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A Think-Aloud Assessment of Metacognition in 8th Grade Students: Using The Oregon Trail

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A Think-Aloud Assessment of Metacognition in 8th Grade Students: Using *The Oregon Trail*

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Abstract

Metacognition, the awareness of one's own learning, can be divided into five distinct steps (Ambrose et al., 2010). Moreover, metacognition can be measured through offline (retrospective self-report questionnaires) or online assessments (asking students to explain their decision making during a problem solving task, called "think-aloud"). The current study assessed the effectiveness of a think-aloud assessment using *The Oregon Trail* game to measure metacognition, in comparison to a self-report measure of metacognition, the Metacognition Five (MC5). *The Oregon Trail*, which is metacognitive in nature, is a videogame designed to teach students about the journey of the pioneers and the obstacles they faced during the era of Westward Expansion in the United States during the 19th century. The students play the game as the wagon leader that tries to successfully take his or her party from Independence, Missouri to Oregon. Of additional interest was whether there was a relationship between academic grades and performance on *The Oregon Trail* task. Participants played the game for twenty minutes as the researcher tallied their game play behavior and asked them to explain their reasoning behind key game play decisions. Both behavioral tallies and coded statements from the think-aloud procedure were positively correlated with academic performance and with scores on the MC5 measures. Due to the small sample size (n=15) these correlations were not statistically significant but were in the predicted direction. The study demonstrated the potential usefulness of online assessments of metacognition.

Keywords: metacognition, middle school students, "Think-Aloud" assessment

Think-Aloud Assessment: An On-line Assessment of Metacognition in 8th Grade Students

Self-Regulated Learning

Self-regulated learning (SRL) is a theory of learning that is based on Albert Bandura's social cognitive theory of self-regulation (Schraw, Crippen, & Hartley, 2006). Bandura (1991) suggested that human behavior is influenced by two sets of factors: external outcomes and self-regulatory processes. External outcomes refer to one's environment, which can impact learning. In regards to self-regulatory processes, Bandura (1991) focused on one's capacity to self-reflect and react as a response to one's feelings, thoughts, motivations, and actions. Thus, he argued that effective learning was not solely based on behaviors, but includes interactions between one's learning environment and internal affective factors. Self-regulated learning is therefore an individual's ability to comprehend and manage one's own learning (Schraw et al., 2006).

Self-regulated learning consists of three distinct components: cognition, metacognition, and motivation (Schraw et al., 2006). Cognition refers to the skills needed in order to encode, memorize, and subsequently recall information. Metacognition requires a different set of skills, which allows individuals to understand and monitor their cognitive processes while learning. Lastly, motivation relies on one's own beliefs and attitudes, which ultimately affect both their cognitive and metacognitive skills in relation to one's learning. Schraw et al. (2006) assert that all three components are necessary, but are not sufficient for self-regulation. In other words, all three components are interdependent and are necessary in regulating one's own learning.

Metacognition

According to Ambrose, Bridges, Lovett, DiPietro, and Norman (2010), metacognition involves reflecting on and directing one's own thinking process in relation to learning. They focused on metacognition in college students and highlighted the fact that numerous models have

been proposed to describe the process of metacognition, but all of these models highlight the same five steps.

The first step of Ambrose et al.'s (2010) metacognitive model is assess the task. For example, when students receive an assignment, they have to be able to understand the directions and assess what are the goals and possible constraints of the task at hand. The next step of the Ambrose model is evaluating strengths and weaknesses. In this step, students have to consider which areas of the study they excel at and which ones involve struggles and to keep these differences in mind when it comes to completing their assignment. As an example, if students are required to give a presentation on a given topic, they may note that they have strong communication skills, but may struggle in terms of organizing the presentation. Planning is a crucial step of metacognition, so students must be capable of breaking down their assignment into steps in order to guarantee completion. In the case of students doing a presentation, they might give themselves deadlines to complete certain steps of the assignment: when to finish conducting all the research, find various photos or video clips to include in the PowerPoint, make the PowerPoint, rehearse, etc. Next, students have to apply strategies to execute their plan and monitor their progress. Finally, students should reflect on the extent to which the approach they use to complete the presentation is working so that they may adjust and restart the process if necessary for future assignments.

Metacognition plays a significant role in numerous areas of learning. According to Flavell (1979), a multitude of studies have shown that metacognition is vital in oral communication of information, oral persuasion, oral comprehension, reading comprehension, writing, language acquisition, attention, memory, problem solving, social cognition, and various types of self-control and self-instruction. Therefore, there is no doubt that metacognitive skills

are necessary for students to possess in order to succeed in various areas of study and learning skills.

Strategies to Promote Metacognition

Ambrose et al. (2010) included suggestions for teachers to utilize in order to promote metacognition in their students. The first strategy is to model their own metacognitive process for their students. Thus, teachers should show their students how they would go about completing the same assignment, explaining each step of their own process. The next strategy is scaffolding, which is when the teachers provide students with cognitive supports in the earlier stages of their learning and then gradually remove these extra supports as the students develop a greater mastery of these skills (Ambrose et al., 2010).

Metacognitive Interventions

A meta-analysis done by Dignath and Buttner (2008) revealed that metacognitive interventions helped improve students' academic performance and fostered the development of life-long learning. Dignath and Buttner (2008) pinpointed several important elements of an effective intervention: explicit instruction of metacognitive skills conducted by researchers as opposed to traditional classroom teachers, inclusion of group activities which result in higher motivation and performance, and self-assessment and reflection. Furthermore, Schraw et al. (2006) asserted that collaboration is key for both education and learning. In fact, the clearest example of the role of collaboration and learning is the utilization of cooperative learning groups (Schraw et al., 2006). Hogan (1999) developed the Thinking Aloud Together (TAT) program in order to promote metacognition and self-regulation in small collaborative groups. Hogan (1999) found that the students placed in TAT programs demonstrated a greater metacognitive awareness of their learning compared to students in the control group. In studies conducted by Woodruff

and Meyer (1997) and Bianchini (1997), small group collaborations were shown to be more effective when students were doing inquiry based discussion of problems or when they were given explicit training on how to best work in small groups. However, cooperative student groups can be difficult to initiate and manage in a classroom (Schraw et al., 2006).

In a study by Paris, Cross, and Lipson (1984), third and fifth grade classes were selected to participate in a metacognitive study with the hopes of improving reading comprehension. Two classes from each grade received metacognitive training for four months that informed them about strategies to improve reading comprehension. Additionally, two classes from each grade were assigned to the control group and received no additional intervention. At the conclusion of the study, classes who received the training scored higher on reading comprehension performance tests than their control counterparts in both grade levels (Paris et al., 1984). The findings of the Paris et al. (1984) study emphasize the effectiveness of metacognitive training to improve learning in elementary-school-aged students.

Another study, conducted by Zepeda, Richey, Ronevich, and Nokes-Malach (2015) aimed to assess a self-guided metacognitive intervention that specifically targeted planning, evaluating strengths and weaknesses, and monitoring performance and investigated how these three skills contribute to adaptive problem solving in an eighth grade science class. The eighth grade students took a pretest on their conceptual knowledge and understanding of physics. Afterwards, the instructor administered the intervention for four weeks, which required the completion of eight packets in both the experimental and control groups. At the conclusion of the intervention, the students from both groups completed the same post-test. Zepeda et al. (2015) found that the experimental group performed better on problem solving and reported

higher levels of self-efficacy. However, there was no difference in their self-reports of metacognition between both conditions.

Findings from Past Studies at Trinity College

There have been several metacognitive interventions conducted by Trinity College psychology students in the past that have shown mixed results of effectiveness. For all the prior interventions, the *Learn 2 Learn* intervention started around October of the fall semester and finished around March of the spring semester. Students filled out the same close-ended and open-ended questions of metacognition in the fall and spring semesters. Additionally, the student researchers led all the intervention and control sessions. During the winter break, the students participating in the study were asked to complete "The Winter Booklet," which had several activities aimed at maintaining their understanding and use of metacognition.

Godfrey (2014) and Lopez (2014) found significant effects of the implemented intervention on eighth grade students' metacognition and academic performance. During the academic year, the researchers held eight sessions for the eighth graders in their social studies classroom that focused on teaching and improving metacognitive skills, by using Ambrose et al.'s (2010) five-step model of metacognition. The students assigned to the control group had sessions that helped them learn more about college. Godfrey (2014) and Lopez (2014) found significant intervention effects when metacognition was assessed with close-ended questions, but not when it was assessed with the open-ended questions.

In contrast, Fulton (2015) and Schackner (2015) failed to find any significant differences between the *Learn 2 Learn* and control groups through the same self-assessments. They postulated that the lack of results could be due to teacher effects since they had worked alongside the same eighth grade teacher who had assisted in previous versions of the same study.

Gonzalez (2016) and Thomann (2016) assessed the effectiveness of the intervention in both the sixth and eighth grades. The sixth graders had six sessions to discuss metacognition if assigned to the *Learn 2 Learn* group or transitioning into high school if selected to be in the control group. The eighth graders had eight sessions total for both the experimental and control groups. The intervention in both grade levels was designed to be more interactive than previous iterations of the study by including hands-on activities, PowerPoints, and discussions with the students. Contrary to their hypotheses, the effect of the intervention on metacognition only approached significance with eighth grade students.

Assessment of Metacognition

Online Assessments. An on-line assessment of metacognition is a method of obtaining the desired data through a specific task, unlike offline assessments, which are done by the participants before or after completing the task. However, on-line assessments are time-consuming, labor-intensive, and must be conducted one-by-one (Veenman, Bavelaar, De Wolf, & Van Hout-Wolters, 2014). Despite these inherent disadvantages, on-line measures seem to be more predictive of learning performance in comparison to offline measures (Veenman & Spaans, 2005).

There have been several studies lead by Veenman and colleagues that aimed to shift the focus of assessing metacognition in the direction of on-line assessments (Veenman et al., 2014; Veenman, Prins, & Verheij, 2003; Veenman, Van Hout-Wolters, & Afflerbach, 2006). For instance, Veenman et al. (2003) compared undergraduate students' self-reports with their think-aloud measures as they completed a reading task. Students' were consistent in their self-reports when they expressed their particular study behaviors. However, students did not perform said study activities as frequently as they had indicated in their self-reports when they were

doing the reading task (Veenman et al., 2003). Thus, it appears that expressed self-report behaviors did not coincide with the actual behavior.

Observation studies. Boekarts and Corno (2005) stressed that online observations capture the actions that are occurring in the moment better than recalled offline assessments. In the case of observation studies, researchers decide what aspects of self-regulated learning and strategy use they intend to observe and assess (Boekarts & Corno, 2005). Furthermore, these observations can be conducted based on an individual participant or on interactions between two or more participants. Alongside the observations, coding systems work in conjunction with a verbatim record of what is being said by target students and/or their teachers. It is clear that observation studies provide a rich collection of qualitative data, and at times may also include quantitative data, in terms of both verbal and non-verbal behavior while completing the task at hand. Moreover, structured or semi-structured interviews may be used as a way to further gain qualitative insight. The main objective of these interviews is to record the students' and/or teachers' experiences, which simply cannot be explored with self-report, retrospective measures. Unstructured interviews allow the participant to openly communicate their experiences and are recorded as individual narratives. In structured interviews, the researchers asks critical questions in order to get at what they choose to focus on and each question builds on the previous one. Semi-structured interviews allow the researchers to choose which questions they would like to ask from the list of generated questions, which prompts students to reflect on strategy use, thoughts, feelings, awareness of external factors, etc.

Think-Aloud. In a think-aloud session, students report their thoughts, feelings, and self-regulated learning strategies while they are completing a task (Boekarts & Corno, 2005). Unlike an interview, participants continue to verbalize their thought process, feelings,

and strategy use as they perform the task. These kind of studies, just like observation studies, result in verbal data from the selected participants. Think-aloud studies record these ongoing thoughts and feelings as they occur in the moment, rather than requiring the participant to recall them after task completion. Think-aloud studies also have several disadvantages. Students, especially in the case of younger students, may have difficulty expressing their thoughts and feelings because of a restricted vocabulary. Students may also need a lot of practice in order to successfully perform both tasks simultaneously (Boekarts & Corno, 2005).

Veenman, Elshout, and Groen (1993) investigated the convergent validity, which is the degree to which two related measures align, of logfile indicators and an on-line assessment, in this case, a think-aloud assessment. Logfile indicators indicated how the program was used and what actions were being made in the game. In a computer-simulated game to learn about calorimetry, participants had to heat blocks of several different materials and weights on a burner and subsequently measure the temperatures of each block. In a pilot study, a composite logfile measure was used to keep track of frequency of experiments and the frequencies of measuring the initial and final temperature of the blocks correlated .62 with a think-aloud measure of metacognitive skillfulness. Similarly, Veenman et al. (2003) confirmed that logfile and think-aloud measures in two different studies had a strong positive correlation between .84 and .85. The logfile measures then demonstrated an incremental development of metacognitive skills in 9, 14, 17, and 22-year-old participants.

In a study by Veenman et al., (2014), secondary school students were asked to complete the Otter Task, which required them to experiment with five independent variables (habitat, environmental pollution, public entrance, setting out new otter couples, and feeding fish in the

winter time) in order to learn the combined effects on otter population growth. The variables could have no effect (public entrance), a main effect (habitat, pollution), and an interaction with another variable (habitat x setting out new couples; pollution x feeding fish). Participants were asked to complete a minimum of 15 experiments and they were able to consult their earlier experiments and their results by referring to the storehouse. Numbers of experiments conducted and think times were considered to be positive indications of metacognitive use. It was found that metacognitive skills can be adequately measured through an on-line task in conjunction with computer logfiles from the Otter task. Therefore, this demonstrates that evaluating both quantitative and qualitative data through a computer-simulated game must be the best mechanism of assessing metacognition.

Analysis of Work Samples. Winne and Perry (2000) assessed the observable traces of students' processes that they leave behind as they work on a designated task. These traces can be recorded and examined through carefully designed computer or text learning studies. Another way to analyze work samples is to collect physical copies of the students' work. In other studies, marked text passages while studying, sections copied, patterns of moves in a computer problem solving game or task, etc. were used to investigate self-regulated strategies and metacognition across several age groups. In this way, there is evidence to demonstrate that a student can distinguish between major points and details in a particular reading, for example, which evaluates the self-regulation of their own learning.

Offline Assessments. Offline measures, such as questionnaires, are done either before or after completing a task. Unlike online assessments, which are time-consuming and must be done one-on-one, questionnaires are easy to administer to large groups of participants, readily usable in classrooms, and measure all three components of self-regulated learning: cognitive,

motivational, and affective (Paris & Paris, 2001). Another benefit of questionnaires is that they provide a global assessment of metacognition as opposed to an online assessment, which tends to have a more narrow focus of metacognition. In other words, the questions in a survey evaluate metacognitive use more broadly whereas think-aloud assessments evaluate the use of metacognition in a specific task.

Most self-report questionnaires use Likert scales that reliably assesses the number of times students report using a particular strategy (Boekarts & Corno, 2005). An example would be the Motivated Strategies for Learning Questionnaire (MSLQ) developed by Pintrich, Smith, Garcia, and McKeachie (1991), which measures both reported cognitive and metacognitive strategy use that relates to students' motivational beliefs and attitudes. This is an example of an offline approach to measuring metacognition through self-report questionnaires.

Howe, Naratil, Reuman, and Anselmi (unpublished, 2012) developed a new questionnaire to measure metacognition, the Metacognition-5 (MC5), which assesses the five metacognitive steps outlined by Ambrose et al. (2010). The MC5 includes 35 self-report items, which use a five-point Likert scale, with equal representation of all five steps of the model.

Godfrey, Lopez, Shimmel, Anselmi, and Reuman (unpublished, 2014) created a version of the MC5 with open-ended questions. This version of the MC5 consists of 8 open-ended questions about the students' awareness and use of metacognitive skills in their social studies class. The coding manual and criteria for this version of the MC5 was adapted from Van Kraayenoord and Paris (1997), with students' responses scored from a 0 to 3 point scale. Godfrey (2014) and Lopez (2014) subsequently conducted a metacognitive intervention with eighth grade students and found that the students' MC5 scores, when assess with close-ended and open-ended questions, improved due to the intervention.

However, there are several disadvantages to offline measures as well. The principal problem with offline self-reports is that the responses to the questions must be derived from a reconstruction of memories (Veenman, 2011). The reconstruction of the learners' memories is at risk of memory failure, distortion, and different interpretations of the meaning of the question (Veenman, 2011). Questionnaires are often affected by social desirability bias. Social desirability bias is the tendency of participants to answer a question based on what they believe is more socially acceptable or what the researcher wants rather than accurately capturing individuals' thoughts or feelings (Grimm, 2010).

Correlation between offline and online measures of metacognition

There is ample evidence to suggest that students' off-line self-reports do not correlate with their actual metacognitive strategy use during a task (Veenman et al., 2014). According to Veenman et al. (2014), correlations between offline and online measures are weak with an average of $r = .15$ (Veenman, 2011; Veenman et al., 2003). Moreover, several qualitative analyses reveal that offline self-reports do not align with specific online behaviors (Winne & Jamieson-Noel, 2002). In other words, learners do not follow through on what they said they would do and/or do not accurately recall what they have done previously. Additionally, correlations with different offline measures are often weak to moderate while correlations among on-line measures are moderate to strong (Veenman & Spaans, 2005). Furthermore, in the review study by Veenman and Spaans (2005), the correlation between offline measures and academic performance ranged from negative values to .36, as opposed to online measures, which have a positive correlation with academic performance ranging from .45 to .90. The disparity found between offline and online measures in relation to academic performance and accuracy of measuring metacognition, suggests that online measures are a better option for assessing

students' metacognition. However, it is important to note that these prior studies did deliberately attempt to conduct an online assessment to directly coincide with an offline assessment of metacognition.

Current Study

As a continuation of a think-aloud pilot study looking at an online assessment conducted by Gonzalez (2016), the current study assessed the efficacy of a think-aloud measure in assessing active metacognition, evaluated the correlation between online measurements of metacognition and academic performance, and measured the correlation between an online measure (think-aloud) and an offline self-report questionnaire (MC5).

This year's iteration of the study included a qualitative analysis based on the transcription of the participants' responses to various questions designed to get at each step of Ambrose's model (2010) as well as quantitative data from the game choices the participants make. Additionally, a coding manual adapted from the open-ended MC5 was developed in order to code each transcription in a way that should coincide with the offline self-report questionnaire. The online measure would be based on the 1990 MS-DOS computer game, *The Oregon Trail.*

Hypotheses

H1. The questionnaire method and Think-Aloud method of measuring metacognition will correlate with each other.

H2. Both the questionnaire and Think-Aloud methods will predict grades equally well.

Although these hypotheses seem to be contrary to the findings of Veenman et al.'s research, this current study consciously adapted the coding manual for the think-aloud assessment to align with that of the open-ended MC5. Therefore, it is postulated that the

correlation between these two measures would be stronger than two unrelated online and offline measures used in prior studies. It is hypothesized that both the think-aloud and survey measures of metacognition will predict grades equally well because the questionnaire, a global measure, is a global indicator of overall performance outcomes, such as their academic performance in all their courses. This would be the case because the survey measure would assess students' use of metacognition in general, which is not context-dependent to their social studies class. On the other hand, the think-aloud assessment is a narrow measure, meaning that it would better predict a narrow performance outcome, such as a student's grade in social studies.

Method

The think-aloud protocol utilized the videogame, *The Oregon Trail*. The game was originally designed to teach students about the journey of the pioneers and the obstacles they faced during the era of Westward Expansion in the United States during the 19th century. *The Oregon Trail* is set in 1848 and has the player play the game as the wagon leader that tries to successfully take his or her party from Independence, Missouri to Oregon.

Participants

The participants (N= 11 females and 4 males) were selected from the two *Learn 2 Learn* experimental groups from the 8th grade social studies classes that were already participating in this year's iteration of the metacognitive intervention (see Appendix A). The study was previously designed to include students from both the *Learn 2 Learn* experimental and *College Knowledge* control groups in the 8th grade, but the *College Knowledge* 8th graders did not receive prior experience with the game prior to the start of this study. Therefore, a comparison between the two groups cannot be made. Participants were selected based on whether or not they had turned in the consent form for this study (see Appendix B).

The school administration, teachers, students, and parents were informed and agreed to participate. The study was approved under the same IRB registration as the metacognitive intervention study.

Procedure

All students who participated in the study had prior experience playing *The Oregon Trail*. The students should have played the game during their winter break as they were completing the Winter Booklet, designed to maintain their knowledge and use of metacognition while no intervention sessions were taking place or during the first session back from winter break with the rest of the class and fellow research instructor (see Appendix C). In addition, the *Learn 2 Learn* eighth graders played completed a worksheet during one of the intervention sessions while playing *The Oregon Trail* to get acquainted with the three different careers options in the game (see Appendix D).

Participants were pulled out of their respective social studies classes to take part in the study. Each participant met individually with a researcher who gave students information about the study and who subsequently prompted the participant to answer questions during the testing session. As the participant played the game, the researcher ask the participant questions which probed him or her to explain why he or she made certain game play decisions or actions throughout key point of game play. After the session was over, the participant returned to his or her social studies class. The researcher transcribed and coded the student's verbal responses based on the adapted open-ended MC5 coding manual. In addition, the researcher counted the number of times the participant performed certain actions, faced obstacles, and the number of party members dead (see Appendix E).

Participants' games were screen-recorded and their responses audio-recorded for later transcription and coding.

Measures

Behavior Tallies: *The Oregon Trail* online measurement. The metacognitive strategies that were tallied by the researcher included the number of times the participant:

(1) Size up the situation (Monitor Performance & Apply Strategies)

(2) Check supplies (Monitor Performance & Apply Strategies)

(3) Look at map (Monitor Performance & Apply Strategies)

(4) Change pace (Reflect & Adjust)

(5) Change food rations (Reflect & Adjust)

(6) Stop to rest (Reflect & Adjust)

(7) Attempt to trade (Reflect & Adjust)

(8) Talk to people (Monitor Performance & Apply Strategies)

(9) Go hunting (Reflect & Adjust)

(10) Buy supplies (Reflect & Adjust)

(11) Number of obstacles encountered

The eleven game play behaviors of the behavior tallies from *The Oregon Trail* online assessment of metacognition were standardized in order to complete data analyses. However, "talk to people" and "attempt to trade" were removed from the analyses because they were not correlated with the other game play behaviors. Afterwards, the mean of the remaining nine standardized game play behaviors were computed to summarize this portion of the online assessment of metacognition. The Cronbach's alpha for this nine-item scale was .80.

Coded Statements: *The Oregon Trail* online measurement. The verbal responses provided by each participant were transcribed and coded (see Appendix F). Each question asked by the researcher was designed to hone in on one specific step of the five-step metacognition model. Based on the verbal response and reasoning by the participant, each response was coded, meaning that the participant would get a score on a 0 to 3 scale to evaluate each step of their metacognitive use and strategies. Listed below is an example of one question for each step of the model (see Appendix G for an example scoring):

(1) What do you think the end goal of the game is? (Assess the Task)

(2) What are the advantages of the career you choose? (Evaluating Strengths)

(3) What month did you choose to leave? (Planning)

(4) Why did you decide to (ford/caulk/wait for better weather/ask a Native American for help/take the ferry) in order to cross the river? (Apply Strategies & Monitor Performance)

(5) Overall, would you have made any changes at he beginning of the game if you could? (Reflect & Adjust)

Additionally, there were eleven different scenarios that were later categorized for the participants' verbal responses. Each participant was given a mean think-aloud score based on at least three of these categories because participants varied in which game play choices they made.

MC5. During the main intervention, the MC5 questionnaires were given to the students to complete on two separate days. These two questionnaires were used at time different time intervals, pre- and post-intervention. The Day 1 Questionnaire listed 35 close-ended items that measured the five steps of Ambrose et al.'s (2010) model (Godfrey et al., 2014). The items were measured on a five-point Likert scale.

Quarterly Grades. As a measure of their academic performance, the researchers are given access to the students' grades on an online system called PowerSchool. The academic year for the Hartford Magnet Trinity College Academy is split into two quarters a semester. PowerSchool shows the students' grade for each quarter, what grades they earned on assignments, quizzes, and exams.

Results

Correlations between the think-aloud and survey measures of metacognition

The correlations between the average of the coded statements from the think-aloud measure of metacognition and the survey measure of metacognition (MC5) collected at both pre- and post-intervention are shown in Table 1. For the pre-intervention MC5 measures, the correlations with the coded statements were overall moderate and positive (range = .22 and .46) (see Table 1). On the other hand, the correlations between the post-intervention MC5 measures for each step of the metacognition model and the coded statements were weakly positive or negative (range = -.10 and .21). Similarly, there were weak, but positive correlations between the think-aloud behavior tallies and the survey measure of metacognition at pre-intervention (range = .16 and .35) and post-intervention (range = .07 and .15) (see Table 2).

Correlations between the measures of metacognition and academic performance

There was a positive, but non-significant average correlation between the think-aloud measure of metacognition based on coded statements and academic performance (average r = .42) (see Table 3). The average correlation between the think-aloud measure of metacognition based on behavior tallies and the students' social studies grades was also weakly positive (average r = .24). The correlation between the overall MC5 score and the students' social studies grades was moderately positive (average r = .43 and r = .57 based on pre- and post-intervention

measures of MC5 respectively). Despite the different values for each measure of metacognition, there was no significant difference between any of the measures in terms of predicting student grades.

Discussion

Given the questions asked on the survey, we expected a relationship between the MC5 and Think-Aloud measures, but not a strong one. The Think-Aloud measure assessed students' metacognitive behavior in a specific task, while the MC5 survey assessed students' beliefs about how frequently these behaviors occurred. Despite that, the think-aloud measure resulted in positive correlations with the survey measure of metacognition, as well as grades. Although the correlations between the two measures of metacognition were weak, there is evidence to suggest that there is potential in online assessments of metacognition. At this point, it remains quite difficult to evaluate the efficacy of this online measure due to the small sample size, but it definitely shows promise.

Moreover, offline and online measures of metacognition predict student grades equally well. Therefore, there is potential for the utilization of video games to assess and foster metacognition because it is a more engaging task. Furthermore, an online measure such as the *Oregon Trail* may give teachers insight on how to better communicate with their students about metacognition. By having students verbally explain how they are using metacognitive strategies, teachers can learn how to help students improve their use of metacognition as well.

Recommendations for Future Research

The correlations between the MC5 and the think-aloud measure were weak because the MC5 is an inherently global measure that requires recall whereas the think-aloud measures from the *Oregon Trail* more narrow and specific. Perhaps students should play the game multiple

times because by having them play more often, their coded statements could be more generalizable.

Additionally, the survey measure included open-ended questions that were coded for levels of metacognition. The correlations between the think-aloud score and the survey measure may be stronger if the think-aloud score was compared to students' answers to the open-ended survey questions.

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Tables

Table 1. Correlations Between Mean of Coded Think-Aloud Statements and Survey Measures of Metacognition (MC5) Collected Pre- and Post-Intervention.

Survey Measure (MC5)	Survey Measure Collected At	
MC5 Scale	Pre-Intervention	Post-Intervention
AT	.46 †	.21
ESW	.36	.11
P	.46 †	-.10
ASMP	.34	-.18
RA	.22	.02
Overall Score	.43	.00

AT= Assess the Task ESW= Evaluate Strengths and Weaknesses P= Plan ASMP= Apply Strategies and Monitor Performance RA= Reflect/Adjust

N= 15 † ($p \geq .10$)

Table 2. Correlations Between Think-Aloud Measure of Metacognition Based On Behavior Tallies and Survey Measures of Metacognition (MC5) Collected Pre- and Post-Intervention.

Survey Measure	Survey Measure Collected At	
MC5 Scale	Pre-Intervention	Post-Intervention
AT	.22	.15
ESW	.17	.13
P	.16	.07
ASMP	.16	.08
RA	.35	.11
Overall Score	.25	.12

AT= Assess the Task ESW= Evaluate Strengths and Weaknesses P= Plan ASMP= Apply Strategies and Monitor Performance RA= Reflect/Adjust

N= 15 † ($p \geq .10$)

Table 3. Correlations Between Metacognition Measures and Social Studies Grades

Metacognition Measure	Marking Period			
	Q1	Q2	Q3	Average
Think-Aloud				
Behavior Tallies	.28	.20	.26	.24
Coded Statements	.43	.36	.47†	.42
MC5 Overall				
Pre-Intervention	.37	.46†	.47†	.43
Post-Intervention	.54*	.62*	.55*	.57

N= 15 † ($p \geq .10$) * ($p \geq .05$)

Appendices

Appendix A

HARTFORD Public Schools
CHOOSE. ACHIEVE. SUCCEED.

HARTFORD MAGNET TRINITY COLLEGE ACADEMY
at The Learning Corridor
Sally A. Biggs, Principal

Trinity College
Hartford, Connecticut

Dear Parent/Guardian,

As part of the Learning Corridor partnership and our relationship with Trinity College we have been invited to participate in an ongoing research project. Students will be learning about strategies that may help improve academic motivation. The study, *Self-Regulated Learning in Middle School Social Studies*, is designed to measure students' motivational beliefs and ways in which students self-regulate their learning.

During the 2nd marking period students will answer questions about their learning styles, learn effective study techniques, and participate in activities to stimulate learning. We anticipate the project will take approximately 4-5 hours (typically 20-30 minute sessions) spread out over the duration of one marking period. Trinity Professors Dina Anselmi and David Reuman will be overseeing the project. The classroom activities will be conducted by Trinity students under my direct supervision.

If you have any questions or concerns regarding this exciting opportunity, please feel free to contact me (860-695-7226) and/or Mrs. Biggs (860-695-7201). We look forward to sharing our research results in the spring. Please sign this consent form indicating you have read this letter and agree to have your child participate in this study.

Sincerely, Ms. Avery, Miss Heller, and Mr. Roarty

Title of Project: *Self-Regulated Learning in Middle School Social Studies*

Principal Investigators: Dina Anselmi, Ph.D. (860) 297-2236 or Dina.Anselmi@trincoll.edu
Department of Psychology, Trinity College, Hartford, CT 06106

David Reuman, Ph.D. (860) 297-2341 or David.Reuman@trincoll.edu
Department of Psychology, Trinity College, Hartford, CT 06106

Deb Avery davery@hartfordschools.org
Andrea Heller andrea.heller@hartfordschools.org
Tim Roarty timothy.roarty@hartfordschools.org
Hartford Magnet Middle School, Hartford, CT 06106

I acknowledge that I have received and read a letter explaining the *Self-Regulated Learning in Middle School Social Studies* study. I understand that there are no known risks to participants in the study, that my child is free to withdraw from participation at any time, and that any questions that I may have about the study will be answered fully by the principal investigators.

☐ I grant permission for my son / daughter to participate.
☐ I do not grant permission for my child to participate.

Print Your Son's / Daughter's Name	Print Your Name
Your Son's / Daughter's Signature	Your Signature

Appendix B

HARTFORD Public Schools
CHOOSE. ACHIEVE. SUCCEED.

HARTFORD MAGNET TRINITY COLLEGE ACADEMY
at The Learning Corridor
Sally A. Biggs, Principal

Trinity College
Hartford, Connecticut

Dear Parent/Guardian,

As you already know, we have been invited to participate in a promising ongoing research project proctored by faculty and students at Trinity College. The students in my class will be learning about strategies that may help improve academic motivation. The study, *Self-Regulated Learning in 8th Grade Social Studies*, is designed to measure students' motivational beliefs and ways in which students self-regulate their learning.

In addition to the general experimental design, your child has been selected to join a subset of students who will be asked to answer questions related to their thought processes during an educational game that all of the students will play. Accordingly, they will be audio-video recorded initially, but once the answers are transcribed and assigned to their confidential ID numbers, the recordings will be destroyed.

If you have any questions or concerns regarding this exciting opportunity, please feel free to contact me (860-695-7226) and/or Mrs. Biggs (860-695-7201). We look forward to sharing our research results in the spring. Please sign this consent form indicating you have read this letter and agree to have your child participate in this specific aspect of the larger study that you have already consented to.

Sincerely, Ms. Avery

Title of Project: *Self-Regulated Learning in 8th Grade Social Studies*

Principal Investigators: Dina Anselmi, Ph.D. (860) 297-2236 or Dina.Anselmi@trincoll.edu
Department of Psychology, Trinity College, Hartford, CT 06106

David Reuman, Ph.D. (860) 297-2341 or David.Reuman@trincoll.edu
Department of Psychology, Trinity College, Hartford, CT 06106

Deb Avery davery@hartfordschools.org
Hartford Magnet Middle School, Hartford, CT 06106

I acknowledge that I have received and read a letter explaining this specific student assignment within the *Self-Regulated Learning in 8th Grade Social Studies* study and will be the subject of audio-visual recording. I understand that there are no known risks to participants in the study, that my 8th grade child is free to withdraw from participation at any time, and that any questions that I may have about the study will be answered fully by the principal investigators.

☐ I grant permission for my 8th grade son / daughter to participate.
☐ I do not grant permission for my child to participate.

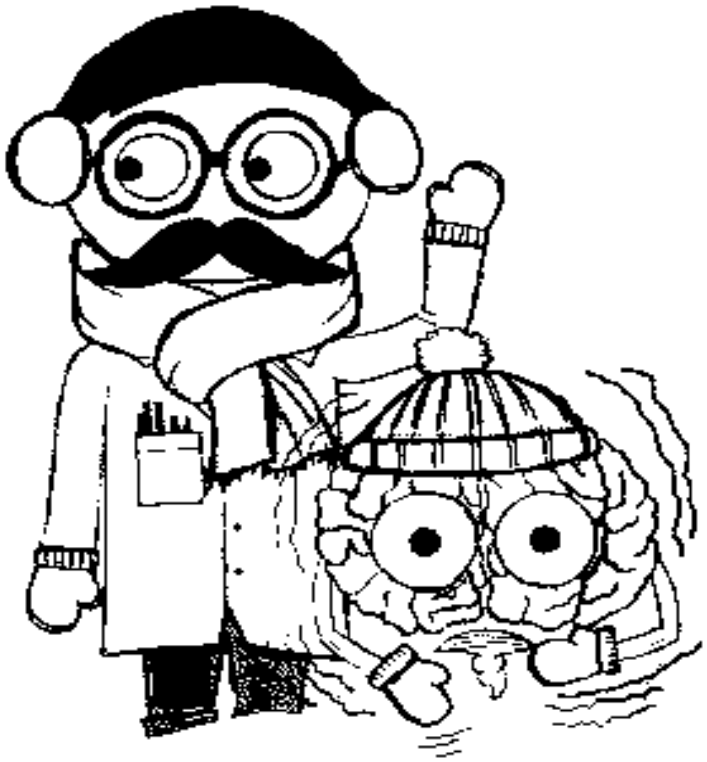
Print Your 8th grade Son's / Daughter's Name _____ Print Your Name _____

Your Son's / Daughter's Signature _____ Your Signature _____

Appendix C

LEARN2LEARN

WINTER BOOKLET – 8th GRADE



Name: _____ Block: _____

Check and date the activities that you have completed:

☐ **Are You Learning to Learn?**
(Date completed: _____)

☐ **Jesse's History Paper**
(Date completed: _____)

☐ **Alex's History Paper**
(Date completed: _____)

☐ **Lewis & Clark Expedition**
(Date completed: _____)

☐ ***The Oregon Trail* Practice**
(Date completed: _____)

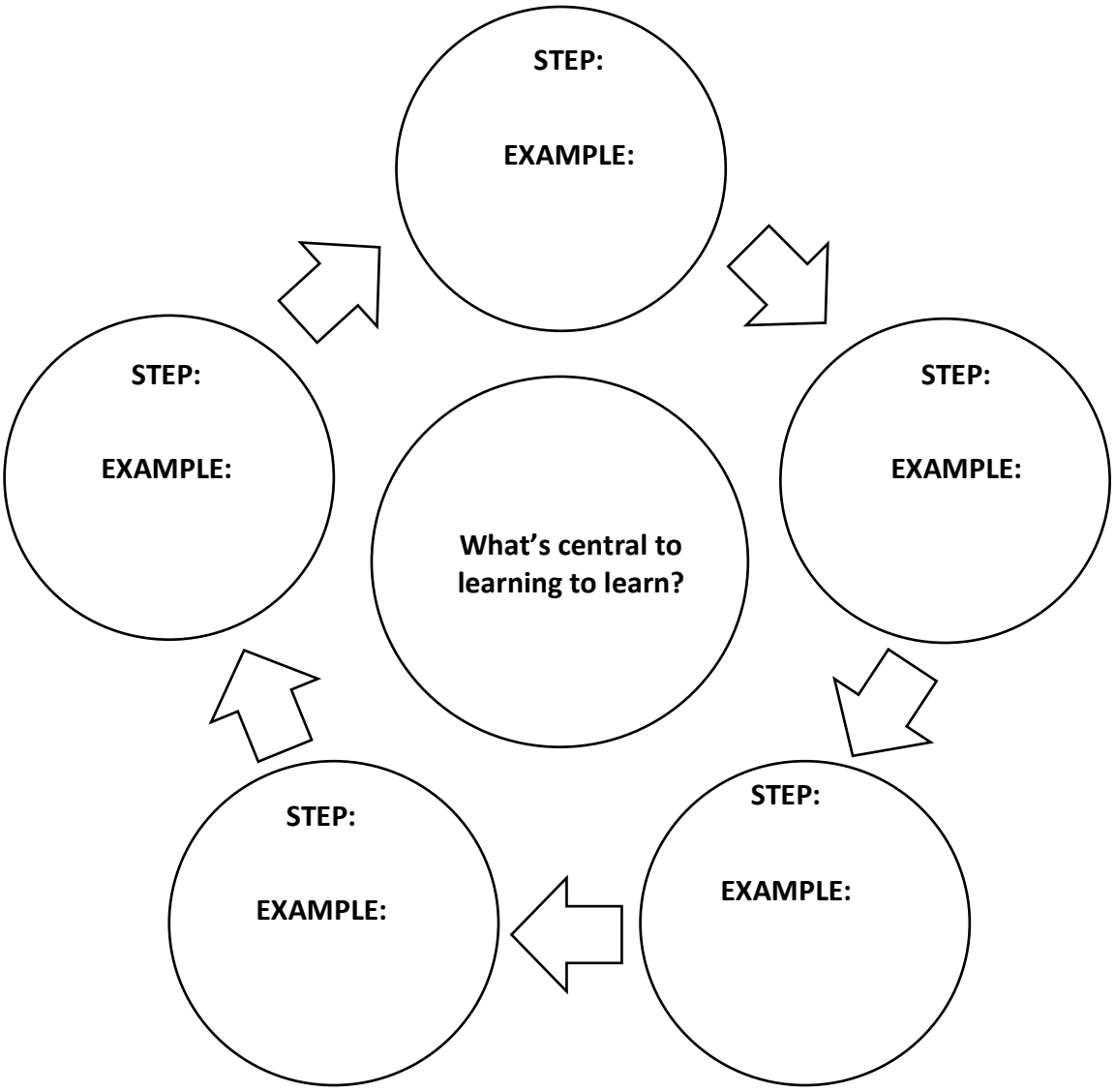
COMPLETE YOUR BOOKLET BY JAN. 25TH FOR A SURPRISE REWARD!

ACTIVITY #1

ARE YOU LEARNING TO LEARN?

DIRECTIONS:

First, fill out the empty Learn 2 Learn steps as best as you can without looking at your notes. Afterwards, make sure you have the correct steps in order by checking against your laminated Learn 2 Learn Model*. Write down <u>one example</u> of each step.*



Did you get them all right the first time? Which steps did you miss at first?

_____

_____

ACTIVITY #2

JESSE'S HISTORY PAPER

DIRECTIONS:

Please read Jesse's story and answer ALL the questions.

Jesse's history professor at Trinity started the class announcing that they were being assigned a paper on the Civil War. Jesse was handed a sheet with directions for the assignment and its due date, which he quickly skimmed while talking to one of his friends. The following week he ran into Alex who was in the same History class. Alex asked Jesse how he was doing with the paper, which he had completely forgotten about. He then realized that the paper was due in one week.

Swamped with assignments for other classes, Jesse had to start working on the paper the day before it was due. Since it was a paper that required a lot of work and research, Jesse had to stay up all night working on it. Doing the research and readings took up a lot of time so he wasn't able to write out an outline for the paper, and had to jump right into the writing. He had a lot of ideas and knew what he wanted to write, but didn't know how to organize it. He was able to write just the right number of pages but was hesitant that he had included everything the professor had asked for. Rushing to finish it on time, he was unable to proofread it before handing it in for a grade.

QUESTIONS:

1) Did Jesse use any sort of strategies to help himself complete the assignment efficiently?

YES NO

a. If yes, explain what strategies he used…

_____
_____
_____
_____

2) Do you think Jesse should have done anything differently? If yes, explain.

_____
_____
_____
_____
_____
_____

3) Which steps of the 5-step Learn 2 Learn model did Jesse apply when he was writing his paper? For each step that he used, describe how he did so.

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

ACTIVITY #3

ALEX'S HISTORY PAPER

DIRECTIONS:

Please read Alex's story and answer ALL the questions.

Alex's history professor at Trinity began class with the announcement that they were being assigned a paper. Alex was handed directions for the paper from his Professor and began to read carefully. He read that the paper would be due in 2 weeks and was on the Civil War. He immediately took out his planner and wrote down when the paper was due.

After class, Alex went back to his room and began to write out a plan for the next two weeks. He knew that he had two other papers and another big project to do before the end of the year and would have to manage his time well. He decided to spend an hour on the paper

every day. He first began by doing research on the subject until he was ready to make an outline of everything he planned to write about. After making an outline, he realized his paper was going to be too long and needed to be shortened. He took out some of the information he believed to be irrelevant and started to write the paper. He was done two days early, giving him plenty of time to read the paper over for spelling mistakes before handing it in for a grade.

QUESTIONS:

1) **Did Alex use any sort of strategies to help himself complete the assignment efficiently?**

   YES NO

   a. **If yes, explain what strategies he used…**

_____
_____
_____

2) **Do you think Alex should have done anything differently? If yes, explain.**

_____
_____
_____
_____
_____
_____

3) **Which steps of the 5-step Learn 2 Learn model did Alex apply when he was writing his paper? For each step that he used, describe how he did so.**

_____
_____
_____
_____
_____
_____
_____
_____
_____

_____
_____
_____

ACTIVITY #4

LEWIS & CLARK EXPEDITION ACTIVITY

DIRECTIONS:

Imagine you are either Lewis or Clark and are about to embark on your expedition across the western portion of the United States. Please answer ALL of the following questions about your civilization, providing as many examples as possible:

1) What types of supplies should you take on the expedition? Why?

_____
_____
_____
_____

*** WHICH LEARN 2 LEARN STEP(S) DID YOU USE TO ANSWER QUESTION 1?**

_____

2) What are some positives and negatives of going on this expedition? You might consider the journey itself and the potential outcomes.

Positives	Negatives

*** WHICH LEARN 2 LEARN STEP(S) DID YOU USE TO ANSWER QUESTION 2?**

_____

Lewis and Clark made many maps of the area during their expedition. Along the way, they recorded the different animals and resources they saw as they crossed rivers, lakes, and mountains.

3) As you cross the following areas, list what resources you might have seen AND explain how it could help you along your journey:

Lewis & Clark traveling down the river	*Crossing the Rocky Mountains*	*Viewing the Pacific Ocean for the first time*
Example: **1. Fish – it provided them food so that they did not starve.**		

WHICH LEARN 2 LEARN STEP(S) DID YOU USE TO ANSWER QUESTION 3?

_____

Below is a map of Lewis & Clark's trek to the Pacific Coast. Imagine you are on the same route BUT must stop upon finding that a wildfire has wiped out the rest of the trail.

4) What might you do to fix the situation and get yourself back on course? Why?

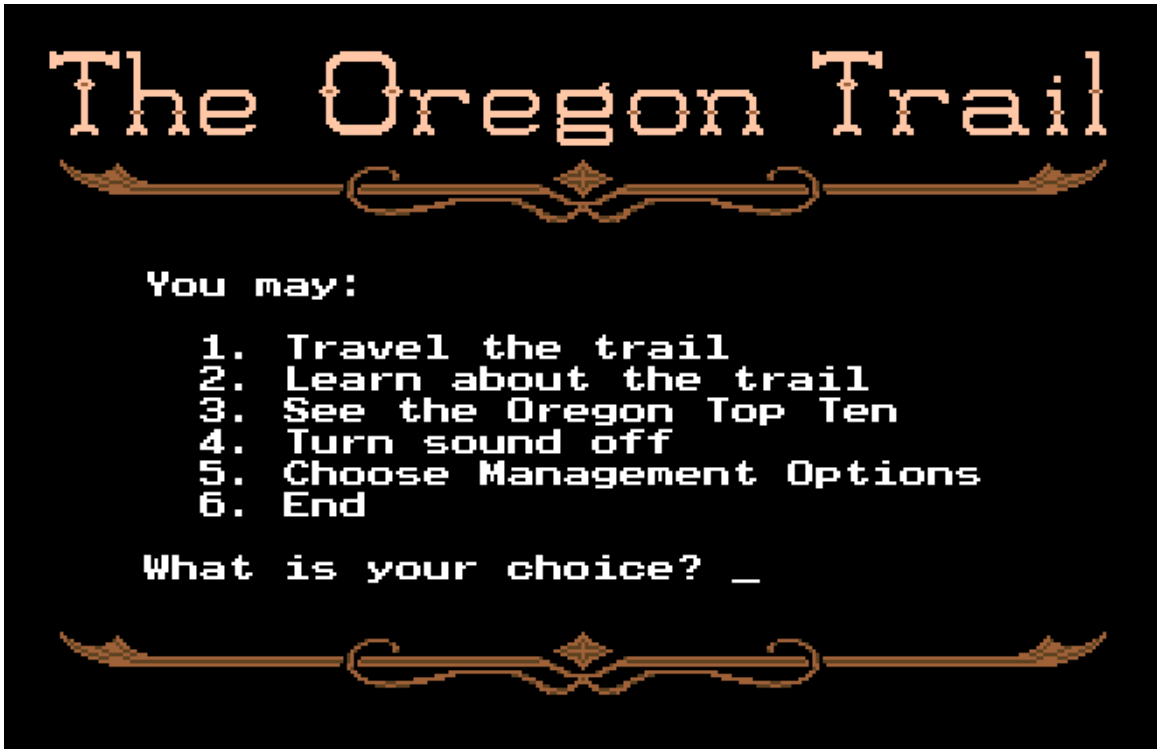
_____
_____
_____
_____

WHICH <u>LEARN 2 LEARN STEP(S)</u> DID YOU USE TO ANSWER QUESTION 4?

_____

ACTIVITY #5

***THE OREGON TRAIL* PRACTICE**



DIRECTIONS:

After learning how to play The Oregon Trail*, play the game* **AT LEAST THREE TIMES,** *once as each occupation (**banker, carpenter, and farmer**). Do not worry about finishing the game entirely each time, but do make sure you know the differences between each occupation.*

TO ACCESS THE GAME: Open an internet browser and type in the following URL to access *The Oregon Trail* game: **http://j.mp/L2L-Oregon**

During one of your games, answer the following questions on the next page, giving explanations when necessary:

1) **What character/occupation did you chose to be?** (Circle one)

BANKER **CARPENTER** **FARMER**

Explain why you chose this job: _____
_____
_____
_____

2) What month did you choose to leave? (Circle one)

MARCH APRIL MAY JUNE JULY

Explain why you chose to leave for this month: _____
_____
_____
_____
_____

3) How did you spend your money? List <u>how many</u> of each item you bought and the cost, then <u>explain why</u> you chose to spend your money that way.

Oxen: _____
_____
Food: _____
_____
Clothing: _____
_____
Ammunition: _____
_____
Spare Parts: _____
_____

4) If you ever stopped along the way, what changes did you make (if any)? Why?

_____
_____
_____
_____

5) Whenever someone got sick/injured/died, what did you do? Why?

_____
_____
_____
_____

6) **Whenever you crossed a river, which option did you pick? Why?**

_____
_____
_____

7) **Did you make it to Oregon?** (Circle one)
   YES **NO**
   a. **If yes, report your score:** (Including how many people, items, and food you have left)

      _____
      _____
      _____
      _____

8) **What could you have done differently to finish successfully if you died or to improve your score if you survived?**

_____
_____
_____
_____
_____

9) **How many times did you play the game in total?** (Remember, you need to play the game at least three times, once under each occupation).

   _____

☺REMEMBER TO TURN IN YOUR COMPLETED

WINTER BOOKLET FOR A SURPRISE REWARD!

Appendix D

Oregon Trail Careers

Session 1

1. Profession: _____
2. How far did you make it?

3. If you were a banker in the 1800s, would you have considered making this trip?

4. What sort of education do you think you would need to be a banker in the 1800s?

Session 2

1. Profession: _____
2. How far did you make it?

3. If you were a farmer in the 1800s, would you have considered making this trip?

4. What sort of education do you think you would need to be a farmer in the 1800s?

Session 3

1. Profession: _____
2. How far did you make it?

3. If you were a carpenter in the 1800s, would you have considered making this trip?

4. What sort of education do you think you would need to be a carpenter in the 1800s?

Appendix E

Oregon Trail – Online Measurement / Think-Aloud

STUDENT/PARTICIPANT NAME:	
HISTORY BLOCK: (please write which block the student has history/social studies, not when the testing takes place)	
RESEARCHER NAME:	
DATE:	TIME:

Instructions for the student/participant: *"We will be assessing your thinking style while playing* THE OREGON TRAIL. *Play the game as you would normally do so until we stop you to ask questions about your gameplay. You do not have to wait for us to ask these questions for you to continue. Please speak* ***loudly and clearly*** *when answering questions. There are no right or wrong answers. Please try to explain your answers as completely as possible." If you have any questions while you're playing the game, please feel free to ask.*

Instructions for researcher: *Please ask the following questions verbally. For each action the student makes throughout the game, make sure to ask* ***WHY*** *he/she did something. You do not have to write down all of the participant's responses as they will be recorded.* ***HOWEVER****, please try to take notes for questions that have blank spaces/boxes for you to write in.*

BEFORE GAME: Ask the Student…

1) How many times have you played *The Oregon Trail*? _____

2) When did you play *The Oregon Trail*? (Exact dates not necessary: during winter break, right before this session, etc.) _____

START GAME. Set timer for 20 minutes.

3) Do you understand how to play the game? (ASSESS THE TASK)

4) What do you think the end goal of the game is? (ASSESS THE TASK)

a.) What Learn 2 Learn step or steps did you use to answer these questions? (ASSESS THE TASK)

5) What occupation did you pick? _____ (PLANING/EVALUATING STRENGTHS & WEAKNESSES)

a.) What are some advantages for you of choosing this occupation? (EVALUATE STRENGTHS)

b.) What are some disadvantages for you of choosing this occupation? (EVALUATE WEAKNESSES)

c.) What Learn 2 Learn step or steps did you use to decide on the occupation you chose? (PLANING/EVALUATING STRENGTHS & WEAKNESSES)

6) What month did you choose to leave? _____ (PLANNING/REFLECT & ADJUST?)

a.) What are the advantages of leaving the month that you chose? (EVALUATE STRENGTHS)

b.) What are some disadvantages of leaving that month? (EVALUATE WEAKNESSES)

c.) What Learn 2 Learn step or steps did you use to choose when you left? (PLANNING/EVALUATE STRENGTHS & WEAKNESSES/ REFLECT & ADJUST?)

7) What did you decide to buy? (PLANNING/APPLYING STRATEGIES)

a.) Why did you decide to spend as much money as you did on the particular things you bought? (PLANNING/APPLYING STRATEGIES/EVALUATING STRENGTHS & WEAKNESSES)

Note to researcher: feel free to probe the student about why they bought the items they bought (ammunition, clothing, spare parts, food, oxen; example, may buy a lot of oxen and ammunition because those are hard to come by, but they can always hunt for food when needed) (PLANNING/APPLYING STRATEGIES/EVALUATING STRENGTHS & WEAKNESSES)

Follow up: **If the student saved some money –** ***"Why did you decide to save some of your money?"*** (PLANNING/APPLY STRATEGIES)

8) *During a **River Crossing*** – make sure to ask the student **why** they chose the action that they decided on. (ford, caulk, ask an Native American for help, take the ferry, wait) (APPLY STRATEGIES & MONITOR PERFORMANCE/ REFLECT & ADJUST)

9) When **A WAGON MEMBER GETS SICK OR INJURED**- make sure to ask the student why they chose the action that they decided on. (APPLY STRATEGIES & MONITOR PERFORMANCE/ REFLECT & ADJUST)

10) When they **RUN OUT OF FOOD**- make sure to ask the student why they chose the action that they decided on. (hunt, change meal portions, etc.) (APPLY STRATEGIES & MONITOR PERFORMANCE/ REFLECT & ADJUST)

11) When they decide to **ACCEPT OR DENY A TRADE**- make sure to ask the student why they chose the action that they decided on. (EVALUATE STRENGTHS & WEAKNESSES/APPLY STRATEGIES & MONITOR PERFORMANCE/ REFLECT & ADJUST)

12) When they **LOOK AT THE MAP**- ask them why (PLANNING/ASSESS THE TASK)

13) When they **CHANGE PACE**- ask them why (APPLY STRATEGIES & MONITOR PERFORMANCE/REFLECT & ADJUST)

14) When they **CHANGE FOOD RATIONS**- ask them why (APPLY STRATEGIES & MONITOR PERFORMANCE/REFLECT & ADJUST)

15) When they decide to **REST FOR ___ DAYS**- ask them why (why that number of days?) (PLANNING/APPLY STRATEGIES & MONITOR PERFORMANCE/REFLECT & ADJUST)

16) When they decide to **HUNT**- ask them why (APPLY STRATEGIES & MONITOR PERFORMANCE/REFLECT & ADJUST)

17) When they **CHECK SUPPLIES-** ask them why (PLANNING/REFLECT & ADJUST)

18) When they **SIZE UP THE SITUATION-** ask them why (PLANNING)

19) When they decide to **BUY SUPPLIES AT A LANDMARK**- ask them why (PLANNING/REFLECT & ADJUST)

20) When they decide to **TALK TO PEOPLE**- ask them why

AFTER GAME.

21) Does the student survive at the end of the 20 minutes? (please circle one)
YES NO

22) If **only some of your members or none of your members survived**, what do you think you could have done differently to change this outcome? (EVALUATE WEAKNESSES/REFLECT & ADJUST)

If **all of your members survived**, why do you think you were so successful? (EVALUATE STRENGTHS/REFLECT & ADJUST)

23) Overall, would you have made any changes at the beginning of the game if you could? (REFLECT & ADJUST)

AFTER TESTING: QUANTITATIVE DATA

PLEASE TALLY THE FOLLOWING. FOR EACH TIME THE STUDENT DOES ANY OF THE FOLLOWING!

How many times did the student choose to SIZE UP THE SITUATION? (including landmark stops)

How many times did the student CHECK SUPPLIES?

How many times did the student LOOK AT MAP?

How many times did the student CHANGE PACE?

How many times did the student CHANGE FOOD RATIONS?

How many times did the student STOP TO REST?

How many times did the student ATTEMPT TO TRADE?

Follow up: **Why did you accept or decline the offer?**

How many times did the student TALK TO PEOPLE?

How many times did the student GO HUNTING?

How many times did the student BUY SUPPLIES? (during landmark stops)

Please tally how many times the student encountered **obstacles** (given via notifications) throughout the game. This includes wagon members getting sick/injured, bad weather, getting lost, getting robbed, etc.

Number of wagon members dead?

Appendix F

Think-Aloud Verbal Responses Coding Criteria

General Coding Outline:

0 – student did not assess the dimension or feature addressed by the question; gave no response; gave an inappropriate response

1 – partial explanation or superficial analysis, not sufficient to demonstrate metacognitive processes

2 – relevant/reasonable complete response

3 – complete response with elaboration or a demonstration of multiple strategies

Question 1: What are some advantages of the occupation you chose? (ESW)

0 – No response/inappropriate response/incomplete nonsensical answer
Ex. I don't know.

1 – Names one advantage with very little explanation as to why it's helpful in the game.
Ex. The banker has a lot of money.

2 – Student says one or two advantages and either gives a slight elaboration or doesn't address how it is helpful in the game.
Ex. The carpenter has a better chance at repairing broken wagon parts.

3 – Complete response that addresses **why** the advantages named are helpful in being successful in the game.

Ex. Even though the farmer doesn't have a lot of money, he can grow his own food if he runs out, which is very helpful when you are far away from the nearest fort. Also, if you survive, you get more points at the end, so you have a better chance of getting on the leader board.

Question 2: What are some of the disadvantages of the occupation you chose? (ESW)
0 – No answer/irrelevant answer/incomplete answer

Ex. Not sure.
I don't know.

1 – Names one disadvantage with no elaboration or it is irrelevant to game play.

Ex. Well the banker has more money, so more likely to be robbed. (Not true in the game)

2 –Names at least one relevant disadvantage, but doesn't explain how it affects game play or doesn't elaborate much.

Ex. The carpenter doesn't have a lot of money, which could make buying supplies later harder.

3 – Gives multiple disadvantages or gives a thorough enough explanation for one disadvantage.

Ex. Well, playing as a farmer means you have less money, so you can't buy everything that you need in the beginning. Also, later on in the game, it gets a lot harder to buy the supplies that you are low on or missing.

Question 3: What supplies did you decide to buy? (Plan)

0 – No response/inappropriate response/Incomplete response

Ex. I just picked randomly.

1 – Provides a vague response.

Ex. I just get the things I think I need.

2- Student provides a complete response and hints at how he or she plans on surviving the journey.

Ex. Food is definitely important, so you need a lot of that. Also, it's much cheaper to buy it now.

3- Student provides a thorough explanation.

Ex. I'm planning to buy 2000 pounds of food because I think that's enough to make it throughout most of the journey. I'm also going to buy plenty of ammunition so if I do run out, I can hunt for some food and save some money while I am on the trail.

Question 4: How did you decide to ford (caulk/take a ferry/etc.) the river? (Apply Strategies and Monitor Performance)

0 – No answer/Nonsensical/Incomplete

Ex. I just guessed.

1 – Student provides little explanation on how he or she chose the option.

Ex. I just thought it was the best option.

2 – Student shows that he or she considered the other options before choosing one.

Ex. At first I wanted to take the ferry, but I didn't think waiting three days was worth it. So I think caulking was a safe alternative.

3 – Student considers more than one other option and explains thoroughly why the other options were not used.

Ex. I remember the last time I forded a river this deep, it didn't end to well for me. Usually caulking works, but there's always a chance someone can drown or supplies could be lost. That's why I'm choosing the ferry. It's the safest option available and I think it's worth waiting three days and paying $5.

<u>Question 5:</u> Overall, would you have made any changes at the beginning of the game if you could?

0 – Incomplete/blank/inappropriate response

1 – Strategy listed with no explanation, or an explanation that shows no conceptual or even superficial understanding of the strategy.

Ex. I might change my occupation.

2 – Response with one strategy (or more) and a reasoning of why the strategy is helpful.

Ex. I would change the month that I left. I think July was way too hot and it means I have less time to travel before winter hits.

3 – Conceptual, process understanding of the strategies listed above. More than one strategy listed with a clear explanation of how the student applies both of them.

Ex. I would have changed my occupation to a farmer because he can actually grow his own food, so I don't have to worry as much about having to hunt, since I'm not very good at it. Also, I would have left in April so that way I have more time to travel before winter starts and the weather would be a lot better for the people and the oxen, so they would have better health.

Appendix G

Oregon Trail – Online Measurement / Think-Aloud

R- Researcher

P- Participant

Student ID 3003

R: How many times have you played *The Oregon Trail*?

P: ummm, like four or five times

R: When did you play *The Oregon Trail*?

P: I just uh, played it at home for fun, you know. My class didn't get the winter booklet, because of uh, mix up or something.

R: Do you understand how to play the game?

P: Yes, it's pretty simple actually. (2- the student says yes but doesn't address why understanding how to play the game is important)

R: What do you think the end goal of the game is?

P: So you want to get your wagon and your family all the way to Oregon safely. (2- the student states the end goal but doesn't explain why)

R: What *Learn 2 Learn* step or steps did you use to answer the question?

P: Ahh, I know this! Understand the task? (correct)

R: Okay, now you can go ahead and start, sorry about that.

P: So I can just pick whatever I want?

R: Yeah, you can pick whatever you want.

P: So the banker is the easiest, so I'm going to stick with that one. Mmm, I'll just put random people.

R: Okay, so what, you picked the banker?

P: Yeah!

R: What are some advantages of choosing the banker?

P: A lot of money! (2-gives a reason that relates to performance/strategy in the game)

R: A lot of money? And what are some disadvantages of choosing the banker?

P: Mmm, nothing really. Just that, it's just less money for like farmer or carpenter. It kind of gives it a, you know, an easy game setting. (0- doesn't address disadvantages)

R: Okay. And what *Learn 2 Learn* step or steps did you use to decide what occupation you wanted to do?

P: Ohhh, I knew that! It's going to be really hard to do uh farmer cuz it has the least money and you like definitely need like a lot of oxen and food and all of these supplies.

R: Okay, so actually I missed it. So what month did you decide to leave?

P: April.

R: And like why did you decide or, what are some good advantages of that?

P: Ohh, well time goes really fast so there could be a lot of mistakes you can make like uh, the wagon could break down for like five days and it takes like five days to fix it. And in March, it's way too early and the oxen need grass. So, can I play buy now? (3-lists several reasons that state advantages)

R: Yeah sure. Actually, just really quickly, sorry. What are some disadvantages of leaving in April?

P: Well, I think it's a little too early, you could say, but, I believe it would go by fast. (1-lists one reason)

R: Okay, so now you can start buying things just tell me why you decide to buy what you're buying.

R: So I know you need the oxen for example, how many are you planning to buy?

P: I'm going to buy 10 oxen, or 5 yoke.

R: Okay and why is that?

P: Well, you don't want too little or too much and I believe that's a reasonable amount, so it's just $200. Besides, some oxen can run off for a few days too, and that's one of the problems. (3-explains why it's reasonable-cost, potential for runaway oxen)

R: Okay and you can keep going buying your supplies. Bless you.

P: Thanks. Okay, so it's 200 pounds of food per person is recommended so I'm going to buy a little bit of extra. I'm going to buy 1200 pounds of food because sometimes, a thief can steal yoke, food, or ammunition. (3-considers the recommendation and what could happen during the game to lose food)

R: Sure.

P: Uh, clothing. Umm, I'm going to buy 10 sets because that's the basic amount. That's two sets per person and five people. And then ammunition. I'm going to buy just a little bit, two boxes because you know, from advice, you don't, like, try and hunt and it's really hard and you don't really need it because you have a lot of food. (3-clearly explains rationale for buying little ammunition)

R: Mhhmm.

P: And uh, spare parts. Definitely want to buy the max amount, which is three each. And so the total cost will be $634.00. (1-states that he is buying the maximum amount but doesn't explain why)

R: Okay.

P: So, can I, can I advance?

R: Sure, but why did you want to save essentially $1000 and so?

P: Well, sometimes thieves can steal like clothing, which is essential and food and so, that can take a lot and if we do. So like, if the wagon breaks, we'll lose a lot of supplies. (3-gives examples of why it is useful to have extra money)

R: Sure, okay thank you. You can go ahead and play the game.

R: So I see you already changed the pace and the ration portions.

P: Yeah!

R: Why did you do that?

P: Well, I want the pace like fast, but not too fast and I know steady can be like really slow at times. So, and the food rations, I know that, you know, I tested it, they can go with, without food, like I bought zero food at the beginning and they can go for like, twelve days. I still want a reasonable amount because food can go down very quickly. (2-provides vague answer for changing pace/3- hints at reflecting on prior experience)

R: So why did you check the map?

P: Uh, just, so the first one is, mm, just a little bit. I can easily advance I just want to see what's ahead.

R: Okay-

P: And I rested because, if you don't, you get a day's rest when you like, look around. If you don't stop, people can get really tired and they can die really quickly. They need rest. (3-gives couple of reasons why it's important to rest)

P: I'm going to try to ford the river because it's only 5.2 feet deep. Ahh, that didn't work out. See, what happens is that a lot of oxen die, so that's why I wanted to buy a lot. (3-relates back to his reasoning when buying supplies, reflecting)

P: I really hate these river scenarios because people don't know what to do and it's just a lucky guess. So you have to pick.

R: Yeah, it's a little tricky because I've played the game too. Like, you have to be careful on what you decide.

P: See, like I take a break at each landmark.

R: So why is that? So—

P: So they can rest for a little bit.

P: I'm going to try to caulk it this time cuz, it's just. I know, from, a lot of people, umm doing the other option and, a lot of people just decide to float it because it's the better option in that scenario because you don't lose any oxen if you do drown.

(3-clear demonstration of reflecting on prior experience)

P: And the reason why I bought the max amount of supplies for like the wagon is because you uh, lose them very quickly.

(2-now he mentions why he wanted to get 3 of each part)

R: So why did you check your supplies?

P: Well I know we lost all three wagon wheels, but I uh just wanted to make sure how much oxen we have left.

P: I'm going to buy some supplies. I'm gonna buy two wagon wheels and two oxen.

R: So why did you decide two for each?

P: Umm, I don't really need a lot of it at the start. But until later. Well, it gets, the prices increases over time and I didn't want to get too much oxen. Er, I don't want to spend too much money on wagon wheels. Two is good enough for each supply to fix the wagon.

(3- thorough explanation)

R: Okay.

P: So I'm going to continue. I'm going to decide to change the pace.

R: Why is that?

P: So, umm, I want to take it easy on the oxen for now. At the start, it's fairly easy. So, we can continue at this pace—we can continue at this pace until it gets really hard to find food and everything.

(3-signs of reflection and considering current circumstances and how it will change)

R: So why did you decide to repair it?

P: Well, repairing it, even though it can take time, doesn't work, you can just replace it with another axle or wheel or spare part. And if you do run out, if you repair it, it's like a free bonus. You don't even need to replace it with anything and that costs money.

R: So you're checking your supplies again. Why is that?

P: Ehh, well, you need, well, food can go down quickly on meager and even on bone dry. Eh, that doesn't obviously give them food, but it's just really. I just want to not waste all the food and spend a lot of money because up the road, it's hard to buy food without wasting money.

P: I'm starting to buy supplies, I just want a little bit more food.

R: Okay.

P: Maybe like, 200 pounds of food since it's still really cheap.

P: And, I'm going to check the map just to observe where we are. We're at Fort Laramie I think, yeah. So we still have a ways to go and it's May and we already covered about, we already covered about 640 miles and that's just in a month. So that's why I wanted to start early.

R: Okay.

P: I'm going to decide to rest them for two days cuz health is poor right now. See, it's fair health now, but it's good to rest them once in awhile cuz they'll just get really tired in the end. And see the 200 pounds of food we already bought is just going down really quickly. And finding wild fruit like that can really give me like an extra day or so of food. Like when I first played this game, like when I finished it through cuz we weren't able to finish it in class. What happened was we ran out of food in the end. I ran out of food in the end and I was like, really desperate, but I learned that they can go for a really long time without food, but the health just goes down really, it just gets really bad from there.

(3-ealborated and gave an extensive response)

P: I'm going to check the map again to you know, see where we are. So we are at South Independence Rock. Yeah, we're almost about half way through.

P: And then another, after this, I think it's a really annoying river.

R: I think so. I remember, I was playing this yesterday.

P: Yeah, and there's this area where there's little water and inadequate grass. Cuz it's June, there's not really a lot of things. Cuz if you start early, there is grass, but only for a little bit. But, in the beginning, it's just really cool, health's good, everything is great, but then everything gets worse along.

P: See we're already in June and I'm checking the map, we're about half way through. And that's three months already and we're just half way through. And okay, this is the divided part. I'm gonna head for the fort just because it has supplies and because at the river, you can lose a lot of stuff. I mean, we already lost one person and one person is sick too. So I'm gonna probably restock on just a few, like 100 pounds of food, 150 about. See, which is fine, more wild fruit. So I'm going to get about 180 pounds of food.

(3-evaluated strengths and weaknesses of both options, adjusting based on circumstances)

R: Why 180?

P: Well like I wanna keep it at 1000 but once we get more at the end, we need a lot of it, and there's not a lot of forts, so I want to keep it at a steady pace cuz, even if we uh, find a lot, there's like no forts or anything for miles, and we have to have a lot of food. I wanna make sure it lasts awhile even though the price is rising. At the beginning it was about like 20, now its 35. So I'm going to buy 180 pounds of food. And then leave the store and check the map just to see where we are. And we're at Fort Bridger. And we're going to head to Soda Springs, I think.

P: Just to restock. See, we're getting lucky cuz we are finding wild fruit, two in a row, which is lucky. The last thing I need is for someone to get dysentery.

R: Oh yeah, that's awful.

P: Yeah.

P: I'm gonna, since we're half way through, I'm going to change the pace to strenuous or whatever it's called, the medium pace because I think it's a better decision since we have a long way to go. And the there isn't a fort I believe, if I look at the map for awhile I think after Fort Hall. There's like a lot, like a lot, of empty space and desert. And continue on trail.

(2-decent explanation)

P: Broken arm. Ahh, dysentery. Okay, since he has dysentery, I'm gonna rest for three days cuz health is Really poor and just really poor now, so. I'm gonna check supplies cuz, I wanna make sure we're good on everything. Kay, and we're going to need a few wagon axles, so I'm gonna buy that from the shop. I'm going to buy one from the shop. See, it's still 20 per axle, pretty expensive, and I want to save a lot of money.

See, the health is still poor. But it'll start to improve once we get through the next fort.

(3-clear reflecting and adjusting)

R: Why do you want to save a lot of money?

P: You get more points at the end, with a lot of money I mean.

R: That's true.

P: If you're aiming for a high score, you wanna get a lot of money. And at the next fort, I'm gonna—ugh, we got one of these rivers. I'm gonna try to buy some food probably.

P: Ahh, there's an impassable trail, so the food just dies down a lot. If you leave earlier, it hits July and it's probably going to get really cold since it's August already.

P: I'm not going to look around because I wanna save time. I'm gonna try to—uh let me check that. I'm going to caulk it because it is 6 feet deep and it's not like 2 feet. Looks like we got lucky there.

P: Now I'm going to check the map—uh not that, the map. And see, we're almost at Ford Paul I think. We're probably gonna restock, ahh, another person died. That's two people down.

P: See, the health is really poor in this area. So I'm gonna rest for just a day. Check my supplies cuz I don't think we don't got too much good on food and I'm going to buy about 100 pounds of food. Just to save money. And you know, that can go really quick when you have a problem and you have to rest for a little bit.

P: Okay, one of the oxen is injured, so I'm going to change the pace back to normal, cuz you don't want them to go for a long time, just at a very fast pace. Even if it's just uh, the medium one. I'm probably going to speed it up by the time we get to September.

(3-clear indication of reflecting and adjusting)

P: And see, the food we already bought is going down really quickly.

R: Why do you want to speed up around September?

P: Well, the snow and everything I think comes when it gets cooler and it gets harder. I'm going to look around Blue Mountains and maybe I'll try hunting just this once.

R: Why are you deciding to hunt this time?

P: Eh, I don't know. Maybe we can get lucky and try to get something, but I don't know how you'll hunt actually.

R: So I think you can't hunt when you're at a landmark. So you have to wait until after you pass it.

P: Ah. Oh yeah, let me see the map cuz we have two places. I'm going to head for the Fort just, and I think there's a point. Well, this is the final stretch right here, so I'm going to change the pace up probably.

R: And why do you want to make them go faster?

P: Just in case, I know at the end I had all five people at the last 12 miles and someone died.

R: Oh, so this actually the end of the twenty minutes, so you don't have to play anymore.

P: Ah.

R: I just have a few questions for you at the end. So, okay. So you mentioned earlier that two of your wagon members died. What do you think you could have done differently to change this outcome?

P: Well, obviously I should have definitely not have forded that river cuz that's a really risky decision. But the other one, I couldn't really do much about it and it's just poor health the entire time we went through it.

(2-only addresses one area for improvement)

R: Okay and I think this is the last question. So, overall, would you have made any changes at the beginning so you could have improved your score or the way you played?

P: So definitely changed the way I forded the river obviously—uh, because of that, I lost food, oxen, and a member, which costs more money because of that.

(2-thinks about it a little)

R: Okay.

P: Yeah.

R: Well thank you for your time and playing the game for me. So this is actually the end of it, so you can go back to class.

P: Okay, thank you,

R: Thank you so much again!

P: Yeah, no problem.