).

**Assessing Level of Students’ Reflective Thinking Using the Rubric**

In order to examine research question 2 and 4, each student’s reflective thinking was assessed with the rubric described above. In study 1, individual students who received the treatment completed the six reflective thinking activities and posted them to the on-line course management system during the two week experimental period. For assessing the level of each student’s reflective thinking, only the last of the six reflective thinking entries was used. Only the last entry was used because research on reflective journal writing indicates that students should be given a period of time in order to develop their conscious and purposeful reflective thinking (Moon, 1999). Therefore, in study 1, reflective thinking activities 1 to 5 were regarded as development time that students could adjust to reflective thinking and develop their ability to think reflectively.

Therefore, 37 reflective thinking entries in study 1 were read and analyzed by the researcher and assigned a level of reflection relating to the rubric. After completing the first assessment, a second rater who was doctoral graduate student read the same entries and assessed them against the rubric. The rater did not have any information about the students other than their names, which appeared in their reflective thinking entries. Before having the second rater assess the student’s level of reflection, the researcher met
with the rater in order to explain the purpose of study and content of the rubric system. The researcher and the rater practiced with two samples of reflective thinking in order to reach a conceptual consensus on the level of reflective thinking described in the rubric. After 37 reflective thinking entries were evaluated and rated by both raters, the results were compared. There was a difference in assigned levels for five of 37 reflective thinking entries. This meant that the percent agreement as a measure of inter-rater reliability was 86.4%. The researcher and the rater discussed the difference in ratings by reviewing the entries. After discussion, the difference in ratings between the two raters was resolved.

**Survey: Students’ Perceptions on Reflective Thinking Tool**

The purpose of the survey (See Appendix G) was to obtain students’ perception on their use of the reflective thinking tool in their on-line learning. The survey was designed to explore how the reflective thinking tool was actually used and perceived by the students. Of special interest was the ways in which the tool helped learners think reflectively about their learning processes and performance. This survey consisted of 14 questions using a 5-point Likert scale (1=Strongly Disagree to 5=Strongly Agree) and 3 open-ended questions.
Procedure

2003 Fall Semester Students

Pre-Study: 1 week prior to the experiment

Recruitment

Pretest of Metacognitive Awareness

Experimental Treatment For Two Weeks

1st on-line learning session

Reflective thinking activity

2nd on-line learning session

Reflective thinking activity

3rd on-line learning session

Reflective thinking activity

4th on-line learning session

Reflective thinking activity

5th on-line learning session

Reflective thinking activity

6th on-line learning session

Reflective thinking activity

Post-Study Immediately After the experiment

Posttest of comprehension

Posttest of problem solving

Posttest of Metacognitive Awareness

Survey of students’ perceptions on reflective thinking tool

Figure 3-4. Procedure of study 1.
Study 1 was carried out with college students who took an agricultural business management course. The researcher visited the class and explained the purposes, the procedures, and the benefits of the study to all 49 students one week prior to the experiment. All 49 students agreed to participate in the study. The metacognitive awareness was administered as a pretest at that time. After recruiting and administering the pretest, the researcher briefly explained the reflective thinking tool and its use for learning by using an overhead projector in the classroom.

During the two-week experiment, six on-line learning sessions (see Table 3-2) were provided. The students participated in these on-line learning sessions and activities through ANGEL course management system from a place that was convenient to them on Monday, Wednesday, and Friday. In each learning session students were asked to study a case or answer questions by studying all assigned on-and off-line learning materials, and then use the on-line reflective thinking tool to reflect on their own learning experiences. In total, six reflective thinking activities were completed using the reflective thinking tool. Each student’s reflective thinking responses were stored in the on-line course system. The students were required to complete all learning activities and assignments including the reflective thinking activity by the midnight of each day. The instructor and teaching assistant of the course monitored students’ learning progress and activities and supported them by providing feedback via an email and discussion board throughout two weeks of on-line learning. No feedback was provided on their reflective activities.

The comprehension and problem solving posttests were administered during the first in-class session after the two-week experiment. The metacognitive awareness and
survey of students’ perceptions of the reflective thinking tool were given as a posttest during the second in-class session after the two-week experiment.

**Data Analysis**

In this study, a t-test and a one-way ANOVA were used to analyze the effects of reflective thinking tool on students’ learning performance and metacognitive awareness. The assumptions for the use of a one-way ANOVA are that 1) the dependent variable is normally distributed, and 2) the two groups have approximately equal variance on the dependent variable. The assumptions for the use of a paired sample t-test are that 1) the observations are independent of each other, 2) the dependent variable is measured on an interval scale, and 3) the differences are normally distributed in the population. The Statistical Package for the Social Sciences (SPSS) software version 10 was used to run the data analysis.
Study 2

Participants

The participants for study 2 were college students enrolled in a statistics course, titled Elementary Statistics, in the 2004 Spring Semester in a land-grant university in the northeastern United States. This course had three sections under one instructor and two teaching assistants.

In order to obtain students’ consent, the purpose of the study, a brief description of the procedure, and the benefits for participating in the study were explained to all 233 students in three sections of the course. There were 226 students who agreed to participate in the study. However, 157 students’ data from all three sections of the course was used for study 2 because of missing data from some participants. They received extra credit for their participation in the study. The demographics of the participants are described in Table 3-4.

An assignment into one of two groups, treatment or control group, was made based on each section of the course that students were attending. Assigning students into different groups with different treatment in the same section could have caused considerable concern and cross contamination. Therefore, two of the three sections were assigned as the treatment group and the third was assigned as the control group.
<table>
<thead>
<tr>
<th>Category</th>
<th>Variable</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
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<tr>
<td></td>
<td>Female</td>
<td>68</td>
<td>43.31</td>
</tr>
<tr>
<td>Class Standing</td>
<td>Sophomore</td>
<td>51</td>
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</tr>
<tr>
<td></td>
<td>Junior</td>
<td>90</td>
<td>57.32</td>
</tr>
<tr>
<td></td>
<td>Senior</td>
<td>16</td>
<td>10.19</td>
</tr>
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<td></td>
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<td>26</td>
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<td>5.73</td>
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<td></td>
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<td>7.00</td>
</tr>
<tr>
<td></td>
<td>American</td>
<td>2</td>
<td>1.27</td>
</tr>
<tr>
<td></td>
<td>Hispanic</td>
<td>5</td>
<td>3.18</td>
</tr>
<tr>
<td></td>
<td>Asian</td>
<td>7</td>
<td>4.45</td>
</tr>
<tr>
<td>Take the Course</td>
<td>Required</td>
<td>138</td>
<td>87.89</td>
</tr>
<tr>
<td></td>
<td>Interested</td>
<td>6</td>
<td>3.82</td>
</tr>
<tr>
<td></td>
<td>Recommended</td>
<td>12</td>
<td>7.64</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>1</td>
<td>0.63</td>
</tr>
<tr>
<td>Online Course</td>
<td>Yes</td>
<td>106</td>
<td>67.51</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>51</td>
<td>32.48</td>
</tr>
<tr>
<td>Reflective Thinking</td>
<td>Yes</td>
<td>11</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>146</td>
<td>92.99</td>
</tr>
<tr>
<td>Writing Experience</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Research Design**

In study 2, a posttest-only control-group research design (Gall, Borg & Gall, 1996) was used. It was designed to compare the treatment group with the control group on students’ learning performance and metacognitive awareness. The research design for study 2 is illustrated as follows:

- Experimental Group: O X₁ O
- Control Group: O X₂ O

**Note:**
- X₁: Treatment using the reflective thinking tool
- X₂: No reflective thinking tool used

The independent variable in this study was reflective thinking. The dependent variables were comprehension, problem solving, and metacognitive awareness.

Participants in the treatment group used a reflective thinking tool during a two-week period. They participated in a total of six reflective thinking activities and posted them to the on-line course management system. Participants in the control group were only asked to write down what they learned after they completed their on-line learning activities, but were not given any reflective thinking tool during that time.
The Context of the Study

Statistics 200, STAT 200, was an undergraduate course designed to provide statistical concepts and methods such as descriptive statistics, frequency distributions, statistical inference, linear regression and correlation (see Figure 3-5 for the course syllabus screen).

![Figure 3-5. Sample screen of the STAT 200 course syllabus.](image)

The three sections of this course that participated in study 2 were taught by one instructor and two teaching assistants. The instructor had more than 30 years of teaching and research experience in the field of statistics and the two teaching assistants were doctoral graduate students majoring in statistics. Each section had a computer lab activity
on Monday and Friday and one large group meeting in a classroom on Wednesday each week. Three sections had different computer lab schedules, but all three sections met in the large group meeting on Wednesday. In the computer lab, the students of all three sections were required to work on learning activities (e.g., data analysis, individual and group readiness quizzes) in pairs or small groups to apply what they learned from their reading assignments. In the computer lab, the students accessed the course web site, ANGEL, to use datasets or review learning materials or take a quiz (see Figure 3-6 for a sample lab quiz activity). In the large group meeting, the instructor’s lecture focused on statistical concepts and methods they would practice in the computer lab activity.

![Figure 3-6](image.png)

Figure 3-6. Sample screen of a lab quiz activity in STAT 200 course.

In study 2, all instructional and learning activities were both classroom-based and on-line in a learning environment as described above. During the two-week experiment,
students participated in six learning sessions based on the course schedule designed by the instructor (see Table 3-5). After completing each learning session, the students were asked to use the reflective thinking tool to reflect on their own learning experience, and to post them on the on-line course management system.

Table 3-5

Six Learning Sessions and Learning Activities

<table>
<thead>
<tr>
<th>Learning session</th>
<th>Learning topics</th>
<th>Primary learning activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Summary table for statistical techniques</td>
<td>Large group lecture</td>
</tr>
<tr>
<td>2</td>
<td>Confidence intervals for a proportion</td>
<td>Activity on test about a proportion $p$ in the computer lab</td>
</tr>
<tr>
<td>3</td>
<td>Sampling Distribution of the sample mean A population mean $\mu$</td>
<td>Activity on test about a population mean in the computer lab</td>
</tr>
<tr>
<td>4</td>
<td>Comparison of two means</td>
<td>Large group lecture</td>
</tr>
<tr>
<td>5</td>
<td>Comparison of two proportions</td>
<td>Activity on two sample problems in the computer lab</td>
</tr>
<tr>
<td>6</td>
<td>Sample size and power</td>
<td>Activity on two sample problems in the computer lab</td>
</tr>
</tbody>
</table>

Treatment: Reflective Thinking Tool

As described in study 1, the same treatment, the reflective thinking tool, was used in study 2.

According to researchers (e.g., Kyza, Golan, Reiser, & Edelson, 2002; Walters, Seidel, & Gardner, 1994; Zimmerman, 2002), six targeted areas of reflection have been discussed as important factors that influence students’ learning processes and
performance. Therefore, these areas function as an object to students’ reflective thinking in the reflective thinking tool. This tool employs a self-assessment format and a question prompt format. The self-assessment format serves as a starting point for supporting students’ reflection on each targeted area and asks student to evaluate each using a 5-point Likert scale (i.e., 1 = not at all, to 5 = a great deal) in terms of how well they have performed. The question form helps students reflect deeply and describe why they assessed themselves the way they did on their self-assessment. For example, a self-assessment form in this tool asks students “how well did you understand what you learned in today’s learning?” and a question form asks students “why do you think this?” as shown in Figure 3-7.
The reflective thinking tool was embedded in the on-line learning management system, ANGEL. Students used this tool for their reflective activities, stored their reflection reports and retrieved them for their review or consideration during the two-week study.
Instruments

**Metacognitive Awareness Test**

As described in study 1, in order to investigate research question 3 and 4, the same metacognitive awareness test was used and administrated in the treatment group before and after on-line learning.

Schraw & Dennison (1994)’s the Metcognitive Awareness Inventory (MAI) (Appendix C) was used and administrated as a pre and a post test. MAI has a 7-point Likert scale (1=not at all true me to, 7=very true of me). Schraw and Dennison (1994) reported that the Cronbach alpha reliability coefficient of this test was .90 for college students. The Cronbach alpha reliability coefficient of the pre-MAI test was .82 and that of the post-MAI test was .91 in Study 2.

**Comprehension Test**

In study 2, the comprehension test designed by the instructor assessed students’ understanding and comprehension about statistical concepts and methods that the students studied during the two-week study. This instrument consisted of 23 multiple-choice items. Each item was given 5 points. This test focuses on students’ understanding about the statistical factual knowledge and concepts. The reliability, Cronbach α, of this instrument in this study was .83.


A Rubric System for Assessing Level of Students’ Reflective Thinking

The same rubric system for assessing level of students’ reflective thinking from study 1 was used again in study 2.

This rubric system includes 4 different levels of reflective thinking:

Level 1: descriptive writing (not reflective, but reports events or actions that occurred in learning)

Level 2: descriptive reflection (reflective, provides reasons based on personal judgment)

Level 3: dialogic reflection (provides discourse with one’s self, an exploration of possible reasons)

Level 4: critical reflection (provides events or actions that are located in and influenced by historical, social, and/or political contexts)

Level 1, descriptive writing, is the lowest level of reflective thinking, and Level 4, critical reflection, is the highest level of reflective thinking in this rubric system (See Appendix F).

Assessing Level of Students’ Reflective Thinking Using the Rubric System

As described in study 1, the same procedure for assessing level of students’ reflective thinking was used in study 2. For assessing the level of each student’s reflective thinking, only the last of the six reflective thinking entries was used for the same reasons as described in study 1. In study 2, 84 reflective thinking entries were read and analyzed
by two raters including the researcher and assigned a level of reflection relating to the rubric. More specifically, the researcher assessed all 84 reflective thinking entries and then had two different individuals assess a subset of the 84. One rater assessed 10 entries from the 84 and the other assessed the remaining 74. There was a difference in assigned levels for 12 of 84 reflective thinking entries meaning that the percent agreement as a measure of inter-rater reliability was 85.7%. The researcher and the relevant rater discussed the difference in ratings by reviewing the entries and the rubric system. After discussion, the difference in ratings was resolved.

**Survey: Students’ perceptions on reflective thinking tool**

The same survey as described in study 1 was used in study 2.

This survey consisted of 14 questions with a 5 point Likert scale (1 = Strongly Disagree, to 5 = Strongly Agree) and 3 open-ended questions.
Procedures

Figure 3-8 illustrates the procedures that were followed in Study 2.

Pre-Study: 2 weeks prior to the experiment

Recruitment

Treatment Group

Control Group

Pretest of Metacognitive Awareness

Experimental Treatment For Two Weeks

Reflective Thinking Activity

1st learning session

2nd learning session

3rd learning session

4th learning session

5th learning session

6th learning session

1st learning session

2nd learning session

3rd learning session

4th learning session

5th learning session

6th learning session

Post-Study After the experiment

Posttest of comprehension

Posttest of Metacognitive Awareness

Survey of students’ perceptions on reflective thinking tool

Figure 3-8. Procedures of study 2.
For study 2, the students were recruited from three sections of a statistics course. The researcher visited the large group session for all three sections and explained the purposes, the procedures, and the benefits of the study to students two weeks prior to the experiment. Two hundred twenty six students from three sections of the course agreed to participate. One week prior to the experiment the researcher assigned students of the first and third section as the treatment group by informing them via email giving them access to only their section folders on ANGEL based on the recommendation of the instructor. The treatment group was informed to take the metacognitive awareness pretest via the course management system. Also, students of second section were assigned as the control group by being informed and given access to only their section folders on ANGEL. The control group was not given the metacognitive awareness pretest.

The treatment and the control groups took the same six learning sessions in both classroom-based and online learning contexts over a two-week period. Students in the treatment group were asked to use the on-line reflective thinking tool to reflect on their own learning experience after completing each of the six learning sessions. Students in the control group did not use the reflective thinking tool but they were asked to write one short paragraph about what they learned and post it on the course on-line system after completing each learning session.

After the two weeks, metacognitive awareness and survey of students’ perceptions on the reflective thinking tool were administrated as a posttest to the treatment group via the on-line course management system. The comprehension posttest was administrated to both the treatment and control group in the fifth day after the end of the two-week learning activities.
Data Analysis

The same methods as described in study 1 for data analysis for were used in study 2.

In this study, a t-test and a one-way ANOVA were used to analyze the effects of reflective thinking tool on students’ learning performance and metacognitive awareness. The assumptions for the use of a one-way ANOVA are that 1) the dependent variable is normally distributed, and 2) the two groups have approximately equal variance on the dependent variable. The assumptions for the use of a paired sample t-test are that 1) the observations are independent of each other, 2) the dependent variable is measured on an interval scale, and 3) the differences are normally distributed in the population. The Statistical Package for the Social Sciences (SPSS) software version 10 was used to run the data analysis.
CHAPTER 4

RESULTS

The purpose of the study was to explore the effects of using an electronic supported reflection tool designed to prompt students to think reflectively about their learning goals, motivation, understanding, learning strategies, and interaction with peers and instructors on students’ learning performance and metacognitive awareness in an online learning context. Two experiments in this research study were conducted as described in Chapter 3. This chapter describes the results of the statistical analysis of study 1 and 2 conducted for this research study.

Study 1

As described in chapter 3, in study 1 a cohort research design was used to compare the learning performance of a cohort group receiving a treatment with that of another cohort who did not received the treatment.

For assuring initial equivalence between the treatment and control group, the first semester exams were compared for each semester in the AGBM 200 course. The test items that both cohort groups took were exactly same. Table 4-1 presents the descriptive results.
Table 4-1

Descriptive Statistics For The Treatment And Control Groups On Their First Exam

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>50</td>
<td>89.26</td>
<td>6.52</td>
</tr>
<tr>
<td>Treatment Group</td>
<td>37</td>
<td>91.46</td>
<td>6.08</td>
</tr>
</tbody>
</table>

The assumptions for the use of a one-way ANOVA are that 1) the dependent variable is normally distributed, and 2) the two groups have approximately equal variance on the dependent variable. The study met these assumptions in the use of a one-way ANOVA.

Table 4-2 shows the result of a one-way ANOVA for the treatment and the control group on their first exam. This result indicates that there was no statistically significant difference between the treatment and control group. Therefore, they were treated as comparable groups.

Table 4-2

One-Way ANOVA For The Treatment And The Control Group On Their First Exam

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>102.869</td>
<td>1</td>
<td>102.869</td>
<td>2.567</td>
<td>.113</td>
</tr>
<tr>
<td>Within Groups</td>
<td>3414.809</td>
<td>85</td>
<td>40.174</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3517.678</td>
<td>86</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Effect of a Reflective Thinking Tool on Students’ Learning Performance

*Question 1: Does the use of a reflective thinking tool affect students’ learning problem solving?*

*Hypothesis 1: Students studying with a reflective thinking tool will perform significantly better on problem solving than those who do not study with a reflective thinking tool.*

To test hypothesis 1, a one-way ANOVA was carried out to compare problem solving scores for both groups. Table 4-3 shows descriptive statistics for the treatment and control group on the problem solving test. As shown in Table 4-3, the standard deviation of the control group on the problem solving test was much larger than that of treatment group. However, the large standard deviation of the control group cannot be explained.

<table>
<thead>
<tr>
<th>Table 4-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptive Statistics For The Treatment And The Control Group on The Problem Solving Test</td>
</tr>
<tr>
<td>N</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Control Group</td>
</tr>
<tr>
<td>Treatment Group</td>
</tr>
</tbody>
</table>
Table 4-4 shows the result of a one-way ANOVA for the treatment and control group on the problem solving test. This result indicates a significant difference between the treatment and control group on problem solving performance (F=6.290, p<.014). The students who used the reflective thinking tool performed significantly better on problem solving than those who did not use reflective thinking tool.

Table 4-4

One-Way ANOVA For The Treatment And The Control Group On a Problem Solving Test

<table>
<thead>
<tr>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1134.689</td>
<td>1</td>
<td>1134.689</td>
<td>6.290</td>
</tr>
<tr>
<td>Within Groups</td>
<td>15332.644</td>
<td>85</td>
<td>180.384</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>16467.333</td>
<td>86</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. *P<.05
Difference in Learning Performance by Level of Students’ Reflective Thinking

Question 2: Is there any difference between comprehension or problem solving scores by level of students’ reflective thinking?

Hypothesis 2: Students who have higher levels of reflective thinking will perform significantly better than those who have lower levels of reflective thinking on comprehension and problem solving.

Table 4-5 presents descriptive statistics for students’ learning performance by level of their reflective thinking.

Table 4-5

Descriptive Statistics For Students’ Learning Performance By Level Of Their Reflective Thinking

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comprehension</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 1</td>
<td>17</td>
<td>41.47</td>
<td>7.24</td>
</tr>
<tr>
<td>Level 2</td>
<td>20</td>
<td>51.00</td>
<td>13.04</td>
</tr>
<tr>
<td>Level 3*</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Level 4*</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Problem Solving</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 1</td>
<td>17</td>
<td>66.18</td>
<td>8.26</td>
</tr>
<tr>
<td>Level 2</td>
<td>20</td>
<td>69.30</td>
<td>9.21</td>
</tr>
<tr>
<td>Level 3*</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Level 4*</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note. Level 1: Descriptive Writing Level, Level 2: Descriptive Reflection Level
* No students showed levels 3 or 4 for reflective thinking.
Table 4-6 shows the results of a one-way ANOVA for students’ learning performance by level of their reflective thinking. This result indicates that there was a significant difference between comprehension scores by level of students’ reflective thinking ($F=7.179$, $P<.011$), while there was no significant difference between problem solving scores by level of students’ reflective thinking.

Table 4-6

One-Way ANOVA For Students’ Learning Performance By Level Of Their Reflective Thinking

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comprehension</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>834.467</td>
<td>1</td>
<td>834.467</td>
<td>7.179</td>
<td>.011*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>4068.235</td>
<td>35</td>
<td>116.235</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4902.703</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Problem Solving</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>89.654</td>
<td>1</td>
<td>89.654</td>
<td>1.161</td>
<td>.289</td>
</tr>
<tr>
<td>Within Groups</td>
<td>2702.671</td>
<td>35</td>
<td>77.219</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2792.324</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* $^*P<.05$
Effect of a Reflective Thinking Tool on Students’ Metacognitive Awareness

*Question 3: Does the use of a reflective thinking tool increase students’ metacognitive awareness, as measured by Metacognitive Awareness Inventory (MAI) before and after on-line learning?*

*Hypothesis 3: Students studying with a reflective thinking tool will significantly increase their metacognitive awareness.*

Table 4-7 shows descriptive statistics for pre-and post-metacognitive awareness for students who studied with reflective thinking tool.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-MA</td>
<td>37</td>
<td>5.0494</td>
<td>.3601</td>
</tr>
<tr>
<td>Post-MA</td>
<td>37</td>
<td>5.1476</td>
<td>.4923</td>
</tr>
</tbody>
</table>

The assumptions for the use of a paired sample t-test are that 1) the observations are independent of each other, 2) the dependent variable is measured on an interval scale, and 3) the differences are normally distributed in the population. The study 1 and 2 met these assumptions in the use of a paired sample t-test.

A paired sample t-test was carried out to compare pre-and post-metacognitive awareness score for students who used reflective thinking tool. Table 4-8 shows the result...
of a paired sample t-test for pre-and post-metacognitive awareness. The post-
metacognitive awareness scores were significantly higher than the pretest scores (t=-
.0982, p<0.019). This is an indication that students’ metacognitive awareness was
enhanced by the activity of reflective thinking.

Table 4-8

Paired Sample T-Test for Pre-and Post-Metacognitive Awareness (MA)

<table>
<thead>
<tr>
<th>Paired Difference in means</th>
<th>t</th>
<th>df</th>
<th>Significance (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-MA – Post-MA</td>
<td>-.0982</td>
<td>-2.458</td>
<td>36</td>
</tr>
</tbody>
</table>

Note. *P<.05

In order to examine which component among two sub-components of
metacognitive awareness, knowledge about cognition and regulation of cognition, was
significantly increased by the use of a reflective thinking tool, a second paired sample t-
test was conducted. Table 4-9 shows descriptive statistics for sub-components of pre-and
post-metacognitive awareness.
Table 4-9

Descriptive Statistics For Sub-Components Of Pre-and Post-Metacognitive Awareness (MA)

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-MA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-KAC</td>
<td>37</td>
<td>5.3311</td>
<td>.4523</td>
</tr>
<tr>
<td>Pre-ROC</td>
<td>37</td>
<td>4.9162</td>
<td>.3920</td>
</tr>
<tr>
<td>Post-MA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-KAC</td>
<td>37</td>
<td>5.3634</td>
<td>.6098</td>
</tr>
<tr>
<td>Post-ROC</td>
<td>37</td>
<td>5.0504</td>
<td>.4830</td>
</tr>
</tbody>
</table>

Note. KAC: Knowledge about Cognition
      ROC: Regulation of Cognition

Table 4-10 shows the result of a paired sample t-test for sub-components of pre- and post-metacognitive awareness. The results indicate that regulation of cognition (ROC) was significantly increased by the reflective thinking activity (t=-.1342, p<.01) while knowledge about cognition (KAC) was not significantly increased.

Table 4-10

Paired Sample T-Test For Sub-Components of Pre-and Post-Metacognitive Awareness (MA)

<table>
<thead>
<tr>
<th></th>
<th>Paired Difference in means</th>
<th>T</th>
<th>df</th>
<th>Significance (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-KAC – Post-KAC</td>
<td>-.0323</td>
<td>-.506</td>
<td>36</td>
<td>.616</td>
</tr>
<tr>
<td>Pre-ROC – Post-ROC</td>
<td>-.1342</td>
<td>-2.706</td>
<td>36</td>
<td>.010*</td>
</tr>
</tbody>
</table>

Note. *P<.05
Difference in Students’ Metacognitive Awareness by Level of Their Reflective Thinking

*Question 4: Is there any difference in their metacognitive awareness by level of students’ reflective thinking?*

*Hypothesis 4: Students who have higher levels of reflective thinking will demonstrate a higher metacognitive awareness score than those who have lower levels of reflective thinking.*

Table 4-11 shows descriptive statistics for metacognitive awareness by level of students’ reflective thinking.

<table>
<thead>
<tr>
<th>Metacognitive Awareness Level</th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>17</td>
<td>4.8937</td>
<td>.5677</td>
</tr>
<tr>
<td>Level 2</td>
<td>20</td>
<td>5.3635</td>
<td>.2673</td>
</tr>
<tr>
<td>Level 3*</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Level 4*</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note:* Level 1: Descriptive Writing Level, Level 2: Descriptive Reflection Level, *No students showed levels 3 or 4 for reflective thinking.*
Table 4-12 shows the result of a one-way ANOVA for metacognitive awareness by level of students’ reflective thinking. The results show a significant difference in metacognitive awareness by level of students’ reflective thinking (F=10.599, p<.003). Students who have higher levels of reflective thinking demonstrated significantly higher metacognitive awareness than students who have lower levels of reflective thinking.

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metacognitive Awareness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>2.028</td>
<td>1</td>
<td>2.028</td>
<td>10.599</td>
<td>.003*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>6.697</td>
<td>35</td>
<td>.191</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8.726</td>
<td>36</td>
<td>.191</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. *P<.05

In order to explore further differences in sub-components of metacognitive awareness by level of students’ reflective thinking, a second one-way ANOVA was conducted. Table 4-13 shows descriptive statistics for the sub-components of metacognitive awareness by level of students’ reflective thinking.
Table 4-13

Descriptive Statistics for Sub-Components of Metacognitive Awareness (MA) by Level of Students’ Reflective Thinking

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Knowledge about Cognition</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 1</td>
<td>17</td>
<td>5.0624</td>
<td>.6655</td>
</tr>
<tr>
<td>Level 2</td>
<td>20</td>
<td>5.6194</td>
<td>.4259</td>
</tr>
<tr>
<td>Level 3*</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Level 4*</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Regulation of Cognition</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 1</td>
<td>17</td>
<td>4.8454</td>
<td>.5595</td>
</tr>
<tr>
<td>Level 2</td>
<td>20</td>
<td>5.2246</td>
<td>.3300</td>
</tr>
<tr>
<td>Level 3*</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Level 4*</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*No students showed levels 3 or 4 for reflective thinking.

Table 4-14 shows the results of a one-way ANOVA for sub-components of metacognitive awareness by level of students’ reflective thinking. This result shows a significant difference for both knowledge about cognition (F=9.486, p<.004) and regulation of cognition (F=10.599, p<.003) by level of students’ reflective thinking, with those showing level 1 (the level of descriptive writing) and 2 (the level of descriptive reflection).
Table 4-14

One-Way ANOVA for Sub-Components of Metacognitive Awareness (MA) by Level of Students’ Reflective Thinking

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge about Cognition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>2.855</td>
<td>1</td>
<td>2.855</td>
<td>9.486</td>
<td>.004*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>10.532</td>
<td>35</td>
<td>.301</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13.386</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Regulation of Cognition   |                |    |             |       |       |
| Between Groups            | 1.321          | 1  | 2.028       | 10.599| .003* |
| Within Groups             | 7.076          | 35 | .191        |       |       |
| Total                     | 8.387          | 36 |             |       |       |

Note. *P<.01
Students Perceptions on the Use of Reflective Thinking Tool

*Question 5: How do the students perceive the reflective thinking tool in terms of its usefulness in and contribution to their reflection and on-line learning?*

The survey was administrated to investigate how students value their use of the reflective thinking tool in their learning process. Thirty-seven students’ responses to 14 questions with a 5 point Likert scale are described in Table 4-15. Students’ responded positively to all questions asking about usefulness of the reflective thinking tool with two exceptions. Students responded negatively to interaction with peers and their instructor.

The results indicate that students felt that the reflective thinking activity helped them reflect on their learning performance and process (e.g., understanding, strategies, and motivation).

Most students’ responses to open-ended questions in the survey also support the notion that they have benefited from the use of reflective thinking. One student wrote:

*I think it was helpful. It helped me understand what I was learning and what I wasn’t and how I could fix it.*

Some students indicated issues they encountered with reflective thinking tool. The issues are related to questions used for promoting reflection. One student wrote:

*I felt like it asked the same questions over and over.*
### Table 4-15

Mean for Students Perception on the Use of Reflective Thinking Tool in Study 1

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1 – learning goals</td>
<td>3.27</td>
</tr>
<tr>
<td>Q2 – monitoring understanding</td>
<td>3.92</td>
</tr>
<tr>
<td>Q3 – monitoring learning strategies</td>
<td>3.76</td>
</tr>
<tr>
<td>Q4 – monitoring what, how and why</td>
<td>3.62</td>
</tr>
<tr>
<td>Q5 – evaluating learning performance</td>
<td>3.54</td>
</tr>
<tr>
<td>Q6 – interaction with peers</td>
<td>2.41*</td>
</tr>
<tr>
<td>Q7 – interaction with instructor</td>
<td>2.84*</td>
</tr>
<tr>
<td>Q8 – motivation</td>
<td>3.30</td>
</tr>
<tr>
<td>Q9 – motivation</td>
<td>3.46</td>
</tr>
<tr>
<td>Q10 – new perspective</td>
<td>3.54</td>
</tr>
<tr>
<td>Q11 – evaluation one’s ability</td>
<td>3.92</td>
</tr>
<tr>
<td>Q12 – internalization of reflection</td>
<td>3.38</td>
</tr>
<tr>
<td>Q13 – transfer reflection to other situation</td>
<td>3.41</td>
</tr>
<tr>
<td>Q14 – willingness to continue to use tool</td>
<td>3.42</td>
</tr>
</tbody>
</table>

* Students’ responses to question 6 and 7 were negative.
In study 2, for assuring initial equivalence between the treatment and control group, the first semester exams taken before participating in this study were compared. Table 4-16 presents descriptive statistics for the treatment and the control group on their first exam.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>73</td>
<td>75.52</td>
<td>12.20</td>
</tr>
<tr>
<td>Treatment Group</td>
<td>84</td>
<td>77.31</td>
<td>13.54</td>
</tr>
</tbody>
</table>

Table 4-17 shows the result of a one-way ANOVA for the treatment and the control group on their first exam. The result indicates that there was no statistically significant difference between the treatment and control. Therefore, they were treated as comparable groups.
Table 4-17

One-Way ANOVA for the Treatment and the Control Group on Their First Exam

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>125.000</td>
<td>1</td>
<td>125.000</td>
<td>.747</td>
<td>.389</td>
</tr>
<tr>
<td>Within Groups</td>
<td>25924.172</td>
<td>155</td>
<td>167.253</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>26049.172</td>
<td>156</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Effect of a Reflective Thinking Tool on Students’ Learning Performance

*Question 1: Does the use of a reflective thinking tool affect students’ learning comprehension?*

*Hypothesis 1: Students studying with a reflective thinking tool will perform significantly better on comprehension than those who do not study with a reflective thinking tool.*

To examine hypothesis 1, a one-way ANOVA was carried out. Table 4-18 shows descriptive statistics for the treatment and the control group on the comprehension test.

Table 4-18

Descriptive Statistics for the Treatment and the Control Group on a Comprehension Test

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>73</td>
<td>75.07</td>
<td>14.80</td>
</tr>
<tr>
<td>Treatment Group</td>
<td>84</td>
<td>76.23</td>
<td>16.13</td>
</tr>
</tbody>
</table>
Table 4-19 shows the result of a one-way ANOVA for the treatment and the control group on the comprehension test. The results indicate no significant difference between the treatment and the control group on comprehension performance. Students who studied with a reflective thinking tool did not perform statistically better than the students who studied without a reflective thinking tool on comprehension (F=.217, p=.642).

Table 4-19

One-Way ANOVA for the Treatment and the Control Groups on a Comprehension Test

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>52.347</td>
<td>1</td>
<td>52.347</td>
<td>.217</td>
<td>.642</td>
</tr>
<tr>
<td>Within Groups</td>
<td>37355.360</td>
<td>155</td>
<td>241.002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>37407.707</td>
<td>156</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Difference in Learning Performance by Level of Students’ Reflective Thinking

**Question 2: Is there any difference between comprehension scores by level of students’ reflective thinking?**

**Hypothesis 2:** Students who have higher levels of reflective thinking will perform significantly better than those who have lower levels of reflective thinking on comprehension.

Table 4-20 presents descriptive statistics for students’ learning performance by level of their reflective thinking.

<table>
<thead>
<tr>
<th>Level</th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehension</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 1</td>
<td>53</td>
<td>74.13</td>
<td>16.38</td>
</tr>
<tr>
<td>Level 2</td>
<td>31</td>
<td>79.81</td>
<td>15.27</td>
</tr>
<tr>
<td>Level 3*</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Level 4*</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Note.** Level 1: Descriptive Writing Level, Level 2: Descriptive Reflection Level,
* No students showed levels 3 or 4 for reflective thinking.
Table 4-21 shows the results of a one-way ANOVA for students’ learning performance by level of their reflective thinking. This result indicates that there was no significant difference between comprehension by level of students’ reflective thinking. Student who had a higher level of reflective thinking did not perform significantly better than the students who had a lower level of reflective thinking on comprehension performance.

Table 4-21

One-Way ANOVA for Students’ Learning Performance by Level of Their Reflective Thinking

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehension</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>629.788</td>
<td>1</td>
<td>629.788</td>
<td>2.464</td>
<td>.120</td>
</tr>
<tr>
<td>Within Groups</td>
<td>20954.914</td>
<td>82</td>
<td>255.548</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21584.702</td>
<td>83</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Effect of a Reflective Thinking Tool on Students’ Metacognitive Awareness

Question 3: Does the use of reflective thinking tool increase students’ metacognitive awareness, as measured by Metacognitive Awareness Inventory (MAI) before and after on-line learning?

Hypothesis 3: Students studying with a reflective thinking tool will significantly increase their metacognitive awareness.

The hypothesis predicted that students’ metacognitive awareness would be significantly increased by the use of reflective thinking tool. Table 4-22 shows descriptive statistics for pre-and post metacognitive awareness for students who studied with a reflective thinking tool.

Table 4-22

Descriptive Statistics for Pre-and Post-Metacognitive Awareness (MA)

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-MA</td>
<td>84</td>
<td>5.0417</td>
<td>.3491</td>
</tr>
<tr>
<td>Post-MA</td>
<td>84</td>
<td>5.1527</td>
<td>.4809</td>
</tr>
</tbody>
</table>
A paired sample t-test was carried out to compare pre-and post metacognitive awareness scores for students who used reflective thinking tool. Table 4-8 shows the results of a paired sample t-test for pre-and post metacognitive awareness. The post-metacognitive awareness scores were significantly higher than the pretest scores \( (t=-4.247, p<.000) \).

<table>
<thead>
<tr>
<th>Paired Difference in means</th>
<th>t</th>
<th>df</th>
<th>Significance (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-MA – Post-MA</td>
<td>-.1110</td>
<td>83</td>
<td>( .000^* )</td>
</tr>
</tbody>
</table>

Note. \( ^*P<.05 \)

In order to examine which component among two sub-components of metacognitive awareness, knowledge about cognition and regulation of cognition, was significantly increased by the use of reflective thinking, a second a paired t-test was conducted. Table 4-24 shows descriptive statistics for sub-components of pre-and post-metacognitive awareness.
Table 4-24
Descriptive Statistics for Sub-Components of Pre-and Post-Metacognitive Awareness (MA)

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-MA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-KAC</td>
<td>84</td>
<td>5.3304</td>
<td>.4442</td>
</tr>
<tr>
<td>Pre-ROC</td>
<td>84</td>
<td>4.9045</td>
<td>.3846</td>
</tr>
<tr>
<td>Post-MA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-KAC</td>
<td>84</td>
<td>5.3671</td>
<td>.6034</td>
</tr>
<tr>
<td>Post-ROC</td>
<td>84</td>
<td>5.0540</td>
<td>.4740</td>
</tr>
</tbody>
</table>

Note. KAC: Knowledge about Cognition
ROC: Regulation of Cognition

Table 4-25 shows the results of a paired t-test for sub-components of pre-and post-metacognitive awareness. The results presents the component of regulation of cognition (ROC) was significantly increased by the reflective thinking activity (t=-4.546, p<.000) while the component of knowledge about cognition (KAC) was not significantly increased (t=-.874, p=.385).

Table 4-25
Paired Sample t-test for Sub-Components of Pre-and Post-Metacognitive Awareness (MA)

<table>
<thead>
<tr>
<th></th>
<th>Paired Difference in means</th>
<th>t</th>
<th>df</th>
<th>Significance (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-KAC – Post-KAC</td>
<td>-3.67E-02</td>
<td>-.874</td>
<td>83</td>
<td>.385</td>
</tr>
<tr>
<td>Pre-ROC – Post-ROC</td>
<td>-.1495</td>
<td>-4.546</td>
<td>83</td>
<td>.000*</td>
</tr>
</tbody>
</table>

Note. *P<.05
Difference in Students’ Metacognitive Awareness by Level of Their Reflective Thinking

*Question 4: Is there any difference in their metacognitive awareness by level of students’ reflective thinking?*

*Hypothesis 4: Students who have higher levels of reflective thinking will demonstrate a higher metacognitive awareness score than those who have lower levels of reflective thinking.*

Table 4-26 shows descriptive statistics for metacognitive awareness by level of students’ reflective thinking.

Table 4-26

Descriptive Statistics for Metacognitive Awareness (MA) by Level of Students’ Reflective Thinking

<table>
<thead>
<tr>
<th>Metacognitive Awareness</th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>53</td>
<td>5.0878</td>
<td>.5287</td>
</tr>
<tr>
<td>Level 2</td>
<td>31</td>
<td>5.2636</td>
<td>.3676</td>
</tr>
<tr>
<td>Level 3*</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Level 4*</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note. Level 1: Descriptive Writing Level
Level 2: Descriptive Reflection Level
*No students showed levels 3 or 4 for reflective thinking.*
Table 4-27 shows the results of a one-way ANOVA for metacognitive awareness by level of students’ reflective thinking. The result shows no significant difference in metacognitive awareness by level of students’ reflective thinking (F=2.668, p=.106). Students who had a higher level of reflective thinking did not have significantly higher metacognitive awareness than students who had a lower level of reflective thinking.

Table 4-27

One-way ANOVA for Metacognitive Awareness (MA) by Level of Students’ Reflective Thinking

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metacognitive Awareness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>.605</td>
<td>1</td>
<td>.605</td>
<td>2.668</td>
<td>.106</td>
</tr>
<tr>
<td>Within Groups</td>
<td>18.590</td>
<td>82</td>
<td>.227</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>19.195</td>
<td>83</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In order to explore further differences in the sub-components of metacognitive awareness by level of students’ reflective thinking, a second one-way ANOVA was conducted. Table 4-28 shows descriptive for sub-components of metacognitive awareness by level of students’ reflective thinking.
Table 4-28

Descriptive Statistics for sub-components of Metacognitive Awareness (MA) by Level of Students’ Reflective Thinking

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge about Cognition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 1</td>
<td>53</td>
<td>5.3229</td>
<td>.6770</td>
</tr>
<tr>
<td>Level 2</td>
<td>31</td>
<td>5.4427</td>
<td>.4510</td>
</tr>
<tr>
<td>Level 3*</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Level 4*</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

| Regulation of Cognition |     |        |           |
| Level 1                | 53  | 4.9733 | .5080     |
| Level 2                | 31  | 5.1920 | .3783     |
| Level 3*               | 0   | -      | -         |
| Level 4*               | 0   | -      | -         |

Note: *No students showed levels 3 or 4 for reflective thinking.

Table 4-29 shows the results of a one-way ANOVA for sub-components of metacognitive awareness by level of students’ reflective thinking. The results show a significant difference in only the component of regulation of cognition (F=4.329, p<.041) by level of students’ reflective thinking. There was no significant difference in the component of knowledge about cognition by level of students’ reflective thinking (F=9.486, p=383).
Table 4-29

One-way ANOVA for Sub-Components of Metacognitive Awareness (MA) by Level of Students’ Reflective Thinking

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Knowledge about Cognition</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>.281</td>
<td>1</td>
<td>.281</td>
<td>.769</td>
<td>.383</td>
</tr>
<tr>
<td>Within Groups</td>
<td>29.935</td>
<td>82</td>
<td>.365</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>30.216</td>
<td>83</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Regulation of Cognition</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>.935</td>
<td>1</td>
<td>.935</td>
<td>4.329</td>
<td>.041*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>17.712</td>
<td>82</td>
<td>.216</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>18.647</td>
<td>83</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. *P<.05
Students Perceptions of the Use of Reflective Thinking Tool

Question 5: How do the students perceive the reflective thinking tool in terms of its usefulness in and contribution to their reflection and on-line learning?

Eighty four students’ responses to 14 questions with a 5 point Likert scale are presented in Table 4-30. The results indicate that the reflective thinking activity helped students in the treatment group reflect on their learning performance and process (e.g., understanding, strategies, and motivation). The results were also supported by students’ responses to an open-ended question asking about benefits from the use of reflective thinking tool. Interestingly, the benefits that most students mentioned were grouped into two areas: reflection on their understanding about content knowledge and on learning performance in terms of whether the learning goals were achieved.

Some students indicated issues they encountered with reflective thinking tool. They pointed out that they had difficulty in understanding and using the reflective thinking tool. This issue is discussed in term of implications for the effective use of reflective thinking and instructional design in chapter 5.
Table 4-30

Mean for Students Perception on the Use of Reflective Thinking Tool in Study 2

<table>
<thead>
<tr>
<th>Question number</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1 – learning goals</td>
<td>3.51</td>
</tr>
<tr>
<td>Q2 – monitoring understanding</td>
<td>3.54</td>
</tr>
<tr>
<td>Q3 – monitoring learning strategies</td>
<td>3.37</td>
</tr>
<tr>
<td>Q4 – monitoring what, how and why</td>
<td>3.60</td>
</tr>
<tr>
<td>Q5 – evaluating learning performance</td>
<td>3.63</td>
</tr>
<tr>
<td>Q6 – interaction with peers</td>
<td>3.30</td>
</tr>
<tr>
<td>Q7 – interaction with instructor</td>
<td>3.49</td>
</tr>
<tr>
<td>Q8 – motivation</td>
<td>3.32</td>
</tr>
<tr>
<td>Q9 – motivation</td>
<td>3.43</td>
</tr>
<tr>
<td>Q10 – new perspective</td>
<td>3.58</td>
</tr>
<tr>
<td>Q11 – evaluation one’s ability</td>
<td>3.85</td>
</tr>
<tr>
<td>Q12 – internalization of reflection</td>
<td>3.42</td>
</tr>
<tr>
<td>Q13 – transfer reflection to other situation</td>
<td>3.44</td>
</tr>
<tr>
<td>Q14 – willingness to continue to use tool</td>
<td>3.45</td>
</tr>
</tbody>
</table>
### Summary of the Results

A summary of the results is presented in Table 4-31.

#### Table 4-31

**Summary of the Results**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Study 1</th>
<th>Study 2</th>
</tr>
</thead>
</table>
| 1. Students studying with a reflective thinking tool will perform significantly better on comprehension and problem solving than those who do not study with a reflective thinking | - Significant difference for problem solving  
  \( T > C \)                                                                 | - No significant difference for comprehension  
  \( T = C \)                                                                 |
| 2. Students who are higher level of reflective thinking will perform significantly better than those who are lower level of reflective thinking on comprehension and problem solving | - Significant difference for comprehension  
  \( H > L \)                                                                 | - No significant difference for comprehension  
  \( H = L \)                                                                 |
|                                                                           | - No significant difference for problem solving  
  \( H = L \)                                                                 |                                                                         |
| 3. Students studying with a reflective thinking tool will significantly increase their metacognitive awareness | - Significant increase in total metacognitive awareness                  | - Significant increase in total metacognitive awareness                  |
|                                                                           | - Significant increase in only regulation of cognition                   | - Significant increase in only regulation of cognition                   |
| 4. Students who showed higher levels of reflective thinking will demonstrate a higher metacognitive awareness score than those who showed lower levels of reflective thinking | - Significant difference in both knowledge about cognition and regulation of cognition | - Significant difference in only regulation of cognition |

*Note: T: Treatment group, C: Control Group  
H: Group of higher level of reflective thinking,  
L: group of lower level of reflective thinking*
CHAPTER 5
DISCUSSION

The purpose of the study was to explore the effects of using a reflective thinking tool designed to prompt students to think reflectively about their learning goals, motivation, understanding, learning strategies, and interaction with peers and instructors on students’ learning performance and metacognitive awareness in an on-line learning context. Specially, this study tried to investigate 1) if the use of reflective thinking tool was effective in enhancing students’ learning performance and metacognitive awareness, 2) if there was any difference in learning performance and metacognitive awareness by level of students’ reflective thinking, and 3) how the students perceived the reflective thinking tool in its use for their learning.

Two research studies were conducted. Study 1 was implemented with a cohort research design in an agricultural business management course. Thirty seven college students who received the treatment, the reflective thinking tool, for two weeks in the 2003 Fall semester were compared with a cohort group of 50 students who did not receive the treatment in the 2003 Spring semester. Also, the level of reflective thinking of the 37 students who completed the reflective thinking activity was analyzed in terms of learning performance (comprehension and problem solving) and metacognitive awareness.
Study 2 was carried out with college students in a statistics course that provided both a classroom-based and an on-line learning environment. Students in the treatment group (N=84) used a reflective thinking tool during the two-week experiment, whereas students in the control group (N=73) did not perform reflective thinking activity. The two groups were compared in terms of their learning performance on comprehension only. Also, students’ performance and metacognitive awareness in the treatment group were compared by their level of reflective thinking.

The findings from study 1 and 2 are discussed by research focus: 1) effects of a reflective thinking tool on students’ learning performance, 2) difference in learning performance by level of students’ reflective thinking, 3) effects of a reflective thinking tool on students’ metacognitive awareness, and 4) difference in students’ metacognitive awareness by level of reflective thinking. Implications for instructional design, future research and limitations of this study are also discussed.

**Effects of a Reflective Thinking Tool on Students’ Learning Performance**

Different levels of learning outcomes were measured in study 1 and 2 in order to investigate if the use of the reflective thinking tool was an effective way to enhance students’ learning performance. In study 1, students who used the reflective thinking tool performed significantly better on problem solving than those who did not use the reflective thinking tool. In study 2, there were no significant differences between the treatment and the control groups on comprehension.
These findings from study 1 and 2 are discussed from the perspective of previous research that used different formats for prompting students’ reflective thinking (e.g., learning journal writing, questions prompts).

For problem solving performance, the findings from study 1 are consistent with those of previous researchers (King, 1991; Lin, 1999). King (1991) reported that the use of questions for prompting reflection on a problem solving process influenced students’ math problem solving performance. The study by Lin (1999) showed that students who used question prompts for facilitating metacognition performed better on biology problem solving. Thus, from this empirical evidence, it can be concluded that providing students with an opportunity for reflective thinking can enhance students’ problem solving performance in a variety of contents (e.g., math, biology and business). Therefore, there is some evidence to suggest that reflective thinking activities should be emphasized and integrated into the learning process in order to improve students’ problem solving.

For comprehension, the findings from study 2 are consistent with those of Cole (1995), who found that the use of journal writing for prompting reflection was not significantly related to college students’ reading comprehension in a literature course. However, the study by McCrindle & Christensen (1995) reported that students who wrote reflective journals in an introductory biology course for five weeks performed significantly better on a comprehension test. Thus, these differing results provide insufficient evidence to make conclusive recommendations regarding the effects of a reflective thinking tool on comprehension. This is a research area that should be explored in future studies.
Overall, the results of study 1 and 2 indicate that the reflective thinking activity can be effective for problem solving, but not for comprehension. The findings from study 1 and 2 do not fully support the theoretical assumptions and hypotheses that reflective thinking encourages learners to develop a deep understanding of a domain; however, there is some evidence to suggest that problem solving ability can be improved by having students articulate, monitor, and evaluate what they have learned (Ertmer & Newby, 1996; Moon, 1999; Perkins, Jay, & Tishman, 1993). The inquiry regarding this area should be continued to understand if there are other types or formats of reflective thinking tools that would result in enhanced comprehension.

**Difference in Learning Performance by Level of Students’ Reflective Thinking**

The results from study 1 and 2 were not consistent. In study 1, there was a significant difference between comprehension scores by level of students’ reflective thinking, while there was no significant difference between problem solving scores by level of students’ reflective thinking. This was a surprising finding, given the positive significant effect on problem solving noted in hypothesis 1 for using the tool. In contrast, study 2 showed no significant difference between comprehension scores by level of students’ reflective thinking. Problem solving was not tested.

One possible explanation for this inconsistency is the low levels of students’ reflective thinking in both study 1 and 2. The students in both study 1 and 2 were assessed as a level 1 or 2, which indicates relatively low levels of reflective thinking. No
students showed levels 3 or 4 of reflective thinking which is a higher level of reflective thinking. Thus, comparison between these two lower levels of reflective thinking on learning performance may have made a significant difference for lower level of thinking as required by comprehension, but may not have made a significant difference for higher levels of thinking as required in problem solving.

Regarding students’ level of reflection, the fact that the number of students assessed as level 1 in the treatment group was 53 and level 2 was 31 in study 2 may raise another consideration. It may indicate that most students failed to develop a higher level of reflective thinking (level 3 or 4) with a given reflective thinking tool. It could be because the duration that the students were exposed to develop reflection may not have been sufficient. It may also indicate that a direct training program that teach how to think reflectively and how to effectively use a reflective thinking tool may be needed for the learners to develop a higher level of reflective thinking. Finding ways to promote level 3 and 4 reflective thinking may enable researchers to further explore and explain these conflicting results. This is an inquiry area that should be explored in the future studies.

**Effect of a Reflective Thinking Tool on Students’ Metacognitive Awareness**

In both study 1 and 2, students’ metacognitive awareness was significantly increased by the activity of reflective thinking. Also, the component of regulation of cognition was significantly increased by the reflective activity while the component of knowledge about cognition was not significantly increased.
The empirical data provided evidence to support the researchers’ assertions that the activity of reflective thinking enhances students’ metacognitive awareness. Also, it is consistent with the study by McCrindle and Christensen (1995), which reported that the use of a learning journal for reflective thinking yielded greater metacognitive awareness. Thus, the practice of reflective thinking is an effective way to increase students’ metacognitive awareness.

The results of this study showed that the reflective thinking activity significantly increased regulation of cognition between the two components of metacognition, knowledge and regulation. This empirical evidence supports other researchers’ perspectives (e.g., Davidson & Sternberg, 1998; Ertmer & Newby, 1996) that reflective thinking is strongly associated with the component of regulation that refers to cognitive activities to plan, monitor, and evaluate the learning process and performance. Thus, providing students with the practice of reflection leads to increased metacognitive skills.

The findings from both study 1 and 2 indicated the reflective thinking activity did not significantly increase knowledge about cognition among two component of metacognition. This result implies that knowledge about cognition that refers to what learners know about their cognition (e.g., knowledge about self, how to use strategies, why to use strategies) may not be increased by the reflective activity. In both cases, knowledge of cognition was already high as shown in the pretest at 5.331 (SD = 0.45) and 5.330 (SD = 0.44); thereby indicating that the participants already had knowledge of how and why strategies were to be used. This difference is important to consider in that
students often know the how and why of learning, but may not regulate themselves without being encouraged to think reflectively.

**Difference in Students’ Metacognitive Awareness by Level of Reflective Thinking**

In study 1, the results showed a significant difference in metacognitive awareness by level of students’ reflective thinking. More specifically, students who had higher levels of reflective thinking demonstrated significantly higher knowledge about cognition and higher regulation of cognition. In study 2, however, the results showed that students who had higher levels of reflective thinking demonstrated significantly higher regulation of cognition but not higher knowledge about cognition.

From the results of study 1 and 2, it can be concluded that students who have a higher level of reflective thinking show a higher regulation of cognition. This finding indicates that higher reflective thinkers regulate their cognitive activities (i.e., planning, monitoring, and evaluating their learning process and performance). Both reflective thinking and regulation of cognition have very similar activities in terms of executing the cognitive activities. In this sense, it can be inferred that reflective thinking and the component of regulation of cognition are interrelated. However, the results of the present study do not provide clear explanation about the relationship between reflective thinking and the component of knowledge about cognition. They are still puzzling.
Implications for the Effective Use of Reflective Thinking and Instructional Design

The following implications were made from students’ responses to open-ended questions in the survey that examined students’ perceptions on the use of reflective thinking.

First, provide instruction or guidance for effectively using a reflective thinking tool before providing the reflective thinking activity. Some students expressed that they experienced difficulty in engaging in reflective thinking with the given reflective thinking tool. The instruction or guidance should focus on how to reflect on their learning experience and how to effectively use a reflective thinking tool. One strategy would be to model how an expert thinks reflectively and uses a reflection tool for their learning. It is important to test this strategy in future experimental research.

Second, provide students with a more flexible structure for the reflective thinking tool: some students pointed out that questions used in reflective thinking tool were fixed and repeated every day and did not allow them to add their own questions for reflection or to skip some questions that were not highly related to their learning activity on a particular day. A more flexible structure for the reflective thinking tool that reflects students’ needs may help students concentrate on their own reflection. This is another area for future experimental research.

Third, provide students with a more interactive on-line learning environment. In study 1, students expressed a negative reaction to interaction with peers and their instructor. That might be related to the learning environment of study 1 that students felt that they did not have opportunities to interact with their instructor and peers in the
context of on-line learning as much as they did in their classroom-based learning environment. More interactive on-line learning environment may influence the development of students’ reflective thinking.

**Implications for Future Studies**

The following suggestions are made for conducting future research with this reflective thinking tool.

First, train students on how to effectively use a reflective thinking tool: the present study did not provide learners with a training program that taught them how to think reflectively with a reflective thinking tool before the experiment was implemented. This training may help learners prepare to use the reflective thinking tool in their learning situations (e.g., students become comfortable with the reflective thinking process and its benefits) and enhance positive attitudes towards reflective thinking. Therefore, future research should consider training students with reflective thinking tool.

Second, intensify the treatment effects by having a longer treatment period: in the present study, the treatment was given for two weeks. Two weeks may not be enough for learners to internalize the reflective thinking as one of their important learning activities or to develop a higher level of reflective thinking that would lead to the improvement of comprehension. In order to increase the effects of reflective thinking activity, in future study, a longer treatment period (e.g., one semester) should be provided.

Third, investigate the effects of reflective thinking activity on different levels or types of students’ learning performance: the present study explored the effects of
students’ reflection on comprehension and problem solving. It would be worth pursuing the effects of reflective thinking on other types of learning performance such as argumentation, case study, and ill-structured problem solving or on different levels of learning outcomes such as concepts, rules and principles, and problem solving. These studies could result in a taxonomy that indicates which types of learning performance or level of learning would be significantly enhanced by the reflective thinking activity.

Fourth, explore how a teacher or instructor’s feedback on learners’ reflective thinking influences their learning performance and development of reflective thinking, and how instructors could use that information in their teaching: in the present study, students’ reflective thinking on their learning was not used by their instructor. Students’ reflection can provide instructors with valuable information (e.g., students’ learning processes, motivation, and understanding on their learning task). Instructors can use this information to provide individual student feedback for enhancing students’ reflective thinking and learning performance. Thus, in future research it will be valuable to investigate the impact of teachers’ feedback on students’ reflection.

Fifth, determine how reflective thinking may change students’ affective responses such as motivation and belief: the present research focused on the effects of reflective thinking activity on students’ cognitive growth. Through the practice of reflective thinking, students can also be affectively changed. For instance, reflecting on one’s learning experience may transform a student’s negative feelings or motivation (e.g.,
unconfident, anxiety, and difficulty) into positive ones. A qualitative approach may be appropriate to explore this future research.

Sixth, compare the results of collaborative reflective thinking with personal reflective thinking: the current study focused on personal reflective thinking. Students in this study were encouraged to reflect on their own learning experience and were not given the opportunity to share their reflection with their peers. Collaborative reflection may provide students with an opportunity to share their reflection on learning experience with their peers and to think more reflectively through peer interaction. In future research, it would be useful to compare collaborative reflection with personal reflection and to explore the effects of collaborative reflection on both individual and group performance.

Seventh, compare an unstructured reflective thinking tool with a structured reflective thinking tool: the reflective thinking tool used in the present study was structured in such a way that asked students to reflect on given themes. Although this type of reflection tool gives students a clear focus for reflection, this tool may limit students’ reflective thinking on their learning experience. An unstructured reflection may give students more freedom and responsibility in determining what, how and why they reflect for improving their learning. Therefore, in future research, it may be important to examine other types of reflective thinking tools that may be effective for the development of reflective thinking.

Finally, measure students’ metacognitive awareness in both an experimental and control group. The present study measured students’ metacognitive awareness in only the experimental group who received the reflective thinking tool. Measuring metacognitive
awareness in both a control and an experimental group can help determine whether growth in metacognitive awareness is the result of the reflective thinking tool rather than other factors related to the course.

**Limitations of the Study**

First, study 1 used a cohort research design and therefore the results may have been affected by differences in semesters rather than the treatment.

Second, study 2 was implemented in a mixed learning environment, classroom-based and on-line learning. The findings from study 2 cannot be extended to a completely on-line learning environment.

Third, in study 2, random assignment was conducted at the section level rather than at the individual participant level.

Fourth, in both study 1 and 2, students’ metacognitive awareness was measured in only the experimental group who received the reflective thinking tool. The absence of the metacognitive awareness measure from control group limited the examination of other relationships between metacognitive awareness and reflective thinking activity by the comparing experimental and control groups.
References


Appendix A

An Example of Informed Consent Form
INFORMED CONSENT FORM FOR SOCIAL SCIENCE RESEARCH

The Pennsylvania State University

Title of Project: The Effects of a Reflective Thinking Tool on Learning.

Principal Investigator: Younghoon Kim, 315 Keller Building, University Park, PA 16802 (814) 867-2370, yhk101@psu.edu
Advisor: Barbara L. Grabowski, Ph.D., 314F Keller Building, University Park PA 16802 (814) 863-7380, bgrabowski@psu.edu

1. Purpose of the Study: The purpose of this research is to explore the effects of a reflective thinking tool designed to promote students to think reflectively about their learning experience on learning in an on-line learning context.

2. Procedures to be followed: This study is being conducted in conjunction with the learning activities associated with the two weeks of on-line ANGEL exercises that are a normal part of your course. If you agree to participate in this study, you will be asked to complete a learning awareness survey two times. It takes approximately 10 minutes. After two weeks of on-line learning, you will be asked to complete a survey about your on-line activities and to release your scores on your exam and responses to the on-line learning activities.

Please be aware that all your responses to surveys or tests that will be used in this study will be only accessible by the researchers of this study. The audio tapes that will be recorded in the interview will be kept at the researcher’s home and only accessible by the researcher. All data that will be obtained in this study will be destroyed within 5 years after publication of the study. Your instructor will not be informed as to who has agreed to participate in the study. You have the right to not participate in any learning activities and to not answer specific questions on survey or tests that will be used in this study.

3. Discomforts and Risks: There are no known potential risks to the participants. If any of the data is published or presented at a professional conference, no personally identifying student information will be used.

4. Benefits:
   a. The current students will benefit from using a new learning strategy, called a “reflective thinking tool” designed to help your learning process and performance.
   b. The results of this research study will add to the literature on a learning strategy that might be adopted by other educators.

5. Duration/Time: This study will take approximately 35 additional minutes to your normally scheduled learning activities during a two weeks period.
6. Statement of Confidentiality: The researchers will be the only persons with access to information or data that you respond to during the study. All data collected will be kept sealed in a locked filing cabinet at the researchers’ office or home. If this research is published, no information that would identify you will be written.

7. Right to Ask Questions: You may ask any question about the research procedures, and these questions will be answered. Further questions should be directed to Younghoon Kim, 315 Keller Building, by calling (814) 867-2370 or sending email to yhk101@psu.edu; or Dr. Barbara Grabowski, Associate Professor at Instructional Systems program, 314F Keller Building, by calling (814) 863-7380 or sending email to bgrabowski@psu.edu. If you have questions about your rights as a research participant, contact Penn State’s Office for Research Protections at (814) 865-1775.

8. Compensation: No compensation will be offered.

9. Voluntary Participation: Participation is voluntary. You can withdraw from the study at any time by notifying the principal investigator. You can decline to answer specific questions.

You must be 18 years of age or older to consent to participate in this research study. If you consent to participate in this research study and to the terms above, please sign your name and indicate the date below.

You will be given a copy of this consent form to keep for your records.

______________________________________  _____________________
Participant Signature     Date

I, the undersigned, verify that the above informed consent procedure has been followed.

______________________________________  _____________________
Investigator Signature     Date
Appendix B

Reflective Thinking Tool

B-1. Reflective Thinking Tool: An On-line Version

B-2. Reflective Thinking Tool: Paper-Based Version
B-1. Reflective Thinking Tool: An On-line Version

**Reflective Thinking Activity**
Do reflective learning activity whenever you have STAT 260 class and ANGEL assignments from 3/17 - 3/31.

**Learning Goals**

4. What were your learning goals in today's learning?

5. How successfully did you achieve your learning goals in today's learning?
   - 1 - Not successfully
   - 2 - A little successfully
   - 3 - Somewhat successfully
   - 4 - Successfully
   - 5 - Very successfully

6. Based on your rating on question 5, why do you think this? Provide your specific reasons.

**Understanding Learning Strategies**

7. What did you learn in today's learning?
Understanding Learning Strategies

7. What did you learn in today’s learning?

8. How well did you understand what you learned in today’s class?
   - 1 - Not at all
   - 2 - A little
   - 3 - Somewhat
   - 4 - A lot
   - 5 - A great deal

9. Based on your rating on question 8, why do you think this? Provide your specific reasons.

10. How well did you use your learning strategies (e.g., self-question, summary) to better understand what you learned in today’s class?
   - 1 - Not at all
   - 2 - A little
   - 3 - Somewhat
   - 4 - A lot
   - 5 - A great deal

Interaction with Peer and Instructor

12. How well did you interact with your peers in order to better understand knowledge and skills you studied in today’s class?
   - 1 - Not at all
   - 2 - A little
   - 3 - Somewhat
   - 4 - A lot
   - 5 - A great deal

13. Based on your rating on question 12, why do you think this? Provide your specific reasons.

14. How well did you interact with your instructor or teaching assistant(s) in order to better understand knowledge and skills you studied in today’s class?
   - 1 - Not at all
   - 2 - A little
   - 3 - Somewhat
   - 4 - A lot
   - 5 - A great deal

15. Based on your rating on question 14, why do you think this? Provide your specific reasons.
Feeling & Motivation

16. What kinds of feeling or motivation did you experience in today's learning? (e.g., confidence, difficulty, comfort, anxiety)

17. Based on your response to question 16, why do you think this? Provide your specific reasons.

Changes

18. What changes do you want to make to the way you learn for next class?

19. Based on your response to question 18, why do you think this? Provide your specific reasons.
B-2. Reflective Thinking Tool: Paper-Based Version

Name: ____________________________ Date: ____________________
Topic of Today’s Learning: ________________________________

Please respond to each of questions by thinking deeply about your learning process and performance you have performed in today’s learning.

**Learning Goals**

1. What were your learning goals in today’s learning?

2. How successfully did you achieve your learning goals in today’s learning?

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<tr>
<td>Not Successfully</td>
<td>Somewhat</td>
<td>Very Successfully</td>
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   2-1. Why do you think this? Provide your specific reasons.

**Understanding/Learning Strategies**

3. What did you learn in today’s learning?

4. How well did you understand what you were studying in today’s learning?

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<td>Not At All</td>
<td>Somewhat</td>
<td>Very Well</td>
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   4-1. Why do you think this? Provide your specific reasons
5. How well did you use your learning strategies to better understand what you learned in today’s learning?

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<td>Not At All</td>
<td>Somewhat</td>
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5-1. Why do you think this? Provide your specific reasons.

### Interaction with peer and instructor

6. How well did you interact with your peers in order to better understand knowledge and skills you studied in today’s class?

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<td>Not At All</td>
<td>Somewhat</td>
<td>Very Well</td>
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6-1. Why do you think this? Provide your specific reasons.

7. How well did you interact with your teacher or teaching in order to better understand knowledge and skills you studied in today’s class?

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<td>Not At All</td>
<td>Somewhat</td>
<td>Very Well</td>
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</table>

7-1. Why do you think this? Provide your specific reasons.
Feeling & Motivation

8. What kinds of feeling or motivation did you experience in today’s learning? (e.g., confidence, difficulty, comfort, anxiety, satisfaction, dissatisfaction)

8-1. Why do you think this? Provide your specific reasons.

Change

9. What changes do you want to make to the way you learn for next lesson?

9-1. Why do you think this? Provide your specific reasons
Appendix C

Metacognitive Awareness Inventory
The following questions ask about the way you study and learn. Please take a moment to respond to these questions. **Remember there are no right or wrong answers, just answer as accurately as possible.** Use the scale below to answer the questions. If you think the statement is very true of you, circle 7; if it is not at all true of you, circle 1. If the statement is more or less true of you, find and circle the number between 1 and 7 that best describes you.

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<th>5</th>
<th>6</th>
<th>7</th>
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<tbody>
<tr>
<td><strong>1. I ask myself periodically if I am meeting my goals.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
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<tr>
<td><strong>2. I consider several alternatives to a problem before I answer.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<tr>
<td><strong>3. I try to use strategies that have worked in the past.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<tr>
<td><strong>4. I pace myself while learning in order to have enough time.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<tr>
<td><strong>5. I understand my intellectual strengths and weaknesses.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<tr>
<td><strong>6. I think about what I really need to learn before I begin a task.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<tr>
<td><strong>7. I know how well I did once I finish a test.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<tr>
<td><strong>8. I set specific goals before I begin a task.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td><strong>9. I slow down when I encounter important information.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<tr>
<td><strong>10. I know what kind of information is most important when I learn.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td><strong>11. I ask myself if I have considered all options when solving a problem.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td><strong>12. I am good at organizing information.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<tr>
<td><strong>13. I consciously focus my attention on important information.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<tr>
<td><strong>14. I have a specific purpose for each strategy I use.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<tr>
<td><strong>15. I learn best when I know something about the topic.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td>6</td>
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<tr>
<td><strong>16. I know what the teacher expects me to learn.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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17. I am good at remembering information.

18. I use different learning strategies depending on the situation.

19. I ask myself if there was an easier way to do things after I finish a task.

20. I have control over how well I learn.

21. I periodically review to help me understand important relationships.

22. I ask myself questions about the material before I begin.

22. I think of several ways to solve a problem and choose the best one.


25. I ask others for help when I don’t understand something.

26. I can motivate myself to learn when I need to.

27. I am aware of what strategies I use when I study.

28. I find myself analyzing the usefulness of strategies while I study.

29. I use my intellectual strengths to compensate for my weaknesses.

30. I focus on the meaning and significance of new information.

30. I create my own examples to make information more meaningful.

32. I am a good judge of how well I understand something.

33. I find myself using helpful learning strategies automatically.

34. I find myself pausing regularly to check my comprehension.

35. I know when each strategy I use will be most effective.

36. I ask myself how well I accomplished my goals once I’m finished.
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<tr>
<td>37.</td>
<td>I draw pictures or diagrams to help me understand while learning</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>38.</td>
<td>I ask myself if I have considered all options after I solve a problem.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>39.</td>
<td>I try to translate new information into my own words.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>40.</td>
<td>I change strategies when I fail to understand.</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td>5</td>
</tr>
<tr>
<td>41.</td>
<td>I use the organizational structure of the text to help me learn.</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>42.</td>
<td>I read instructions carefully before I begin a task.</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>43.</td>
<td>I ask myself if what I’m learning is related to what I already know.</td>
<td>1</td>
<td>2</td>
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<tr>
<td>44.</td>
<td>I re-evaluate my assumptions when I get confused.</td>
<td>1</td>
<td>2</td>
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<tr>
<td>45.</td>
<td>I organize my time to best accomplish my goals.</td>
<td>1</td>
<td>2</td>
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<tr>
<td>46.</td>
<td>I learn more when I am interested in the topic.</td>
<td>1</td>
<td>2</td>
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<tr>
<td>47.</td>
<td>I try to break studying down into smaller steps.</td>
<td>1</td>
<td>2</td>
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<tr>
<td>48.</td>
<td>I focus on overall meaning rather than specifics.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>49.</td>
<td>I ask myself questions about how well I am doing while I am learning something new.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>50.</td>
<td>I ask myself if I learned as much as I could have once I finish a task.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>51.</td>
<td>I stop and go back over new information that is not clear.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>52.</td>
<td>I stop and reread when I get confused.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Appendix D

AGBM 200 Comprehension Test
AGBM 200 Comprehension Exam

Directions: Put your name on the examination. Read all the questions carefully before answering.

1. Financial records should be kept on all the following except:
   a. expenses
   b. returns on investment
   c. future levels of interest rates
   d. inventory levels
   e. return on invested capital

2. All of the following general headings can be found on a balance sheet except:
   a. stockholder equity
   b. owners’ equity
   c. assets
   d. liabilities
   e. none of the above

3. To be considered a current liability an item must be:
   a. payable in cash within the next accounting period
   b. received in cash within the next accounting period
   c. include all items to be incurred in the coming accounting period
   d. less than the corresponding entry for current assets
   e. none of the above

4. Gross margin is defined to be:
   a. net income less taxes
   b. overhead plus cost of goods sold
   c. depreciation plus bad debt expense
   d. other income less other expenses
   e. revenue from sales less cost of goods sold

5. Operating expense should include all of the following except:
   a. manages’ salary
   b. personnel manager’s salary
   c. salaries of salesman
   d. country club membership fees
   e. direct materials
6. Financial record are essential because they help a manager determine:
   a. the firm’s financial condition
   b. the firm’s progress toward goals set in planning
   c. if the firm made a profit
   d. if the firm made a loss
   e. all of the above

7. The basic accounting documents include:
   a. checkbook
   b. balance sheet
   c. income statement
   d. profit and loss statement
   e. only b, c, and d

8. Examples of current assets would include all of the following except:
   a. building and equipment
   b. cash
   c. inventory
   d. accounts receivable
   e. U.S. securities

9. Owners’ equity includes all of the following except:
   a. capital check
   b. net income from the year
   c. reserves
   d. commodity allocation accounts
   e. retained earnings

10. Cost of goods sold represents:
    a. direct costs of all overhead used in the accounting period
    b. the implicit cost of inventory for the period
    c. the direct cost of purchasing and manufacturing the goods that were sold during the accounting period
    d. the cost of all materials and labor purchased during the period
    e. none of the above

11. Comparative statements analysis can be applied in all the following situations except:
    a. two balance sheets from two consecutive periods
    b. two P&L statement from two consecutive periods
    c. two statements of net working capital from two consecutive periods
d. two balance sheets from two non-consecutive periods
e. none of the above

12. Which of the following changes in financial statement generally are not cause for alarm?
   a. a decrease in net working capital
   b. a decrease in accounts payable
   c. a decrease in cash on hand
   d. a decrease in dividends
   e. all of the above

13. The cost of goods sold is found only on the following financial document:
   a. sources and uses of net working capital
   b. balance sheet
   c. profit and loss sheet
   d. retained earnings sheet
   e. none of the above

14. Net working capital is defined to be:
   a. current liabilities less current assets
   b. late assets less current liabilities
   c. current worth less current assets
   d. fixed assets plus current assets
   e. none of the above

15. Net working capital can be changed by
   a. selling a piece of equipment for cash
   b. buying materials for inventory for cash
   c. buying materials for inventory and buying on short term credit
   d. selling goods on credit
   e. none of the above

16. Use of net working capital include all of the following except:
   a. depreciation
   b. payment of dividends
   c. retirement of stock
   d. purchase of fixed assets
   e. receiving of dividends
17. Liquidity ratios measure a firm’s ability to:
   a. pay it long term debts
   b. meet its day to day cash needs
   c. make a profit from each dollar of sales
   d. control its net working capital
   e. none of the above

18. All of the following ratios measure solvency except:
   a. debt to equity
   b. times interest earned
   c. debt to assets
   d. profits to sales
   e. none of the above

19. All of the following ratios measure activity except:
   a. inventory turnover
   b. accounts receivable turnover
   c. accounts returned turnover
   d. accounts payable turnover
   e. none of the above

20. Ratios are valuable to managers because they
   a. keep a close eye on future control decisions
   b. are valuable planning tool
   c. help analyze past performance and indicate areas where corrective action should be taken
   d. help identify what types of corrective action are needed to improve performance
   e. none of the above
Appendix E

AGBM 200 Problem Solving Test
AGBM 200 Problem Solving Test

1. The government is planning to invest $414.021 million in pollution control equipment. In return the citizen will receive benefits of $30 million per year for the next 50 years. On investments of this sort the government must receive a return equal to the long treasury rate of 5% per year.

   A. Evaluate this alternative using the net present value (NPV) procedure.

   B. Evaluate this alternative using the benefit/cost procedure

   C. Determine the minimum dollar return per year needed to make this investment alternative acceptable.

   D. Determine the internal rate of return (IRR) of this project
2. Develop a cash flow budget using the following information
   a. inventory turnover ratio = 12.
   b. Cost of goods = 50% of sales
   c. Accounts payable turnover ratio = 12.
   d. Accounts receivable ratio = 12
   e. Sales are all on credit
   f. Minimum cash balance = $100
   g. Sept. projected sales = $4,500
   h. Oct. projected sales = $5,000

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<thead>
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<th>Item</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
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<td>Projected Sales</td>
<td>2500</td>
<td>3000</td>
<td>4000</td>
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<tr>
<td>Purchases</td>
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<td></td>
<td></td>
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<tr>
<td>Pay Acct. Payable</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Pay Overhead</td>
<td>1800</td>
<td>1800</td>
<td>1800</td>
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<tr>
<td>Total Cash Outflow</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Projected Sales</td>
<td>2500</td>
<td>3000</td>
<td>4000</td>
</tr>
<tr>
<td>Cash Sales</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Collect Acct. Rec</td>
<td>1000</td>
<td></td>
<td></td>
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<tr>
<td>Total Cash Inflow</td>
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<td></td>
<td></td>
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<tr>
<td>Begin Cash Bal.</td>
<td>500</td>
<td></td>
<td></td>
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<tr>
<td>Cash Inflow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Cash Avail</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash Outflow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Cash</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needed Borrowings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ending Cash Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative Borrowings</td>
<td></td>
<td></td>
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</table>
Appendix F

A Rubric System for Assessing Level of Students’ Reflective Thinking
# A Rubric System for Assessing Level of Students’ Reflective Thinking

<table>
<thead>
<tr>
<th>Level of Reflection</th>
<th>Criteria</th>
<th><strong>Example</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lower level of reflection</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Level 1 *(Descriptive Writing)* | - Not reflective  
- Description of events or actions that occurred in learning  
- No attempt to provide reasons/justification for events or actions that a student experienced in learning | “I read reading materials and understood key concepts”  
“I did my assignments” |
| Level 2 *(Descriptive Reflection)* | - Reflective, not only a description of events but some attempt to provide reason/justification for events or actions but in a reportive or descriptive way  
- Recognition of alternative viewpoints in discussion  
- Reflection is based on one perspective/factor as rationale or based on the recognition of multiple factors and perspectives | “After reading a textbook, I did a case study. But, I am not sure if my answers are correct because there is something I did not understand well on my own” |
| Level 3 *(Dialogic Reflection)* | - Demonstrates a “stepping back” from the events/actions leading to a different level of mulling about discourse with self and exploring the experience, events, and actions  
- Uses qualities of judgments and possible alternatives for explaining and hypothesizing  
- The reflection is analytical or integrative, linking factors and perspectives | ***No example*** |
| **Higher level of reflection** | | |
| Level 4 *(Critical Reflection)* | - Demonstrates an awareness that actions and events are not only located within and explicable by multiple perspectives, but are located in and influenced by multiple historical and socio-political contexts | ***No example*** |


**Examples came from students’ reflective thinking in study 1.

***There were no students showing level 3 & 4 of reflective thinking in both study 1 & 2.
Appendix G

Survey: Students’ Perceptions on Reflective Thinking Tool
## Perceptions of Reflective Thinking Tool

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate number.

1 = Strong Disagree  
2 = Disagree  
3 = Somewhat  
4 = Agree  
5 = Strong Agree

### During two weeks of on-line learning reflective thinking tool helped me...

1. Consider what my learning goals were.  
   1 2 3 4 5

2. Monitor my understanding of key concepts or principles that I have learned.  
   1 2 3 4 5

3. Monitor my learning strategies that I have used to organize and integrate knowledge that I was studying.  
   1 2 3 4 5

4. Think consciously about what, how, and why I was studying during on-line learning.  
   1 2 3 4 5

5. Evaluate my learning performance in terms of whether or not I have achieved my learning goals.  
   1 2 3 4 5

6. Consider how well my group work and how I might help my group work even better  
   1 2 3 4 5
7. Consider how well I interact with my teacher in order to understand what and how I was studying.
   1  2  3  4  5

8. Put more my efforts on my learning process.
   1  2  3  4  5

9. Have more confidence to successfully complete learning tasks given.
   1  2  3  4  5

10. Find out better ways to learn.
    1  2  3  4  5

11. Find out my intellectual weakness and strength in learning.
    1  2  3  4  5

12. Build a habit of reflective thinking in both learning and everyday life.
    1  2  3  4  5

13. Apply my reflective thinking to other classes.
    1  2  3  4  5

14. I would like to continue to use the reflective thinking journal.
    1  2  3  4  5

Please answer the following questions.

15. What other ways do you think you have benefited from the use of reflective thinking tool in on-line learning?

16. How do you feel about reflective thinking tool?

17. Are there any problems or issues you encountered with reflective thinking tool?
Appendix H

STAT 200 Comprehension Test
1. The width of the box plot for the 5#-summary for females is ___
   A. 2   B. 4   C. 6   D. 8   E. 17

2. One of the female students reported her height was 55". Which statement below is true:
   A. She may have made a mistake--her actual height could have been 5'5", so her height should have been given as 65".
   B. If she didn't make a mistake, then her height is an outlier, since it is more than 1.5 IQR's below the first quartile.
   C. Both A and B are possible.
   D. Neither A nor B is possible.

3. For females, the minimum height is 55". If it were deleted from the data set, the standard deviation of female heights ___.
   A. would decrease   B. stay the same   C. would increase

Descriptive Statistics

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<th>Variable</th>
<th>Gender</th>
<th>N</th>
<th>Mean</th>
<th>Median</th>
<th>TrMean</th>
<th>StDev</th>
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<tbody>
<tr>
<td>Height</td>
<td>female</td>
<td>114</td>
<td>64.581</td>
<td>65.000</td>
<td>64.748</td>
<td>3.102</td>
</tr>
<tr>
<td></td>
<td>male</td>
<td>88</td>
<td>69.813</td>
<td>71.000</td>
<td>70.069</td>
<td>4.405</td>
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</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gender</th>
<th>SE Mean</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Q1</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>female</td>
<td>0.291</td>
<td>55.000</td>
<td>72.000</td>
<td>63.000</td>
<td>67.000</td>
</tr>
<tr>
<td></td>
<td>male</td>
<td>0.470</td>
<td>56.000</td>
<td>79.000</td>
<td>68.000</td>
<td>72.875</td>
</tr>
</tbody>
</table>

4. The following graph compares the fastest speed reported ever driven between a sample of males and a sample of females (Note: On graph’s vertical axis, F = Females and M = Males ).
Which of the following statements is true?
   A. The median fastest speeds for the males and females are about the same.
   B. There are no outliers in the sample of males or in the sample of females.
   C. The lower quartile for females is about the same as the upper quartile for males.
   D. The lower quartile for males is about the same as the upper quartile for females.

5. A sample of Stat 200 students is asked, “How much time did you spend studying for the Stat 200 exam?” Which of the following graphs should not be used to describe the resulting data?
   A. Boxplot        B. Dotplot        C. Stem and Leaf       D. Pie chart     E. Histogram

6. Which choice lists two statistics that give information only about the “spread” of a dataset (and not the location)?
   A. Mean and standard deviation
   B. IQR and standard deviation
   C. Median and range
   D. Mean and median

7. The pattern of women's right hand spans follows a bell-shaped or normal curve. The mean for women's right hand spans is about 20 centimeters with a standard deviation of about 2 centimeters. The Empirical Rule states that about 95% of women will have a right hand span between what two numbers?
   A. 19 and 21       B. 18 and 22       C. 17 and 23       D. 16 and 24       E. 15 and 25

8. Which choice gives two variables for which regression and correlation can be used to analyze the relationship?
   A. gender and GPA
   B. opinion about the death penalty and opinion and gun control laws.
   C. heights of female students and heights of their mothers
   D. regression and correlation could be used for all of choices A, B, and C

9. Regression analysis is used to describe the relationship between ___
   A. two categorical variables
   B. one categorical variable and one quantitative variable.
   C. two quantitative variables
   D. none of the above.

10. A scatter plot and regression line can be used for all of the following except,
    A. to determine if any (x,y) pairs are outliers.
    B. to determine if a cause-and-effect relationship exists between x and y.
    C. to estimate the average y at a specific value of x.
    D. to determine if there is a linear relationship between x and y
Questions 11 and 12. A long-term study of 150,000 students on the number of times students change majors showed that the average for this population was 1.50 with a standard deviation of 1.00. For a random sample of 100 students from this population the average was 1.18 with a standard deviation of 0.92.

11. The number 1.50 is a
   A. sample mean     B. random variable C. parameter D. statistic

12. If $X =$ number of times each of the 150,000 students changed majors were tallied and arranged in a table with values 0, 1, 2, … and their relative frequencies of occurrence, we would have obtained ___
   A. the probability distribution of $X$
   B. the cumulative probability distribution of $X$
   C. a binomial distribution for the distribution of $X$
   D. a normal distribution for the distribution of $X$

13. What is the proper notation for the mean of a population?
   A. $\bar{x}$   B. $\mu$   C. $\sigma$   D. $s$

14. Which of the following is an example of a binomial random variable?
   A. The number of games your favorite baseball team will win this coming season.
   B. The number of questions you would get correct on a multiple-choice test if you randomly guessed on all questions.
   C. The number of siblings a randomly selected student has.
   D. The number of coins a randomly selected student is carrying.

15. A researcher conducts a study to compare the reading scores (as evaluated by a reading test) of students instructed by a standard method to students instructed by an innovative method.
   A. The explanatory variable is teaching method     B. The explanatory variable is reading score

Use the following table with Questions 16 and 17. The random variable $X$ has a binomial distribution with where $n = 5$ (the number of trials) and probability of success $p = .2$. The probability distribution function for this random variable $X$ is given below:

<table>
<thead>
<tr>
<th>$x$</th>
<th>$p(x)$</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>0.33768</td>
</tr>
<tr>
<td>1</td>
<td>0.40960</td>
</tr>
<tr>
<td>2</td>
<td>0.20480</td>
</tr>
<tr>
<td>3</td>
<td>0.05120</td>
</tr>
<tr>
<td>4</td>
<td>0.00640</td>
</tr>
<tr>
<td>5</td>
<td>0.00032</td>
</tr>
</tbody>
</table>
16. What is the probability of observing exactly two successes?
   A. .33768   B. .2048   C. .0512   D. .00032

17. What is the probability that a sample proportion \( \hat{p} = x/n \) would equal 0.6?
   A. .33768   B. .2048   C. .0512   D. .0064

18. Which of the following is a parameter?
   A. The mean of a sample of size 100 from a normal population.
   B. The range in ages of 100 men selected at random.
   C. The proportion of adults in a sample of size 500 who smoke.
   D. The average height in a population of all American males.

19. A confidence interval for a population proportion \( p \)
   A. is always centered at \( \hat{p} \); that is, \( \hat{p} \) is at the middle of the interval.
   B. is always centered at \( p \); that is, \( p \) is at the middle of the interval.
   C. has a width that is not affected by sample size.
   D. has a width that is not affected by the level of confidence.

20. CNN conducts a poll in which the sample size is 1600. The conservative 95% margin of error is
   A. 1/1600   B. \( \frac{1}{\sqrt{1600}} = .025 \)   C. 1/20 = .05   D. None of these

21. Suppose it is reported that the margin of error for a poll is 3.5%. Which of the following statements correctly interprets this value?
   A. In about 95% of all random samples of this size from the same population, the difference between the sample percent and the population percent will be less than 3.5%.
   B. In about 3.5% of all random samples of this size from the same population, the sample percent will equal the population percent.
   C. The probability that a 95% confidence interval based on this poll does not cover the population proportion is 3.5%.
   D. In about 95% of all random samples of this size from the same population, the difference between the sample percent and the population percent will be more than 3.5%.

22. A recent Gallup Poll of 400 American adults asked 'Do you approve of the way President Bush is handling issues on the domestic side?' Describe the sampling distribution of the sample proportion \( \hat{p} \) who say 'yes', if in fact 60% of all American adults approve. The sampling distribution of \( \hat{p} \) is approximately normal with ___.
   A. mean 240 and SD(\( \hat{p} \)) = 9.8
B. mean 240 and SD(\hat{p}) = .098
C. mean 0.60 and SD(\hat{p}) = .0245
D. mean 0.60 and SD(\hat{p}) = .24

23. Suppose that in a clinical trial, 280 of 400 patients (70%) are successfully treated with a new medication. Which of the following is an approximate 95% confidence interval for the proportion successfully treated with the new medication?

A. \[280 \pm 2 \sqrt{\frac{0.70 \times (1 - 0.70)}{400}}\]
B. \[0.70 \pm \sqrt{\frac{0.70 \times (1 - 0.70)}{400}}\]
C. \[0.70 \pm 2 \times \sqrt{\frac{0.70 \times (1 - 0.70)}{400}}\]
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