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ABSTRACT

This research examined the effects of teaching metacognitive strategies on performance in a self-directed learning situation. All participants, 60 university students enrolled in a beginning photography course for non-art majors, were subject to the same conditions. The treatment was embedded instruction and practice in reflection, planning, and evaluation. Metacognitive awareness was measured prior to and after the treatment. The use of metacognitive strategies was measured by a self-reflection survey, following the first and last assignment. These assignments were identical and provided for the assessment of performance. Results indicated that the treatment had a positive effect on learning. The change in metacognitive awareness led the researchers to conclude that instructional strategies that teach students to practice metacognitive skills while learning course content improves the use and awareness of these skills, as well as performance. The Metacognition Awareness Inventory, the student self-report survey for assignment 1, the heuristic used to measure students' change in performance, and tables summarizing results are appended. (Author/MES)

The Effects of Metacognitive Training on Performance and Use of Metacognitive Skills in Self-Directed Learning Situations

By:

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THE EFFECTS OF METACOGNITIVE TRAINING ON PERFORMANCE AND USE OF METACOGNITIVE SKILLS IN SELF-DIRECTED LEARNING SITUATIONS

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Abstract

This study intended to determine the effects of teaching metacognitive strategies on performance in a self-directed learning situation. All participants, 60 university students enrolled in a beginning photography course for non-art majors, were subject to the same conditions. The treatment was embedded instruction and practice in reflection, planning and evaluation. Metacognitive awareness was measured prior to and after the treatment. The use of metacognitive strategies was measured by a self-reflection survey, following the first and last assignment. These assignments were identical and provided for the assessment of performance. Results indicated that the treatment had a positive effect on learning. The change in metacognitive awareness led the researchers to conclude that instructional strategies which teach students to practice metacognitive skills while learning course content improves the use and awareness of these skills as well as performance.

Introduction

Metacognition is the ability to reflect, control and understand, in a self-aware mode, one's own learning and cognition (Schraw and Dennison, 1994). Philosophers for ages have been intrigued by the self-reflective nature of human thought. For some, it is the behavior that is the basis of our humanity. Metacognitive strategies as defined by Flavell (as cited in Lin, 1994, p. 489-490) are understanding and regulating one's own cognitive processes in order to monitor, direct and control them. Metacognitive skills include perception of oneself as a learner, an awareness of the nature of a task's components, and knowledge of when and how to use effective strategies. These factors combine to determine which tasks learners find worthwhile and how they choose to engage them (Paris & Winograd as cited in Lin, 1994, p. 490).

Metacognition becomes increasingly important in situations of heightened learner self-direction, where learners are asked to decide what, how and when to explore (Lin, 1994). Examples of such instructional situations are computer-based hypermedia simulations, web-based instruction, and asynchronous, distance learning environments. These environments have an extended complexity and a lack of structure that impose increased responsibilities and cognitive processing requirements on users. A lack of the metacognitive abilities to self-reflect, plan, monitor, evaluate, and adjust one's own cognitive strategies hinders learning under these conditions (Horak, 1991; Blakey and Spence, 1990; Ridley, Schutz, and Glanz, 1992; Lin, 1994).

Today the application of metacognitive research has become useful beyond theoretical models. The results are metacognitive strategies that students can be taught. Guided practice in managing their own experience allows students to develop the metacognitive strategies needed to continue to direct their own learning. (Metcalfe and Shimamura, 1994). Strategies include connecting new information to former knowledge, deliberating on how to select what to learn, planning the activity, and evaluating what is learned. Research suggests that making students aware of these strategies may be useful, that students can develop strategies on their own, and that their use increases learning and performance (Blakey, 1990). Research in metacognition has followed two paths, one details how it develops naturally throughout life and the second concentrates on the training potential of metacognitive strategies (Lin, 1994). Most previous research on metacognition describes the phenomena in the assimilation of complex information rather than tasks which are intended to produce personal or novel products. This study was situated in a studio art class and was different than most research and provided a unique context for metacognitive strategies training.

This study focused on training students in the use of metacognitive strategies and the effect on their use of metacognitive processes or activities in self-directed learning. The training was designed into the instructor-led lessons, which focused students' attention on planning, reflection and evaluation.

The long range goals of this research are to find what effect training metacognitive strategies will have on performance and future use of metacognitive processes, as well as to identify a method of training metacognitive strategies that is highly effective. Indicators of effect will be the performance on the comparison between students' first attempt and final attempt at an open assignment.

The primary expectation of this study was that students who have or develop, and then use metacognitive strategies would improve performance in making photographs. Regardless of the source of the student's metacognitive skills, whether gained prior to or during the course, it was expected that using strategies to monitor

what they know would increase the depth of their knowledge and determination to make images which were better than earlier attempts. We hope that such determination supported by metacognitive ability would continue beyond the course as students develop into life long learners.

Demands that are put on students to be self-reflective and creative also require them to be aware of their own conceptual underpinnings. It is the context of complex learning situations that puts pressure on students to develop an awareness of metacognition. Since the course content was complex and demanded constant improvement over previous work, it was expected that post treatment surveys would show significant differences to prior condition surveys of metacognitive awareness.

Method

Participants

During the fall term of 1998, 60 students in a sophomore photography class for non-art majors at a state university made up a sample of convenience for this study. There were 22 males and 38 females. There were no graduate students and all but 4 students were under 25. Participants were present for at least 80% of all classes. The research conformed to the guidelines set forth by the human subjects committee of the university.

Measures

The first item, a Metacognitive Awareness Inventory (MAI) (Appendix A), was used twice as a before and after comparison. It was administered the first time in the second week and a second time 10 weeks later. The MAI survey, designed and tested by Schraw and Dennison (1994), provided a reliable test of metacognitive awareness. The research conducted by Schraw was similar to our testing group in age and demographics. The survey has 52 statements which participants reacted to by marking a Likert scale with numbers from 0 (never true) to 10 (always true). The statements represented two component categories of metacognition, knowledge and regulation. Within the knowledge component were statements of declarative knowledge (knowledge about self and about strategies), procedural knowledge (knowledge about how to use strategies), and conditional knowledge (knowledge about when and why to use strategies). The regulation component covered planning (goal setting), information management (organizing), monitoring (assessment of one's learning and strategy), debugging (strategies used to correct errors) and evaluation (analysis of performance and strategy effectiveness after a learning episode).

A self-report survey (Appendix A) was administered twice: first, after students completed the first assignment; the second time after the last assignment. The survey was designed to capture the degree and type of planning and self-reflection students did before and during the preparation of the work. The survey reflects the strategies we used to embed training in context. The survey questions were written to gather data and to be a learning activity. This activity shows students the questions they should be asking themselves to become metacognitively aware in terms of planning and making photographs.

The third measure was a heuristic used to compare the first assignment and the last assignment (Appendix A). It was designed to measure students' performance change from the work done at the beginning of the course to work done at the end of the course. Each participant's work, completed in four categories of subject matter, was evaluated based on technical skill, subject matter, and composition. Two judges were asked to measure the improvement (0-3) from the first assignment to the last on each skill category for each subject matter set of photographs. Zero meant there was no positive difference between the work. A score of one meant slight change; two, noticeable improvement; and three meant significant positive improvement. Students received 12 different scores, totaling a possible 36 points, from each judge.

Materials

Instructional activities and student materials were developed from several sources of research descriptions. Blakley and Spence (1990) identify specific strategies for developing metacognitive behaviors that were helpful in creating definitions and descriptions of metacognition for students as "Knowing what you already know...." as well as developing guided practice self-reflection and interview questions. Their recommendation of social interaction and guided discussion about thinking in context of course content was included in the treatment activities as a necessary condition for the training of reflective processes, as also suggested by Von Wright (1992), Erickson and Simon (1993), and Sitko (1998).

Procedures

Students met for 10 three-hour sessions in which metacognitive training was embedded into the course content. Each meeting presented the content, which had been part of the syllabus for several years. The lessons for this study had been modified to require students to recognize others' use of metacognitive skills while working, and practice the skills themselves. For example:

- Several videotapes of famous artists were shown in class. Participants were asked to actively watch the film while answering questions related to the artist's methods on worksheets during and after the showing. They also were expected to take notes when the tape was stopped to illustrate specific instances when the artist was employing their own metacognitive strategies such as planning, monitoring and knowledge assessment.
- During the midterm critique class, where several students' photos from past classes were shown, questions were posed to practice planning, visualization and self reflection: "Where's the camera?; Where has the photographer placed the viewer?; When you are making a photograph, how do you manipulate the placement of the camera to create this viewpoint?"

The first and last assignments were given 10 weeks apart; they had identical requirements. Students were instructed to make photographs of four subject matter categories: portraits, still life, landscapes, and self-portraits. They were required to submit two examples in each category. Emphasis was put on planning, designing, and making unique images for the rest of the students to enjoy, understand, and as defined in class, "be able to make their own."

Between the first and last assignment, three other assignments were given over a period of five weeks. These assignments were completed in three parts. They gave the students practice in self-reflection, image visualization, planning, and assessing what they knew or needed to know. The first part was a handout instructing the participants to write or sketch some ideas for this new photograph. A week later, students, in a collaborative planning exercise, were interviewed by each other about their ideas for the assignment. The interview was facilitated by a worksheet of guiding questions; notes were taken and returned to the person interviewed. For the third meeting, the photographs that were done for this assignment were brought in for a critique. Every student gave a written critique of someone else's work and received a critique. This 3-step procedure was followed for all three practice assignments.

After students had completed the three specific subject matter practice assignments, they were given the final assignment. They had to repeat the first assignment to demonstrate what they had learned in the course. It was given in the context of a final exam and meant to challenge students to think and plan. The importance of doing the best they could was emphasized. Their evaluation would be based on improvement over the first assignment.

Research Design

The study was designed as a related sample and data was collected for mixed method analyses. No thought was given to using a control group due to the ethical problem of withholding skills training; therefore all participants were given the same treatment. The independent variables are the pre-tested metacognitive awareness MAI scores and a series of metacognitive strategy training sessions. The dependent variables were the performance in making photographs, measured by the change in performance score, and the use and acquisition of metacognitive skills, measured by the post MAI score and self-report surveys.

Descriptive statistics illustrate a difference in the means collected from the MAI survey. Inferential statistical procedures (t test and Wilcoxon signed ranks test) require random samples. Our design, based on a sample of convenience, could not make inferences to populations beyond this classroom. We understand that the best approach, according to Ludbrook and Dudley (1998), would be a permutation test but the time and software required were not available to the researchers. The self-reported data on the use of metacognitive skills in completing assignments at the beginning and the end of the course were used for qualitative analysis. The change-in-performance scores were used to create two performance groups of ten students each, High and Low, as a means of descriptive comparison.

Results

Changes in Total Mean Score.

Figure 1 shows the difference between mean scores for every subject before and after the treatment. Table 1 is the mean and standard deviation of the pre and post MAI scores. We cannot defend the use of statistical tests to draw inferences to a larger population but we do feel that the descriptive statistics support a rational verbal argument that this group was trained in and developed additional metacognitive skills. To understand the effects of metacognitive strategies training on changes in the subjects' performance we must accept the reported increase in the mean of metacognitive use is due to the embedded treatment in the course content. Qualitative analysis of students' changes in attitudes, strategies, and self-reflective reports offer additional evidence that students' thinking and learning strategies for completing this photography were affected by the treatment embedded design of the course content.

Figure 1. Differences in Mean MAI Scores

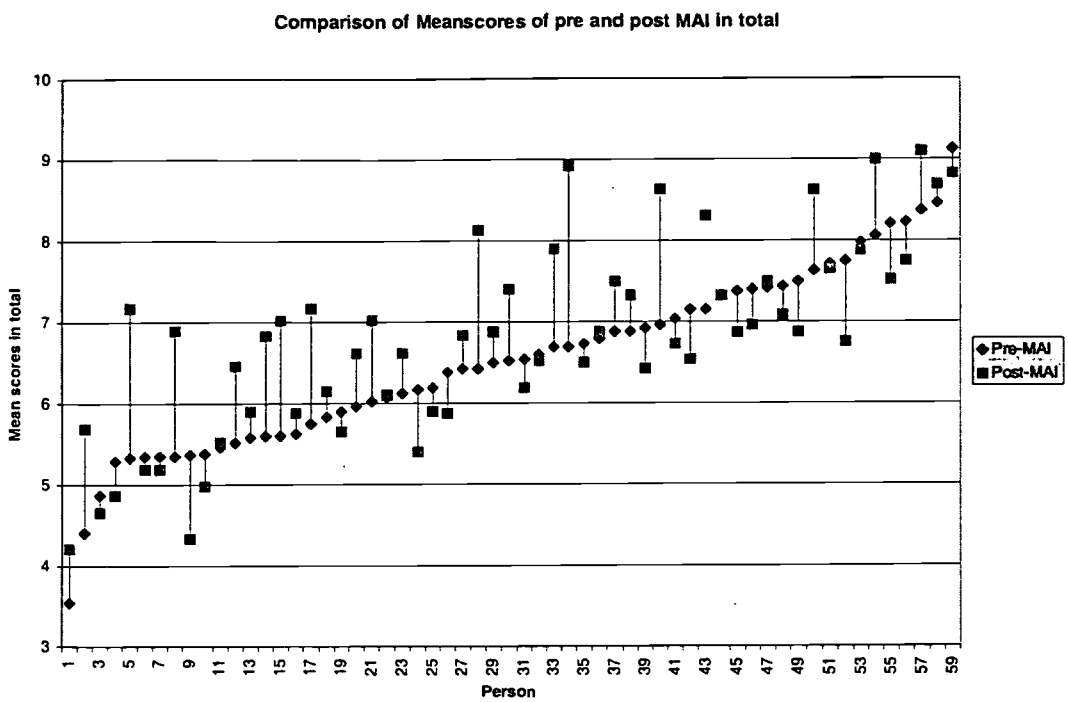

Table 1. Mean and Standard Deviation of Total MAI Scores

N=60	Mean	SD
Pre MAI	6.50	1.12
Post MAI	6.80	1.18

Self-report surveys Comparing Assignments 1 & 8.

Students' self-report surveys were analyzed by first selecting the ten extreme examples of High and Low performing students. The High or Low category reflects the level of change of performance score. The High score represents a change in performance score of 33 or more, while the Low group had scores of 16 or less, from a possible score of 72. These analyzes (Appendix B) compare in two ways the responses of these students to the questions: "What skills were necessary to do good work? ... Did you have them?" and "Describe the steps you took to do the assignment." The first compares the responses on assignment 1 and 8 for each student, showing individual change from the beginning to the end of the course and how this change differs for the Low and High performing students. In the second analysis, responses were coded into metacognitive categories to compare the use of these strategies in the two groups.

The comments of students with high change scores tend to show increased confidence in their work and a gained awareness of the skills and attitudes required to make good photographs. The comments of the lower scoring students tend to reflect little change in the understanding of the skills needed for good photography, or an accurate awareness of their actual ability to make photographs.

For example, when asked "What skills were necessary to do good work?", nine of ten high performing participants used words that addressed their thinking skills rather than just technical information. The descriptors used by these participants for necessary skills included these types of terms:

- manipulating meaning
- determine what was fitting, interesting,
- ability to look at photos critically
- use different perspectives
- remove things to simplify
- have patience, knowledge, creativity

High performing students demonstrated an objective look at their recently acquired skills. In some cases expressing what they had learned and what they still needed to learn. Participant 4 first took photographs intuitively, "doing what I felt" but later described necessary skills as being able to "determine what was fitting, interesting." Participant 65 knew at first that she did not know or have the "skills to do good work" but later describes feeling "more confident" and the "skills necessary to do good work are dedication, acceptance of failure, perseverance, and creative imagery. Another participant (69) used the same words, "patience, knowledge, creativity" to describe skills.

In contrast, the descriptors used by low performing participants for necessary skills included such terms as:

- attention to technical details
- know your f/stops and speeds
- time, patience and money
- a good eye and ability to work the camera

These participants' first comments imply that they consider these skills as things that have not yet been given to them, rather than something to pursue. Six low performing participants, after doing assignment 8, continue to describe necessary skills as technical ability, like "know your f/stops and speeds" and "focus, aperture, shutter speed". High performance students used different terms: "need more awareness of composition"; "tried to visualize pictures I knew were possible"; "take into account the lighting,... removing things from the picture to simplify it." In both groups, the comments illustrated a self-evaluation but the key difference was the characterization of "skills" for technical (psychomotor) goals and thinking (cognition) goals.

When responding to the second self-report prompt "Describe the steps you took to do the assignment." the comments of both groups tended to be more similar. One High group student describes the steps for the first assignment much like the others in both groups "... looked around and took what I thought was interesting." However, that student's description of the last assignment changed to " Decided to photograph things there that have meaning to me." Other comments more evident in the High group's responses for the second assignment relate to photographs being "posed, set up, staged" and many comments from this group also discuss the selection process as part of the steps.

After participants' comments were classified according to metacognitive components, we found both groups made the same comments related to the first assignment in the planning and monitoring categories. In planning, both groups characterized their behavior as "spent a week thinking," "planned in my head," "thought about what I liked." For monitoring, both groups made similar comments, such as "photographed what I liked that applied," "took pictures of places, people, or things that I had been admiring."

The low performing students seemed to repeat their comments from the first assignment when describing assignment 8. Most of their comments were still mentioning "thought about subject matter" and "thought about what would be better." Two participants chose to suspend any planning or monitoring and let chance take its course. They put themselves in situations and relied on intuition to find things interesting enough to photograph.

The difference becomes apparent when high performing students report how it is "interesting to now look at similar subjects in such a different light," Other High participants said "thought about, tried to visualize, pictures," "had ideas for pictures," and "went out, tried to make what I visualized." It is these comments that illustrate a change from their early thoughts about what makes a good picture to using their experience as interpretation.

Discussion

The study found that training students to use metacognitive strategies can affect learning and performance. The results also show that students who improve their level of awareness of metacognition also apply the skills to their problem solving in more direct content specific ways than those who do not change, regardless of the initial level of their awareness. The implication for designers of instruction is that instructional strategies for practice of content should be embedded with exercises that also improve metacognitive skills. Students should be given activities which require them to become aware of what they know, plan what they need to learn, and monitor their strategy choices, so they can be self-directed learners.

One of the most significant findings of this research is the value of the embedded design. Embedded design requires that metacognitive strategies be related directly to course content. For the instructional designer this means developing strategies that deliver course content which also address components of metacognitive awareness. Activities such as presenting examples of experts in the field using self-reflection to solve problems, writing work plans and journals, shared dialog in determining workable solutions to given problems and collaborative critique of work are some examples of embedded metacognitive practice.

As learning strategies and environments become more self-directed in nature, instructional designers must develop ways to bring these theories into practice to help learners be successful. The results found in this study conclude that embedding metacognitive practice in content learning activities helped students become more proficient at guiding their own learning.

Another important observation was that some students who reported high metacognitive awareness did not necessarily report their use in doing coursework. Metacognitive skills need to be practiced like any other skill in order to become effective. Students must be motivated to apply metacognitive strategies, which always require extra time and effort. This implies that designers should embed not only metacognitive practice within content delivery but motivating strategies as well. Future replications of this study will look at motivation as part of the embedded design.

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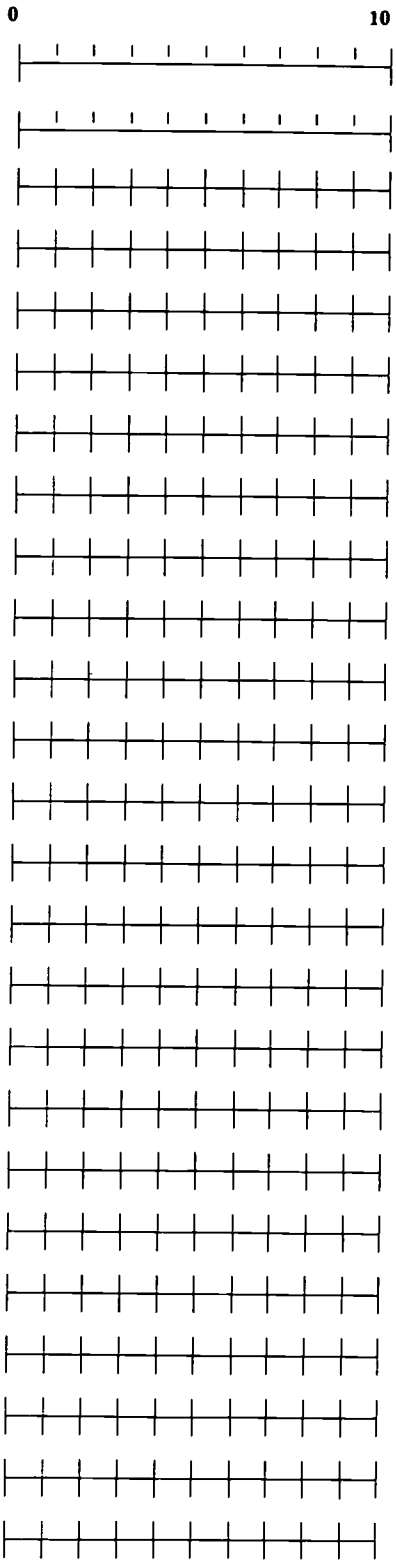
Appendix A

The measures in this appendix are the Metacognition Awareness Inventory, the student self-report survey for assignment 1, and the heuristic used to measure students' change in performance.

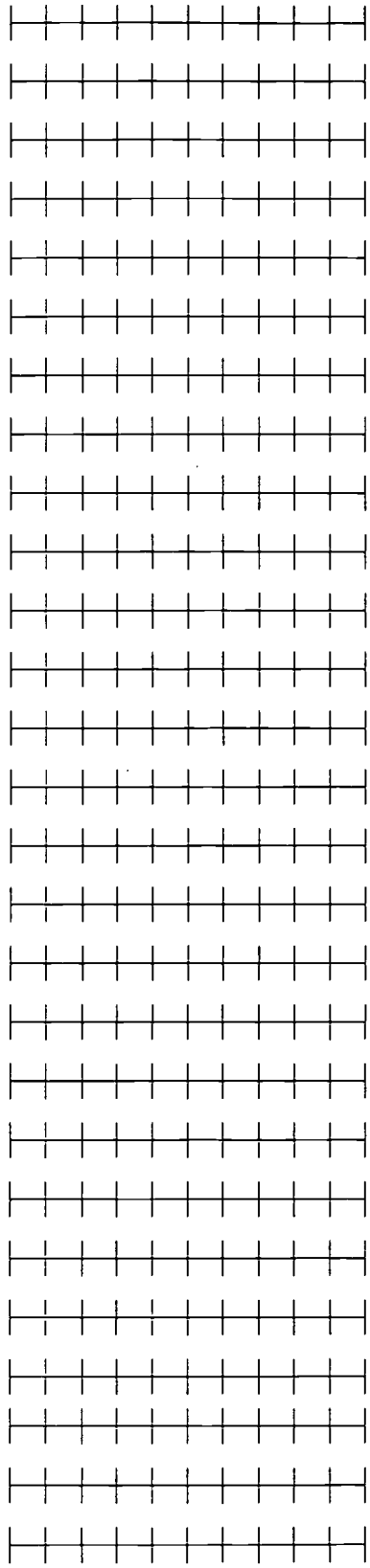
Name_____

Please read the statement and consider how much you agree with it... then mark the scale to the right. (0) means total *disagreement* 10 means total *agreement*.



1. I ask myself periodically if I am meeting my goals. (M)
2. I consider several alternatives to a problem before I answer.
3. I try to use strategies that have worked in the past.
4. I pace myself while learning in order to have enough time.
5. I understand my intellectual strengths and weaknesses
6. I think about what I really need to learn before I begin a task.
7. I know how well I did once I finish a test
8. I set specific goals before I begin a task
9. I slow down when I encounter important information
10. I know what kind of information is most important to learn.
11. I ask myself if I have considered all options when solving a problem.
12. I am good at organizing information
13. I consciously focus my attention on important information.
14. I have a specific purpose for each strategy I use.
15. I learn best when I know something about the topic.
16. I know what the teacher expects me to learn.
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.
23. I think of several ways to solve a problem and choose the best one.
24. I summarize what I've learned after I finish.
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.
31. 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.
37. I draw pictures or diagrams to help me understand while learning
38. I ask myself if I have considered all options after I solve a problem.
39. I try to translate new information into my own words.
40. I change strategies when I fail to understand
41. I use the organizational structure of the text to help me learn.
42. I read instructions carefully before I begin a task.
43. I ask myself if what I'm reading is related to what I already know.
44. I reevaluate my assumptions when I get confused.
45. I organize my time to best accomplish my goals.
46. I learn more when I am interested in the topic.
47. I try to break studying down into smaller steps.
48. I focus on overall meaning rather than specifics.
49. I ask myself questions about how well I am doing while I am learning something new.
50. I ask myself if I learn as much as I could have once I finish a task
51. I stop and go back over new information that is not clear.
52. I stop and reread when I get confused.



11/23/98

For this exercise you will review how you did Assignment 1.

Name _____

In order to improve the way you make photographs it is critical that you take time to review and reflect on how you make photographs. Learning how to ask and answer the following questions is as important to improving your work as making photographs.

Doing the Assignment

Describe the assignment in your own words....

Explain the purpose as you understood it....

Thinking back.... did you have all the skills necessary to do good work?

Describe the steps you took to do the assignment...

Planning the Assignment

Did you plan how to make these photographs? Yes / No

Did you write your ideas down Yes / No... or sketch the composition... Yes / No

If you did write or draw your plan, did it help you make the images? Yes / No

As for the technical requirements of the shooting....

Did you have the right supplies? ... Yes / No
Did you take the pictures **all at once** or **over several sessions**?
How many rolls of film did you use? ____
Did you design a photograph that was beyond your skills or expertise?
Yes / No

Recall how Hockey was creating and then designing his *"joiner"*... he would try things and change his mind and talk to himself—when you were taking your pictures...

Did you change your mind while taking the pictures? ... Yes / No
Did you talk to yourself while planning or taking the photographs? ...Yes / No

Evaluating the Assignment

Most of the time photographs come out different than we expect them.
When you first saw the prints from the processing lab...

Were they what you expected? *Yes or No*

Did they communicate the idea/meaning you had intended? *Yes or No*

Did they give you ideas for new photographs that you want to make?
Yes or No

Did you redo any photographs before turning them in? *Yes or No*

How did your evaluation of what others said about your work affect how you think about doing more work? *In other words, explain how you will use critiques...*

Appendix B

Student ID: _____

Total Score: _____

Name: _____

Photo Class Assignment: Measuring Change in Performance

	No Change	Some Change	Definite Change	Exceptional Change	Scores
Portrait					
Technical	0	1	2	3	
Composition	0	1	2	3	
Subject Matter	0	1	2	3	
				Portrait	_____
Landscape					
Technical	0	1	2	3	
Composition	0	1	2	3	
Subject Matter	0	1	2	3	
				Landscape	_____
Still Life					
Technical	0	1	2	3	
Composition	0	1	2	3	
Subject Matter	0	1	2	3	
				Still Life	_____
Self Portrait					
Technical	0	1	2	3	
Composition	0	1	2	3	
Subject Matter	0	1	2	3	
				Self Portrait	_____
				Total Score	

To determine how metacognitive strategy training differently affected metacognitive processing, the data collected from 40 of the self-reflection reports on the first and eighth assignments were compared in two ways. The first comparison, Table B1 shows each student's responses to two specific questions asked in the two reports. For Table B2, responses were coded into metacognitive categories: declarative knowledge, procedural knowledge, conditional knowledge, planning, managing information, monitoring, debugging, and evaluating strategies.

Table B1. Self-report surveys: Comparing Assignments 1 & 8.

What skills were necessary to do good work? ... Did you have them?

High	Assignment 1	Assignment 8	Low	Assignment 1	Assignment 8
4	Understood requirements, did what I felt	Determine what was fitting, interesting. Shows in my work	1	Definitely Not.	Skills needed were good selection and composition of photos, with attention to technical details. Yes I had them.
5	Knew what I wanted but don't have the experience to manipulate the camera to receive the desired results.	Need understanding of shutter speeds, apertures, and light. I could have used more; light meter would have helped.	8	Yes, after taking several pictures, I remembered how to do things and experimented	A good camera, a camera you're used to, know your f/stops and speeds.
7	I haven't mastered aperture and speed, so used automatic settings. Decent showing of ideas & style.	Knowledge of manipulating shutter speed, f-stop, color temp, meaning. Yes.	10	Yes, but it depends what good work is. It was fine for my second project but far from a gallery.	It was very important that you had a good idea, of how to work your camera. This involves items such as focus, aperture, shuttle speed, etc. Yes, I feel I have a good understanding of the skills needed for this assignment.
13	Fair job. First time with adjustable camera.	Using depth of field, speed, lighting contrast knowing what to leave in, what to keep out. I feel I was better at using these skills at the end of the semester.	11	Yes. I seemed to manage taking the photos. I think I am pretty god at taking pictures.	To do good work, one must be able to see a situation in a photograph and make it look excellent and yes, I did have them.
19	I need more awareness of composition. I concentrated every subject square in the middle of the field.	Ability to look at photos critically and objectively to design photographs that were better. Yes.	25	No. I don't have any skill with a manual camera and I don't quite know how to use it.	Time, patience, money, a need to do better. I had some of these... others I lacked in.
51	To take pictures in a way that the surroundings in the picture is interesting. I think I had them.	The skills in the class that I learned... the different perspectives of things that I could photograph enabled me to do good work.	29	Yes. The only thing I lacked was time! After my first roll of film got exposed I had little time to retake photos.	The only skills needed are a good eye for a subject and ability to work the camera. I'm not great at picking subjects but I can work the camera well.
53	I had basic knowledge of how to use my camera for "snapshots". No idea what type/genre of photography I preferred and/or was more skilled at	I knew more than I did at the start but still need practice	45	Creativity	No speed skills.
56	I tried to visualize pictures I knew were possible, while still being something that I wanted.	I needed to take into account the lighting, any special effects I might try, removing things from the picture to simplify it, etc. I had some idea of these skills before, but not to the depth I have now.	46	Yes, I had already acquired the basic knowledge needed to do the assignment.	In order to do this, I needed to be able to quickly determine the camera settings and also be able to figure out what made good composition - I got better.
65	I did not have all the necessary skills to do good work.	Skills necessary to good work are dedication, acceptance of failure, perseverance, and creative imagery. I didn't possess all this skills when I first came into this class but now I feel more confident that I do possess them.	64	No, I don't think I had all the skills to do good work. I had just gotten my 1st manual camera & was very unsure of it & my ability to use it. I spent an entire day taking pictures all over town & when I went to pick up the developed film it turned out I had loaded the film wrong & didn't get a single picture.	Creativity, an understanding f your cameras functions, an understanding of light, space, and your subject. Deciding what you are trying to capture 1st.
69	In general my photographs were good work. visually pleasing, for beginning photos.	Patience, knowledge, creativity, work. Yes.	76	For the most part, some pictures came out better than others, while others came out not as I expected.	To plan, see, know what I wanted and the ability to create images. - Sometimes.

Describe the steps you took to do the assignment

Low			High		
	Assignment 1	Assignment 8		Assignment 1	Assignment 8
1	Some forethought about who and what I considered photo material - personal choices. Waited for a trip to New Orleans to capture one of the scenes	Most of the photos were taken on a trip to Busch Gardens. I took many rolls with this assignment in mind	4	I thought of a few pictures in my head, but besides those, I just kept my eyes pen and searched for subjects.	See things not obvious to regular viewers. Sometimes I just got lucky with what came off the roll of film.
8	I looked for things that intrigued me. Took a shot of it. Experimented with the same shot. Picked the best. Studied the ones messed up.	Drove out to Lake Jackson, several different parks. Walked the trails, looking for something that caught my eye.	5	Figured out who I wanted the portraits to be of. Just looked around and thought what I thought was interesting. Ponder what I liked so I could then know what I wanted to shoot.	Went home. Decided to photograph things there that have meaning to me. Walked around with the camera, capturing some things by accident. Others I posed, set up.
10	Tried to picture a scene that would be easy to produce. Picked a person and a location Began taking pictures	Planned what I wanted to photograph. Made a short list. Went about photographing.	7	I went out to Lake Jackson for things to photograph. Took an old friend out and took a couple photos of her around town, home.	Went to scenic areas. Took shots I had thought about. The objects just came to me when I was around them.
11	Read the assignment Photographed what I liked that applied	I kept in mind what the assignment was. Tried to find it. Took the picture, developed, and mounted it.	13	Took pictures of places, people, or things that I had been admiring for some time. The self-portrait was more thought out.	Wandered, exploring, looking, thinking about compositions. Watched for good lighting opportunities. Staged portrait. Cat was opportunity.
25	Took my camera everywhere until I found exactly what I wanted	Looked at what I had done before. Thought about what would be better. Attempted to do it.	19	I thought about what I would like. Made a list of possible subjects. Took far more than necessary to insure acceptable photos.	Over a month's time, I'd have an idea and set it up. Made repeated trips to Lake Ella for candid shots. Took more than necessary. Selected the best examples.
29	Thought about things that would reflect myself Took the photos Developed them Chose the best	I did not plan the subjects. I enjoy just taking pictures when I see an opportunity. Many of the photos were spontaneous.	51	Thought of what kind of areas I wanted. Took a trip to Tampa and found those types. Some things I just took pictures as I went. Selected the most interesting.	Thought about the assignment. Through the weeks, came across situations.
45	Spent a week thinking. One day to snap a roll	When I was free, I just grabbed my camera bag, went outside, and took pictures. Most of my images are seen every day by everyone.	53	Made sure I understood the assignment. Went over possibilities in my mind. Took several photos. Made a photographing trip around town and campus. Chose photographs that fit.	Looked back at 1st assignment to see what to do differently. Looked over other assignments to find preferences. Though out possible ideas. Took pictures based on the ideas. Other things seen while photographing. Picked those that worked best.
46	Planned places, people or things Lighted, distanced, focused them	Brought my camera everywhere I went for a month. Began to go places solely for the purpose of taking the pictures	56	Thought about what would be available to me: lighting, subject, etc. I went out, set it up, shot a couple, trying to get the angle, shadows, etc. that I wanted.	Thought about, tried to visualize pictures. Went out, tried to make what I visualized. Experimented while doing this.
64	Think about my subjects Drove around with camera. Got them developed Chose which pictures	Looked at my old work to decide what could make it better. Decided on subjects, began to get ideas	65	Planned the pictures in my head. Tried to take those and others. Took more random pictures than planned. Re-took some.	Reevaluated my own work, deciding what I liked, disliked. Interesting to now look at similar subjects in such a different light. Fully understanding that snapshots are not photographs.
76	76Planned in my head. Pictured what & where	Thought about subject matter. Created atmosphere if controllable. Took pictures.	69	Went out around town. Took various pictures from the categories. Went out another time at night. Picked out the ones I liked.	Had ideas for pictures. Created and shot them. Others I just saw and wanted to photograph.

Table B2. Metacognitive evidences of Assignments 1 and 8 for both groups

		Low Performance Group		High Performance Group	
Component	**Description**	**Observed Evidence (Assignment 1)**	**Observed Evidence (Assignment 8)**	**Observed Evidence (Assignment 1)**	**Observed Evidence (Assignment 8)**
Declarative Knowledge	Knowledge about self and about strategies. "I know..."	• after taking several pictures, I remembered how to do things and experimented • I seemed to manage taking the photos. I think I am pretty good at taking pictures. • I had already acquired the basic knowledge needed to do the assignment.	• Skills needed were good selection and composition of photos, with attention to technical details. • Time, patience, money, a need to do better	• Understood requirements, did what I felt • Knew what I wanted but don't have the experience to manipulate the camera to receive the desired results. • I haven't mastered aperture and speed, so used automatic settings. Decent showing of ideas & style. • I need more awareness of composition. • To take pictures in a way that the surroundings in the picture is interesting.	• Need understanding of shutterspeeds Apertures, and light. • Knowledge of manipulating shutter speed, F-stop, color temp, meaning. • I knew more than I did at the start but still need practice • I needed to take into account the lighting, any special effects I might try, removing things from the picture to simplify it, etc. • I had some idea of these skills before, but not to the depth I have now. • Skills necessary to good work are dedication, acceptance of failure, perseverance, and creative imagery. • Patience, knowledge, creativity, work.

Procedural Knowledge Procedural Knowledge	Knowledge about how to use strategies. "First, … then…"	• I don't think I had all the skills to do good work. I had just gotten my 1st manual camera & was very unsure of it & my ability to use it. I spent an entire day taking pictures all over town & when I went to pick up the developed film it turned out I had loaded the film wrong & didn't get a single picture.	• Created atmosphere if controllable. • It was very important that you had a good idea, of how to work your camera. This involves items such as focus, aperture, shuttle speed, etc. • To do good work, one must be able to see a situation in a photograph and make it look excellent • The only skills needed are a good eye for a subject and ability to work the camera. I'm not great at picking subjects but I can work the camera well. • In order to do this, I needed to be able to quickly determine the camera settings and also be able to figure out what made good composition • Creativity, an understanding of your cameras functions, an understanding of light, space, and your subject. Deciding what you are trying to capture 1st.	• I had basic knowledge of how to use my camera for "snapshots". • No idea what type/genre of photography I preferred and/or was more skilled at • I tried to visualize pictures I knew were possible, while still being something that I wanted.	• Using depth of field, speed, lighting contrast knowing what to leave in, what to keep out. I feel I was better at using these skills at the end of the semester. • Ability to look at photos critically and objectively to design photographs that were better • The skills in the class that I learned… the different perspectives of things that I could photograph enabled me to do good work.
Conditional Knowledge	Knowledge about when & why to use strategies "If…, then "				

Planning	Goal setting "I want... ; here's how..."	• Some forethought about who and what I considered photo material - personal choices. • Tried to picture a scene that would be easy to produce • Thought about things that would reflect myself • Spent a week thinking. • Planned places, people or things • Think about my subjects • Planned in my head • Took my camera everywhere until I found exactly what I wanted	• To plan, see, know what I wanted and the ability to create images. • Planned what I wanted to photograph. • Thought about what would be better. • Decided on subjects, began to get ideas • Thought about subject matter. • Began to go places solely for the purpose of taking the pictures	• Figured out who I wanted the portraits to be of. • I thought about what I would like. • Thought of what kind of areas I wanted. • Thought about what would be available to me: lighting, subject, etc. • Planned the pictures in my head.	• Decided to photograph things there that have meaning to me. • Wandered, exploring, looking, thinking about compositions. • Over a month's time, I'd have an idea and set it up. • Thought about the assignment. • Thought about, tried to visualize pictures. • Had ideas for pictures.
Managing Information	Organizing "Make a list...			• Made a list of possible subjects.	
Monitoring Monitoring	Assessment of one's learning and strategy "How am I doing?"	• Read the assignment and photographed what I liked that applied • Lighted, distanced, focused them	• I kept in mind what the assignment was and tried to find it and took the picture, developed, and mounted it. • Looked at what I had done before. • I did not plan the subjects but I enjoy just taking pictures when I see an opportunity. Many of the photos were spontaneous.	• I thought of a few pictures in my head, but besides those, I just kept my eyes pen and searched for subjects. • Took pictures of places, people, or things that I had been admiring for some time. • I went out, set it up, shot a couple, trying to get the angle, shadows, etc. that I wanted • Took more random pictures than planned.	• Walked around with the camera, capturing some things by accident. • Took shots I had thought about. • Watched for good lighting opportunities. • Took more than necessary. • Through the weeks, came across situations. • Went out, tried to make what I visualized. • Interesting to now look at similar subjects in such a different light.

Debugging	Strategies used to correct errors "What needs changing?"	• Experimented with the same shot. • Studied the ones messed up.	• I took many rolls with this assignment in mind • Attempted to do it. • Looked at my old work to decide what could make it better.	• Re-took some.	• Made repeated trips to Lake Ella for candid shots. • Experimented while doing this. • Reevaluated my own work, deciding what I liked, disliked.
Evaluating	Analysis of performance and strategy effectiveness after the learning episode "How did I do, compared to before and others?	• Picked the best • Chose the best			• Sometimes I just got lucky with what came off the roll of film. • Selected the best examples. • Fully understanding that snapshots are not photographs.

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