Spring 5-2010

THE EFFECT OF REFLECTIVE PORTFOLIO USE ON STUDENT SELF-REGULATION SKILLS IN SCIENCE

Jacob C. Greenwood
Western Connecticut State University, drjgreenwood@gmail.com

THE EFFECT OF REFLECTIVE PORTFOLIO USE ON STUDENT SELF-REGULATION SKILLS IN SCIENCE

Jacob C. Greenwood

Bachelor of Science in Biology, University of New Hampshire, 1997
Master of Science in Education, University of Southern Maine, 2001

A Dissertation

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Education in Instructional Leadership

in the

Department of Education and Educational Psychology

at

Western Connecticut State University

2010

THE EFFECT OF REFLECTIVE PORTFOLIO USE ON STUDENT SELF-REGULATION SKILLS IN SCIENCE

Jacob C. Greenwood

Western Connecticut State University

Abstract

This study investigated the use of reflective portfolios in science as a means to provide students a medium to develop a repertoire of study and self-regulation strategies. These self-regulation strategies can be accessed and utilized by students to engage in independent study and help to manage workloads from multiple teachers. The use of a reflective portfolio addresses the theoretical framework laid out by Pintrich which organized regulatory processes according to four phases (a) planning, (b) self-monitoring, (c) control, and (d) evaluation. The reflective portfolio included student work samples, revisions of work, reflections, and goal statements. Construction of the portfolio gave students the opportunity to engage in a cyclical process of self-regulation facilitating an on-going assessment dialogue between themselves and their teacher.

The focus of this study was a convenience sample of students from a public high school in a suburban community (population of 24,000) in the Northeast. The study used a quasi-experimental research design. Participants in the study included 158 (n=158) students in a nonrandomized control-group, pretest-posttest design. Two different situations were compared; (a) reflective portfolio use and (b) no use of reflective portfolios.

Research question 1 asked: Is there a significant difference in the self-regulatory skills of high school science students who produce reflective portfolios for their science assignments and

those who do not? The Motivated Strategies for Learning Questionnaire (MSLQ) subscales of Metacognition Self-Regulation, Effort Regulation, Time and Study Environment, Rehearsal, Elaboration, and Organization were used to assess student self-regulatory skills. A multivariate analysis of variance (MANOVA) was applied where the six subscales served as the multiple dependant variables. The isolation of which specific self-regulatory learning strategies (Metacognition Self-Regulation, Effort Regulation, Time and Study Environment, Rehearsal, Elaboration, and Organization) were affected by reflective portfolio use in science was statistically insignificant.

Research question 2 asked: Is there change over time in the Portfolio Rubric scores within the group of students who produce reflective portfolios? The student generated reflective portfolios produced in the treatment group were assessed using the Portfolio Rubric. Four one-way repeated measure analysis of variance (ANOVA) procedures were used to ascertain if the rubric scores varied depending on the time interval. Statistically significant gains in students' rubric scores over time suggest students do benefit from structured goal setting, revision, and reflection. The findings of this study support the use of reflective portfolios to provide students the necessary mastery goal orientation to reflect upon their current progress towards meeting their academic goals. Additionally, this study suggests reflective portfolio use allows students to consider behavioral changes necessary to meet their goals and provides a framework for a dialogue about self-regulation and performance between teachers and students.

APPROVAL PAGE

WESTERN CONNECTICUT STATE UNIVERSITY

School of Professional Studies
Department of Education and Educational Psychology
Doctor of Education in Instructional Leadership

Doctor of Education Dissertation

THE EFFECT OF REFLECTIVE PORTFOLIO USE ON STUDENT SELF-REGULATION SKILLS IN SCIENCE

Presented by

Jacob C. Greenwood, EdD

Edward Duncanson, EdD Primary Advisor	Signature	3.20.2010 Date
Marcia Delcout, PhD Secondary Advisor Committee Member	Marcia Delcourt Signature	3/20/10 Date
Robert Pauker, EdD Secondary Advisor Committee Member	Signature	March 20, 2010 Date

2010

ACKNOWLEDGEMENTS

I would like to thank Dr. Edward Duncanson for his tireless efforts to keep me on track, on task, and on time in order to accomplish my goals. Additionally, the guidance, support, and direction of Dr. Marcia Delcourt not only has enabled me to complete this project but also has challenged and stimulated me both intellectually and personally over the past five years. Special thanks to Dr. Robert Pauker and Dr. Michael Hibbard for sharing their valuable time and expertise with me throughout this process. Lastly, a thank you to T. J. Leonard: cohort member, cheerleader, colleague, and above all, a friend.

DEDICATION

This dissertation is dedicated to my family who have stood by me and supported me throughout this process. My son, Everett, and daughter, Anabelle, always greeted me, regardless of the hour I returned home, with warm hugs and kisses. To my wife Janessa, there are no words to express the sincere thanks I owe you for surviving this process with me. A special thanks to my nephew, John McLaughlin, for hours of data entry on a hot summer afternoon.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF TABLES

TABLE OF TABLES (continued)

CHAPTER ONE: INTRODUCTION TO THE STUDY

Overview

The need for this study was predicated on the findings of Zimmerman (2002) who stated that although the benefits of students' use of self-regulatory processes are well documented, few teachers effectively prepared students to learn on their own. Teachers rarely encouraged students to establish specific goals, taught specific study strategies, or assessed students' beliefs about learning to identify difficulties before they become problematic (Zimmerman, 2002). Moreover, students were rarely given the opportunity to self-evaluate their own work or critically consider their competence on new tasks (Zimmerman, 2002).

According to Zimmerman (2001, 2002) what characterizes self-regulating students is their active participation in learning from a metacognitive, motivational, and behavioral point of view. Self-regulating students see themselves as agents of their own behavior. They believe learning is a proactive process. Additionally, they are self-motivated and they use strategies that enable them to achieve desired academic results (Montalvo & Gonzalez-Torres, 2004). Pintrich (2000) proposed a theoretical framework which organized self-regulated learning into four phases: planning (goal setting), self-monitoring, control (managing motivation), and reaction and reflection (metacognition).

One means to train students in goal setting, metacognition and self-monitoring is through the use of reflective portfolios. A study conducted by Driessen, van Tartwijk, Overeem, Vermunt, and van der Vleuten (2005) showed reflection is a prerequisite for learning in the context of real practice. The creation of a reflective portfolio allowed students to understand how they learned best, in what ways they learned best, and their limitations related to specific tasks. In the portfolio process students build a history of their learning including personal goals, work samples, revisions and corrections, and reflections. Ultimately, the portfolio will be used as a medium for reflection. Ideally, students set goals for themselves and judge how well they reach those goals. Goal setting provides a strong foundation for future, honest self-evaluation and reflection (Courtney & Abodeb, 1999). When using portfolios, students routinely, thoughtfully and honestly evaluate their own learning with far more detail and introspect than a teacher ever could. Through the portfolio process these evaluations of learning made by the student are documented in personal goals and self-reflections.

According to Wade and Yarbrough (1996), reflective portfolio use stimulated students to develop a new understanding and appreciation of their experiences, recognize links between different aspects of these experiences, and formulate insights to be tested in future actions. This form of self-monitoring should allow students to understand how to apply strategies that allow them to do well on various tasks to related tasks of similar scope and range. The portfolio becomes a monitoring activity to provide information about relative discrepancies between a goal and current progress toward that goal (Pintrich, 2004).

The aim of this study was to measure the effect reflective portfolio construction has on the self-regulation skills of high school science students. The reflective portfolio included student work samples, revisions of work, reflections, and goal statements. Construction of the portfolio took place over a 20-week period giving students the opportunity to engage in a cyclical process of self-regulation facilitating an on-going assessment dialogue between themselves and their teacher. This study utilized a quasi-experimental research design. A nonrandomized control-group, pretest-posttest design was used to compare two different situations; (a) reflective portfolio use and (b) no use of reflective portfolios.

Rationale

Adequate training in goal setting, metacognition and self-monitoring can help all students improve their degree of control over learning and performance. The purpose of this study was to investigate if the use of reflective portfolios in science can engage students in a cyclical self-regulation model involving forethought, performance control, and self-reflection which are considered key strategies used by self-regulated learners (Schunk & Zimmerman, 1998). By using these self-regulatory skills students can become empowered to guide their own learning and internalize the criteria for judging success. In the current era of standards-based education, the need for formative assessments which improve engagement and learning have become increasingly important.

Statement of the Problem

Students lack an understanding of their existing self-regulatory skills and opportunities to develop new ones. Students need a medium, such as a reflective portfolio, to develop a repertoire of study and self-regulation strategies which they can access and utilize to engage them in independent study and help them to manage workloads from multiple teachers as well as display independence and self-efficiency outside of the classroom (Zimmerman, 2002). Reflective portfolio use in science fosters the development of study and self-regulation strategies by engaging students in a cyclical self-regulation model involving forethought, performance control, and self-reflection which are considered key strategies used by self-regulated learners (Schunk & Zimmerman, 1998).

Significance of the Study

Students and teachers alike can benefit from this study. Students may gain a deeper understanding of their existing self-regulatory skills and develop new self-regulatory skills which will have a direct effect on behaviors and strategies used to attain goals. Likewise, teachers may benefit by using a formative assessment tool which could improve engagement and learning.

In the current era of standards-based education, the need for formative assessments which improve engagement and learning have become increasingly important. As stated by the National Committee on Science Education Standards and Assesmments in The National Science Education Standard (1996), "When teachers treat students as serious learners and serve as coaches rather than judges, students come to understand and apply standards of good scientific practice" (p.88). The council also indicated in the standard

> The purported objectivity of short-answer tests is so highly valued that newer modes of assessment, such as portfolios, that rely on apparently more subjective scoring methods are less trusted by people who are not professional educators. Overcoming this lack of trust requires that teachers use assessment plans for monitoring student progress and for grading. Clearly relating assessment tasks and products of student work to the valued goals of science education is integral to assessment plans. Equally important is that the plans have explicit criteria for judging the quality of students' work that policy makers and parents can understand (p.89).

The method suggested in this study for the production of student generated reflective portfolios is a criterion-based procedure teachers can use in their classrooms to meet the federal science standard.

The Connecticut State Board of Education stated in Connecticut's Five-year Comprehensive Plan for Education 2006-2011 (2007), "districts must develop formative assessments and provide a small, safe, personalized, and positive learning environment" (pp. 3, 4). Similarly, the Connecticut State Board of Education stated in their position statement on science education (2008), "teachers must provide varied assessments and use the results to inform instruction" (p. 4). It continues, "Teachers must develop rich science lessons, inquiry investigations, and assessments that monitor student achievement in science" (p. 2). The use of reflective portfolios in the classroom meets all these goals as the reflections, revisions, and goal statements represent on-going snapshots of student learning and achievement throughout the year.

Additionally, due to the formative nature of the reflective portfolio as an assessment tool, it can readily be used by the teacher to inform instruction. Reflective portfolios involve the teacher in a rich collaboration with each student (Courtney & Abodeeb, 1999). This is achieved through teacher-student dialogues about the process of collection, selection, and assessment of what has been learned. In this sense, the portfolio becomes a powerful formative assessment tool for the teacher stimulating a rich, ongoing dialogue between the teacher and student throughout the academic year clarifying student misconceptions and highlighting areas for instructional improvement for the teacher.

Definition of Key Terms

1. *Criteria* are guidelines, rules, or principles by which student responses, products, or performances are judged (Arter & McTighe, 2001).
2. *Goal setting* is committing oneself to specific, proximal, and challenging learning outcomes (Zimmerman et al., 1996).
3. *Mastery goals* are goals in which the student focuses on the task at hand and what needs to be done to improve knowledge, understanding, and skill (McMillian & Hearn, 2008).
4. *Metacognition* is a person's awareness of his or her own thinking (Crain, 1992).

5. *Reflection* is the active, persistent, and careful consideration of any belief or supposed form of knowledge (Dewey, 1910).
6. *Self-assessment* is reflecting upon, reconsidering, and revising the meaning of what a student has already learned, produced, and believed to be knowledge (Wiggins, 1998).
7. *Self-monitoring* is systematic, deliberate observation of covert and overt aspects of one's performance on a given task (Zimmerman et al., 1996).
8. *Self-regulated learning* is an approach to learning involving goal setting, strategy use, self-monitoring, and self-adjustment to acquire a skill (Zimmerman et al., 1996).
9. *Self-regulation* is processes that activate and sustain cognitions, behaviors, and affects, and that are oriented toward goal attainment (Zimmerman, 1990).
10. S*tudent portfolios* are a purposeful collection of student work that tells a story about the student's efforts, progress, or achievement. This collection must include student participation in selection of portfolio content, guidelines for the selection of that material, criteria for judging the merit of the work collected, and evidence of student self-reflection (Arter & Spandel, 1992).

Chapter Summary

Teachers rarely encourage students to establish specific goals, teach specific study strategies, or assess students' beliefs about learning to identify difficulties before they become problematic (Zimmerman, 2002). Moreover, students are rarely given the opportunity to self-evaluate their own work or critically consider their competence on new tasks (Zimmerman, 2002). Yet, students are expected to engage in independent study and manage workloads from multiple teachers as well as display independence and self-efficiency outside of the classroom (Zimmerman, 2002). Adequate training in self-regulation (goal setting, metacognition and self-monitoring) can help all students improve their degree of control over learning and performance. This study used a quasi-experimental nonrandomized control-group, pretest-posttest design to compare two different situations; (a) reflective portfolio use and (b) no use of reflective portfolios to investigate the use of reflective portfolios in science as a means to engage students in a cyclical self-regulation model. Additionally, the use of a repeated measures research design was used to see if significant gains in students' reflective portfolio scores occurred over time.

CHAPTER TWO: REVIEW OF THE LITERATURE

Chapter Overview

This chapter describes the theory, constructs, production requirements, and research supporting reflective portfolio use. The chapter consists of the following sections: self-regulation and social cognitive theory, motivation and self-regulation, portfolios defined, mastery goal orientation, self-assessment, self-reflection, assessment, and portfolio use.

Self-Regulation and Social Cognitive Theory

Self-regulation consists of processes that activate and sustain cognitions, behaviors, and affects, and that are oriented toward goal attainment (Zimmerman, 1990). This process can be viewed in the cyclical phases of forethought, volitional (performance) control, and self-reflection (Schunk & Zimmerman, 1998). These self-regulation phases involve such academic processes as goal setting, planning, self-efficacy, motivation, attention, self-monitoring, self-evaluation, self-reaction, and adaptivity.

The self-regulation process is affected by many factors echoed in the social cognitive theory of Albert Bandura. Social cognitive theory identifies four core features of human agency being intentionality, forethought, self-reactiveness, and self-reflectiveness (Bandura, 2001). An intention is a representation of a future action to be preformed. Intentions, therefore, affect the likelihood of actions at a future point in time. In essence, intentions are centered on future plans of action. People tend to form intentions that include action plans and strategies for realizing them (Bandura, 2004). These future plans of action are rarely specified in full detail. They are filled in and adjusted, revised, refined, and reconsidered in the face of new information as the plan is carried out (Bratman, 1999). Therefore, successful implementation of the plan requires self-regulation of intentions. For this reason, educators must help students be cognitive of their own thinking, to be strategic, and direct their motivation towards meaningful goals (Montalvo & Gonzalez Torres, 2004). The goal needs to be for students to learn to be their own teachers (Schunk & Zimmerman, 1998). In this sense, teachers need to move from teaching towards guiding students in self-reflective practice.

Using forethought, people set goals for themselves and anticipate the outcome of prospective actions which guide and motivate their efforts (Bandura, 2004). They anticipate the consequences of prospective actions and create courses of action to produce desired outcomes and minimize detrimental ones (Bandura, 2001). Forethought allows people to continually plan ahead throughout their lives, reorder their priorities, and structure their lives accordingly. Behavior is therefore motivated and directed by projected goals and anticipated outcomes. Future events become regulators of behavior. In regulating behavior, people adopt courses of action likely to produce positive outcomes and discard those that bring unfavorable outcomes. People begin to regulate the present to dictate a desired future.

Self-reactiveness speaks to the notion that people are not only planners and forethinkers, but self-regulators as well (Bandura, 2004). Self-directedness is the deliberate ability to make choices and action plans as well as shape courses of action to motivate and regulate their execution (Bandura, 2001). It works through self-regulatory processes that link thought to action.

Social cognitive theory postulates that the self-regulation process (a component of self-directedness) is itself composed of three major levels being (a) self-monitoring, (b) self-judgment, and (c) self-reaction (Bandura, 1986). Self-monitoring is deliberate attention to specific aspects of one's behavior. Bandura recommended assessing behaviors based on dimensions such as quantity, quality, rate, and originality (Bandura, 1986). Self-monitoring is assisted through self-recording where behaviors are recorded over time through such activities as goal setting. When rooted in an individual's values and personal identity, goals give activities meaning and purpose (Bandura, 1986). Goal setting motivates individuals to become self-evaluative of activities they engage in. Self-evaluation becomes conditional on the standard set by the goal, thereby giving direction to sustain effort towards goal attainment. When self-monitoring results in goal progress, students are often motivated to improve (Schunk, 1989).

Self-monitoring is linked closely to self-judgment which refers to comparing present performance with a standard (Schunk & Zimmerman, 1998). Bandura (1986) placed a great emphasis on the importance of the self-judgment process and on the factors which may affect one's self-judgments. The judgments made by an individual are linked to the type and importance of the standard being used for comparision. Standards come in two forms being absolute or normative. Absolute standards are fixed such as when a student attempts to finish a task in a given amount of time. Normative standards are based on the performance of others such as when a student attempts to be the first one in a class to complete a task. Standards often are acquired by observing models where a student compares his or her work against others or against written norms (such as a rubric) to evaluate the appropriateness of the work under consideration (Bandura, 1986). Providing students with evaluation standards through rubrics, models, and exemplars helps students concretely understand outcomes and expectations (McMillan & Hearn, 2008). Ultimately, when students compare their performance against standards information is provided about progress (Schunk & Zimmerman, 1997).

Self-reaction involves making evaluative responses to judgments of one's performance (Schunk & Zimmerman, 1997). Evaluative reactions involve students' beliefs about their progress; for example whether it is good or bad, acceptable or not acceptable, beyond or below expectation (Schunk & Zimmerman, 1997). The belief that one is making acceptable progress towards a goal and the expected satisfaction that a goal will be attained affects both motivation and self-efficacy (Schunk & Zimmerman, 1998). When self-monitoring results in goal progress; the motivation to improve is fostered (Schunk, 1989). Yet, negative evaluations need not decrease motivation as long as students believe they are capable of improving. Motivation cannot improve if students think they lack the capability to improve and that increased effort or better use of strategies will not help (Schunk, 1994). Self-reactions can raise self-efficacy when they are linked to actual accomplishments. Often, the accomplishment is influenced by tangible rewards which validate the perception of progress. For example, students who believe they are improving their study routine might reward themselves by taking a break (Schunk, 1994). If the student perseveres in the face of adversity and judges that he has improved his study routine he feels better about himself. Based on this positive efficacy belief the student rewards himself with a break.

These three self-regulatory processes; (a) self-monitoring, (b) self-judgment, and (c) self-reaction; interact with one another and with environmental processes (Schunk & Zimmerman, 1997). As students observe and monitor their own performances, they judge them against standards and react to their judgments. A student's judgments set the stage for additional and future observations and monitoring.

The final component to social cognitive theory is self-reflectiveness which involves the metacognitive capacity to reflect upon oneself and one's actions (Bandura, 1986). Through reflection people evaluate their motivation, values, and meaning behind their pursuits. Ultimately, self-reflection becomes a vehicle for self-adjustment. These adjustments rooted in reflection, operate as guides and motivators based on an individual's belief that he or she can exert some measure of control over his or her own functioning. This belief can be defined as one's self-efficacy. Individuals need to believe they can achieve a desired result through their own actions. Otherwise, individuals have little incentive to persevere in the face of adversity.

Efficacy beliefs play an integral role in social cognitive theory because they influence whether individuals think pessimistically or optimistically (Bandura, 1986). These beliefs are neither global personality traits nor general self-concept, but instead specific self-conceptions that individuals develop from experience such as successes and failures in different activities. Therefore, Bandura (1986) believed efficacy plays a key role in self-regulation in relation to motivation. Based on efficacy beliefs, individuals chose what challenges to undertake, how much effort to expend, and how long to persevere when faced with obstacles and failure. A strong sense of efficacy reduces the likelihood of negative effects on the individual such as stress or depression in taxing situations and strengthens resiliency to adversity. As students work on tasks, they note their progress mentally which conveys to them what they are capable of learning and raising their self-efficacy (Schunk, 1989). In the end, an individual's efficacy beliefs shape the course of his or her life by influencing the types of activities the individual engages in and environments the individual selects. Therefore, efficacy effects personal choices made by an individual and therefore can profoundly affect his or her personal development. Social influences from the activities an individual chooses to engage in and environments an individual selects will influence their competencies, interests, and values long after the initial decisions were made. Thus, through choice, people have a hand in what they become (Bandura, 1986).

In summary, social cognitive theory views human functioning as a series of reciprocal interactions between behavioral, environmental, and personal variables (Bandura, 1986). The four components of social cognitive theory being intentionality, forethought, self-reactiveness, and self-reflectiveness define the construct of self-regulation and its three processes of forethought, performance control, and self-reflection. These three self-regulatory processes do not function in isolation, but interact with one another to shape an individuals' view of their world and who they become.

Studies show that students who self-regulate their learning (Corno, 2001; Weinstein, Husman, & Dierking, 2000; Winne, 1995; Zimmerman, 1998, 2000, 2001, 2002):

1. are familiar with and understand how to use a series of cognitive strategies (repetition, elaboration, and organization), which help them to attend to, transform, organize, elaborate, and recover information;
2. know how to plan, control, and direct their mental processes toward the achievement of a goal (are metacognitive);
3. display a set of motivational beliefs and adaptive emotions (such as self-efficacy, setting of learning goals, developing positive emotions towards tasks), and have the capacity to modify and control these, adjusting them to the requirements of the task at hand;
4. plan and control the time and effort used on tasks and create favorable learning environments;
5. participate in and control classroom tasks and classroom climate and structure, to the extent that the context allows; and
6. can use a series of volitional strategies to avoid external and internal distractions.

In schools, these self-regulatory processes allow students to observe their performances, judge them against goal standards, and react to those judgments. Their evaluations and reactions set the stage for additional observations (Schunk & Zimmerman, 1997). Correctly implemented, activities that promote self-regulated learning can promote intrinsic motivation, internally controlled effort, mastery goal orientation, and meaningful learning (McMillan & Hearn, 2008).

Pintrich Model of Self-Regulated Learning

Puustinen and Pulkkinen (2001) highlight Pintrich's model of self-regulated learning as one of the most important attempts at synthesizing the processes and activities which help to increase self-regulated learning. Pintrich proposed a theoretical model based on social cognitive theory. The approach used by Pintrich aimed to classify and analyze the different processes comprising self-regulated learning as outlined by Bandura's social cognitive theory (which characterizes self-regulation as an interaction between personal, behavioral, and contextual processes) (Montavo & Gonzalez Torres, 2004). In Pintrich's model, regulatory processes are organized according to four phases; (a) planning, (b) self-monitoring, (c) control, and (d) evaluation. Within each of the phases, self-regulation activities are structured into four areas: cognitive, motivational/affective, behavioral, and contextual. In the Pintrich model, these four phases represent a sequence followed by a student, but they are not hierarchically or linearly structured (Montavo & Gonzalez Torres, 2004). In fact, phases may occur simultaneously producing multiple interactions between the processes. Pintrich also indicates that not all learning activities explicitly involve self-regulation. Prior experience may be used by the student to automatically perform a task eliminating the need for such self-regulatory processes as planning, control, and evaluation.

Pintrich's model for self-regulation begins in the planning phase where activities such as goal setting and activation of prior knowledge occurs in the cognitive area; activation of motivational beliefs such as self-efficacy, task value, and goals occurs in the motivational/affective area; planning the time and effort to be used on a task occurs in the behavioral area; and activating the perceptions regarding a task and the class context occurs in the contextual area.

The self-monitoring phase contains activities that help the student become aware of his or her cognition and motivation (cognition area and motivation/affect area), time and effort use (behavior area), and conditions of the task and context (context area). Self-monitoring involves the self-observation of comprehension or metacognitive awareness (cognition area and motivation/affect area), as well as the processes a student uses to be aware of his or her motivation and effort (behavior area). The context area of self-monitoring involves the characteristics of a task and the classroom context (what are the class norms and rules, how is performance evaluated, what are the task requirements) (Montavo & Gonzalez Torres, 2004).

Control activities involve the selection and utilization of strategies (cognitive and metacognitive), motivation and emotions (motivational strategies and emotion control strategies), and time and effort regulation of tasks, as well as control over atmosphere and structure of the class (Montavo & Gonzalez Torres, 2004). An important control activity is the construction of knowledge through the process of revision and reprocessing of ideas and information which promotes greater learning (Scardamalia & Bereiter, 1986). Studies of high school students have provided support that revision improves the quality of written composition (Ash, 1983) and that older students make more meaningful revisions than younger students (Graves & Murray, 1980).

Finally, the reflection phase encompasses the judgments, evaluations, and reactions a student makes regarding a task in comparison to established criteria (his or her own, or the teacher's). Also, critically seeking the cause of success or failure and behavior choice to be followed in the future are characteristics of this phase (Montavo & Gonzalez Torres, 2004).

In summary, the Pintrich model provides a framework from which to analyze the different cognitive, behavioral, motivational, and contextual processes involved in self-regulated learning. What sets this model apart from its predecessors is the contextual phase. This model proposed that students can do something to change their context and therefore, the manipulation of the environment used for learning becomes an important aspect of self-regulated learning (Montavo & Gonzalez Torres, 2004).

Motivation and Self-Regulation

While research in the 1970s and 1980s focused on cognitive variables such as information processing, cognitive style, learning strategies, prior knowledge, and thinking processes, research in the late 1980s and into the 1990s focused on motivational processes such as self-concept, self-efficacy, attributions, and goal setting (Montavo & Gonzalez Torres, 2004). An interest in how these variables were linked gave rise to research on self-regulation. Studies in this area agreed that learning strategy development encouraged cognitive learning and learning motivation. Interestingly, researchers also suggested that improvement in motivational beliefs not only effected learning motivation but also influenceed the nature of how students process information, select, and used learning strategies. Specifically, Wigfield and Eccles (2000) researched Atkinson's model of expectancy values which included ability beliefs, expectancies for success, and the components of subjective task values. This study highlighted the importance of students' self-efficacy beliefs and the importance of goal orientation to motivation and the regulation of learning (Montavo & Gonzalez Torres, 2004). Bandura (1986) believed self-efficacy plays a key role in self-regulation in relation to motivation.

Studies using the Motivated Strategies for Learning Questionnaire (MSLQ) have correlated relationships between motivation, learning strategies, and academic performance

(Pintrich, Smith, Garcia, & McKeachie, 1991). Data from 356 Midwestern college students and 24 community college students in the winter of 1990 were used for a correlational study. The study used confirmatory factor analysis to link motivation, learning strategies, and course final grade. The scale correlations with final grade were significant and alpha levels from correlational analysis ranged from .52 to .93, considered fairly robust. Additionally, Zimmerman (2001) and Schunk (2001) have contributed studies which highlight the positive effect of student self-efficacy beliefs on the process of self-regulation.

Portfolios Defined

A portfolio is a collection of student work assembled to provide a representation of that student's achievement (Stiggins, 1997). In practice, portfolios often consist of two major categories (Friedman et al., 2001). First, a collection of evidence in the form of student generated artifacts chronicling events and experiences and second, a reflection by the student on what has been learned. Recently, portfolios have gained popularity because of the flexibility they provide teachers in their assessment practices.

Several important purposes for portfolios as assessment tools have been outlined. They include their ability to track student achievement over time to reveal improvement or the lack thereof, preserve the detailed and complex picture of student achievement, and afford students an excellent context within which to take responsibility for maintaining and tracking their files and records of achievement. Additionally, portfolios help students learn to reflect on and see their own improvement as achievers, provide important insights into students' academic self-concepts, academic interests, and sense of their own needs, and provide excellent opportunities for students to practice their reasoning proficiencies. Also, they help students analyze their own work, compare work over time, draw inferences about their growth or needs, and learn evaluative or critical thinking skills. Lastly, portfolios allow students to understand the work production requirements of real-life situations (Stiggins, 1997).

To merge effectively into instruction, a portfolio must tell a story (Stiggins, 1997). This story is told through the specific guidelines used to select artifacts for inclusion into the portfolio. Guidelines vary depending on the purpose of the portfolio. Student portfolios may vary widely in content and purpose and even in who decides what goes into the portfolio (Sweet, 1993). Decisions about what goes into a portfolio are typically made by the student creating the collection but also may involve teachers and peers as well as the structural supports outlining the requirements for the entire portfolio. Kenfield (1994) suggested that teachers should set specific guidelines for portfolio production while still allowing the portfolio to display the uniqueness of each student. The materials included in the portfolio should both provide structure and display uniqueness. The artifacts would include formal writing along with drafts (such as short stories and lab reports), anecdotal writing (such as journal entries and learning logs), homework and class work samples, student generated goals for academic progress, and student self-reflections of goals, assessments, development in work, and attitude towards school and self. Kenfield (1994) continued by highlighting that it is the last recommendation of self-reflection which should get the greatest emphasis. She suggested reflection is one of the best ways for students to be active participants in setting goals for their own learning. Through this process the portfolio will support broader thinking around the subject matter being investigated within the reflection and encourage the development of higher order thinking skills (Kneale, 2002).

Portfolio Structures

Spandel and Culham (1995) suggested several portfolio structures termed the (a) celebration portfolio, (b) the time sequence portfolio, and (c) the status report portfolio. A celebration portfolio is a personal collection of favorite works and special academic mementos. This type of portfolio displays a final collection of a student's best work and final drafts (Uphoff, 1989). They portray the best academic experiences of that student. The time sequence portfolio is used to show change over time and comes in two forms; the growth portfolio and the project portfolio. A growth portfolio uses constant evaluation criteria to show improvement over time. This sort of developmental portfolio would contain work samples that represented student growth over time and involved an assemblage of a large collection of artifacts (Uphoff, 1989). Alternately, a project portfolio describes specific work carried out over a period of time. In this case, the evaluation criteria will be suited to the individual steps and strive for an increase in the work quality at each step. Lastly is the status report portfolio. The status portfolio presents evidence that certain levels of proficiency have been met. An example of this type of portfolio would be a college admissions portfolio used to provide evidence of mastery in high school (Uphoff, 1989).

Historically, the use of portfolios has found wide-spread success in at least three facets of assessment (Underwood, 1998). First, is the use of the portfolio to foster the kind of careful, patient work habits observed in craftsmen and artists. Learning, therefore, occurs in chunks spread out over long periods of time. Students, over this time, will develop a keen sense of the standards and criteria necessary to critically judge their own performance. Consequently, assessment is not restricted to finished products, but also to works in progress.

This leads to the second facet which is the use of portfolios to display real student work produced in the natural classroom setting over time. A process approach to assessment can be fostered through the portfolio process versus a onetime external predictor of content attainment. The notion of assessing students alone, with no time for revision, without discussion, without feedback, and without any sense of communication seems instinctively troubling (Belanoff & Elbow, 1986). Friedman et al. (2001) suggested that the use of portfolios as a means of summative assessment not only measured desired learning outcomes, but also enhanced the development of strategies, skills, and cognitive processes necessary for lifelong learning.

Last, is the ability of portfolios to demonstrate student growth in writing particularly at the secondary level. Large-scale traditional testing routinely highlights student reading proficiency. For most of the century, the assessment of reading has been accomplished by means of multiple choice tests with little concern over the possible negative impact these tests may have on reading instruction (Underwood, 1998). Conversely, ever since the College Board added writing assessment to their Comprehensive Exam in 1916, heated debate over writing instruction has ensued (Greenberg, 1992). Portfolios not only offer the tools necessary to gather more and better data about student writing they also model the kinds of practices students need to become more proficient writers as well as readers.

Paulson, Paulson, and Meyer (1991) summarized the keys to successful reflective portfolio use into three facets. First, portfolio use is an opportunity to learn over time. The end product must contain information showing the student engaged in self-reflection. Next, students must be given the opportunity to select work samples because this will help the students' value themselves as learners and their own work. Finally, the portfolio must illustrate growth with actual examples of work showing improvement over time. In regards to grading, teachers need to be conscious of the evolving nature of the portfolio when using it as an assessment tool to ensure students are actively participating in the process at every possible opportunity (Hansen, 1998).

Mastery Goal Orientation

The portfolio process begins with students setting mastery goals. A mastery goal is one in which the student focuses on the task at hand and what needs to be done to improve knowledge, understanding, and skill (McMillian & Hearn, 2008). Students will reach mastery goals through such cognitive processes as thinking, self-monitoring, and generating solutions. Additionally, students who set mastery goals tend to immerse themselves in the task and continually check their progress. The goal setting process involves the student setting goals which are attainable in a specified amount of time. These goals need to be focused on specific self-monitoring strategies which will increase the likelihood of the student attaining their specified goal. In this way, the portfolio becomes a highly individualized and an intensely personal assessment tool to both the teacher and the student (Sweet, 1993).

A study conducted by Mousoulides and Philippou (2005) supported Pintrich's (2000) earlier research that students who set and pursue mastery goals use deeper cognitive strategies (elaboration and organization) and deeper metacognitive strategies (planning and self-observation). In the autumn of 2004, 194 sophomore pre-service teachers who attended a mathematics course participated in a study to test the prediction of a causal model that explains the impact of self regulatory learning, which encompasses students' motivational beliefs and self-regulation strategy use on their achievement in mathematics. A 26-item questionnaire based on the MSLQ (Pintrich, Smith, Garcia, & McKeachie, 1991) was used. The tested model contained both observed (measured) variables and latent constructs. The observed variables were specified as indicators for each of the latent constructs. One of the factors was measured by six indicators (Self-Efficacy), two factors were measured by four indicators (Task Value and Elaboration) and four of the factors were measured by three indicators each (Mastery Goal

Orientation, Extrinsic Goal Orientation, Organization and Metacognitive Strategies). The Cognitive Strategies latent factor was measured by the two factors Elaboration and Organization. Finally, the factor Self-Regulation Strategies use was measured by Cognitive Strategies and Metacognitive Strategies.

The results indicated all factors used displayed high casual effects ranging from .48 - .91. This study confirmed that mastery goal orientation, can predict a student's self-efficacy. The causal effect of mastery goal orientation on self-efficacy was very high, being .85. This finding indicated that mastery goal orientation is a strong predictive factor of self-efficacy and therefore has an indirect effect on achievement through self-efficacy. Additionally, this study supported that mastery goals effect motivational beliefs about students themselves and towards tasks (high self-efficacy in the face of adversity, task enjoyment, a high level of value of tasks, task importance, and positive reaction to task as assigned). Finally, this studied supported that mastery goals effected effort, persistence, and behaviors related to help seeking in the face of academic adversity.

Mastery Goals and Motivation

Achievement motivation theorists have used careful empirical data to develop a goal-driven model of motivation aligned with the theory behind portfolio use (Underwood, 1998). Dweck and Leggett (1988) explained that students who engage deeply in the face of challenges exhibit mastery goal orientation (sometimes referred to as learning goal orientation or task involved goal orientation). These students believed the effort they exhibited would improve them intrinsically and they therefore valued learning for learning's sake (Harkness, D'ambrosio, & Morrone, 2006). Students who did not persist in the face of challenges, or engage deeply, exhibited performance goal orientation. These students solely sought to gain approval and advance their status. Performance goal orientated students tended to be more focused on the outcome of learning and not on the process of learning. Therefore, these students tended to view learning as a means to an end and were concerned with gaining external rewards or positive judgments of their abilities. Ames (1990) reported that students tended to favor performance goals over mastery goals based on school socialization. Children favored the norms set by schools such as extrinsic rewards, ability grouping, and an emphasis on production, speed, and perfection which all lent them to performance goal orientation.

A study by Patrick, Anderman, Ryan, Edelin, and Midgley (2001) found that teachers in mastery focused classrooms emphasized the importance of active learning, student involvement, and effort. Conversely, it was reported that performance focused classrooms emphasized grades, formal assessments, and students' relative performance in relation to the other students in the class. The study used a qualitative case study research design with seven 7th grade students over the period of 1 academic year. Data from observations and interviews using naturalistic inquiry were collected as well as one survey which generated quantitative data used to enrich the qualitative findings. The data revealed several key findings supporting the link between behaviors and goals that correspond with their personal goals. Students' personal goals seemed to emerge from a series of negotiations that occurred between family goals, school goals, classroom goals, and peer goals. Simply put, students' motivation to exhibit particular behaviors was a manifestation of the interaction between their own personal goals and external goals placed on them by families, schools, teachers, and peers. Therefore, performance focused classrooms should yield performance goal-orientated students while mastery focused classrooms should yield mastery-orientated students. Patrick et al. (2001) also noted that teachers in mastery goal focused classrooms showed greater enthusiasm towards each day's lesson. In order for students to be cognitively engaged, they must be active participants in learning through conversations and the exchange of ideas with teachers and other students supporting mastery goal orientation (Harkness, D'ambrosio, & Morrone, 2006). Portfolio assessment systems, orientated towards mastery goals, support student ownership, choice, task engagement, and reflective analysis. Classroom structures that support mastery goal orientation afford students the freedom to share ideas, ask questions, and make mistakes (Muthukrishna & Borkowski, 1996).

Mastery Goals and Self-Regulation

Pintrich (2000) supported that students' use of mastery goals was associated with cognitive and self-regulatory strategies. Once a goal has been set by the student, the reflective portfolio becomes a monitoring activity to provide information about relative discrepancies between a goal and current progress toward that goal (Pintrich, 2004). When students are focused on trying to improve their understanding they are more likely to put effort into their schoolwork (Patrick, Ryan, & Kaplan, 2007). The effort manifests itself in increased thoughtfulness, the use of self-regulatory strategies, and an increase in interactions with others concerning learning and achievement. Meece and Holt (1993) reported in a study of 257 5^{th} and 6^{th} grade middle school science students using cluster analysis procedures that individuals with high mastery goal orientations had higher effort, grades, and test scores than did students with higher performance goal orientations.

A qualitative study of four eighth grade science students by Patrick and Yoon (2004) echoed the findings of Meece and Holt. Of the four students studied over the 8-week period, three embraced a mastery goal orientation displaying increased conceptual understanding and test scores. The fourth student, who showed evidence of not being mastery goal orientated, had no increase in conceptual understanding or test scores. These findings were consistent with the vital role mastery goal orientation has on conceptual understanding.

Studies in high schools have supported these claims as well. In a study of 167 high school students, Ames and Archer (1988) showed the use of mastery goals increased beneficial achievement behaviors such as selection of better learning strategies, more positive attitudes, selection of challenging tasks, and increased work satisfaction. The 91 boys and 85 girls in the study attended an academically advanced high school. Randomly selected students responded to questionnaires designed to measure the students' perception of their goal structure on 6 learning strategies scales. A factor analysis revealed alphas levels from .77 - .88 with a correlation between scales of -.03. The findings suggest students who exhibited mastery goal orientation fostered a way of thinking necessary to sustain involvement in the learning. Additionally, mastery goal orientation increased the likelihood that students pursued tasks that fostered learning.

However, even though numerous negative effects of performance goal orientation have been documented, studies have shown a student's goal orientation can change over time. Gehlbach (2006) found that students who began a school year with suboptimal goal orientations for their given classroom setting could change. A sample of 917 9th and 10th grade world history students completed the Patterns of Adaptive Learning Survey as a pretest in September and as a posttest in May of the same academic year. Factor analysis revealed that with a teacher's support, students will pursue more mastery oriented goals given the structure of the classroom supports mastery goal orientation over performance goal orientation. The goals students set appear to be influenced by the structure of the learning environment. Additionally, Gehlbach

(2006) reported increases in mastery goal use related to higher year-end content knowledge, grades, interest, course satisfaction, social perspective taking, and historical empathy.

Self-Assessment and Revision

The process of student self-assessment involves reflecting upon, reconsidering, and revising the meaning of what a student has already learned, produced, and believes to be knowledge (Wiggins, 1998). Self-assessment is an integral part of self-monitoring emphasizing autonomy and student responsibility (Boud, 1999). It allows students to uphold their own standards without being policed from the outside. Furthermore, student self-monitoring of learning is important in knowledge construction (Shepard, 2001). That is, students construct meaning, in part, through self-assessing prior to and during learning (McMillian & Hearn, 2008). The medium for self-assessment within the reflective portfolio is the selection and revision of artifacts to be included within the portfolio by the student.

Revision is an important aspect in the development of knowledge. Students learn what they are trying to say as they write and revise (Odell, 1980). This construction of knowledge through the process of revision and reprocessing of ideas and information promotes greater learning (Scardamalia & Bereiter, 1986). Learners begin with partial knowledge and over time with repeated exposure the learner adds continually to his or her knowledge base (Hofstetter, Sticht, & Hofstetter, 1999). To facilitate this process, revision should require students to add new information to the artifact being revised as well as correct errors and clarify distinctions between the current artifact and the standard being used (such as a rubric, exemplar, or model artifact) (Marzano, 2007). Quality revisions require structure and guidance and therefore the standard against which the artifact is being compared becomes of primary importance. Revisions based on the writers' perspective of quality do not stress the link between writing and audience

(Fitzgerald & Markham, 1987). Judgments of quality revisions need to be based on the readers' perspective, not the writers' perspective. Revisions produced without structure and guidance can become highly superficial and therefore not meaningful to the student as a medium for self-reflection (Fitzgerald, 1987). Therefore, the reader (teacher) should use a known standard such as a rubric, exemplar, or model artifact to facilitate the production of quality and meaningful revisions by the student.

Self-Reflection

Almost 100 years ago John Dewey outlined the importance of the reflective process. Dewey (1910) defined reflection as "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends" (p. 6). He continued to describe reflective thought as conscious and voluntary effort. Dewey then defined the reflective process in two parts "(a) a state of perplexity, hesitation, doubt; and (b) an act of search or investigation directed toward bringing to light further facts which serve to corroborate or to nullify the suggested belief" (p. 9). John Dewey used the terms "active, persistent, act of search and investigation" quite purposefully to describe reflection as a pursuit which must be undertaken by the learner and is therefore not a passive process. Additionally, Dewey clearly understood the reflective process to be under the control of the student when he described it as conscious and voluntary. Dewey went on to stress the importance of past experiences and prior knowledge. He stated that reflection should lead to suggestions for change because "If the person has had some acquaintance with similar situations, if he has dealt with material of the same sort before, suggestions more or less apt and helpful are likely to arise" (p. 12). These suggestions will develop through the reflective process as one hunts for additional evidence to validate the suggestion or prove it absurd. Dewey concluded by saying "Reflective thinking, in short, means judgment suspended during further inquiry" (p. 13).

The progressive education movement of the 20th century begun by John Dewey was continued by Jerome Bruner (1966) who discussed the importance of reflection to students in making knowledge their own. He suggested that by having students reflect back on a difficult problem and recasting what occurred in a mode of thought understood by the student may help increase understanding and long-term knowledge retention.

Building on Dewey's and Bruner's work, Marzano (2007) took the concept of reflection into the 21st century and into the classroom by defining the reflective process as a macrostrategy (set of interacting instructional strategies) used by the teacher. In this sense, reflection is used to help students actively process content during critical-input experiences. Here again, reflection is an intentional act, engaging students in interrogating their own thinking to construct some understanding of it (Lyons, 2002b). Marzano continued by stating that students use reflection as a means to identify points of confusion, the level of certainty they had about content, preconceptions that were accurate, and preconceptions that were inaccurate.

Reflection not only is an effective tool for the student, but for the teacher as well, in terms of instruction. Butler and Winne (1995) reported that asking students to reflect on areas of confusion enhances their learning and provides the teacher with valuable diagnostic information. Teachers should therefore use student reflections as a reflective opportunity for themselves by comparing their own teaching to the ends that were sought. Reflection is not solely a disposition or a set of strategies for a teacher, but also a kind of analytical knowledge brought to bear on one's work (Richert, 1987). In the end, teachers can use these reflections of their own practice to enhance student learning and the quality of instruction being delivered.

White and Frederiksen (1998) reported that the power of reflective assessment is so strong that it even holds promise in reducing the achievement gap. Three teachers teaching four parallel seventh-grade classes in 2 urban schools followed a standardized science curriculum for 14 weeks. The curriculum was designed to promote thinking in science through the use of seven scientific investigations. Each teacher involved two classes in small group evaluative discussions about the investigations while the remaining two classes engaged in a process of reflective assessment. The reflective assessment followed a feedback loop where students were introduced to 9 assessment criteria (Overall Quality, Understanding, Inquiry, Connections, Design, Using Tools, Reasoning, Communication, and Teamwork) assessed on a 5-point Likert scale. During and at the end of each investigation, students assessed themselves against these known criteria. Upon the completion of an investigation, students wrote brief narrative statements assessing their work. Then, they presented their work to the class who, in turn, assessed the presentations using the 9 known criteria. An ANOVA was performed on the nine known criteria which compose quality scientific research along with gender and achievement on state mandated exams. In comparing the treatment group (reflective assessment feedback loop) against the control group (evaluative discussion) the variable Overall Quality displayed statistical significance of $F(1,106) = 6.82$, $p < .005$. Additionally, a significant interaction was displayed between the treatment and scores on state standardized exams with an $F(1, 106) = 4.98$, $p < .01$. No significant interactions between gender and the treatment were observed. For each of the 9 criteria, effect size ranges were greater for low achieving students ($.25\sigma – 1.03\sigma$) as measured with state mandated exam scores than for higher achieving students ($-.13\sigma$ - $.34\sigma$) on state mandated exams. The results of this study revealed that the weakest students in the reflective assessment group performed as well as the strongest students in the control group on state mandated exams. Furthermore, the other students in the reflective assessment group did even better than the control group. The achievement gap, in the reflective assessment classrooms, was reduced by half.

Ash and Clayton (2004) report that there is a lack of effective structures to help instructors from diverse disciples guide students through reflecting and meaningful strategies to evaluate written products. Welch (1999) pointed out that students need help connecting experiences in classes with their beliefs and assumptions and with deepening their learning. To this end, Eyler (2000) called for the development of mechanisms that support students in demonstrating learning outcomes. She believed what is needed is a measure where students can show that they have achieved greater understanding, the ability to apply knowledge, and problem solving skills and cognitive development.

A framework for student reflection provided a structured mechanism for students to demonstrate learning rather than merely reporting it (Ash & Clayton, 2004). Generally, student written reflections should include the three phases of (a) a description of the artifact or experience, (c) an analysis of the relevant learning that occurred, and (b) the articulation of the learning outcomes. This sort of a process to build reflections provides an opportunity for students to examine their experiences in the classroom in relation to specific course content and allows them to explore the similarities and differences between theory and practice. It also allows students personal reflective time on their feelings, assumptions, strengths, weaknesses, traits, skills, and sense of identity.

Eyler, Giles, and Schmiede (1996) commented that the reflective process does not need to be difficult, but it does need to be a purposeful and strategic process. The framework developed by Ash & Clayton (2004), termed articulated learning, provides the needed structure for the reflective process. Articulated learning establishes a foundation for students to use the reflective process to improve the quality of future learning and of future experiences. This process can be used to support critical thinking about a student's own learning. The articulated learning structured reflection response is guided by four prompts (a) what did I learn, (b) how did I learn it, (c) why is this learning significant, and (d) in what ways will I use this learning for future goals and self-improvement. Prompt four sets the tone for critical thinking about learning because it allows students to recognize what they have learned, places the reflection in the context of the experience, and requires a concise expression of their own learning. The reflection should be a set of paragraphs preceded by its accompanying prompt. Due to the structured nature of the reflection, written reflections can be used for both summative and formative assessments of student learning by the teacher.

Self-Reflection and Reflective Portfolio Use

One means to address the concerns voiced by Eyler et al. (1996) which also incorporates a structured reflective response as outlined by Ash and Clayton (2004) is through the production of a formative assessment such as a reflective portfolio. Portfolio use has shifted in recent history from a mode of representation and documentation to a deliberate method for reflective inquiry (Lyons, 2006). Each artifact in the reflective portfolio is accompanied by a student self-reflection on his or her progress towards a mastery goal in reference to the selected, revised, and included artifact. Typically, these reflections focus on problem areas, what has already been learned, what still needs to be learned, and plans for how any new learning might take place (Snadden & Thomas, 1998). The student self-reflection fosters metacognition, a person's awareness of his or her own thinking, and is the cornerstone of the reflective portfolio (Crain, 1992). Students benefit from explaining their work and their own evaluation of quality through reflective activities such as written self-reflections (McMillian & Hearn, 2008). Reflection helps students think about what they know or learned while they identify areas of confusion, so they can create new goals. Students evaluating what they have learned, what they still need to accomplish, and how they can achieve their goals can all support deeper understanding and more mature reflection skills.

Kneale (2002) described that personal portfolio use provided a supportive and structured process to reflect upon learning, performance, and achievement for personal, educational and career development. The use of reflection helps students become more effective, independent, and confident self-directed learners, understand how they are learning and relate their learning to new contexts, and improve study skills. Moreover, reflection allows students to articulate and investigate personal goals and evaluate their progress towards those goals as well as encourages a positive attitude to learning throughout life.

Lyons (2002a) used case studies to empirically supported portfolio proponents' claims that reflection is the core of the process bringing about new knowledge of practice to consciousness. Professors from the University of College Cork in Ireland (UCC) produced portfolios as a means to document and present evidence of their teaching. Findings revealed that 19 out of 20 UCC professors reported that through the reflective portfolio process new consciousness in their teaching was revealed. For 17 of the 20 faculty, four actions ensued due to the new consciousness in their teaching being (a) a greater articulation of personal goals and practices for themselves and their students, (b) questions concerning what students learn and how they learn it, (c) the consideration of changes in their teaching, and (d) actual changes to their teaching practices. This validates John Dewey's suggested outcomes of reflective thinking from the early 1900's.

Other benefits can be yielded from written reflections such as an integration of literacy development in content areas and a more dynamic look at the multiple learning styles which exist within the classroom setting. Brown (1994) explained that written reflections have significant effects on students' skills in writing. Portfolio use consisting of work samples and written reflections fostered an integration of writing in the curriculum, provided a provision of a clear and complete writing profile recording growth over time, and recognized the divergent learning styles of students.

Self-Judgment Using Criteria

Assessment of the portfolio by the teacher provides students with an opportunity to use a number of tools from the portfolio in reflective practice, where they discuss issues related to personal learning needs (Stewart & Richardson, 2000). The quality of the artifact included as well as the quality of its accompanying reflection is assessed against a scoring rubric. It is recommended that careful, specific self-assessment techniques are used in any process of ongoing assessment, especially those supported by rubrics (Andrade, 2000). Rubrics allow teachers and students to clearly and accurately measure the quality of a desired performance or product (Bargainner, 2003). Rubrics are based on criteria that a performance or product must meet to be successful. Criteria need to be related directly to the purpose and nature of the task (Wiggins, 1998). In other words, a student should not be able to meet all the criteria and still not be able to complete the task as outlined in the rubric. In rubric design, the teacher must be careful not to overvalue the specific methods and formats and undervalue the result. The longitudinal use of teacher generated rubrics which outline clear standards for meeting grading criteria allows for quality student self-assessment and self-monitoring.

Valencia (1990) described the grading process by providing some general scoring guidance. Holistic grading of work samples (artifacts) is appropriate on a day to day basis within the classroom. However, the contents of the portfolio must be graded following strict criteria set by the teacher and with the aid of analytic rubrics. Analytic rubrics isolate the major traits of the artifact into separate criteria and yield a composite score (Moon, Brighton, Callahan, & Robinson, 2005; Wiggins, 1998). The use of holistic rubrics on a long-term multifaceted assignment such as a portfolio may compromise validity, reliability, and the quality of the feedback to the student. Valid inferences on results of the many work samples in a portfolio must each be assessed separately. The quality of feedback may be compromised if holistic grading is used because two artifacts equally deficient, one in grammar with excellent content and the other in content with terrible grammar, would receive the same grade even though the assignment focused on content and not grammar. Also, unwittingly, different judges of an artifact may score it differently by applying different criteria within a holistic grading scheme. The use of analytical rubrics provides clear, distinct, and aptly weighted criteria allowing for a process favoring consistency and stability. Additionally, students can more easily judge their own performance in an analytical grading scheme. Students should be engaged in the scoring process as they select and self-evaluate artifacts to be included within the portfolio.

Reflection involves learners exploring their understanding of what they are doing and the impact it has on themselves and others (Boud, 1999). This process is fundamentally messy. Contrary to assessment, which celebrates certainty, reflection thrives on doubt. Assessment emphasizes the known in a presentation of one’s best work. Reflection is about exploration, questioning, and probing discrepancies. Intrinsically, both assessment and reflection occur whether they are prompted or not. Yet, the assessment of reflection is often an incompatible idea due to the very nature with which reflection is founded; probing, unsure, and seeking rather than finite and finished. Therefore, even though assessment and reflection are central processes in the validation of success in education, the personal nature of reflection poses challenges to its inclusion in curriculum and standard use as an assessment practice (Stewart & Richardson, 2000).

Assessing Reflection

A lack of agreement exists about what constitutes reflection and there is no widely accepted means of identifying or accessing reflection (Morrison, 1996). However, the personal nature of the portfolio work done by students lends to a highly individualized form and structure that still needs specific guidelines due to the implications of formal assessment (Stewart & Richardson, 2000).

Issues related to the definition and assessment of reflection can be combated through the designing of rubrics to guide the production of quality reflections by students. The rubric, if designed properly, provides the quantification necessary to use self-reflection as a component of a students' grade (Ash & Clayton, 2004). Carefully designed rubrics can become a medium to assess the quality of a student's thinking. The rubric should be based on levels of mastery relative to a given standard that has been written by the teacher with specific references to the learning it is based on. The rubric focuses the student's written reflection around the specific learning objectives being investigated and incorporates the standards of critical thinking concerning the student's performance. In this way, the student's reflection becomes a highly personalized assessment of a particular learning objective in question. Additionally, the rubric provides valuable feedback to the teacher as possible student confusions become evident to the teacher as the reflections are assessed against the rubric.

Arter and Spandel (1992) outlined the criteria for a quality reflection into five guidelines which can be used by the teacher to design a rubric or other assessment tool. These criteria are:

1. Coverage – Addresses criteria the artifact was assessed with.
2. Accuracy – Depicts an accurate view of achievement and growth.
3. Specificity – Includes examples to support points made in the self-reflection.
4. Integration – Synthesizes important insights into broader conclusions about achievement.
5. Revelation – Brings new insights about learning.

Using these criteria, the assessment of student self-reflections becomes a seamless process to both the teacher and the student (Stiggins, 1997). Additionally, both the teacher and the student become partners in the process of transforming static student achievement evidence (artifacts) into a current view of the on-going process of achievement and growth.

Portfolio Popularity

Portfolios have become a common feature in many schools and districts (Wiggins, 1998). Compared to a system dependant on traditional testing, the portfolio process is a system built on diverse evidence and anchored in student work. Additionally, students can be more effectively invited into the self-assessment process through the use of portfolios.

Portfolios have been shown to serve many useful purposes (Nidds & McGerald, 1997). First, is the ability of portfolios to provide an organized means of monitoring student progress. Second, is that carefully maintained and examined portfolios can enhance both teaching and learning by engaging the teacher and the student in the process of learning and product production to demonstrate learning has occurred. Finally, the time spent compiling and assessing the portfolios provides valuable insight into the learning of students and enhances the daily operations of the classroom as it becomes focused on individual student's learning. Many teachers, administrators, and policymakers have learned that portfolios can support quality teaching and improve student learning because portfolios convey to students the criteria of quality work so that they can apply these criteria to their own work and monitor their own progress (Sweet, 1993). Nidds and McGerald (1997) concluded that portfolios have been shown to serve many useful purposes. These purposes include the ability to provide an organized means of monitoring student progress, the enhancement of both teaching and learning by engaging the teacher and the student in process and progress, and by providing valuable insight into the learning of students and the daily operations of the classroom. Also, portfolio use engages students in activities that are likely to result in products worthy of sharing and referring back to periodically. Likewise, Kneale (2002) investigated personal development portfolios required of all college students in the United Kingdom. She reported students who chronicled their work opened a channel of communication between themselves and their teachers that is focused on individual student work. Likewise, Kneale reported the benefits of portfolios were increased self-confidence, increased evaluation skills, and more sophisticated and more in-depth long-range planning from students. Kneale concluded by stating the most prominent action promoted by portfolio use was the development of reflective skills in students.

Portfolios can also serve as a focal point for teacher-parent conferences and teacher-student conferences alike. In a Rose and Gallup 1999 Phi Delta Kappa/Gallup poll of the general public, respondents were asked "what would provide the most accurate picture of a public school's academic progress?" (p. 52). The greatest number of responses (33%) said examples of student's work. Standardized tests and letter grades, conventional measures of student achievement in public schools, both had percentages which fell below the possible response of examples of student work (Kohn, 2000). This suggests that the general public would favor a method students can use to demonstrate learning through work samples such as a portfolio.

Portfolios are made of real student writing and other artifacts created over time in a natural classroom setting (Underwood, 1998). Though some theorists have suggested that norm-referenced assessments ought to be kept in a portfolio, the notion of portfolios is generally in opposition to external tasks and assessments. Belanoff and Elbow (1986) commented that the idea of students taking large-scale common assessments seemed to contradict an instructional program committed to collaboration and community. They argued that a clear link between "real" teaching and "real" writing involves a process-orientated ideology, such as can be fostered through the portfolio process.

Advantages of Portfolio Use in Schools

Previous research suggests that the use of portfolios has other distinct advantages. Portfolios promote reflective practice and self-evaluation, link experience with personal interpretation, and provide an on-going basis for planning and goal setting (Baume, 2001). It has also been suggested that portfolios enhance the development of strategies, skills, and cognitive processes necessary for lifelong learning (Friedman, Davis, Harden, Howie, Ker, & Pippard, 2001). Ashcroft and Hall (2006) produced a study which deemed portfolios as an appropriate method of assessment alongside more traditional approaches. The study consisted of 154 final year undergraduate pharmacy students at the University of Manchester. Portfolios were produced by students to document and reflect on evidence to demonstrate they understood links between learning and prescribing. Upon completion of the portfolios, students completed a questionnaire comprised of 4 sections designed to elicit responses regarding the students' view of the impact of portfolio use on their learning. The students in the study confirmed expectations that the portfolio would help them to reflect on their approach to learning and develop a clearer understanding of their personal and professional development.

In a northern California middle school in 1994-1995, portfolios were used as an alternative assessment method in math, science, English, and physical education classrooms (Underwood, 1998). The portfolio project was to design a portfolio prototype which could be used as a California state assessment tool grounded in research literature, the state's experiences, and teacher's experiences on site. The portfolio project was to develop a supplemental assessment to external assessments, such as standardized exams. Another part of the project was to determine whether students in the portfolio classrooms did learn more and do better than students in traditional assessment classrooms. This quasi-experimental mixed-method pilot study would serve two purposes for the state of California. First, it would build the knowledge base of teachers at the site who could continue the work in subsequent years. Second, it would provide data to answer the question as to whether a portfolio assessment system could be justified by improved student achievement. Traditional classroom assessment done by one teacher was compared to portfolio use in an alternative assessment classroom where the portfolios were graded by an external committee of teachers using a locally developed rubric. Measures of reading achievement, writing achievement, goal orientation, and the effects of group placement (either control or experimental group) were examined. The mixed-method ANOVA revealed a statistically positive effect between reading achievement and portfolio use ($F(3, 443) = 8.5$, $p < .01$). Additionally, statistically significant results were seen between goal orientation and portfolio use ($F(1, 451) = 7.57$, $p < .05$). The grounded theory ethnographic research provided substantial evidence that showed students learned more in the portfolio classroom than did students in the no portfolio classroom. In conclusion, this study showed that portfolios are an effective instructional tool having a positive influence on student achievement. Notably, students in the alternative assessment classroom registered significantly higher levels of goal orientation.

Fifth grade students in an inclusive urban school district produced written reflective portfolios of pen-pal letters which were assessed by pre-service teachers who used these letters as part of their own reflective portfolios (Hansen, 1998). The pre-service teachers' portfolios were used to gain insights into the complexities of teaching in an inclusive urban school district and also to provide an opportunity for the teachers to engage in the reflective writing process along with the students. The development of the portfolios revealed that written reflection was a key component to the ownership of course objectives. Additionally, the loose organization of the portfolios and strict requirements for sections to be included within the portfolios allowed maximum individualization for the students and pre-service teachers alike.

In Kentucky, large-scale portfolio use in the fourth and eighth grades was used to reform curriculum and instruction (Stecher, 1998). Principals noted, in response to portfolio use, changes in course offerings (an increase in higher level mathematics and writings courses with a decrease in remedial and basic academic subjects and enrichment courses), an increase in before and after school remedial programs, and a focus by teachers to match curriculum to the content of the portfolio assessment (more time on writing with less on punctuation and spelling and more time on problem solving and reasoning in mathematics with less on computation). Principals also noted teachers increasingly provided interdisciplinary experiences in content areas. Additionally, principals reported student grouping patterns were affected with a decrease in homogeneous groups. Teachers noted they changed how they prepared and delivered lessons.

They reported a greater innovation in instructional planning and an increase in the frequency of assignments demonstrating complex thinking and problem solving.

A study in 2003, of 154 undergraduate pharmacy students (107 female and 47 male) found portfolios to be an appropriate method for assessing students when used alongside more traditional assessments (Ashcroft & Hall, 2006). The aim of the portfolio process was to complement the courses being taught with reflective evidence based assessments. The students' views were compiled through a questionnaire upon the completion of the project. The questionnaire focused on four facets of portfolio production being (a) impact on learning, (b) view on building, (c) as a means of assessment, and (d) to support professional development. Students viewed the impact of the portfolio process on their learning as positive with 63.8% reporting the portfolio increased their knowledge base and 63.4% reporting the portfolio allowed for increased reflection. Additionally, 58.2% reported the portfolio allowed them to identify their strengths and weaknesses. In building the portfolio, 46.7% reported it was a useful learning experience and 45.1% felt they gained a sense of achievement and developed necessary organization skills. The students reported that the portfolio was an effective method to assess learning with 83.7% reporting they would rather have a portfolio assessment than a traditional written examination. As a means to measure continued growth and professional development, 71.1% reported the portfolio would be a good means of documenting this and 52.9% reported the portfolio would be a good tool for judging the recertification of pharmacists. All in all, the students' responses confirmed that the portfolio was an effective method to foster reflection on learning and to develop a better understanding of personal traits and professional development.

In 2005, a report was published chronicling reflective portfolio use by undergraduate medical students over a 2-year period (Driessen, van Tartwik, Overeem, Vermunt, & van der

Vleuten, 2005). The conditions for successful reflective portfolio use were identified through interviews using grounded theory with 13 teachers (mentors) experienced in mentoring students through the reflective portfolio process. The portfolios produced by the students engaged them in a cyclical process of self-regulation in which they looked back on their actions, analyzed them, thought up alternatives, tried out new practices, looked back on their practices, and continued this process. The objective was to learn from experience with reflection becoming a condition for professional development. The study was focused on teachers' impressions of the portfolio process rather than students' impressions because teachers' perceptions of the use and usefulness of portfolios can be a decisive factor in the successful implementation of the portfolio process.

The reflective portfolios produced by the students consisted of written self-assessments of personal development and self-assessments of learning goals derived from the self-assessments of personal development, artifacts to support the self-assessments, and written feedback from the students' mentors. Twice annually students and mentors discussed portfolio progress in terms of quality and needs for improvement. Mentors' written feedback from these meetings were added to the portfolios. The semi-structured interviews with the mentors focused on three topics: (a) the mentor's definition of reflective skills, (b) the portfolios effectiveness in stimulating student reflection on experiences and development, and (c) the conditions for successful portfolio use.

In analysis, the mentors defined portfolios in terms of their purposeful method to foster reflection on students' strengths and weaknesses. All mentors reported that compiling the portfolios fostered critical thinking by the students on their own performance and development. The critical nature of the self-assessments and reflections allowed mentors to identify students who lacked the ability to critically appraise their own performance which was viewed as a critical component of a medical doctor. Four conditions for successful portfolio use emerged through the interviews being (a) good coaching by an experienced mentor, (b) clear and structured guidelines for portfolio production, (c) previous experience and practice by the students in self-reflection and adequate amounts of worthy artifacts and experiences for the self-assessments, and (d) summative assessments of reflective skills to ensure that the portfolio process is taken seriously by the students. These results suggested that reflective portfolio production was a potentially valuable instrument for the assessment of undergraduate medical students. Reflective portfolios were shown to be a powerful tool for learning and assessment within a favorable learning environment.

Summary of Chapter

Social cognitive theory views human functioning as a series of reciprocal interactions between behavioral, environmental, and personal variables (Bandura, 1986). The four components of social cognitive theory being intentionality, forethought, self-reactiveness, and self-reflectiveness define the construct of self-regulation and its three processes of forethought, performance control, and self-reflection.

Pintrich proposed a theoretical model based on social cognitive theory. The approach used by Pintrich was to classify and analyze the different processes comprising self-regulated learning as outlined by Bandura's social cognitive theory (Montavo & Gonzalez Torres, 2004). In Pintrich's model, regulatory processes are organized according to four phases (a) planning, (b) self-monitoring, (c) control, and (d) evaluation. Within each of the phases, self-regulation activities are structured into four areas: cognitive, motivational/affective, behavioral, and contextual.

The use of a reflective portfolio addresses the theoretical framework laid out by Pintrich in a practical manner within the confines of the classroom setting. The reflective portfolio provides a supportive and structured process to reflect upon learning, performance, and achievement (Kneale, 2002). The use of reflection helps students become more effective, independent, and confident self-directed learners, understand how they are learning and relate their learning to new contexts, and improve study skills. Moreover, reflection allows students to articulate and investigate personal goals and evaluate their progress towards those goals as well as encourages a positive attitude to learning throughout life.

Research has shown portfolio use promoted reflective practice and self-evaluation (Baume, 2001), was an appropriate method for assessing students when used alongside more traditional assessment (Ashcroft & Hall, 2006), and enhanced the development of strategies, skills, and cognitive processes necessary for lifelong learning (Friedman et al., 2001)

CHAPTER THREE: METHODOLOGY

Chapter Overview

The purpose of this study was to investigate if the use of reflective portfolios in science would engage students in a cyclical self-regulation model involving forethought, performance control, and self-reflection. This chapter describes the research methodology, methods, and materials for this study. The chapter consists of the following sections: setting and sample, research questions and hypotheses, type of data, instrumentation and testing, research design and analysis, and data collection timeline.

Setting and Sample

A convenience sample of students from a public high school in a suburban community (population of 24,000) in the Northeast participated in this study (ZIPskinny). The median income in the community is $107,000 which is well above the county average of $84,000 and the U.S. average of $54,000. The ethnicity of the community is homogeneous being 95% White, 2% Asian, 2% Hispanic, and .2% Black. The educational background of the community reflects 66% of the total population of adults as having a Bachelor's degree or higher. As of 2000, 72% of the population was identified as married with 58% having been in their homes within the community for at least five years. The community has six elementary schools, two middle schools, and one high school servicing a total student population of 5,600. There are 360 full-time teachers within the district with a student to teacher ratio of 18:1.

The high school houses 1,751 students in grades 9-12 (Connecticut State Department of Education, 2008). Only 20 students (1.1%) at the high school are eligible for free or reduced lunch (state average 23.8%). The staff consists of 126 certified teachers: 4 paraprofessionals; 5 library media specialists and assistants; 11 counselors, social workers, and school psychologists;

2 school nurses; and 43 other non-instructional support staff such as custodians, administrative assistants, and maintenance staff. The teachers have an average of 16 years of experience in education and 81.5% of the teachers have a Master's degree or higher. Average class sizes are 19 in mathematics, 21 in science, 21 in English, and 21 in social studies. Students are required to receive 3 credits (1 credit is equal to 1 year) in science (100% receive 3 or more credits), 3 credits in mathematics (94.3% receive 4 or more credits), 4 credits in English (100% receive 4 or more credits), 3.5 credits in social studies (73.8% receive 4 or more credits), 1 credit in world language (73.3% receive 3 or more credits), 1.5 years of physical education (1 credit), ½ credit of health, and 1 credit in applied arts (business, technology education, and family and consumer science). Students were tested in 22 different Advanced Placement (AP) courses while the state average per school is 9. In the 22 different courses, 89.8% of students scored a 3 or better (state average is 71.5%) on the AP exams given annually in May. The ethnicity of the students within the high school is primarily White (1,632 students) with 60 Asian American students, 44 Hispanic students, 14 Black students, and 1 American Indian student comprising the remainder. The school has 7 students who are not fluent in English (0.4%) while the state average is 3.5%. The dropout rate is 0.1% with 98.8% of students graduating in 2007. Of the graduates in 2007, 97.8% enrolled in post-secondary higher education, joined the military, or were employed. Standardized test scores are well above the state averages in reading, writing, mathematics, and science. See Table 1 for percentages of sophomores who passed state mandated exams in 2007.

Table 1

Percent of Sophomores Passing State Mandated Exams in 2007

Subject Area	School	State
Reading	84.1%	45.5%
Writing	92.8%	57.9%
Mathematics	88.2%	50.1%
Science	80.3%	46.3%

Likewise, students are above the state average in all categories on the SAT exam (see Table 2).

Table 2

Mean SAT Exam Scores 2007

SAT Reasoning Test	School	State
Mathematics	578	504
Critical Reading	566	502
Writing	568	503
Graduates Tested (%)	100%	77.6%

Note. The lowest possible score on a subtest is 200, the highest possible score is 800.

Participants in the study consisted of 158 students (n=158) divided into eight classrooms (see Table 3). Students were grouped into the classrooms based on the science course in wich they were currently enrolled. With exceptions (students retained or accelerated), freshmen generally were enrolled in Earth Science, sophomores in Biology, and juniors in Chemistry. Four teachers each with two classes similar in level participated in the study. For each teacher, one class served as the experimental group while the other served as the control group. The school offered two levels in science; College Prep and Honors. Students were placed by the school into either Honors or College Prep courses based on their current math course, teacher recommendations, guidance counselor recommendation, and parental input. Honors students were considered by the school to be higher achieving. Any student not participating in an Honors class automatically was placed in a College Prep class. All courses used in this study were College Prep which was defined by the school as a heterogeneous mix of students. The study consisted of two freshman College Prep Earth Science courses, two sophomore College Prep Biology courses, and four junior College Prep Chemistry courses. The experimental group consisted of one Earth Science class, one Biology class, and two Chemistry classes and had a total sample size of 78 students (n=78). The control group also consisted of one Earth Science class, one Biology class, and two Chemistry classes with a total sample population of 80 students (n=80). In total the experimental group consisted of 22 freshman, 19 sophomores, and 37 juniors. The control group consisted of 20 freshman, 24 sophomores, and 36 juniors. It should be noted that a minimum of three years of science is required for graduation. Therefore, seniors generally took science courses as electives based on interest and did not participate in the study because they may not have been representative of the total population, which was required to take science courses.

Table 3

Numbers of Participants in Study

	Population Size	Experimental Group Size	Control Group Size	Sample Size
Freshman in Earth Science	193	22	20	42
Sophomores in Biology	214	19	24	43
Juniors in Chemistry	191	37	36	73
Total	598	78	80	158

Research Questions and Hypotheses

Research question 1

Is there a significant difference in the self-regulatory skills (Effort Regulation and Time, Study Environment, Rehearsal, Elaboration, Organization, and Metacognition Self-regulation) of high school science students who produce reflective portfolios for their science assignments and those who do not?

Hypothesis. There is a significant difference in the self-regulatory skills (Effort Regulation and Time, Study Environment, Rehearsal, Elaboration, Organization, and Metacognition Self-regulation) of high school science students who produce reflective portfolios for their science assignments compared to those who do not.

Research question 2

Is there change over time in the Portfolio Rubric scores within the group of students who produce reflective portfolios?

Hypothesis. There will be a change over time in the Portfolio Rubric scores within the group of students who produce reflective portfolios.

Type of Data

Data collected were interval-level quantitative in nature in the form of subscale group means using the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & McKeachie, 1991). Additionally, repeated measures group means were collected at 5-week intervals using the Portfolio Rubric. Data were analyzed using SPSS statistical software (2001).

Description of Instruments

Motivated Strategies for Learning Questionnaire

The instrument used to assess research question 1 was the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & McKeachie, 1991). The MSLQ is an 81-item, self-report instrument designed to measure students' motivational orientations and their use of various learning strategies MSLQ is divided into two broad categories being motivation and learning strategies. Altogether, the MSLQ has 15 subscales: six within the motivation section and nine within the learning strategies section. Students rate themselves on a 7-point Likert scale, from 1 (not at all true of me) to 7 (very true of me). Scores for each subscale are averaged to provide a mean for each subject. Following confirmatory factor analyses, the authors calculated internal consistency estimates of reliability (Cronbach's alpha). These indicated that the MSLQ had reasonable factor validity (Pintrich, Smith, Garcia, &

McKeachie, 1991) (see Table 4). The majority of the Cronbach's alpha for the individual subscales (9 of 15) fell between .70 and .93 making them fairly robust. The remainder of the subscales ranged between .52 and .70. The authors calculated predictive validity of the MSLQ by producing correlations of the subscales with students' final course grades from a sample of 380 students. All correlations were in the expected direction showing the subscales to have sound predictive validity. The MSLQ assesses 9 learning strategy scales being Rehearsal, Elaboration, Organization, Critical Thinking, Metacognitive Self-Regulation, Time and Study Environment, Peer Learning, Help Seeking, and Effort Regulation. Due to the sample size used in this study, 6 scales perceived by the researcher to be most aligned with reflective portfolio use in science were chosen. This decision was made by the researcher after reading the descriptions of each scale provided in *A Manual for the Use of the MSLQ* (Pintrich, Smith, Garcia, & McKeachie, 1991). Those scales chosen were Rehearsal, Elaboration, Organization, Metacognitive Self-Regulation, Time and Study Environment, and Effort Regulation.

Table 4

Descriptive Statistics for MSLQ Learning Strategy Scales

	Mean	Standard Deviation	Cronbach's Alpha
Rehearsal	4.53	1.35	.69
Elaboration	4.91	1.08	.76
Organization	4.14	1.33	.64
Metacognitive Self-Regulation	4.54	.90	.79
Time/Study Environment	4.87	1.05	.76

Effort Regulation	5.25	1.10	.69

Portfolio Rubric. The instrument used to assess research question 2 was the Portfolio Rubric (Appendix A). The rubric was used to assess the individual artifacts included in each student's portfolio. Content validity was provided by Stiggins (1997) and Arter and Spandel (1992) who defined the aspects of a quality student reflection as coverage, accuracy, specificity, integration, and revelation. Both Stiggins (1997) and Arter and Spandel (1992) provided clear guidelines for how these criteria (coverage, accuracy, specificity, integration, and revelation) were used to assess student work. The criteria of coverage, accuracy, specificity, integration, and revelation were incorporated into the design of the Portfolio Rubric and used to assess students' self-reflections in relation to their included artifacts. Reliability for the Portfolio Rubric was sought to assess the agreement among raters when using the rubric on student portfolios. The Portfolio Rubric has an overall inter-rater reliability of .996 from a sample of four portfolios scored by four separate raters. Additionally, inter-rater agreement was calculated among the four scorers on each of the four portfolios and found to be 96.78, 86.60, 84.17, and 96.98, respectively (Appendix B). Both the inter-rater reliability and inter-rater agreement provided evidence that scores were consistent among raters when using the Portfolio Rubric.

The Portfolio Rubric was used to assess the artifacts included by the students. Each grading period had required artifacts to be included in the portfolio (see Appendix A). The artifacts of Test, Lab, and Other each included three components. For example, when a student submitted the artifact for Lab; it included the original graded lab, a revision of the lab correcting or addressing any missed points from the original submission, and a written self-reflection in relation to the student's performance on the lab addressing the criteria of coverage, accuracy, specificity, integration, and revelation as outlined on the Portfolio Rubric. The teacher in turn used the Portfolio Rubric to assign a numerical grade to this artifact. Again, consider the submission of the artifact Lab. Using the Portfolio Rubric (Appendix A), the teacher would have first scored the artifact as Excellent, Proficient, or Unsatisfactory based on the first row titled "1. Artifact included with correction." Determination of whether the artifact was Excellent, Proficient, or Unsatisfactory was made by the teacher based on the explanations of each category from the Portfolio Rubric. Once a determination of Excellent, Proficient, or Unsatisfactory was made by the teacher a numerical value was assigned to the artifact for the first row titled "1. Artifact is included with corrections" following Table 5 Artifact Scoring Guidelines. In the example of a Lab, the artifact had a scoring range of 1- 15 as outlined in the Student Portfolio Production Packet given to all participants prior to the study (Appendix A). A degree of subjectivity would have been employed by the teacher at this point. In the example, assume the student's artifact submission most closely aligned with the category of Proficient. A Proficient Lab artifact has a scoring range 6 -10. At this juncture, the teacher would have used his or her judgment as to whether the submitted artifact was more closely aligned with the criteria towards the high end of the range (10) or more closely aligned to the lower end of the range (6). Next, the teacher would have followed the same scoring guidelines for row three titled "3. Quality Reflection". It should be noted that the second row titled "2. Goal Setting" was only used for scoring mastery goals set by students therefore, in our example, the teacher moved directly to row 3 "Quality Reflections." The teacher would now have scored the Lab self-reflection submitted by the student against the criteria of a quality reflection (a. – e.) on the Portfolio Rubric. Again, numerical values were generated by the teacher in the scoring ranges outlined in Table 5. In our example of a Lab, assume the student's submitted Lab self-reflection revealed

Excellent work for Coverage as determined by the teacher using the Portfolio Rubric. Again, the teacher would have assigned a numerical value but this time based on the range of 11 – 15 for Excellent work. Now the teacher moved on to Accuracy and again assigns a numerical value. This process continued through Specificity, Integration, Revelation, and Format. To complete this process, the teacher took an average of all 7 numerical values (Artifact included with corrections, Coverage, Accuracy, Specificity, Integration, Revelation, and Format) to generate a single numerical value for the student's submission of the artifact Lab. Once the teacher had determined which numerical value was most evidenced by the artifact using the Portfolio Rubric, the numerical value was circled on the Portfolio Scoring Sheet (Appendix A). The Portfolio Scoring Sheet was used for convenience purposes to ensure all data were organized for the researcher. Assume in the example of the Lab, the student scored 10 for Artifact included with corrections, 13 for Coverage, 14 for Accuracy, 13 for Specificity, 11 for Integration, 7 for Revelation, and 12 for Format. The teacher would have circled 11 (10 + 13 + 14 + 13 + 11 + 7 + 12/7 = 11) on the Portfolio Scoring Sheet for Lab. This Lab artifact mean score was reported to the researcher for repeated measures data analysis.

This process continued for each artifact required within the grading period. For example, the first grading period was weeks 1 – 5. In weeks 1 – 5, students were required to submit the artifacts of Goal, Test, Lab, and Other. Goal was scored using the Portfolio Rubric starting with the second row titled "2. Goal Setting" instead of the first row titled "1. Artifact included with corrections." Next, the teacher scored the self-reflection accompanying the Goal with the remainder of the Portfolio Rubric as outlined above. It should be noted that the artifact Goal was scored using a range from 1 -5 (see Table 5). The teacher then scored the artifact Test using Portfolio Rubric rows 1, 3 (a. – e.), and 4; the artifact Lab using rows 1, 3 (a. – e.) and 4; and the artifact Other using rows 1, 3 (a. – e.), and 4.

The artifact Other encompassed any classroom activity or homework assignment of particular value to the teacher during the specified grading period. In grading period weeks 1 - 5 and weeks 11 - 15 the artifact Other was scored out of a range of 1 - 5 points while in weeks 6 - 10 and weeks 16 - 20 the Other artifact was scored out of a range of 1 – 10 points. Teachers chose Other artifacts in each case representative of the points possible for the grading period. For example, in grading period weeks 1 – 5 one teacher may have chosen an Other assignment such as a homework assignment because it was worth a total of 5 possible points on the Portfolio Rubric while in weeks 6 – 10 the teacher may have chosen an in-class activity which took 2 days to complete because it was worth 10 possible points towards the Portfolio Rubric score. A greater point value range would have been assigned to an Other artifact which the teacher believed was originally more difficult or time consuming for students to complete. At the completion of the study, the researcher divided all 10-point Other artifact scores by 2 to gain a common scoring scale based on 5 possible points for each of the 5-week grading periods.

Once each artifact had been assigned a composite numerical value a Total numerical value for the entire grading period was calculated. This was calculated by the teacher summing artifact scores within the grading period. For example, if a student scored a 4 for Goal, 11 for Test, 8 for Lab, and 5 for Other during weeks 1 – 5. The teacher would have written the number 31 (4 + 11 + 11 + 5 = 31) beside Total on the Portfolio Scoring Sheet. This value of 31 was reported to the researcher for repeated measures data analysis.

The teacher completed the grading process for the specified grading period by providing specific feedback to the students regarding their self-regulatory skills in the section titled "Comments" on the Portfolio Scoring Sheet. At this point, the teacher critically considered a student's current performance evidenced by the collection of artifacts from the grading period. Teachers used Table 2 "Self-Regulatory Feedback" (Appendix E) to provide specific feedback comments to students regarding areas for improvement. For example, if the student who scored a Total of 31 for the grading period weeks 1 -5 revealed several times in self-reflections from the Goal, Test, Lab, and Other artifacts that he or she studied in front of the television and often rushed through assignments at home. The teacher would have used Table 2 "Self-Regulatory Feedback" to diagnose the student's self-regulatory issue as Time and Study Environment. The teacher would have written comments back to the student on the Portfolio Scoring Sheet such as "consider picking a new study environment" or "seems like you may have a time management issue". These comments would not have been appropriate for a student whose self-reflections revealed issues with organization. The teacher feedback offered was specific to the self-regulatory skills most in need of improvement as revealed by the artifacts submitted by the student. The feedback offered to the students was not limited to the comments found in the Self-Regulatory Skills Table 2 of Appendix E. Teachers were encouraged to offer any feedback necessary to increase student achievement in their current science class.

Total grades for weeks 1 -5, 6 -10, and 11 -15 were calculated out of 40 possible points. The Total grade for weeks 16 – 20 was out of 80 possible points due to the addition of 4 new artifacts (see Appendix F for a description of artifacts). Therefore, to generate a composite Total grade for weeks 16 – 20 teachers divided their Total score by 2 to generate a score similar to those from the previous grading periods. An example of portfolio scoring can be found in Appendix F.

Table 5

Artifact Scoring Guidelines

	Unsatisfactory	Proficient	Excellent
Scoring range of 1-5	1-2	3-4	5
Scoring range of 1-10	1-4	5-7	8-10
Scoring range of 1-15	1-5	6-10	11-15

Research Design and Analysis

This study used a quasi-experimental research design. A nonrandomized control-group, pretest-posttest design was used to compare two different situations; (a) reflective portfolio use and (b) no use of reflective portfolios. This design was selected to investigate the impact reflective portfolios had on student self-regulatory learning skills within intact science classrooms in a school setting where random assignment of students to a treatment group was not feasible.

Research Question One

Research question 1 was assessed using six subscales from the MSLQ. The subscales of Metacognition Self-Regulation, Effort Regulation, Time and Study Environment, Rehearsal, Elaboration, and Organization were used to assess student self-regulatory skills. Each subscale was composed of several items which participants ranked themselves from; 1 (not all true of me) to 7 (very true of me). The position of the items within the MSLQ was variable. For instance, the subscale of Organization was composed of item numbers 32, 42, 49, and 63. Descriptions of the subscales can be found in *A Manual for the Use of the MSLQ* (Pintrich, Smith, Garcia, & McKeachie, 1991). A multivariate analysis of variance (MANOVA) was applied where the six subscale means served as the multiple dependant variables. The independent variable, program type, had two levels being (a) reflective portfolio use and (b) no reflective portfolio use. The following design was used to depict the study:

$$\begin{array}{ccc} O_1 & X & O_2 \\ \hline O_1 & & O_2 \end{array}$$

Figure 1. Control Group Pretest-Posttest Design

Research Question Two

Research question 2 was assessed using four one-way repeated measures analysis of variance (ANOVA) procedures. The student generated reflective portfolios produced in the treatment group were assessed using the Portfolio Rubric four times throughout the 20-week study at 5-week intervals. The four sample means (Test, Lab, Other, and Total) served as the within subjects variables in the ANOVA procedures. The one-way repeated measures ANOVA was used to ascertain if the rubric scores varied depending on the time interval. The following design was used to depict the study:

O X O O O

Figure 2. Repeated Measures Design

Data Collection and Timeline

In January of 2009 permission was granted to the researcher by both the district (Appendix C) and the school (Appendix C) to conduct the study. At the end of January 2009, four teachers who consented to participate in the study received professional development administered by the researcher outlining how the student generated reflective portfolios were to be constructed and graded. Three 2-hour sessions were held to review anchor portfolios and written guidelines for the teachers and students. In February 2009, the treatment was explained to students by the researcher. In February 2009 parents received consent forms to give permission for students to participate in the study (Appendix D). Students were informed that their participation was voluntary and assured that all results would be confidential The MSLQ pretest was then completed by consenting participants. The student generated reflective portfolios were prepared from February 2009 through June 2009. In June of 2009, students completed the MSLQ posttest. Between February 2009 and June 2009, at approximately 5-week intervals (exact dates were agreed upon by the teachers and the researcher), teachers assessed students' progress with their portfolios using the Portfolio Rubric.

Description of Treatment

The treatment was the use of student generated reflective science portfolios. Professional development in the use of reflective portfolios as a means of formative assessment in the classroom was provided to teachers. Three two-hour sessions were held for participating teachers. These sessions included reviewing anchor portfolios and templates of the ingredients necessary for portfolio production. An implementation packet was provided to each participating teacher (Appendix I). Additionally, an explanation of how to manage the practicalities of using portfolios in the classroom was included with an emphasis on grading guidelines, rubric use, and the use of specific self-monitoring strategies as feedback to students. The professional development concluded with a set of guidelines for students (Appendix F) to use in order to produce a reflective portfolio within the confines of the science course in which they are currently enrolled.

The portfolios produced by students included individual goals, self-reflections, original graded artifacts, and revisions of artifacts. Artifacts included in the portfolio fell under several categories. These categories were the kinds of work the teacher wanted to see included within the portfolio. Within the category, the specific product or artifact included was chosen by the student. There was no limit as to what could be included, but there was a minimum as to what must be included. Required work samples included goals, summative assessments, and formal lab reports. Mastery goals were set by each student at the beginning of weeks 1 and 11. These goals needed to be specific and attainable within the 10-week grading cycle between weeks 1 and 11 and weeks 11 and 20. Goal attainment, or the lack there of, was evidenced within the artifacts and reflections within the portfolio. Additionally, at least two formal summative assessments and two formal lab reports were included with corrections and reflections. A final reflection (course reflection at end of 20 weeks) and a keeper letter (from parent to student upon completion of portfolio) were also required within the portfolio. Other categories of artifacts were homework assignemts, journal articles or current events, projects, and a complete unit (all notes, assessments, homework, and activities). An example of the portfolio system and Portfolio Rubric which was given to students can be found in Appendix A.

Statement of Ethics and Confidentiality

A letter of permission from the building Principal (Appendix C) and the Assistant Superintendent (Appendix C) outlining rationale, procedures and time line was secured. A proposal was submitted and approved by the Western Connecticut State University IRB.

Parent permission and student consent were secured before the study. A professional not participating in the study assigned numerical codes for each student.

Student confidentiality was maintained. Data were coded numerically and reported in group format. All data was stored in a locked filing cabinet in the researcher’s office and will be maintained there until the findings are published; these data will be accessible only to other researchers for whom the data will prove useful in further comparative analyses and who are associated with Western Connecticut State University's Doctor of Education in Instructional Leadership Program.

CHAPTER FOUR: ANALYSIS OF THE DATA AND AN EXPLANATION OF THE FINDINGS

Chapter Overview

The purpose of this study was to investigate if the use of reflective portfolios in science would engage students in a cyclical self-regulation model involving forethought, performance control, and self-reflection. Two major research questions were addressed. Research question 1 was: Is there a significant difference in the self-regulatory skills (Effort Regulation and Time, Study Environment, Rehearsal, Elaboration, Organization, and Metacognition Self-regulation) of high school science students who produce reflective portfolios for their science assignments and those who do not? Research question 2 was: Is there change over time in the Portfolio Rubric scores within the group of students who produce reflective portfolios? The results are presented in five sections: (a) methodology summary, (b) population, sample, participants, (c) results, (d) summary of results, and (e) unhypothesized results.

Methodology Summary

This study used a quasi-experimental research design. A nonrandomized control-group, pretest-posttest design was used to compare two different situations; (a) reflective portfolio use and (b) no use of reflective portfolios. This design was selected to investigate the impact reflective portfolios have on student self-regulatory learning skills within intact science classrooms in a school setting where random assignment of students to a treatment group was not feasible.

Research Question One

Research question 1 was assessed using six subscales from the MSLQ (Pintrich, Smith, Garcia, & McKeachie, 1991). The subscales of Metacognition Self-Regulation, Effort Regulation, Time and Study Environment, Rehearsal, Elaboration, and Organization were used to assess student self-regulatory skills. A multivariate analysis of variance (MANOVA) was applied where the six subscales served as the multiple dependant variables. The independent variable, program type, had two levels being (a) reflective portfolio use and (b) no reflective portfolio use.

Research Question Two

Research question 2 was assessed using four one-way repeated measures analysis of variance (ANOVA) procudres. The student generated reflective portfolios produced in the treatment group were assessed using the Portfolio Rubric four times throughout the 20-week study at five-week intervals. The four sample means (Test, Lab, Other, and Total) served as the independent variables in the ANOVA. The one-way repeated measures ANOVA was used to ascertain if the rubric scores varied depending on the time interval.

Population, Sample, Participants

Participants in the study included 158 students who were originally assigned to eight classrooms. Students were grouped into the classrooms based on their current science course. With exceptions (retained students or accelerated students), freshmen generally were enrolled in Earth Science, sophomores in Biology, and juniors in Chemistry. Four teachers, each with two classes similar in level, participated in the study. For each teacher, one class served as the experimental group while the other served as the control group. The experimental group consisted of one Earth Science course, one Biology course, and two Chemistry courses and had a total sample size of 78 students. The control group also consisted of one Earth Science course, one Biology course, and two Chemistry courses with a total sample population of 80 students. In total the experimental group consisted of 22 freshman, 19 sophomores, and 37 juniors. The control group consisted of 20 freshman, 24 sophomores, and 36 juniors. Refer to Table 3 in Chapter 3 for a description of the population and sample.

Results

Code and Value Cleaning

Research question one. The initial data screening process involved code and value cleaning. Once the data set had been collected, code-cleaning procedures determined whether every value for each case in the study contained valid numerical codes. The goal was to determine that each code was within the specific range specified for each case. This was initially done through a visual inspection where the data were examined for missing values. Little variation in the experimental group's sample size was evident. The sample size included 78 participants on week 1 of the study and 76 participants on week 20. This variation can be explained by the emigration of two participants out of the experimental group.

The variations in the control group's sample size are a result of the loss of one entire class data set as well as the emigration of two participants from the study. The sample size was 80 participants on week 1 of the study and 54 participants on week 20. A control class of 24 participants did not participate in the MSLQ post-test. This is a result of oversight by the classroom teacher as all participants had agreed to participate in the study. Even with the loss of these data, a sample size large enough to apply all multivariate procedures needed to investigate research question 1 remained. Due to the size of the data set, SPSS statistical software (2001) was used for further data investigation.

Research question two. Continued visual data screening focused on the data set for research question 2. A sample size of n = 63 was used for an investigation using a repeated measures research design. Experimental group participants' primary science teachers graded their reflective portfolios using the Portfolio Rubric (Appendix A). Sixty-three experimental group portfolios were produced and graded over the 20-week period at 5-week intervals. Visual inspection revealed that some participants randomly choose not to complete the portfolio process for all required artifacts during the 20-week period. These missing values were replaced with zeros due to the fact that the course requirements for each participating teacher included a policy stating class assignments not handed in would receive a score of zero. The zero scores were included in the group means and therefore included in the statistical data analysis. Additionally, a common scoring scale was generated for data comparison purposes. Artifacts labeled as "Other" had point values of either 5 points or 10 points. In grading period weeks 1 - 5 and weeks 11 - 15 the artifact Other was scored out of a range of 1 - 5 points while in weeks 6 -10 and weeks 16 - 20 the Other artifact was scored out of a range of 1 – 10 points. Teachers chose Other artifacts in each case representative of the points possible for the grading period. All 10 point Other artifact scores were divided by 2 to gain a common scoring scale based on 5 possible points. Likewise, Total scores for weeks 1 -5, 6 -10, and 11 -15 were calculated out of 40 possible points. The Total score for weeks 16 – 20 was out of 80 possible points due to the addition of 4 new artifacts (see Appendix F for a description of artifacts). Therefore, to generate a composite Total grade for weeks 16 – 20 teachers divided their Total score by 2 to generate a score similar to those from the previous grading periods.   As with research question 1, SPSS statistical software (2001) was used for further data investigation.

Results Summary

Research Question One

Two-group effects overview. Research question 1 was assessed using six subscales from the MSLQ (Pintrich, Smith, Garcia, & McKeachie, 1991). The subscales of Metacognition Self-Regulation, Effort Regulation, Time and Study Environment, Rehearsal, Elaboration, and Organization were used to assess student self-regulatory skills. A multivariate analysis of variance (MANOVA) was applied where the six subscales served as the multiple dependant variables. The independent variable, program type, had two levels being (a) reflective portfolio use and (b) no reflective portfolio use. This multivariate test revealed no statistical difference in the participants' self-regulatory skills on the subscales of Metacognition Self-Regulation, Effort Regulation, Time and Study Environment, Rehearsal, Elaboration, and Organization after the treatment.

Pretest descriptive statistics. Table 6 displays the pretest descriptive statistics for the subscales of Metacognition Self-Regulation, Effort Regulation, Time and Study Environment, Rehearsal, Elaboration, and Organization between the experimental and control groups. The data were first scanned for missing values. Descriptive pretest statistics for the dependent variables revealed that of the 158 participants in the study, no more than two participants' data were missing between the control and experimental groups for any one subscale. Data were then scanned for outliers; unusual values for a single variable (Meyers, Gamst, & Guarine, 2006). The MSLQ has a 1 – 7 Likert scoring range. The descriptive pretest statistics displayed no scores lower than 1 or higher than 7. This is consistent with the instrument used. The subscales reflect standard deviations ranging from 0.83 – 1.30 with means ranging from 3.81 – 5.07 and medians ranging from 3.83 – 5.25. The multivariate statistical assumption of normality was next investigated. Normality refers to the shape of the continuous variables in the analysis that should correspond to a normal distribution (Meyers, Gamst, & Guarine, 2006). Normally distributed variables generate a skewness value (a measure of symmetry) and a kurtosis value (a measure of peakedness) that hover around 0 but do not exceed the range of -1 to 1(Meyers, Gamst, & Guarine, 2006). The skewness and kurtosis for each subscale fell within the acceptable range -1.0 to1.0 displaying data which were neither too peaked, flat, or asymmetric (skewing towards either the positive or negative in relation to the center point).

Table 6

Pretest Descriptive Statistics

		Rehearsal Experimental	Rehearsal Control	Elaboration Experimental	Elaboration Control	Organization Experimental	Organization Control
N	Valid	78.00	80.00	77.00	79.00	76.00	80.00
	Missing	2.00	0.00	3.00	1.00	4.00	0.00
Mean		4.30	4.53	3.89	3.80	3.94	4.16
Median		4.50	4.75	3.83	4.00	3.88	4.25
Standard Deviation		1.30	1.16	1.06	1.10	1.36	1.16
Skewness		-.36	-.81	.17	-.38	.34	-.17
Kurtosis		-.21	.68	.05	-.08	-.56	-.643

Table 6 *(continued)*

Pretest Descriptive Statistics

		Rehearsal Experimental	Rehearsal Control	Elaboration Experimental	Elaboration Control	Organization Experimental	Organization Control
Range		5.75	5.50	5.33	5.17	6.00	5.00
Minimum		1.25	1.00	1.67	1.00	1.00	1.50
Maximum		7.00	6.50	7.00	6.17	7.00	6.50
Percentiles	25	3.50	3.81	3.17	3.17	3.00	3.25
	50	4.50	4.75	3.83	4.00	3.88	4.25
	75	5.25	5.25	4.67	4.50	4.75	5.00

Table 6 *(continued)*

Pretest Descriptive Statistics

		Metacogntion Experimental	Metacognition Control	Time and Study Environment Experimental	Time and Study Environment Control	Effort Regulation Experimental	Effort Regulation Control
N	Valid	78.00	79.00	78.00	79.00	78.00	79.00
	Missing	2.00	1.00	2.00	1.00	2.00	1.00
Mean		4.09	4.16	4.83	4.86	5.08	5.02
Median		3.96	4.00	4.75	4.88	5.00	5.25
Standard Deviation		.91	.83	1.01	1.00	1.066	1.17
Skewness		.05	.10	-.15	-.67	-.59	-.58
Kurtosis		-.13	-.15	-.12	.44	.95	.15

Table 6 *(continued)*

Pretest Descriptive Statistics

		Metacogntion Experimental	Metacognition Control	Time and Study Environment Experimental	Time and Study Environment Control	Effort Regulation Experimental	Effort Regulation Control
Range		4.58	3.83	5.12	4.62	5.00	5.75
Minimum		1.92	2.42	1.88	2.13	2.00	1.25
Maximum		6.50	6.25	7.00	6.75	7.00	7.00
Percentiles	25	3.50	3.58	4.22	4.38	4.50	4.25
	50	3.96	4.00	4.75	4.88	5.00	5.25
	75	4.75	4.75	5.63	5.50	5.75	6.00

Pretest effects of two-groups on the dependant variables. In an attempt to assess the effects of the independent variable, program type, with two levels being (a) reflective portfolio use and (b) no reflective portfolio use on the six dependant variables (Metacognition Self-Regulation, Effort Regulation, Time and Study Environment, Rehearsal, Elaboration, and Organization) a MANOVA was applied.

The two-group MANOVA required the use of more than one quantitative dependant variable necessitating an examination of Box's Test of Equality of Covariance Matrices to test homoscedasticity. The assumption of homoscedasticity suggests quantitative dependant variables have equal levels of variability across a range of independent variables (Meyers, Gamst, & Guarine, 2006). Table 7 displays Box's Test of Equality of Covariance Matrices which was used to test the null hypothesis that the observed covariance matrices of the dependant variables are equal across the groups. A statistically significant ($p < .05$) Box's Test indicates a homoscedascity assumption violation. The significance value of $p = .94$ indicated equal covariance between the dependant variables for the groups comprising the independent variables and therefore no violation of homoscedascity is observed. This suggested that a MANOVA of the pretest data was appropriate as the pretest experimental and control groups did not differ statistically and could therefore be used for comparison purposes.

Table 7

Box's Test of Equality of Covariance Matrices

Statistic	Value
Box's M	12.47
F	.57
df1	21.00
df2	83831.33
p	.94

To test for differences in the self-regulatory skills between the experimental and control groups prior to the treatment a MANOVA of pretest data were calculated. The MANOVA is used to test the effect of one independent variable on two or more quantitative dependant variables (Meyers, Gamst, & Guarine, 2006). Wilks's Lambda allowed for the evaluation of differences on the independent variable; program type, with two levels being (a) reflective portfolio use and (b) no reflective portfolio use on the six dependant variables; Metacognition Self-Regulation, Effort Regulation, Time and Study Environment, Rehearsal, Elaboration, and Organization. Wilks's lambda varies from 0 – 1 and is used to test whether there are differences between the means of identified groups on a combination of dependent variables; therefore a lower values are desirable (Meyers, Gamst, & Guarine, 2006). This multivariate test revealed no significance differences between the pretest means with $F(6,146) = .44$, $p = .85$ (see Table 8) displaying no statistical difference in the participants self-regulatory skills on the subscales of Metacognition Self-Regulation, Effort Regulation, Time and Study Environment, Rehearsal, Elaboration, and Organization prior to the treatment. This suggests the two groups; (a) reflective portfolio use and (b) no use of reflective portfolio; had equal self-regulatory skills at the beginning of the study.

Table 8

Multivariate Tests Comparing Treatment and Control for Pretest Scores

Effect		Value	F	Hypothesis df	Error df	p	Partial Eta Squared
Intercept	Wilks' Lambda	.03	753.43[a]	6.00	146.00	.00	.97
Group	Wilks' Lambda	.98	.44[a]	6.00	146.00	.85	.02

[a] Exact statistic

Posttest descriptive statistics. Table 9 displays the posttest descriptive statistics for the subscales of Metacognition Self-Regulation, Effort Regulation, Time and Study Environment, Rehearsal, Elaboration, and Organization between the experimental and control groups. The MSLQ posttest was administered upon the completion of the study, after 20-weeks of the treatment (reflective portfolio production). The descriptive statistics were first scanned for missing data. These data revealed of the 158 participants in the study, 132 participated in the posttest. Two participants moved out of the study and 24 participants who had previously agreed to participate in the study did not take the posttest. Next, the descriptive statistics were viewed for outliers. The table displays a range of scores on the subscales from 1 – 7. This is consistent with the MSLQ instrument used which had a Likert scale ranging from 1 – 7 and suggests no outliers exist in the sample. The subscales reflected standard deviations ranging from 0.88 – 1.40 with means ranging from 3.84 – 4.91 and medians ranging from 3.83 – 4.75. The data screening process concluded with an investigation of the multivariate assumption of normality. All skewness and kurtosis values fell within the acceptable range of -1.0 to 1.0 displaying data which were neither too peaked, flat, or asymmetric (skewing towards either the positive or negative in relation to the center point) except for the posttest kurtosis value of 1.66 for the experimental subscale of Metacogntion (Table 9). To further investigate the nature of this value, the researcher proceeded with a Shapiro-Wilk's analysis. The Shapiro-Wilk's analysis uses the mean of the skewness and kurtosis values to adjust for discrepancies in normality. Significant values ($p < .05$) indicate a violation of the assumption of normality. The analysis revealed a $p = .104$ for the experimental group Metacognition subscale indicating the assumption of normality had not been violated. The researcher continued with an investigation of the assumption of homoscedasticity.

Table 9

Descriptive Statistics for Posttests

		Rehearsal Experimental	Rehearsal Control	Elaboration Experimental	Elaboration Control	Organization Experimental	Organization Control
N	Valid	75.00	54.00	74.00	52.00	75.00	54.00
	Missing	5.00	26.00	6.00	28.00	5.00	26.00
Mean		4.30	4.35	4.30	4.08	3.85	4.14
Median		4.50	4.25	4.50	4.00	3.83	4.25
Standard Deviation		1.30	1.40	1.28	1.22	1.26	1.19
Skewness		-.36	-.38	-.31	-.21	-.03	.04
Kurtosis		-.21	-.24	.01	-.13	-.11	-.26

Table 9 *(continued)*

Descriptive Statistics for Posttests

		Rehearsal Experimental	Rehearsal Control	Elaboration Experimental	Elaboration Control	Organization Experimental	Organization Control
Range		5.75	6.00	6.00	5.50	6.00	5.25
Minimum		1.25	1.00	1.00	1.00	1.00	1.75
Maximum		7.00	7.00	7.00	6.50	7.00	7.00
Percentiles	25	3.50	3.44	3.17	2.87	3.25	3.25
	50	4.25	4.50	4.00	3.83	4.25	4.00
	75	5.00	5.25	5.04	4.83	5.00	4.81

Table 9 *(continued)*

Descriptive Statistics for Posttests

		Metacogntion Experimental	Metacognition Control	Time and Study Environment Experimental	Time and Study Environment Control	Effort Regulation Experimental	Effort Regulation Control
N	Valid	75.00	53.00	74.00	54.00	75.00	53.00
	Missing	5.00	27.00	6.00	26.00	5.00	27.00
Mean		4.09	4.26	4.24	4.65	4.66	4.91
Median		3.96	4.25	4.25	4.755	4.69	4.75
Standard Deviation		.91	.88	.90	1.04	1.02	1.14
Skewness		.05	-.43	-.44	-.36	.01	.03
Kurtosis		-.13	-.22	1.66	.92	-.33	-.66

Table 9 *(continued)*

Descriptive Statistics for Posttests

		Metacogntion Experimental	Metacognition Control	Time and Study Environment Experimental	Time and Study Environment Control	Effort Regulation Experimental	Effort Regulation Control
Range		4.58	3.66	4.83	5.75	4.38	5.00
Minimum		1.92	2.17	1.17	1.25	2.50	2.00
Maximum		6.50	5.83	6.00	7.00	6.88	7.00
Percentiles	25	3.67	3.63	4.00	4.00	4.00	4.00
	50	4.25	4.25	4.75	4.69	4.75	4.75
	75	4.92	4.67	5.28	5.44	5.75	5.75

Posttest effects of two-groups on the dependant variable. The two-group MANOVA required the use of more than one quantitative dependant variable necessitating an examination of Box's Test of Equality of Covariance Matrices to test the assumption of homoscedasticity. Table 10 displays Box's Test of Equality of Covariance Matrices used to test the null hypothesis that the observed covariance matrices of the dependant variables are equal across the groups. A statistically significant ($p < .05$) Box's Test indicates a homoscedascity assumption violation. The significance value of $p = .38$ indicated equal covariance between the dependant variables for the groups comprising the independent variables and no violation of the assumption of homoscedasticity. This suggested that a MANOVA of the posttest data was appropriate as the posttest experimental and control groups did not differ statistically by violating homoscedasticity and could therefore used for comparison purposes.

Table 10

Box's Test of Equality of Covariance Matrices

Statistic	Value
Box's M	23.67
F	1.06
df1	21.00
df2	40827.74
p	.38

To test for differences in the self-regulatory skills between the experimental and control groups after the treatment a MANOVA of posttest data was calculated. Wilks' Lambda allowed for the evaluation of differences on independent variables, (a) reflective portfolio use and (b) no reflective portfolio use, in the population on the dependant variables; Metacognition Self-Regulation, Effort Regulation, Time and Study Environment, Rehearsal, Elaboration, and Organization. This multivariate test revealed no significance since $F(6,115) = .62$, $p = .71$ (see Table 11). This result suggests that here were no statistical differences between groups in the participants' self-regulatory skills on the subscales of Metacognition Self-Regulation, Effort Regulation, Time and Study Environment, Rehearsal, Elaboration, and Organization after the treatment.

Table 11

Multivariate Tests Comparing Treatment and Control for Posttest Scores

Effect	Model	Value	F	Hypothesis df	Error df	p	Partial Eta Squared
Intercept	Wilks' Lambda	.03	509.28[a]	6.00	115.00	.00	.96
Group	Wilks' Lambda	.97	.62[a]	6.00	115.00	.71	.03

[a] Exact statistic

Research question one findings summary. Research question 1: Is there a significant difference in the self-regulatory skills (Effort Regulation and Time, Study Environment, Rehearsal, Elaboration, Organization, and Metacognition Self-regulation) of high school science students who produce reflective portfolios for their science assignments and those who do not? The treatment group (reflective portfolio use) had a sample size of n = 78 on week 1 and n = 76 on week 20, the completion of the study. The sample size of the control group (no reflective portfolio use) was n = 80 on week 1 and n = 54 on week 20. A multivariate analysis of variance (MANOVA) was applied where the six subscales (Effort Regulation and Time, Study Environment, Rehearsal, Elaboration, Organization, and Metacognition Self-regulation) served as the multiple dependant variables. The independent variable, program type, had two levels being (a) reflective portfolio use and (b) no reflective portfolio use. Wilks's Lambda allowed for the evaluation of differences on independent variables in the population on the dependant variables. This multivariate test revealed no statistical significance ($F(6,115) = .62$, $p = .71$) in the participants' self-regulatory skills on the subscales of Metacognition Self-Regulation, Effort Regulation, Time and Study Environment, Rehearsal, Elaboration, and Organization after the treatment This suggests the two groups, (a) reflective portfolio use and (b) no reflective portfolio use, displayed no differences in their self-regulatory skills after the 20-week administration of the treatment (reflective portfolio use) when measured with the MSLQ as the pretest and posttest.

Research Question Two

Repeated measures effects overview. Research question 2 was assessed using four one-way repeated measures analysis of variance (ANOVA) procedures. The student generated reflective portfolios produced in the treatment group were assessed using the Portfolio Rubric four times throughout the 20-week study at 5-week intervals. The within subjects variables were the scores for Test, Lab, Other, Total at each of the four time periods throughout the 20-week study. The four one-way repeated measure ANOVA procedures were used to ascertain if the rubric scores varied depending on the time interval. Results indicated that the variables of Test, Other, and Total were significant over time. The following sections will present findings and address the assumptions relevant to a repeated-measures ANOVA.

Effect of within subjects variables on the dependant variable. The one-way within group ANOVA procedures required the use of multiple within subjects variables necessitating the need for Mauchly's Test of Sphericity. Mauchly's Test of Sphericity was used to test the null hypothesis that the dependant variable variances are homogeneous (homogeneity of variance) (Meyers, Gamst, & Guarine, 2006). It also tested the null hypothesis that the correlations between the levels of the within subjects variable were equal. If Mauchly's Test of Sphericity is not significant ($p > .05$), then the sphericity assumption has been met and the researcher should proceed. Conversely, should Mauchly's Test of Sphericity be significant ($p < .05$), then heterogeneity of covariance is indicated. Table 12 reveals Mauchly's Test of Sphericity provided values of $p = .27$ for the independent variable Test, $p = .12$ for the independent variable Lab, $p = .00$ for the independent variable Other, and $p = .31$ for the independent variable Total. This indicated a lack of homogeneity of variance for these four variables as the variable Other was significant ($p <. 05$) with a significance value of $p = .000$ (see Table 13). Therefore, the assumption of sphericity was violated and heterogeneity of covariance was indicated. A correction for the violation of sphericity was calculated. To correct for sphericity, the Greenhouse-Geisser estimate was used to alter the degrees of freedom, thereby altering the significance value of the *F*-ratio. The Greenhouse-Geisser estimate adjusted the *p* value upwards by adjusting the degrees of freedom downwards. Table 12 reveals the hypothesis degrees of freedom were 12 prior to the Greenhouse-Geisser estimate which statistically adjusted the degrees of freedom to 5 (Table 12). All *p* values have been increased due this adjustment, of particular note is Other has been adjusted from .00 to .81, which displayed the assumption of sphericity had been met.

Table 12

Mauchly's Test of Sphericity

Within Subjects Effect	Measure	Mauchly's W	Approximate Chi-Square	df	p	Epsilon:[a] Greenhouse-Geisser
Time	Test	.90	6.36	5	.27	.94
	Lab	.87	8.71	5	.12	.91
	Other	.60	31.05	5	.00	.81
	Total	.91	5.95	5	.31	.93

[a] May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Univariate tests of independent variables. To identify which sample means from the portfolio (Test, Lab, Other, and Total) generated statistically significant results over time, four within group repeated measure ANOVA procedures were calculated. The Greenhouse-Geisser estimate was used to report the significance level of each within subjects variable over time. Results indicated that the variables (Test, Other, and Total) were significant ($p < .01$) over time. Significance levels of $p = .01$ for Test, $p = .01$ for Other, and $p = .01$ for Total were calculated suggesting statistical significance for each of the three variables over time (see (Tables 13, 15, 16). The variable Lab was insignificant at p < .01 revealing a significance value of p = .04 (see Table 14).

It should be noted, the researcher applied the Bonferroni correction and assessed significance at a value of p < .01. Due to the multiple comparisons made from the treatment group within this study the Bonferroni correction suggests a more stringent p value than typically considered acceptable in behavioral science studies (p < .05). The Bonferroni correction divides the accepted significance value by the number of statistical analyses undertaken (Meyers, Gamst, & Guarine, 2006). In this study, 1 MANOVA was performed for research question 1 and 4 ANOVA procedures were performed for research question 2 therefore, the resultant p value was .01 (.05/5).

Significant gains on the Portfolio Rubric scores over time, as evidenced by statistical significance for the variables Test, Other, and Total using four repeated measure ANOVA procedures (see Tables 13, 15, 16), suggested the reflective portfolio treatment effected participants' Portfolio Rubric scores over time.

Table 13

Univariate Test of Test

Source	Measure	Type III Sum of Squares	df	Mean Square	F	p	Partial Eta Squared
Time	Test	181.41	2.81	64.55	3.97	.01	.06
Error (time)	Test	2833.34	174.24	16.26			

Table 14

Univariate Test of Lab

Source	Measure	Type III Sum of Squares	df	Mean Square	F	p	Partial Eta Squared
Time	Lab	103.03	2.74	37.67	2.91	.04	.05
Error (time)	Lab	2192.47	169.57	12.93			

Table 15

Univariate Test of Other

Source	Measure	Type III Sum of Squares	df	Mean Square	F	p	Partial Eta Squared
Time	Other	18.54	2.42	7.67	4.17	.01	.06
Error (time)	Other	275.59	149.86	1.84			

Table 16

Univariate Test of Total

Source	Measure	Type III Sum of Squares	df	Mean Square	F	p	Partial Eta Squared
Time	Total	832.13	2.80	297.11	4.51	.01	.07
Error (time)	Total	11429.18	173.65	65.82			

Descriptive Statistics for within subjects variables. Mean Portfolio Rubric scores were examined at each of the time intervals for the within subjects variables of Test, Lab, Other, and Total. Table 17 through Table 20 displays the mean of each time interval of weeks 1-5, weeks 6-10, weeks 11-15, and weeks 16-20. All four variables displayed a dip in mean scores from weeks 1-5 through weeks 6-10. Subsequently, all four variables displayed a gain in mean scores from weeks 6-10 through weeks 11-15. Additionally, all four variables displayed an increase in mean scores from weeks 11-15 through weeks 16-20. Also of note, all mean scores in weeks 16-20 are higher than mean scores in weeks 1-5.

Table 17

Descriptive Statistics for Test

	Mean	Standard Deviation	N
Test weeks 1-5	11.83	4.49	66
Test weeks 6-10	10.09	5.73	66
Test weeks 11-15	11.38	4.86	66
Test weeks 16-20	12.56	3.79	66

Table 18

Descriptive Statistics for Lab

	Mean	Standard Deviation	N
Lab weeks 1-5	11.71	4.33	66
Lab weeks 6-10	10.88	4.99	66
Lab weeks 11-15	11.06	5.11	66
Lab weeks 16-20	12.49	3.73	66

Table 19

Descriptive Statistics for Other

	Mean	Standard Deviation	N
Other weeks 1-5	3.56	7.16	66
Other weeks 6-10	3.55	1.77	66
Other weeks 11-15	3.11	1.99	66
Other weeks 16-20	3.84	1.61	66

Table 20

Descriptive Statistics for Total

	Mean	Standard Deviation	N
Total weeks 1-5	30.24	12.33	63
Total weeks 6-10	27.54	13.60	63
Total weeks 11-15	28.25	13.44	63
Total weeks 16-20	32.20	7.94	63

Comparison of p-values by time interval. Continued data analysis involved the determination of which time intervals produced significant gains for each of the variables yielding statistically significant results using the repeated measures ANOVA procedures. Paired samples T-tests were used to analyze the variables of Test, Other, and Total since the ANOVA procedures revealed $p < .01$. The variable Lab was not compared by time internal because it did not reveal statistically significant results using the ANOVA procedures ($p = .04$). The time intervals of weeks 1-5, 6-10, 11-15, and 16-20 represented the 4 time intervals. Pair 1 was weeks 1-5 compared to weeks 6-10, pair 2 was weeks 1-5 compared to weeks 11-15, pair 3 was weeks 1-5 compared to weeks 16-20, pair 4 was weeks 6-10 compared to weeks 11-15, pair 5 was weeks 6-10 compared to weeks 16-20, and pair 6 was weeks 11-15 compared to weeks 16-20. Table 21 through Table 23 depicts the results of the paired samples T-tests. Table 21 displays the paired samples T-test results for the variable Test. Statistically significant results were obtained in pair 5, weeks 6-10 compared to weeks 16-20. Table 22 displays statistically significant results for the variable Other at pair 6, weeks 11-15 compared to weeks 16-20. Statistically significant results for Total were revealed in both pairs 5, weeks 10-16 compared to weeks 16-20 and pair 6, weeks 11-15 compared to weeks 16-20. This data displayed no statistically significant results prior to weeks 6-10 suggesting a minimum time requirement of 6-10 weeks for statistically significant results to be observed when using Reflective Portfolios in science.

Table 21

Paired Samples Test for Test

		df	Sig. (2-tailed)
Pair 1	Weeks 1-5 – weeks 6-10	65	.011
Pair 2	Weeks 1-5 – weeks 11-15	65	.542
Pair 3	Weeks 1-5 – weeks 16-20	65	.292
Pair 4	Weeks 6-10 – weeks 11-15	65	.099
Pair 5	Weeks 6-10 – weeks 16-20	65	.001
Pair 6	Weeks 11-15 – weeks 16-20	65	.053

Table 22

Paired Samples Test for Other

		df	Sig. (2-tailed)
Pair 1	Weeks 1-5 – weeks 6-10	65	.952
Pair 2	Weeks 1-5 – weeks 11-15	65	.055
Pair 3	Weeks 1-5 – weeks 16-20	65	.210
Pair 4	Weeks 6-10 – weeks 11-15	65	.050
Pair 5	Weeks 6-10 – weeks 16-20	65	.182
Pair 6	Weeks 11-15 – weeks 16-20	65	.002

Table 23

Paired Samples Test for Total

		df	Sig. (2-tailed)
Pair 1	Weeks 1-5 – weeks 6-10	64	.034
Pair 2	Weeks 1-5 – weeks 11-15	64	.210
Pair 3	Weeks 1-5 – weeks 16-20	64	.163
Pair 4	Weeks 6-10 – weeks 11-15	63	.616
Pair 5	Weeks 6-10 – weeks 16-20	63	.001
Pair 6	Weeks 11-15 – weeks 16-20	63	.004

Research question two findings summary. Research question 2 asked: Is there change over time in the Portfolio Rubric scores within the group of students who produce reflective portfolios? The four sample means (Exam, Lab, Other, and Total) from the student generated reflective portfolios produced in the treatment group served as the within subjects variables in the ANOVA procedures. The treatment group (reflective portfolio use) had a sample size of n = 78 on week 1 and n = 76 on week 20, the completion of the study. The four one-way repeated measure ANOVA procedures were used to ascertain if the rubric scores varied depending on the time interval. Results indicated that three of the variables (Test, Other, and Total) were significant ($p < .01$) over time. Significance levels of $p = .01$ for Test, $p = .01$ for Other, and $p = .01$ for Total were calculated suggesting statistical significance for each of these variables over time. Moreover, an investigation through the use of paired samples T-tests revealed statistically significant results were not observed until weeks 6-10 for the variables Test and Total and not until weeks 11-15 for the variable Other. Significant gains on the Portfolio Rubric scores over time, as evidenced by statistical significance for the variables; Test, Other, and Total, suggested students engaged in self-regulation. The reflective portfolio process; designed to engage participants in the cyclical self-regulatory processes of planning (goal setting), self-monitoring (assignment revisions), control (behavioral changes), and evaluation (reflection); effected participants' Portfolio Rubric scores over time.

Unhypothesized Results

The researcher randomly selected four of the 78 portfolios produced by the treatment group and transcribed a student reflection from each. This unhypothesized data is discussed in the Implications of the Study section in Chapter 5 (see Appendix H for further examples of student self-reflections):

(this portfolio) helped me understand what I was doing wrong and doing right. One thing I learned was to stay more organized. Pulling all my materials together to study for tests and quizzes at the last minute was stressful. I think if I stay organized I will read things over more often before a quiz and improve. (Student 6)

I don't think this test gave a fair indication of what I learned. I knew the material well. I think it was my fault for not studying enough. In the future I will work on studying more often which will help me achieve my goals. (Student 22)

The portfolio got me thinking about what I have to do to improve, but I did not make those changes on future assignments. If I had done the changes I said I would, I think I would have gotten better grades all year. (Student 37)

One thing I did well was identifying the components of the brain from the index in the back of the book. I could improve by making flash cards of these words with definitions from the back of the book. Overall, I don't think I expressed my thoughts clearly when answering the questions. This is because I was distracted. Perhaps this suggests I work better when other things aren't going on. (Student 48)

CHAPTER FIVE: SUMMARY AND RECCOMENDATIONS

Chapter Overview

The need for this study was predicated on the findings of Zimmerman (2002) who stated that although the benefits of students' use of self-regulatory processes are well documented, few teachers effectively prepared students to learn on their own. The aim of this study was to measure the effect reflective portfolio construction had on the self-regulatory skills of high school science students. This chapter will present a summary of the study, a comparison of findings related to literature, limitations, implications, and suggestions for future research.

Summary of Study

According to research results reported by Zimmerman (2002), teachers rarely encouraged students to establish specific goals, taught specific study strategies, or assessed students' beliefs about learning to identify difficulties before they become problematic (Zimmerman, 2002). Moreover, students were rarely given the opportunity to self-evaluate their own work or critically consider their competence on new tasks.

The aim of this study was to measure the effect reflective portfolio construction had on the self-regulatory skills of high school science students. A study done by Driessen, van Tartwijk, Overeem, Vermunt, and van der Vleuten (2005) showed the creation of a reflective portfolio allowed students to understand how they learned best, in what ways they learned best, and their limitations related to specific tasks. Therefore, this study was designed to engage high school science students in the production of reflective portfolios which provided teachers a medium to encourage goal setting, revision, and self-reflection; critical processes used in the self-regulation of learning. Ultimately, the construction of the reflective portfolios gave students the opportunity to engage in a cyclical process of self-regulation and facilitated an on-going assessment dialogue between themselves and their teacher.

A convenience sample of 158 (n=158) students from eight classrooms participated in the study. Students were grouped into the classrooms based on the science course in which they were currently enrolled. With exceptions (students retained or accelerated), freshmen generally were enrolled in Earth Science, sophomores in Biology, and juniors in Chemistry. Four teachers, each with two classes similar in level, participated in the study. For each teacher, one class served as the experimental group producing the reflective portfolios while the other class served as the control group and did not produce the reflective portfolios.

The portfolios produced by students over the 20-week period included individual goals, self-reflections, original graded artifacts, and revisions of artifacts. These artifacts were specifically chosen by the researcher to be components of the reflective portfolio because the intended purpose was to provide teachers a medium to focus students on specific self-regulatory processes. The cyclical process of self-regulation involves forethought, performance control, and self-reflection. To address forethought, students developed mastery goals and reflected on their progress towards their attainment of their stated goals. Performance control was addressed as students revised artifacts included in their portfolios to clear up previous mistakes and misconceptions. Written student self-reflections accompanied each artifact and revision included in the portfolio which addressed self-reflection. Due to the formative nature of the reflective portfolio, teachers had the ability to score and make comments to students regarding their current performance based on the artifacts included within the reflective portfolio at 5-week intervals. The comments made by the teachers to the students were guided by a list of specific self-regulatory processes which they used to suggest strategies to improve students' overall self-regulatory skill development. Students, in turn, read the comments and continued the process of goal setting, revision, and reflection thereby completing the cyclical self-regulatory processes.

All artifacts included in the reflective portfolio generally included 3 components: the original graded assignment, revisions to the assignment, and a written self-reflection. The kinds of assignments included as artifacts fell under categories specific to high school science. These categories were the kinds of work the science teacher wanted to see included within the portfolio. The categories included lab reports, summative tests, short-term activities (such as homework assignments or journal article reviews), mastery goals, and a final course-end reflection. Within the category, the specific product which was included was chosen by the student. For instance, the teacher required a test to be included, but the student chose which test from the 5-week scoring period to include, revise, and reflect on. There was no limit as to what could be included, but there was a minimum as to what must be included which was set by the researcher and enforced by the classroom teacher through the scoring process using the Portfolio Rubric (Appendix A). The process is also detailed in Chapter 3 in the section about instrumentation. An example of the portfolio system and Portfolio Rubric which was given to students can be found in Appendix A.

Research question one. This study sought to quantitatively measure the effect reflective portfolio use had on high school science students using a nonrandomized control-group, pretest-posttest design which compared two different situations; (a) reflective portfolio use and (b) no use of reflective portfolios. The research question which guided this study was; Is there a significant difference in the self-regulatory skills (Effort Regulation and Time, Study Environment, Rehearsal, Elaboration, Organization, and Metacognition Self-regulation) of high school science students who produce reflective portfolios for their science assignments and those who do not?

Data collected were interval-level quantitative values in the form of subscale group means using the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & McKeachie, 1991). The MSLQ is an 81-item, self-report instrument designed to measure students' motivational orientations and their use of various learning strategies. The MSLQ assesses 9 learning strategy scales being Rehearsal, Elaboration, Organization, Critical Thinking, Metacognitive Self-Regulation, Time and Study Environment, Peer Learning, Help Seeking, and Effort Regulation. Due to the sample size used in this study, 6 scales perceived by the researcher to be most aligned with reflective portfolio use in science were chosen. This decision was made by the researcher after reading the descriptions of each scale provided in *A Manual for the Use of the MSLQ* (Pintrich, Smith, Garcia, & McKeachie, 1991). Therefore, a two-group MANOVA was performed on the six dependant variables chosen: Rehearsal, Elaboration, Organization, Metacognitive Self-Regulation, Time and Study Environment, and Effort Regulation.

Statistically significant group mean differences were not observed for the 6 dependant variables when comparing the two different situations; (a) reflective portfolio use and (b) no use of reflective portfolios. These findings will be discussed further in the implications section of this chapter.

Research question two. This study sought to quantitatively measure the effect reflective portfolio use had on high school science students using a nonrandomized repeated measures design. The research question which guided this study was; Is there change over time in the Portfolio Rubric scores within the group of students who produce reflective portfolios? The student generated reflective portfolios produced in the treatment group were assessed using the Portfolio Rubric four times throughout the 20-week study at 5-week intervals. The four sample means (Test, Lab, Other, and Total) served as the independent variables in four seperate ANOVA procedures. The one-way repeated measures ANOVA was used to ascertain if the rubric scores varied depending on the time interval for each variable.

Data collected were interval-level quantitative values in the form of portfolio artifact scores as assessed by classroom science teachers using the Portfolio Rubric (Appendix A). Artifacts included in students' reflective portfolios were assessed by teachers using the Portfolio Rubric at 5-week intervals for a total of 20-weeks. For instance, in weeks 1-5 a student would submit a portfolio which included at least 4 artifacts being a Goal, Test, Lab, and Other assignment chosen by the classroom teacher. Artifacts included the original graded assignment, revisions to the assignment, and a written reflection. For instance, a student submitting the artifact Test would submit the original graded test, revisions to the test, and a reflection of the student's performance on the test. All three components; the test, the revision, and the self-reflection; composed the artifact simply titled Test. Each artifact; the Goal, Lab, Test, and Other assignment; were graded using the Portfolio Rubric. The individual rubric scores for each artifact (Test, Lab, and Other) as well as a Total score for the 5-week period were reported to the researcher as quantitative data to be used for repeated-measures analysis. An example of rubric grading can be found in Appendix F.

Results from the one-way repeated measures ANOVA indicated that three variables (Test, Other, and Total) were significant over time. This suggests the Portfolio Rubric scores of the students in the experimental group (reflective portfolio use) varied depending on the time interval. These findings will be discussed in the implications section of this chapter.

Comparison and Contrast of Findings Related to the Literature Review

The review of literature in Chapter Two suggested self-regulating students are characterized by their active participation in learning from a metacognitive, motivational, and behavioral point of view (Zimmerman, 2001, 2002). These processes can be viewed in the cyclical phases of forethought, volitional (performance) control, and self-reflection (Schunk & Zimmerman, 1998). Simply put, students (a) use metacognition to set goals for themselves (forethought), (b) exhibit control over their behaviors used to attain their goals (performance control), and (c) reflect on the strategies they employed to attain their goals (self-reflection). Students conclude this cyclical process by setting new goals based on their assessment of the strategies they employed to attain their previous goals once again employing forethought and metacognition.

Despite the benefits of students' use of self-regulatory processes, few teachers effectively prepare students to learn on their own (Zimmerman, 2002). Students were rarely encouraged by teachers Teachers rarely encouraged students to establish specific goals, taught specific study strategies, or assessed students' beliefs about learning to identify difficulties before they become problematic (Zimmerman, 2002). Moreover, students were rarely given the opportunity to self-evaluate their own work or critically consider their competence on new tasks (Zimmerman, 2002). This disconnect between theory and practice supported the need for this study on the effect of reflective portfolio use on students' self-regulatory skills.

Relation of research question one to literature review. The MSLQ was used in this study to examine the effect reflective portfolio use had on high school science students' self-regulatory skills development. Six learning strategy subscales (Rehearsal, Elaboration, Organization, Metacognitive Self-Regulation, Time and Study Environment, and Effort

Regulation) from the MSLQ were used to compare students' self-regulatory skills in two different situations (a) reflective portfolio use and (b) no reflective portfolio use. The reflective science portfolios produced by students were designed to engage students in Pintrich's model (2000) of planning (goal setting), self-monitoring, control (managing motivation), and reaction and reflection. Using the MSLQ, this study sought to isolate which specific self-regulatory learning strategies were effected by reflective portfolio use. However, statistically significant results were not observed between the group which used reflective portfolios and group which did not use reflective portfolios when measured with the MSLQ subscales of Effort Regulation, Time and Study Environment, Rehearsal, Elaboration, Organization, and Metacognition Self-regulation.

Relation of research question two to literature review. Significant gains on the Portfolio Rubric scores of students using reflective portfolios over time suggests students engaged in the cyclical self-regulatory processes of planning (goal setting), self-monitoring (assignment revisions), control (behavioral changes), and evaluation (reflection). This study adds to previous research by Baume (2001) which suggested that the use of portfolios promoted reflective practice and self-evaluation, linked experience with personal interpretation, and provided an on-going basis for planning and goal setting. Similarly, a study by Ashcroft and Hall (2006) found portfolios to be an appropriate method to measure students' continued growth. The data from this study adds to the aforementioned studies by supporting that portfolio use over time and on an on-going basis promotes continued growth and enhances reflection and self-regulation in high school science students.

This study used a carefully designed rubric as a medium to assess the quality of a student's thinking. The aspects of a quality student reflection were assessed with the rubric based on the criteria of coverage, accuracy, specificity, integration, and revelation (adapted from Arter & Spandel, 1992). The significance observed over time in this study as measured by the Portfolio Rubric adds substantially to the work of Ash and Clayton (2004) and suggests that rubrics can be used in high school science classes to assess students' self-reflections. This also supports the work of Stiggins (1997) who said portfolios help students learn to reflect.

The remainder of the section will provide literature connections between the statistically significant results observed in this study over time and each of the self-regulatory processes in Pintrich's self-regulated learning model (2000).

Planning. This study yielded a tangible time-bound goal oriented assessment that can be used by high school science students to direct their motivation over time towards the attainment of their personal mastery goals. As stated by Montalvo & Gonzalez Torres (2004) and supported by the results of this study, education must help students to be cognitive of their own thinking, to be strategic, and to direct their motivation towards meaningful goals.

Self-monitoring. McMillian and Hearn (2008) stated students who set mastery goals tend to immerse themselves in the task and continually check their progress. The goal setting process involves the student setting goals which are attainable in a specified amount of time. These goals need to be focused on specific self-monitoring strategies which will increase the likelihood of the student attaining their specified goal. In this way, the portfolio becomes a highly individualized and an intensely personal assessment tool to both the teacher and the student (Sweet, 1993).

Additionally, Bandura (1986) stated that self-monitoring is assisted through self-recording where behaviors are recorded over time through such activities as goal setting. Again, this study provided a tangible format for students to record personal mastery goals over time and therefore facilitated continued effort within the classroom towards goal attainment.

Control. Congruently, the control phase was addressed along with the self-monitoring phase in several fashions within the portfolio process. First, students were asked to correct mistakes previously made on class assignments and resubmit the original artifact along with the corrected artifact. These new submissions represented a conscious awareness of errors previously made and the ability to correct these mistakes required an adaptation of cognitive strategies, a change in effort, and the ability to seek help and renegotiate the task. Studies of high school students have provided support that revision improves the quality of written composition (Ash, 1983). This construction of knowledge through the process of revision and reprocessing of ideas and information promotes greater learning (Scardamalia & Bereiter, 1986). Therefore, the use of revision in this study with high school science students is in accordance with previous research.

Evaluation. The evaluation phase involved reaction and reflection, key components of the reflective portfolio. Each artifact submitted within the portfolio was accompanied by a reflection based on criteria outlined in the reflective Portfolio Rubric (Appendix A). The criteria for quality student reflections were coverage, accuracy, specificity, integration, and revelation (adapted from Arter & Spandel, 1992). These criteria focused the students' written reflections on cognitive judgment, affective reaction, choice behavior, and task and context evaluation. Ultimately, the reflections yielded judgments, evaluations, and reactions which could be used by the students for further planning, monitoring, and control thereby completing the self-regulatory loop orientated toward goal attainment. Bandura (1986) stated that through reflection people evaluate their motivation, values, and meaning behind their pursuits. Ultimately, self-reflection becomes a vehicle for self-adjustment. These adjustments rooted in reflection operate as guides and motivators based on an individual's belief that they can exert some measure of control over their own functioning.

Limitations of the Study

Internal threats to validity. Several threats to internal validity impacted this study in terms of research question 1. Namely; the internal threats of measuring instruments, history, testing, subjects, and mortality will be explained in the following section. The use of a repeated measures design to assess research question 2 generally permitted the control of the internal threats of subjects and testing. However, the internal threat of history may have impacted results and will be discussed in the following section.

Research question one. The most significant limitation to this study was the commitment required by the teachers to score the portfolios and make narrative comments to each student four times over the course of 20 weeks. Teachers used the reflective portfolio scores in addition to the assessments they already had planned during the 20-week period when this study took place. This means the regular classroom instruction and assessment practices did not change but, the portfolios were added onto the students' and teachers' daily obligations. Therefore, the time required to score each portfolio, if a teacher had a class load of 100-150 students, would represent a considerable limitation to the implementation of the reflective portfolio system. This measuring instrument threat would affect the judgments made by the scorers due to fatigue or carelessness (Isaac & Michael, 1997).

The threat of history suggests other events which occurred during the time the experimental treatment (reflective portfolio production) was administered may have impacted the results (Gall, Borg, & Gall, 2003). In regards to this study, the learning environment of the school itself may have impacted the results. The MSLQ was administered before the treatment and after the treatment to both the experimental and control groups using a pretest-posttest design. Descriptive statistics revealed that the control group pretest subscale mean was 4.40 and the experimental group pretest subscale mean was 4.32 suggesting little difference between the two groups prior to the administration of the treatment (Table 6). The control group posttest subscale mean was 4.28 and the experimental group posttest subscale mean was 4.35 (Table 9). Inspection of these results shows no difference between the control or experimental groups over the 20-week period in regards to self-regulatory skills as measured by the MSLQ. However, statistically significant results over time, using the Portfolio Rubric, points to measurable growth in the students' self-regulatory skills.

Furthermore, a testing threat exists when a pretest is administered, followed by an experimental treatment, and then a posttest is administered (Gall, Borg, & Gall, 2003). The pretest administration of the MSLQ may have influenced how students responded to the posttest administration of the MSLQ since there was no alternative form of the MSLQ available.

A subject threat exists due to the fact that the groups are composed of nonrandomized volunteers with different experiential backgrounds regarding self-regulatory skills. According to Boud (1999) students possessing highly developed skills in these areas (self-regulatory) may not be able to demonstrate significant improvement.

Experimental mortality is also a potential threat to this study. Twenty-five control group research participants were lost during the experiment. Therefore, the control group sample size decreased from 79 participants to 54 participants over the 20-week period. Two participants were lost due to transitioning out of the study during the 20-week period after agreeing to participate and taking the pretest. The remaining 23 participants represented an entire class of students who did not take the MSLQ posttest. This was due to oversight by the teacher. Sadly, the posttest was given on the participants' last day of attendance for the school year and therefore there was no opportunity to find the participants and have them take the posttest. The question remains whether the remaining 54 control group participants were representative of the entire control group who agreed to participate in the study.

Research question two. Again, the internal threat of history could have impacted the statistically significant results observed in relation to research question 2. There is no guarantee that the reflective portfolio process influenced students' self-regulatory skills as only the experimental group, which produced the portfolios, could be analyzed. The school's overall learning environment may have produced the significant results observed.

Threats to External Validity. Threats to external validity impacting this study included experimenter effects and the interaction between history and the treatment for research question 1. Research question 2 was threatened by the Hawthorne effect as well as the generalization of findings to the larger population. Each threat will be explained in the sections that follow.

Research question one. Experimenter effects may have affected the overall impact the treatment had on the participants. Intensive professional development was provided to all four teachers who agreed to participate in the study but, their preconceived notions regarding the impact self-regulatory skill development has on high school science students may have affected the importance they placed on the portfolio process. For example, according to Wade & Yarborough (1996) an important factor in an effective portfolio process is the careful balance between structure and freedom. Reflective portfolio use is labor intensive for both the teacher and the student. Students and teachers who take the process less seriously find it is not worthwhile to invest the necessary time and energy.

Additionally, a significant investment of time was required by the researcher and the teachers to ensure all necessary artifacts were included within the portfolios. This threat involves the explicit description of the experimental treatment by the researcher to the participants (Gall, Borg, & Gall, 2003). The initial input by the teachers of two sessions of staff development was supplemented by on-going clarification by the researcher over the course of the 20-week period. Narrative descriptions provided to the participants of the artifacts to be included within the reflective portfolios were often confusing. Therefore, a significant limitation is imposed by the need to have skilled trainers available to assist beginning teachers in the implementation of a reflective portfolio system. Experienced staff developers would be required to ensure teachers are implementing the reflective portfolio system properly. School districts will need to make a long-term commitment to the process to provide teachers the time and training necessary to develop portfolio systems specific to their classrooms.

The interaction between history and the effects of the treatment presented an external threat to validity. The same experiment performed at a later time may yield different results (Gall, Borg, & Gall, 2003). For example, during the 20-week experimental period state mandated standardized exams were administered. This exam relegated both teachers and students to half days for 10 consecutive school days. During this testing period instruction was interrupted and time was at a premium. Eighty-one (36 of whom were in the experimental group) of the 158 participants in the study were required to sit for these state mandated exams. Student as well as teacher engagement in the reflective portfolio process comes into question during this 2-week time period. Fatigue, engagement, and time restraints may all have impacted the development of the reflective portfolios by the students and the assessment of the portfolios by the teachers. The use of a comparison group design for research question 2 should have controlled for this threat to external validity.

Research question two. Research question 2 yielded statistically significant results over time. The ability to generalize these results to the larger population poses an external threat to validity because a sample of convenience comprised of students attending a wealthy, suburban, and ethnically homogenous public school do not accurately reflect students as a whole nationally. Additionally, only College Prep science classes comprised the sample population. Even generalizing the findings to Honors science students within the same setting would be presumptuous. Further research would be required to generalize these findings to other students and settings.

The Hawthorne effect may affect external validity since students who receive special attention may perform better (Gall, Borg, & Gall, 2003). As Zimmerman (2002) stated, teachers rarely encourage students to establish specific goal or assess their students' beliefs about learning. Zimmerman continued, stating students were rarely given the opportunity to evaluate their own work or critically consider their competence on new tasks (Zimmerman, 2002). Therefore, when the teachers in this study began providing specific and written feedback to their students, the special attention the teachers were providing each student was noticeable and novel to the students. This attention given to the students by the teacher may have prompted the statistically significant results and not the treatment itself.

Implications of the Study

This study failed to provide compelling evidence that reflective portfolio use by high school science students impacts specific self-regulatory strategies when measured by the MSLQ. However, statistically significant results over time using the Portfolio Rubric to assess metacognitive skills suggest students do benefit from structured goal setting, revision, and reflection. This section will discuss the implications of these findings.

Research question one. The isolation of which specific self-regulatory learning strategies were affected by reflective portfolio use in science proved inconclusive when measured with the subscales of Effort Regulation and Time, Study Environment, Rehearsal, Elaboration, Organization, and Metacognition Self-regulation (all self-regulatory strategies hypothesized by the researcher to be impacted by reflective portfolio use) using the MSLQ. The MSLQ is designed to be used at the course level and the same individual might report different levels of motivation or strategy use depending on the course (Pintrich, Smith, Garcia, & McKeachie, 1991). The data reported for the MSLQ is from a sample of 380 Midwestern students. These students composed 37 classrooms and spanned 5 disciplines being; natural science, humanities, social science, computer science, and foreign language (Pintrich, Smith, Garcia, & McKeachie, 1991). Neither the biological sciences nor physical sciences were included in this sample. In relation to this study on student self-regulation using reflective portfolios, only 42 participants out of a total sample size of 158 were from the natural sciences (Earth Science). The remaining 116 participants in this study were in biology or chemistry (physical science). The use of the MSLQ as an instrument to isolate which specific self-regulatory learning strategies were affected by reflective portfolio use in science may have been inappropriate due to its limited prior use in science courses.

Additionally, the MSLQ has self-regulatory subscales in Critical Thinking, Peer Learning, and Help Seeking which were not included in this study. The use of a larger sample and increasing the number of subscales tested from six to nine may be necessary. Similarly, the MSLQ also has subscales for motivation. As stated and supported by Bandura (2001), Zimmerman (2000, 2001), and Pintrich (2000), self-regulation is a subset of the construct of motivation. Significant results may have been realized if the MSLQ motivation subscales had been studied along with the compound effects of the motivation subscales and the self-regulatory learning subscales.

Research question two. Statistically significant results over time suggest students did benefit from structured goal setting, revision, and reflection. Reflective portfolios as used in this study provided students the necessary mastery goal orientation to reflect upon their current progress towards meeting their academic goals, allowed them to consider behavioral changes necessary to meet their goals, and provided a framework for a dialogue about self-regulation and performance between the teacher and the student.

This study provides evidence for a method which can be used by high school science teachers as a means to foster self-regulatory learning strategies in their students over time. Reflective science portfolio production fills a void established by Zimmerman (2002) who stated that teachers rarely encourage students to establish specific goals, teach specific study strategies, or assess students' beliefs about learning to identify difficulties before they become problematic. Zimmerman also stated that students were rarely given the opportunity to evaluate their own work or critically consider their competence on new tasks (Zimmerman, 2002).

The aim of this study was to measure the effect reflective portfolio construction had on the self-regulatory skills of high school science students. This was done by fostering self-regulatory skill development in high school science students through the production of reflective portfolios. A study done by Driessen, van Tartwijk, Overeem, Vermunt, and van der Vleuten (2005) showed the creation of a reflective portfolio allowed students to understand how they learned best, in what ways they learned best, and their limitations related to specific tasks. Construction of the reflective portfolio in science gave students the opportunity to engage in a cyclical process of self-regulation facilitating an on-going assessment dialogue between each student and his or her teacher. The dialogue gave teachers a medium to encourage goal setting, revision, and self-reflection; critical processes used in the self-regulation of learning.

The specific format and time period students used to generate the reflective portfolios in science was paramount to successful implementation focusing students on self-regulatory skill development. The portfolios produced by students over the 20-week period included individual goals, self-reflections, original graded artifacts, and revisions of artifacts. Significant gains were not observed prior to the time interval of 6-10 weeks in comparison to the time interval of 11-15 weeks. Significant gains would not have been realized if the researcher had conducted this study for less than 6-10 weeks. Therefore, in order for students to benefit from the reflective portfolio process, the specific format suggested in this study for portfolio production must be followed for a minimum of 6-15 weeks.

Suggestions for Future Research

Research question one. Using the MSLQ subscales of Effort Regulation and Time, Study Environment, Rehearsal, Elaboration, Organization, and Metacognition Self-regulation (all self-regulatory strategies hypothesized by the researcher to be impacted by reflective portfolio use) was inconclusive in isolating which specific self-regulatory processes were effected by reflective portfolio use. Increasing the sample size so the remaining self-regulation subscales from the MSLQ (Critical Thinking, Peer Learning, and Help Seeking) can be studied may prove beneficial.

Similarly, investigation of the MSLQ subscales of Effort Regulation and Time, Study Environment, Rehearsal, Elaboration, Organization, and Metacognition Self-regulation using a repeated measures MANOVA instead of with a pretest-posttest control group design may support that time, in fact, is the key factor to realize significant gains with the MSLQ. The application of the reflective portfolios as the treatment took place over a total of 20-weeks. The MSLQ was administered prior to the treatment as the pretest and after the treatment as the posttest. However, scoring of the reflective portfolio took place at 5-week intervals during the 20-week period using the Portfolio Rubric which did provide statistically significant results over time.

Additionally, the use of the motivation subscales from the MSLQ should be investigated. Significant gains may have been realized if both subscale sets had been studied in their entirety. The impact these subscales have on each other should also be studied. An in-depth multiple regression should be undertaken to investigate the impact motivation and self-regulation, as well as their individual subscales, has on students when used in conjunction with a reflective portfolio system. This may add to previous studies by Schunk (1989) who concluded that when self-monitoring results in goal progress the motivation to improve is fostered. Also, studies by Montavo and Gonzalez Torres (2004) highlighted the importance of goal orientation on motivation and the regulation of learning.

Research question two. Self-reflection, a key component of self-regulatory learning, is addressed through the production of reflective portfolios as students submit written self-reflections with each artifact and revision. This means that at the completion of the 20-week interval, a wealth of written student self-reflections had been submitted. Students' written reflections addressed key self-regulatory processes and potentially evidence both behavioral and motivational changes made by the students over the 20-week period. Further investigation should include a qualitative study of the students' self-reflections produced in accompaniment to the artifacts included within their reflective portfolios. Components of self-regulation and motivation are evident in each of the four samples included in the Chapter Three Unhypothesized

Data section. Student 6 states he or she now knows what is being done right and wrong demonstrating the self-regulatory skill of metacognition. Additionally, the student states that staying more organized would help evidencing organization, another self-regulatory skill. To continue, student 22 states that it is his or her fault for not studying enough, suggesting engagement in the self-regulatory process of metacognition and the self-regulatory learning skill of time and study environment. Student 37 states he or she could improve by making flash cards to address the self-regulatory skill of rehearsal. This brief and random selection of student self-reflections suggests a qualitative follow-up study is necessary.

Likewise, a possible impact to be studied further is the effect reflective portfolio production has on literacy development in the content area of science. Brown (1994) cited that written reflections can have significant effects on students' skills in writing. Portfolio use consisting of work samples and written reflections fostered an integration of writing in the curriculum, provided a provision of a clear and complete writing profile recording growth over time, and recognized the divergent learning styles of students. No study on the effect of reflective portfolio production on high school science students with respect to their literacy development has previously been undertaken. The format suggested in this study for the production of reflective portfolios could be used as a medium for this future research.

Another potential study could include the investigation of whether or not the reflective portfolio process can quantitatively be linked to mastery goal orientation. Mastery goal orientation allows students to engage deeply and persevere in the face of challenges (Dweck & Leggett, 1988). Studies by Ames and Archer (1988), Meece and Holt (1993), Patrick and Yoon (2004), and Gelbach (2006) concluded that mastery goal orientation fosters higher effort, increased grades and test scores, and deeper conceptual understanding.

The use of the reflective portfolio as it impacts teaching also should be investigated. As students revise work and write reflections, revelations about teaching as well as learning are revealed. Richert (1987) concluded that teachers can use student reflections to gain insight into their own practice and enhance student learning and the quality of instruction being delivered. Hofstetter, Sticht, and Hofstetter (1999) added that teachers should use student reflections as an opportunity for themselves by comparing their own teaching to the ends that were sought. Students will generate written reflections for specific assignments and include them in their portfolios. Teachers then can use the student reflections as a diagnostic tool to investigate if the lesson objectives as measured by the assignment were successfully achieved. If numerous students in the class report, through their written reflections, that a particular assignment was unnecessarily confusing or difficult, the teacher can use this information to modify subsequent instruction. Similarly, if numerous students report a particular assignment was enjoyable or beneficial to their overall content attainment, the teacher could naturally use this information to modify subsequent instruction as well. Also, using the student written reflections as a medium to gain a better sense of individual student's strengths and weaknesses could be used to design highly specific differentiated instruction opportunities throughout the school year. To conclude, the wealth of student reflections generated through the reflective portfolio process should be investigated for their potential benefit in enhancing the quality of instruction offered in high school science classes.

Chapter Summary

In conclusion, this study was designed to investigate if the use of reflective portfolios in science would engage students in a cyclical self-regulation model involving forethought, performance control, and self-reflection. There is a substantial body of evidence suggesting the benefits of students' use of self-regulatory processes. However, there was no evidence of a system which could be used by teachers to encourage self-regulatory skill development in science. This study linked the theoretical construct of self-regulation with a practical process which can be used by all high school science teachers. Although this study failed to provide compelling evidence that reflective portfolio use by high school science students impacts specific self-regulatory strategies, statistically significant results over time suggest students do benefit from structured goal setting, revision, and reflection. Despite the need for further research, reflective portfolios, as used in this study, can provide students with the necessary mastery goal orientation to reflect upon their current progress towards meeting their academic goals, allow them to consider behavioral changes necessary to meet their goals, and provide a framework for a dialogue about self-regulation and performance between students and teachers.

References

Ames, C. (1990). Motivation: What teachers need to know. *Teachers College Record*, *91*, 409-421.

Ames, C., & Archer, J. (1988). Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of Educational Psychology, 80* (3), 260-267.

Andrade, H. (2000). What do we mean by results?: Using rubrics to promote thinking. *Educational Leadership, 57* (5), 13-18.

Arter, J., & McTighe, J. (2001). *Scoring rubrics in the classroom: Using performance criteria for assessing and improving student performance.* Thousand Oaks, CA: Corwin Press.

Arter, J., & Spandel, V. (1992). Using portfolios of student work in instruction and assessment. *Educational Measurement: Issues and Practice, 11* (1), 36-44.

Ash, B. H. (1983). Selected effects of elapsed time and grade level on revisions in eighth, tenth, and twelfth graders' writing. *Dissertation Abstracts International, 43,* 3830.

Ash, S. L., & Clayton, P. H. (2004). The articulated learning: An approach to guided reflectionand assessment. *Innovative Higher Education, 29* (2), 137-154.

Ashcroft, D. M., & Hall, J. (2006). Pharmacy students' attitudes and views about portfolio-based learning: A questionnaire survey. *Pharmacy Education, 6* (1), 1-5.

Assessment, N. C. (1996). *National Science Education Standards* . Retrieved October 22, 2008, from http://books.nap.edu/openbook.php?record_id=4962&page=89

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology*, *52*, 1-26.

Bandura, A. (2004). Swimming against the mainstream: The early years from chilly tributary to transformative mainstream. *Behavior Research and Therapy*, *42*, 613-630.

Bargainner, S. (2003). *Fundamentals of rubrics*. (P. C. Series, Producer) Retrieved March 11, 2008, from www.pcrest.com

Baume, D. A. (2001). A briefing on assessment of portfolios: Assessment series. *6*.

Belanoff, P., & Elbow, P. (1986). Using portfolios to increase collaboration and community in a writing program. In P. Connolly, & T. Vilardi (Eds.). New York: MLA.

Boud, D. (1999). Avoiding the traps: Seeking good practice in the use of self assessment and reflection in professional courses. *Social Work Education*, *18* (2), 121-132.

Bratman, M. E. (1999). *Faces of intentions: Selected essays on intention and agency*. New York, NY: Cambridge University Press.

Brown, D. (1994, February). Integrating authentic assessment in social studies. Torrence, CA.

Bruner, J. S. (1966). *Toward a theory of instruction.* Cambridge, MA: Belknap.

Butler, D. L., & Winne, P. H. (1995). Feedback and self-regulated learning: A theoretical synthesis. *Review of Educational Research*, *65* (3), 245-281.

Connecticut State Department of Education (2007, January 3). *A superior education for connecticut's 21st century learners: Five-year comprehensive plan for education 2006-2011*. Retrieved September 24, 2008, from www.sde.ct.gov/sde/lib/sde/pdf/commish/comp_plan06-11.pdf

Connecticut State Department of Education (2008, September 3). *Position statement on science education.* Retrieved September 24, 2008, from www.ctacad.org/CSDE%20Science%20Position%20Statement.pdf

Corno, L. (2001). Volitional aspects of self-regulated learning. In B. Zimmerman, & D. H. Schunk, *Self-regulated laerning and academic achievement: Theoretical perspectives* (pp. 191-225). Hilldale, NJ: Erlbaum.

Courtney, A. M., & Abodeeb, T. L. (1999). Diagnostic reflective portfolios. *The Reading Teacher, 52* (7), 708-714.

Crain, W. (1992). Vygotsky's social historical theory of cognitive development. In C. Wada (Ed.), *Psycology of Learning for Instruction* (3 ed., p. 216). Englewood Cliffs, NJ: Prentice-Hall Inc.

Dewey, J. (1910). *How we think.* Boston, MA: D.C. Heath & Co.

Driessen, E. W., van Tartwik, J., Overeem, K., Vermunt, J., & van der Vleuten, C. P. (2005). Conditions for successful reflective use of portfolios in undergraduate medical education. *Medical Education, 39* (12), 1230-1235.

Dweck, C., & Leggett, E. (1988). A social-cognitive approach to motivation and personality. *Psychology review*, *95*, 256-273.

Education, C. S. (2007, January 3). *A superior education for connecticut's 21st century learners: Five-year comprehensive plan for education 2006-2011*. Retrieved September 24, 2008, from www.sde.ct.gov/sde/lib/sde/pdf/commish/comp_plan06-11.pdf

Education, C. S. (2008, September 3). *Position statement on science education.* Retrieved September 24, 2008, from www.ctacad.org/CSDE%20Science%20Position%20Statement.pdf

Elliot, A. J., McGregor, H. A., & Gabel, S. (1999). Achievement goals, study strategies, and exam performance: A mediatational analysis. *Journal of Educational Psychology, 91*, 549-563.

Eyler, J. (2000). What do we need to know most about the impact of service-learning on student learning? *Michigan Journal of Community Service Learning*, 11-17.

Eyler, J., & Giles, D. E. (1999). *Where's the learning in service-learning?* San Francisco, CA: Jossey-Bass.

Eyler, J., Giles, D. E., & Schmiede, A. (1996). *A practitioner's guide to reflection in service-learning.* Nashville, TN: Vanderbilt University.

Fitzgerald, J. (1987). Research on revision in writing. *Review of Educational Research*, *57*, 481-506.

Fitzgerald, J., & Markham, L. R. (1987). Teaching children about revision in writing. *Cognition and Instruction*, *4* (1), 3-24.

Friedman, B. D., Davis, M. H., Harden, R. M., Howie, P. W., Ker, J., & Pippard, M. J. (2001). Portfolios as a method of student assessment. *Medical Teacher*, *23*, 535-551.

Gall, M. D., Borg, W. R. & Gall J. P. (2003). *Educational research: An introduction,* (7th ed).. New York: Longman Publishers USA.

Gehlbach, H. (2006). How changes in students' goal orientations relate to outcomes in social studies. *The Journal of Educational Research*, *99* (6), 358-370.

Graves, D. H., & Murray, D. M. (1980). Revision: In the writer's workshop and in the classroom. *Jounal of Education*, *162*, 38-56.

Greenberg, K. (1992). Validity and reliability issues in the direct assessment of writing. *WPA: Writing Program Administration*, *17* (1-2), 49-65.

Guilford, J.P. (1954). *Psychometric methods* (2nd ed.). McGraw-Hill Education. *Writing Program Administration*, *16* (1-2), 7-22.

Hansen, B. C. (1998). Using reflective portfolios as a tool to teach writing to students with learning disabilities: A project for preservice teachers. *Reading & Writing Quarterly*, *14* (3), 307.

Harkness, S. S., D'Ambrosio, B., & Morrone, A. S. (2007). Preservice elementary teachers' voices describe how their teacher motivated them to do math. *Educational Studies in Mathmatics*, *65*, 235-254.

Hebert, E. (1998). Lessons learned about student portfolios. *Phi Delta Kaplan*, *78*, 583-585.

Henkin, R. (1993). Emerging feminist themes found in graduate students' portfolios written by women elementary school teachers. *Action in Teacher Education*, *15*, 20-28.

Hinkle, D., & Wiersam, W. J. (2003). *Applied Statistics for the Behaioral Sciences.* Boston: Houghton Mifflin Company.

Hofstetter, C. R., Sticht, T. G., & Hofstetter, C. H. (1999). Knowledge, literacy, and power. *Communication Research*, *26* (1), 58-80.

Isaac, S., & Michael, W. B. (1997). *Handbook in research and evaluation*, (3rd ed). Los Angeles, CA: EdITS.

Kaplan, A., & Maehr, M. L. (1999). Achievement goals and student well-being . *Contemporary Educational Psychology*, *24*, 330-358.

Kenfield, K. (1994, February). *Getting ESL kids in the act*. Paper presented at the meeting of the California Elementary Education Association, Torrance, CA.

Kneale, P. (2002). Developing and embedding reflective portfolios in geography. *Journal of Geography in Higher Education*, *26* (1), 81-94.

Kohn, A. (2000). *The case against standardized tests.* Portsmouth, NH: Heinemann.

Lambdin, D. V., & Walker, V. L. (1994). Planning for classroom portfolio assessment. *Arithmetic Teacher, 41*, 318-324.

Lucas-Lescher, M. (1995). *Portfolios: Assessing learning in the primary grades.* Washington, D.C.: NEA Professional Library.

Lyons, N. (2002a). Results: What faculty say they learn and value. In N. Lyons, A. Hyland, & N. Ryan (Eds.), *Advancing the scholarship of teaching and learning through a reflective portfolio process: the University College Cork experience* (pp. 109-112). Cork, Ireland: University College Cork.

Lyons, N. (2002b). The personal self in a public story. In N. Lyons, & V. LaBoskey (Eds.), *Narrative inquiry in practice: Advancing the knowledge of teaching* (pp. 87-100). New York: Teachers College Press.

Lyons, N. (2006). Reflective engagement as preofessional development in the lives of university teachers. *Teachers and Teaching: Theory and Practice*, *12* (2), 151-168.

Marzano, R. J. (2007). *The art and science of teaching.* Alexandria, VA: Association for Supervision and Curriculum Development.

McMillan, J. H., & Hearn, J. (2008). Student self-assessment: The key to stronger student motivation and higher achievement. *Educational Horizons*, *87* (1), 40-49.

Meece, J. L., & Holt, K. (1993). A patter analysis of students' achievement goals. *Journal of Educational Psychology*, *85*, 582-590.

Meece, J., Blumenfeld, P. C., & Hoyle, R. H. (1988). Students' goal orientations and cognitive engagement in classroom activities. *Journal of Educational Psychology*, *80*, 514-523.

Meyers, L. S., Gamst, G., & Guarino, A. J. (2006). *Applied multivariate research: Design and interpretation.* Thousand Oaks, CA: Sage.

Midgley, C., Feldlaufer, H., & Eccles, J. S. (1989). Student/teacher relations and attitudes towards mathematics before and after transition to junior high. *Child Development*, *61*, 981-992.

Montalvo, F. T., & Gonzalez Torres, M. C. (2004). Self-regulated learning: Current and Future Directions. *Electronic Journal or Research in Educational Psychology, 2* (1), 1-34.

Moon, T. R., Brighton, C. M., Callahan, C. M., & Robinson, A. (2005). Development of authentic assessments fo rmiddle school classrooms. *The Journal of Secondary Gifted Education*, *16* (2/3), 11-133.

Morrison, K. (1996). Developing reflective practice in higher degree students through a learning journal. *Studies in Higher Education*, *21* (3), 317-332.

Mousoulides, N., & Philippou, G. (2005). Students' Motivational Beliefs and Self-Regualtion. In C. H.L., & V. J.L. (Eds.), *Proceedings of the 29th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 3, pp. 321-328). Melbourne.

Muthukrishna, N., & Borkowski, J. G. (1996). Constructivism and the motivated transfer of skills. In M. Carr (Ed.). Cresskill, NJ: Hampton Press Inc.

National Committee on Science Education Standards and Assesmments (1996). *National Science Education Standards* . Retrieved October 22, 2008, from http://books.nap.edu/openbook.php?record_id=4962&page=89

Nidds, J. A., & McGerald, J. (1997). How functional is portfolio assessment anyway? *Education Digest*, *62* (5), 47-50.

Odell, L. (1980). Business writing: Observations and implications for teaching compositions. *Theory Into Practice*, *19* (3), 225-232.

Patrick, H., & Yoon, C. (2004). Early adolescents' motivation during science investigation. *The Journal of Educational Research*, *97* (6), 319-328.

Patrick, H., Anderman, L. H., Ryan, A. M., Edelin, K. C., & Midgley, C. (2001). Teachers communication of goal orientations in four fifth-grade classrooms. *Elementary School Journal*, *102* (1), 35-58.

Patrick, H., Ryan, A. M., & Kaplan, A. (2007). Early adolescents' perceptions of the classroom social environment, motivational beliefs, and engagement. *Journal of Educational Psychology*, *99* (1), 83-98.

Paulson, F., Paulson, P., & Meyer, C. (1991). What makes a portfolio a portfolio? *Educational Leadership*, *48*, 660-663.

Pintrich, P. R., Smith, D. A., Garcia, T., & McKeachie, W. J. (1991). *A manual for the use of the motivated strategies for learning questionnaire (MSLQ).* Ann Arbor, MI: National Center for Research to Improve Postsecondary Teaching and Learning.

Pintrich, P. R. (2000). The role of goal orientation in self-regulating learning. In M. Boekaerts, P. R. Pintrich, & M. Zeider (Eds.), *Handbook of self-regulation* (pp. 451-502). New York: New York Academic Press.

Pintrich, P. R. (2003). Motivation and classroom learning. In W. M. Reynolds, & G. E. Miller (Eds.), *Handbook of Psychology: Educational Psychology* (Vol. 7, pp. 103-122). Hobokin, NJ: Wiley.

Pintrich, P. (2004). A conceptual framework for assessing motivation and self-regulated learning in college students. *Educational Review*, *16* (4), 385-407.

Puustinen, M., & Pulkkinen, L. (2001). Models of self-regulated learning: A review. *Scandanavian Journal of Educational Research*, *45*, 269-286.

Richert, A. (1987). *Reflex to reflection: Facilitating reflection in novice teachers.* Stanford University. Unpublished doctoral dissertation.

Rose, L. C., & Gallup, A. M. (1999). The 31st annual phi delta kappa/gallup poll of the public's attitudes toward the public schools. *Phi Delta Kappan*, 41-56.

Scardamalia, M., & Bereiter, C. (1986). Research on written composition. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed., pp. 778-803). New York: Macmillan.

Schunk, D. (1989). *Social cognitive theory and self-regulated learning.* (B. J. Zimmerman, & D. H. Schunk, Eds.) New York: Springer-Verlag.

Schunk, D. H. (1994). Self-regulation of self-efficacy and attributes in academic settings. In D. H. Schunk, & B. J. Zimmerman (Eds.), *Self-regulation of learning and perfromance: Issues and educational applications* (pp. 75-99). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Schunk, D., & Zimmerman, B. J. (1997). Social origins of self-regulatory competence. *Educational Psychologist*, *32* (4), 195-208.

Schunk, D., & Zimmerman, B. (Eds.). (1998). *Self-regulated learning: From teaching to self-reflective practice.* New York: The Guilford Press.

Schunk, D. H. (2001). Social cognitive theory and self-regulated learning. In D. H. Schunk & B. J. Zimmerman (Eds.), Self-regulated learning and academic achievement: Theoretical perspectives (pp. 125-151). Hillsdale, NJ: Erlbuam.

Schunk, D. (2004). *Learning theories: An educational perspective.* Upper Saddle River, NJ: Merrill /Prentice Hall.

Shepard, L. A. (2001). The role of classroom assessment in teaching and learning. In V. Richardson (Ed.), *Handbook of Reseach and Teaching* (4 ed.). Washington, DC: American Educational Research Association.

Snadden, D., & Thomas, M. (1998). The use of portfolio learning in medical education. *Medical Teacher*, *20*, 192-199.

Spandel, V., & Culham, R. (1995). *Putting portfolio stories to work.* Portland, OR: Northwest Regional Educational Laboratory.

SPSS for Windows, Rel. 11.0.1. 2001. Chicago: SPSS Inc.

Stahle, D. L., & Mitchell, J. P. (1993). Portfolio assessment in college methods courses: Practicing what we preach. *Journal of Reading*, *36*, 538-542.

Stecher, B. (1998). The local benefits and burdens of large-scale portfolio assessment. *Assessment in Education: Principles, Policy, and Practice*, *5* (3), 335-352.

Stewart, S., & Richardson, B. (2000). Reflection and its place in the curriculum in an undergraduate course: Should it be assessed? *Assessment & Evaluaton in Higher Education*, *25* (4), 369-380.

Stiggins, R. J. (1997). *Student-centered classroom assessment.* Upper Saddle Ridge, NJ: Prentice-Hall, Inc.

Sweet, D. (1993). Student portfolios: Administartive uses. *Education Research: Consumer Guide*, *9*.

Tierney, R. J. (1992). Setting a new agenda for assessment. *Learning*, *21*, 61-64.

Underwood, T. (1998). The consequences of portfolio assessment: A case study. *Educational Assessment*, *5* (3), 147-194.

Uphoff, J. K. (1989). *Portfolio development and use; The why's, how's, and what's.* Wright State University, College of Education and Human Services, Teacher Education, Dayton, OH.

Valencia, S. (1990). A portfolio approach to classroom reading assessment. *Reading Teacher, 43,* 338-440.

Wade, R. C., & Yarbourgh, D. H. (1996). Portfolios: A tool for reflective thinking in teacher education? *Teach Teacher Educ*, *12* (1), 63-79.

Weinstein, C. E., Husman, J., & Dierking, D. R. (2000). Self-regulation interventions with a focus on learning strategies. In M. Boekaerts, P. R. Pintrich, & M. Zeider (Eds.), *Handbook of self-regulation* (pp. 728-748). Claerwater, FL: H.Y.H. Publishing.

Welch, M. (1999). The ABCs of reflection: A template for students and instructors to implement written in service-learning. *NSEE Quarterly*, *25*, 22-25.

White, B. Y., & Frederiksen, J. R. (1998). Inquiry, modeling, and metacognition: Making science accessible to all students. *Cognition and Instruction*, *16* (1), 3-118.

Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology*, *25*, 68-81.

Wiggins, G. (1998). *Educative assessment: Designing assessments to inform and improve student performance.* San Francisco, CA: Jossey-Bass Publishers.

Winne, P. (1995). Inherent details of self-regulated learning. *Educational Psychologist*, *30*, 173-187.

Zimmerman, B. (1990). Self-regulating academic learnig and achieving: The emergence of a social cognitive perspective. *Educational Psychology Review, 2*, 173-201.

Zimmerman, B., Bonner, S., & Kovach, R. (1996). *Developing self-regulated learners: Beyond achievement to self-efficacy.* Washington, D.C.: American Psychological Association.

Zimmerman, B. J. (1998). Developing self-fulfilling cycles of academic regulation: An analysis of exemplary instructional model. In D. H. Schunk, & B. J. Zimmerman (Eds.), *Self-regulated learning: From teaching to self-reflective practice* (pp. 1-19). New York: Guilford.

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeider (Eds.), *Handbook of self-regulation* (pp. 451-502). San Diego, CA: Academic Press.

Zimmerman, B. (2001). Achieving academic excellence: A self-regulatory perspective. In M. Ferrari (Ed.), *The pursuit of excellence through education* (pp. 85-110). Mohawk, NJ: Erlbaum..

Zimmerman, B. (2002). Becoming a self-regulated learner: An overview. *Theory into Practice, 41*, 64-72.

ZIPskinny. (n.d.). Retrieved November 9, 2008, from http://www.zipskinny.com/index.php?zip=06877

Appendix A: Student Reflective Portfolio Packet and Portfolio Rubric

<u>Objective:</u> Students will build a history of their learning including personal goals, work samples, and reflections in the form of a portfolio. The portfolio will be used as a medium for reflection. Students know themselves as learners better than anyone else. They set goals for themselves and judge how well they reach these goals. Routinely, students thoughtfully and honestly evaluate their own learning with far more detail and introspect than the teacher ever could.

There is no standard approach to designing a portfolio. It should reflect your individuality as a literate, thinking, reading, writing, and learning human being. Obviously, you will be asked to include certain items into your portfolio, but how the artifacts are represented in the portfolio is limited only to your imagination. My hope is that these portfolios will show the depth, growth and diversity of each of you.

<u>Content:</u> Your portfolio must include (but is not limited to) the following items:

1. **Goals Worksheets** – individual goals and future focus statements (1/quarter, 2 total)
2. **Unit Tests** – corrected exam with written reflection (2/quarter, 2 total)
3. **Lab Reports** – corrected report with written reflection (2/quarter, 4 total)
4. **Other** *10 points*– completed with written reflection (1/quarter, 2 total)
5. **Other** *5 points*– completed with written reflection (1/quarter, 2 total)
6. **Complete Unit** – complete history of all notes, labs, worksheets, activities, homework assignments, etc. for any one unit throughout quarters 3 or 4 with written reflection (1 total)
7. **Final Reflection** – written reflection of thoughts, reactions, and knowledge gained – *minimum of 1 page double spaced* (1 total)
8. **Keeper Letter** – reflection by parent/guardian of the student's portfolio upon completion of the project (1 total)
9. **Original Scoring Sheet** – Grades and comments (1 total)

<u>Grading:</u> Your Science Portfolio will be graded twice per quarter as follows:

<u>Quarter 3 (weeks 1-5)</u>
Goals Worksheet #1: 5 points
Unit Test: 15 points
Lab Report: 15 points
<u>Other: 5 points</u>
Total = 40 points

<u>Quarter 3 (weeks 6-10)</u>
Unit Test: 15 points
Lab Report: 15 points
<u>Other: 10 points</u>
Total = 40 points

<u>Quarter 4 (weeks 11-15)</u>
Goals Worksheet#2: 5 points
Unit Test: 15 points
Lab Report: 15 points
<u>Other: 5 points</u>
Total = 40 points

<u>Quarter 4 (weeks 16-20)</u>
Unit Test: 15 points
Lab Report: 15 points
Other: 10 points
Complete Unit: 10 points
Final Reflection: 10 points
Keeper Letter: 10
<u>Complete Scoring Sheet and Rubric: 10</u>
Total = 80 points

What is a Keeper Letter?

As a final piece to your portfolio, you will ask a parent/guardian to review your completed portfolio. After they have read and understand the contents of your work, ask them to write a letter to you commenting on your work. This letter will be the **first** page of your completed portfolio.

The letter should be a celebration of your work. This is an opportunity to share the learning and growth you have experienced throughout the year with your parents/guardians. There are no length or format requirements to this letter. Within the letter, the following questions may be addressed:

- What kinds of learning activities best suit the learner? How is this displayed within the portfolio?
- Did the student choose worthy and attainable quarter goals? Is attainment of these goals displayed within the portfolio?
- How and where within the portfolio is growth of the student as an individual learner and as a member of a learning community displayed?
- Does the portfolio display learning as a many-faceted experience through the use of varied assessments?
- Do the artifacts included within the portfolio paint an accurate picture of student progress and mastery of content throughout the year?
- What advice would you give to the learner to aid in future success in school based on the excerpts viewed within the portfolio?

How do I write a quality reflection?

Quality reflections will address and be graded on:

- Coverage: Does the reflection address all relevant topics/content?
  - What topics were covered and measured in the assignment?
- Accuracy: Does the reflection display an accurate sense of achievement and growth?
  - Did the results of this assignment give a true indication of what I learned in this unit? Why or why not?
- Specificity: Does the reflection include examples from the assignment to support points made in the reflection?
- Integration: Does the reflection display insights into broader conclusions about achievement?
  - Why did I choose this assignment to be part of my portfolio?
  - How could I have done better on this assignment?
  - How did I do on this assignment in relation to others of similar scope and range?
- Revelation: Does the reflection bring about new insights about learning and achievement?
  - What is the importance of this assignment and/or the material covered in the unit to my everyday life?
  - What did I learn about achievement (good or bad) through this assignment that I can apply to other courses and future schooling?

Goals Worksheet

☆ *Goals MUST be worthy and attainable during the quarter* ☆

Quarter 3 Goal Statement #1 (date:):

Reflection on meeting this goal (date:):
(Attach another sheet if necessary)

Future focus on attaining this goal, if it has not been achieved:

Quarter 4 Goal Statement #2 (date:):

Reflection on meeting this goal (date:):
(Attach another sheet if necessary)

Future focus on attaining this goal, if it has not been achieved:

Portfolio Rubric

	Points	Unsatisfactory	Proficient	Excellent
1. Artifact included with corrections (when applicable)		- Does not include original graded artifact - Does not correct errors in original artifact	- Generally Includes original graded artifact - Generally corrects errors in original artifact	- Includes original graded artifact - Corrects errors in original artifact
2. Goal Setting		- Does not set worthy and attainable goal - Does not reflect on outcome of goal (why or why not met) - Does not describe future focus for meeting goal if not achieved	- Generally sets worthy and attainable goal - Generally reflects on outcome of goal (why or why not met) - Generally describes future focus for meeting goal if not achieved	- Sets worthy and attainable goal - Reflects on outcome of goal (why or why not met) - Describes future focus for meeting goal if not achieved
3. Quality Reflection:				
a. Coverage		- Does not address criteria the artifact was assessed with	- Generally addresses criteria the artifact was assessed with	- Addresses criteria the artifact was assessed with
b. Accuracy		- Does not depicts an accurate view of achievement and growth	- Generally depicts an accurate view of achievement and growth	- Depicts an accurate view of achievement and growth
c. Specificity		- Does not include examples to support points made in self-reflection	- Generally includes examples to support points made in self-reflection	- Includes examples to support points made in self-reflection
d. Integration		- Does not synthesizes important insights into broader conclusions about	- Generally synthesizes important insights into broader conclusions about	- Synthesizes important insights into broader conclusions about achievement

		achievement	achievement	
e. Revelation		- Does not bring new insights about learning	- Generally brings new insights about learning	- Brings new insights about learning
4. Format		- Does not use excellent grammar, spelling, and sentence structure - Is not organized, logical, and sequential - Is not typed, neat, and presentable	- Generally uses excellent grammar, spelling, and sentence structure - Generally organized, logical, and sequential - Generally typed, neat, and presentable	- Uses excellent grammar, spelling, and sentence structure - Organized, logical, and sequential - Typed, neat, and presentable

Scoring Sheet

Quarter 3 (weeks 1-5)	**Comments**
Goal Worksheet 1 2 3 4 5	
Unit Test 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	
Lab Report 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	
Other 1 2 3 4 5 ------------------------ Total =	

Quarter 3 (weeks 6-10)	**Comments**
Unit Test 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	

Lab Report
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Other
1 2 3 4 5 6 7 8 9 10

Total =

Quarter 4 (weeks 11-15)	Comments
Goal Worksheet 1 2 3 4 5 Unit Test 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 Lab Report 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 Other 1 2 3 4 5 ------------------------ Total =	

Quarter 4 (weeks 16-20)	Comments
Unit Test 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 Lab Report 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 Other 1 2 3 4 5 6 7 8 9 10	

Complete Unit
1 2 3 4 5 6 7 8 9 10

Final Reflection
1 2 3 4 5 6 7 8 9 10

Keeper Letter
1 2 3 4 5 6 7 8 9 10

Complete Scoring Sheet 10

Total =

Appendix B: Inter-rater Reliability of Portfolio Rubric

$$ICC(2) = \frac{MSB - MSW}{MSB}$$

ICC(2)=Intraclass Correlation Coefficient, reliability for mean ratings from k raters

MSB=mean square between

MSW=mean square within

Formula 1: *Inter-rater reliability* (Guilford, 1954, p. 395)

Table 1: *Inter-Rater Reliability*

Item Number	Rubric Number	Rater 1	Rater 2	Rater 3	Rater 4	Inter-Rater Agreement/ Item	Inter-Rater Agreement/ Item for All Raters
1	1	5	5	.	.	100.00	
1	2	3	5	5	.	86.67	
1	3	5	5	5	.	100.00	
1	4	5	5	5	5	100.00	
1	5	5	5	.	.	100.00	
1	6	4	5	5	5	95.00	
1	7	5	5	5	.	100.00	
1	8	5	5	5	.	100.00	

Item Number	Rubric Number	Rater 1	Rater 2	Rater 3	Rater 4	Inter-Rater Agreement/ Item	Inter-Rater Agreement/ Item for All Raters
1	9	5	5	5	5	100.00	
1	11	3	.	5	.	80.00	
1	12	5	5	.	.	100.00	
1	13	5	5	5	5	100.00	
1	14	5	5	5	5	100.00	
1	15	5	5	5	5	100.00	
1	16	5	4	.	.	90.00	96.78
2	1	10	12	.	.	73.33	
2	2	15	15	15	.	100.00	
2	5	15	15	.	.	100.00	
2	6	10	10	10	10	66.67	
2	7	15	15	12	.	93.33	
2	8	15	15	15	.	100.00	
2	9	15	15	15	15	100.00	
2	10	11	12	11	.	75.56	
2	11	15	.	15	.	100.00	
2	12	11	15	.	.	86.67	
2	13	15	15	15	15	100.00	

2	14	15	15	15	15	100.00	
2	15	15	15	15	15	100.00	
2	16	7	6	.	.	43.33	86.60
3	1	12	15	.	.	90.00	
3	2	10	15	13	.	84.44	
3	3	15	15	15	.	100.00	
3	4	10	6	6	6	46.67	
3	5	15	15	.	.	100.00	

Item Number	Rubric Number	Rater 1	Rater 2	Rater 3	Rater 4	Inter-Rater Agreement/ Item	Inter-Rater Agreement/ Item for All Raters
3	6	10	10	10	10	66.67	
3	8	15	15	15	.	100.00	
3	9	15	15	15	15	100.00	
3	10	8	15	10	.	73.33	
3	11	8	.	7	.	50.00	
3	12	15	15	.	.	100.00	
3	13	15	15	15	15	100.00	
3	14	15	15	15	15	100.00	

Item Number	Rubric Number	Rater 1	Rater 2	Rater 3	Rater 4	Inter-Rater Agreement/ Item	Inter-Rater Agreement/ Item for All Raters
3	15	15	15	15	11	93.33	
3	16	10	10	.	.	66.67	84.17
4	1	5	4	.	.	90.00	
4	2	3	5	5	.	86.67	
4	3	5	5	5	.	100.00	
4	4	5	5	5	5	100.00	
4	5	5	5	.	.	100.00	
4	6	5	5	5	5	100.00	
4	7	5	5	4	.	100.00	
4	8	5	5	5	.	100.00	
4	9	5	5	5	5	100.00	
4	11	5	.	5	.	100.00	
4	12	5	5	.	.	100.00	
4	13	5	5	5	5	100.00	
4	14	5	5	5	5	100.00	
4	15	5	4	5	5	95.00	
4	16	3	5	.	.	80.00	96.98

Appendix C: District and School Consent Letters

RIDGEFIELD PUBLIC SCHOOLS

70 Prospect Street ◆ Ridgefield, Connecticut 06877
◆ (203) 431-2800 ◆ Fax (203) 431-2810

April 2, 2009

To Whom It May Concern:

This letter is written to inform you that the Ridgefield Public School system is aware of and supports Jacob Greenwood's study of student self-regulatory skills as part of his coursework at WCSU. I am aware that Mr. Greenwood is working with science teachers and students and students at Ridgefield High School.

Sincerely,

Patricia A. Michael

Patricia A. Michael
Assistant Superintendent

www.ridgefield.org

Ridgefield High School
700 North Salem Rd.
Ridgefield, CT 06877
(203) 438-3785 Fax (203) 431-2891

Jeffrey Jaslow, Principal

Diane de Cristo, Assistant Principal
Sarah Isaac, Assistant Principal
Stephanie Parker, Assistant Principal
Robert Slavinsky, Ph.D., Assistant Principal

Kevin Callahan, Dean
Jacob Greenwood, Dean
Marc Katz, Dean
Andrew Maccabe, Dean

February 12, 2009

Dear Parent/Guardian:

This is to confirm that the Ridgefield High School administration is aware of and supports Jacob Greenwood's study of student self-regulatory skills as part of his course work in Instructional Leadership at WCSU.

I understand that Mr. Greenwood will work with a number of science teachers who will be making use of student reflective portfolios in the context of the research project. We are happy to participate in such a project.

Sincerely,

Jeffrey Jaslow
Principal

JJ/al

Appendix D: Consent/Assent Form

February X, 2009

Dear Parent(s)/Guardian(s),

My name is Jacob Greenwood and I am a doctoral candidate from the Department of Educational Psychology at the University of Western Connecticut. Additionally, I have worked at Ridgefield High School as a science teacher and the Dean of Students for the past ten years. I would like to include your child, along with his or her classmates, in my research project on student self-regulatory skills. If your child takes part in the study, he or she will participate in one of two groups. One group will produce a portfolio of work completed in their science class, reflect on that work, and be given specific feedback on their performance in relation to their self-regulatory skills. These portfolios will be graded by his or her classroom teacher. A self-regulatory skills survey will be administered to both groups within his or her class. Both the survey data and portfolio scores will be used to measure the effect of portfolio production in the science classroom. I do not anticipate any risk to your child and your child may benefit from the research by learning more about his or her self-regulatory skills.

Both, the Ridgefield Board of Education and the building Principal have given permission for this study to be completed. The use of portfolios in the classroom is highly aligned with Ridgefield High School's mission statement to enable students to become self-directed and self-reflective learners. Additionally, your child's teacher has volunteered to participate in this study and has received professional development in the production and scoring of portfolios.
Your child's participation in this study is completely voluntary. In addition to your permission, your child will also be asked if he or she would like to take part in this study. Only those children who want to participate will do so, and any child may stop taking part at any time. The choice to participate or not will not impact your child's grades or status at school. To ensure confidentiality, your child's name will not be used and all information gathered will be reported as group results, not individual student results. Please be assured, all information gathered will be held will be held in strict confidence.

On the attached page, please indicate whether you do or do not want your child to participate in this study. Please ask your child to return this form to his or her classroom teacher by February X, 2009. The second attached copy is for your records. Please feel free to contact me directly with any questions. Thank you in advance for your support.

Sincerely,

Jacob Greenwood
Biology Teacher/Dean of Students
Ridgefield High School
(203) 438-3785 x1311
jagreenwood@ridgefield.org

The Effect of Reflective Portfolios on Student Self-Regulatory Skills in Science

Parent/Guardian Section:

If you agree to have your child participate, please complete the following information. Your signature indicates that you agree to have your child participate in the study.

PRINT YOUR CHILD'S NAME	PRINT YOUR CHILD'S TEACHERS NAME

PRINT YOUR NAME	SIGNATURE	DATE

Student Section:

Student's Name PRINTED	Student's SIGNATURE	DATE

I, the signer of this form, have been informed of and understand the nature of this study and freely consent to participate.

Please have your child return this form to: YOUR CHILD'S CLASSROOM TEACHER AT HIS OR HER SCHOOL

This research project has been reviewed and approved by the WCSU Institutional Review Board. If you have questions concerning the rights of the subjects involved in research studies please call the WCSU Assurances Administrator, at (203) 837-8281.

Appendix E: Teacher Reflective Portfolio in Science Implementation Packet

Building Reflective Science Portfolios

1) Why portfolios?

    a. Science teachers lack quality formative assessments.

b. Students do not know what it means to “be a good student”
c. Students do not know what to do to become a “good student”
d. Students have few, if any, coping skills once they realize that they just might not be as “good a student” as they thought they were
e. Students routinely have one study technique that they use no matter the course or the content
f. Students lack opportunities to have meaningful dialogues about performance with their teachers

2) What does all this suggest?
   Students need to be taught self-regulatory skills.

3) Self-regulated learners are actively engaged in forethought, performance control, and self-reflection.
   - Forethought – students set goal for improvement and achievement
   - Performance control – students monitor their performance during activities
   - Self-reflection – students are metacognitive of their strengths and weaknesses related to specific outcomes on activities and use this information to set new goals

4) Correctly implemented, reflective portfolios can foster self-regulated learning and promote intrinsic motivation, internally controlled effort, mastery goal orientation, and meaningful learning.

5) Let’s look at the student packet.

6) Anybody got a calendar?

7) You can switch “other” to be specific for your class. The 5-point “other” will be a smaller assignment such as a homework assignment, article review, or in-class activity within the five week period. The 10-point “other” will be a larger assignment such as a project or term paper within the 10 week time frame (or the entire quarter). After this, I can make copies of the student packet for you.

8) Grading with the rubric and scoring sheet. The rubric is the guideline you must use to assign a point value to each artifact included in the portfolio. You will convert your qualitative values of excellent, proficient, or unsatisfactory to quantitative numbers using Table 1 below. A Total is calculated by adding up the individual values from each included artifact for the selected grading period.

Table 1

Artifact Scoring Guidelines

	Unsatisfactory	Proficient	Excellent

Scoring range of 1-5	1-2	3-4	5
Scoring range of 1-10	1-4	5-7	8-10
Scoring range of 1-15	1-5	6-10	11-15

9) Comments on the scoring sheet. You must provide specific and deliberate feedback addressing students self-regulatory skills based on their included artifacts, their reflections, and your knowledge of them as learners. A list of self-regulatory suggestions is included in Table 2.

10) Grading needs to be timely. Students should be working on their portfolios even when you physically possess them because you are still grading. I urge you to make this grading a priority.

11) Goal setting. Mastery goals need to be set by the students. These goals need to be specific, attainable, and focused on their self-regulatory skills. For example "I want to get an A this quarter" is NOT an attainable goal for many students. Furthermore, what student doesn't want to get an A? *How*, specifically, does the student intend to achieve an A? "I will make note cards of all the terms in the chapter" or "I will study 10 minutes every other night two weeks prior to the exam" or "I will go see my teacher after every lab activity for clarification of my results and conclusions" or "I will form a study group with my three friends in this class and meet in the library every Thursday 7^{th} period to review course material". Now, at the end of the quarter we can say, was this goal beneficial, why or why not?

12) How much class time is this going to take? That ranges based on much you buy into this junk. Minimally, I will need to explain the research to the students, students will need to take a 30 minute MSLQ pre and posttest, and you will explain the portfolio, due dates, and goal setting procedures. If you want to take time for goal setting, exam corrections, and/or general portfolio work during your classes, so be it. Honestly though, students will probably need clarification on the directions and expectations over and over and over and over…

13) Consent forms. No student may participate (control or experimental) without having a signed consent form. I will hand the consent forms out when I explain the research to the students. Can you make it a grade? Ideally, but I just need them.

14) What if a student or his or her parents opts out? What if you just can not get a student to bring in the consent form signed? What if a kid bails in the middle of the portfolio and refuses to finish? First, direct all concerns and complaints to me. Next, in all cases students can be made to do the portfolio if it is a class grade, I just can't use their data. Remember, this is just *another* formative assessment you use and Ridgefield High School believes that teaching students to become self-regulated learners is important (see our mission statement in the front of your room). You can offer an alternative assignment

during any in class work time and excuse them from the portfolio in the grade book. Lastly, this is going to happen, so prepare for it.

15) Format. The Portfolio Rubric states that students are required to
    a) use excellent grammar, spelling, and sentence structure
    b) present material organized, logical, and sequential
    c) hand in the portfolio typed, neat, and presentable

…and, it is not a requirement, but tell them to keep it in a binder.

16) I own these. At the end of the quarter 4 grading cycle do NOT give the portfolios back to the students. I will painstakingly hunt the students down at the beginning of next year and return their portfolios. You can give them their grades any way you see fit, but *please* do not let them have the portfolios back.

17) Please, please, please let me know any concerns you have throughout the process or any way I can help.

18) Let's look at some exemplars.

Table 2 Self-Regulatory Feedback

Self-Regulatory Skill	**Suggested Feedback**
Metacognition	Analyze task before completing or handing in
	Access prior knowledge
	Track attention when reading

	Self-test when reading/studying
	Self-question when reading/studying
	Adjust cognitive activity to suit assignment/task at hand
	Check and correct behaviors during assignment completion/studying
Rehearsal	Recite and name items from a list (make note cards)
	Focus on encoding vocabulary with content
	Make connections between information
	Integrate new information with prior knowledge
Organization	Construct connections among information to be learned
	Select appropriate information to be learned
	Cluster related content
	Outline content/chapters
	Select/Identify main ideas while studying
Help Seeking	Seek support of peers (peer tutoring, study group)
	Seek support of teacher (come for extra help)
	Seek support of parents
Time & Study Environment	Manage available time
	Regulate time use
	Pick new/better study environment
	Set schedule to study/complete assignments
	Effectively use study time Set realistic study goals
	Organize study environment
	Choose a quiet study environment
Effort Regulation	Commit to completing goals
	Commit to new learning strategies
	Control attention even if content is uninteresting/not challenging
	Control attention even if content is too challenging
	Control attention in the face of distractions at school/home
Elaboration	Build internal connections between items to be learned
	Paraphrase
	Summarize
	Create analogies
	Generate notes from reading
	Integrate new material with prior knowledge
Critical Thinking	Apply previous knowledge to new situations to solve problems
	Make informed decisions
	Evaluate based on standards/criteria

Appendix F: Example Portfolio Grading

Goal Total: 4 (5 + 4 + 5 + 5 + 4 + 4 + 5/7 = 4)

Portfolio Rubric

	Points	Unsatisfactory (1-2)	Proficient (3-4)	Excellent (5)
1. Artifact included with corrections (when applicable)		- Does not include original graded artifact - Does not correct errors in original artifact	- Generally Includes original graded artifact - Generally corrects errors in original artifact	- Includes original graded artifact - Corrects errors in original artifact
2. Goal Setting	5/5	- Does not set worthy and attainable goal - Does not reflect on outcome of goal (why or why not met) - Does not describe future focus for meeting goal if not achieved	- Generally sets worthy and attainable goal - Generally reflects on outcome of goal (why or why not met) - Generally describes future focus for meeting goal if not achieved	- Sets worthy and attainable goal - Reflects on outcome of goal (why or why not met) - Describes future focus for meeting goal if not achieved
3. Quality Reflection:				
a. Coverage	4/5	- Does not address criteria the artifact was assessed with	- Generally addresses criteria the artifact was assessed with	- Addresses criteria the artifact was assessed with
b. Accuracy	5/5	- Does not depicts an accurate view of achievement and growth	- Generally depicts an accurate view of achievement and growth	- Depicts an accurate view of achievement and growth
c. Specificity	5/5	- Does not include examples to support points made in self-reflection	- Generally includes examples to support points made in self-reflection	- Includes examples to support points made in self-reflection
d. Integration	4/5	- Does not synthesizes important insights into broader conclusions about achievement	- Generally synthesizes important insights into broader conclusions about achievement	- Synthesizes important insights into broader conclusions about achievement
e. Revelation	4/5	- Does not bring new insights about learning	- Generally brings new insights about learning	- Brings new insights about learning
4. Format	5/5	- Does not use excellent grammar,	- Generally uses excellent grammar,	- Uses excellent grammar, spelling, and sentence

		spelling, and sentence structure - Is not organized, logical, and sequential - Is not typed, neat, and presentable	spelling, and sentence structure - Generally organized, logical, and sequential - Generally typed, neat, and presentable	structure - Organized, logical, and sequential - Typed, neat, and presentable

Portfolio Rubric

Test Total: 11(10 + 13 + 14 + 13 + 11 + 7 + 12/7 = 11)

	Points	Unsatisfactory (1-5)	Proficient (6-10)	Excellent (11-15)
1. Artifact included with corrections (when applicable)	10/15	- Does not include original graded artifact - Does not correct errors in original artifact	- Generally Includes original graded artifact - Generally corrects errors in original artifact	- Includes original graded artifact - Corrects errors in original artifact
2. Goal Setting		- Does not set worthy and attainable goal - Does not reflect on outcome of goal (why or why not met) - Does not describe future focus for meeting goal if not achieved	- Generally sets worthy and attainable goal - Generally reflects on outcome of goal (why or why not met) - Generally describes future focus for meeting goal if not achieved	- Sets worthy and attainable goal - Reflects on outcome of goal (why or why not met) - Describes future focus for meeting goal if not achieved
3. Quality Reflection:				
a. Coverage	13/15	- Does not address criteria the artifact was assessed with	- Generally addresses criteria the artifact was assessed with	- Addresses criteria the artifact was assessed with
b. Accuracy	14/15	- Does not depicts an accurate view of achievement and growth	- Generally depicts an accurate view of achievement and growth	- Depicts an accurate view of achievement and growth
c. Specificity	13/15	- Does not include	- Generally	- Includes examples to

		examples to support points made in self-reflection	includes examples to support points made in self-reflection	support points made in self-reflection
d. Integration	11/15	- Does not synthesizes important insights into broader conclusions about achievement	- Generally synthesizes important insights into broader conclusions about achievement	- Synthesizes important insights into broader conclusions about achievement
e. Revelation	7/15	- Does not bring new insights about learning	- Generally brings new insights about learning	- Brings new insights about learning
4. Format	12/15	- Does not use excellent grammar, spelling, and sentence structure - Is not organized, logical, and sequential - Is not typed, neat, and presentable	- Generally uses excellent grammar, spelling, and sentence structure - Generally organized, logical, and sequential - Generally typed, neat, and presentable	- Uses excellent grammar, spelling, and sentence structure - Organized, logical, and sequential - Typed, neat, and presentable

Portfolio Rubric

Lab Total: 11(10 + 13 + 14 + 13 + 11 + 7 + 12/7 = 11)

	Points	Unsatisfactory (1-5)	Proficient (6-10)	Excellent (11-15)
1. Artifact included with corrections (when applicable)	10/15	- Does not include original graded artifact - Does not correct errors in original artifact	- Generally Includes original graded artifact - Generally corrects errors in original artifact	- Includes original graded artifact - Corrects errors in original artifact
2. Goal Setting		- Does not set worthy and attainable goal - Does not reflect on outcome of goal (why or why not met) - Does not describe	- Generally sets worthy and attainable goal - Generally reflects on outcome of goal (why or why not met) - Generally	- Sets worthy and attainable goal - Reflects on outcome of goal (why or why not met) - Describes future focus for meeting goal if not achieved

		future focus for meeting goal if not achieved	describes future focus for meeting goal if not achieved	
3. Quality Reflection:				
a. Coverage	13/15	- Does not address criteria the artifact was assessed with	- Generally addresses criteria the artifact was assessed with	- Addresses criteria the artifact was assessed with
b. Accuracy	14/15	- Does not depicts an accurate view of achievement and growth	- Generally depicts an accurate view of achievement and growth	- Depicts an accurate view of achievement and growth
c. Specificity	13/15	- Does not include examples to support points made in self-reflection	- Generally includes examples to support points made in self-reflection	- Includes examples to support points made in self-reflection
d. Integration	11/15	- Does not synthesizes important insights into broader conclusions about achievement	- Generally synthesizes important insights into broader conclusions about achievement	- Synthesizes important insights into broader conclusions about achievement
e. Revelation	7/15	- Does not bring new insights about learning	- Generally brings new insights about learning	- Brings new insights about learning
4. Format	12/15	- Does not use excellent grammar, spelling, and sentence structure - Is not organized, logical, and sequential - Is not typed, neat, and presentable	- Generally uses excellent grammar, spelling, and sentence structure - Generally organized, logical, and sequential - Generally typed, neat, and presentable	- Uses excellent grammar, spelling, and sentence structure - Organized, logical, and sequential - Typed, neat, and presentable

Portfolio Rubric

Other Total: 5(5 + 5 + 5 + 5 + 5 + 5+ 5/7 = 5)

	Points	Unsatisfactory (1-2)	Proficient (3-4)	Excellent (5)
1. Artifact included with corrections (when applicable)	5/5	- Does not include original graded artifact - Does not correct errors in original artifact	- Generally Includes original graded artifact - Generally corrects errors in original artifact	- Includes original graded artifact - Corrects errors in original artifact
2. Goal Setting		- Does not set worthy and attainable goal - Does not reflect on outcome of goal (why or why not met) - Does not describe future focus for meeting goal if not achieved	- Generally sets worthy and attainable goal - Generally reflects on outcome of goal (why or why not met) - Generally describes future focus for meeting goal if not achieved	- Sets worthy and attainable goal - Reflects on outcome of goal (why or why not met) - Describes future focus for meeting goal if not achieved
3. Quality Reflection:				
a. Coverage	5/5	- Does not address criteria the artifact was assessed with	- Generally addresses criteria the artifact was assessed with	- Addresses criteria the artifact was assessed with
b. Accuracy	5/5	- Does not depicts an accurate view of achievement and growth	- Generally depicts an accurate view of achievement and growth	- Depicts an accurate view of achievement and growth
c. Specificity	5/5	- Does not include examples to support points made in self-reflection	- Generally includes examples to support points made in self-reflection	- Includes examples to support points made in self-reflection
d. Integration	5/5	- Does not synthesizes important insights into broader conclusions about achievement	- Generally synthesizes important insights into broader conclusions about achievement	- Synthesizes important insights into broader conclusions about achievement
e. Revelation	5/5	- Does not bring new insights about learning	- Generally brings new insights about learning	- Brings new insights about learning
4. Format	5/5	- Does not use excellent grammar,	- Generally uses excellent grammar,	- Uses excellent grammar, spelling, and sentence

		spelling, and sentence structure - Is not organized, logical, and sequential - Is not typed, neat, and presentable	spelling, and sentence structure - Generally organized, logical, and sequential - Generally typed, neat, and presentable	structure - Organized, logical, and sequential - Typed, neat, and presentable

Scoring Sheet

Quarter 3 (weeks 1-5)

Goal Worksheet
1 2 3 (4) 5

Unit Test
1 2 3 4 5 6 7 8 9 10 (11) 12 13 14 15

Lab Report
1 2 3 4 5 6 7 8 9 10 (11) 12 13 14 15

Other
1 2 3 4 (5)

Total = 31/40

Comments

John,

Your goal to make note cards for each chapter was both worthy and attainable. I have noticed you raising your hand more in class recently. Good job. You write in your reflections that you study in front of the TV and often procrastinate. Try finding a quite place in your house to study. Maybe your Mom can help you find a place. Also, do you keep an assignment pad? That would really help you manage your time better.

Quarter 3 (weeks 6-10)

Unit Test
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Lab Report
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Comments

Other
1 2 3 4 5 6 7 8 9 10

Total =

Appendix G: Teacher Scoring Sheets

Scoring Sheet

Quarter 3 (weeks 1-4)	Comments
Goal Worksheet 1 2 3 4 (5)	Great goal! Keep it in mind through the quarter.
Unit Test 1 2 3 4 5 6 7 8 9 10 11 12 13 14 (15)	Preparation does pay off! Sometimes in our haste - we skip ahead of the questions and answer what we think was asked.
Lab Report 1 2 3 4 5 6 7 8 9 10 11 12 (13) 14 15	Keep a watchful eye on your calculations and think about what the numbers mean. Then ask yourself if it makes sense.
Other 1 2 3 4 (5)	Excellent comments on organization to write a technical paper. Would the same process be useful for your R&D Project?
Total = 38	

Quarter 3 (weeks 4-9)	Comments
Unit Test 1 2 3 4 5 6 7 8 9 10 11 12 13 (14) 15	Good prep = good grades. It can be very helpfull to read + understand the problem then plot your approach before putting a pencil to paper. Can actually save time.
Lab Report 1 2 3 4 5 6 7 8 9 10 11 12 13 14 (15)	Nice work! Showing messy work is much better than none at all. On the purpose - write what you would say to a class of students as an introduction to the lab.
Other 1 2 3 4 5 6 7 8 9 (10)	Try practicing in front of your parents. They might see things to improve that you won't realize because you are focused on giving the presentation.
Total = 39	

5

Dom- you need to include the handout with your goal on it. Please add + give back to me. Also use the Hydrate lab report not the Stoich quiz

Scoring Sheet

Quarter 3 (weeks 1-5)

Goal Worksheet
1 2 3 4 5 (5)

Unit Test
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 (12)

Lab Report — Hydrate Lab
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 (13)

Other
1 2 3 4 5 (5)

Total = 35

Comments

Good goal! Hope it works for you.

Think about the problems – then start working! Keep checking yourself to make sure you're on the right track.

Keep checking the instructions during labs (and other stuff) to make sure you are answering the questions

Analyze the problem – research – then outline your response, then start writing. See a link to the RXN Project?

Quarter 3 (weeks 6-10)

Unit Test
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 (11)

Lab Report
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 (11)

Other
1 2 3 4 5 6 7 8 9 10 (7)

Total = 29

Comments

30 minutes may not be enough time. Do you need more time or should you try a different approach to test prep?

Think of specific actions to take to improve your labs. Read + review before the lab. Come + ask questions

Consider what you would do differently if you had another such assignment.

og

Quarter 4 (weeks 10-14)	Comments
Goal Worksheet 1 2 3 4 5	
Unit Test 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	
Lab Report 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	
Other 1 2 3 4 5	
------------------------ Total =	

Quarter 4 (weeks 15-19)	Comments
Unit Test 1 2 3 4 5 6 7 8 9 10 11 12 13 14 (15)	Those concepts + vocab look easy but aren't.
Lab Report 1 2 3 4 5 6 7 8 9 10 11 12 (13) 14 15	Read the procedure carefully!
Other 1 2 3 4 5 6 7 8 9 10	Review procedure + data during the lab to insure you are heading in the right direction.
Complete Unit 1 2 3 4 5 6 7 8 9 10 0	
Final Reflection 1 2 3 4 5 6 7 8 9 (10)	Good job! Keep setting goals + study + Sr. year will be enjoyable + over before you know it.
Keeper Letter 1 2 3 4 5 6 7 8 9 (10)	
Complete Scoring Sheet (10)	Great letter Dan!
------------------------- Total = 66	

6

Quarter 4 (weeks 10-14)	Comments
Goal Worksheet 1 2 3 4 5	Appropriate and insightful! nice to see you're meeting the time goal
Unit Test 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	Make sure to look for connections, why/How? for reasons to explain
Lab Report 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	Nice work. Very organized
Other 1 2 3 4 5	What connection/association with your learning?
Total = 38/40 Nice Improvement	

Quarter 4 (weeks 15-19)	Comments
Unit Test 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 Wonderful	Your progress is Dramatic and it's evident in your class participation and Grades. Your commitment to this portfolio is testament to your work ethic. I hope you found this Activity helpful!
Lab Report 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	
Other 1 2 3 4 5 6 7 8 9 10	
Complete Unit 1 2 3 4 5 6 7 8 9 10 missing 1 Day	
Final Reflection 1 2 3 4 5 6 7 8 9 10	
Keeper Letter 1 2 3 4 5 6 7 8 9 10	
Complete Scoring Sheet 10	
Total = 67/70 Great work	

6

Scoring Sheet

Quarter 3 (weeks 1-4)	**Comments**
Goal Worksheet 1 2 3 4 5	Very practical. Effective time management = key to success
Unit Test 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	- Why do so well? Explain
Lab Report 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	- Establish connections: practical application of this lab + your learning!
Other 1 2 3 4 5	
Total = 28/40 * Include all parts of portfolio	- Construct connections: prior learning and further extensions/opportunity for connection

Written Reflection

Quarter 3 (weeks 4-9)	**Comments**
Unit Test 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	Again, why do you excel in one section - you explored a bit more but do this for each problem
Lab Report 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	Same as above. Not just answers. Reflections!!
Other 1 2 3 4 5 6 7 8 9 10	I like your thoughts!
Total = 32/40	

5

Quarter 4 (weeks 10-14)	Comments
Goal Worksheet 1 2 3 4 5	Excellent specific + achievable goal! Is it working?
Unit Test 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	~~From this lab~~ We all have occasional setbacks when we're not ready. Plan to prepare better for the next test, + you'll see.
Lab Report 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	From this lab, I'd say — Its helping! fine!
Other 1 2 3 4 5	See what I mean!
------------------------ Total =	

Quarter 4 (weeks 15-19)	Comments
Unit Test 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	a few small errors – keep in mind that you mastered the information!
Lab Report 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	Looks like your goal to read labs helped!
Other 1 2 3 4 5 6 7 8 9 10	Keep this in mind next year in Physics! Read the labs before class + think + plan!
Complete Unit 1 2 3 4 5 6 7 8 9 10	What a lot of stuff to learn! Great job!
Final Reflection 1 2 3 4 5 6 7 8 9 10	Just keep trying + it will come to you.
Keeper Letter 1 2 3 4 5 6 7 8 9 10	I'm very happy you didn't follow in your Mom's footsteps by blowing things up! I agree with her that you've done an incredible amount of work this year!
Complete Scoring Sheet 10	
------------------------- Total = 80	

6

Appendix F: Student Reflections

[redacted]

This portfolio was very time consuming and I didn't like doing it. But in the end, It shows me how important it is to see the work I have done and the grades I got. This whole year I became much more interested in science. I really enjoyed this class & enjoyed Oceanography. I wish that I didn't have to learn chemistry and biology in my next few years of high school. During this school year, I have learned things in science that will help me succeed throughout my next seven years as a student. Studying for tests, completing all assignments, listening attentively in class and asking many questions in class are all very important factors to doing well as a student. I can say I have taken away so much from this class and hopefully I will leave my bad habits behind me.

Goals Worksheet

☆ *Goals MUST be worthy and attainable during the quarter* ☆

Quarter 3 Goal Statement #1 (date: 2/18/09): My goal is to study atleast one hour for every test, make notecards and review / complete practice math problems, all in preparation.

Reflection on meeting this goal (date: 3/11/09):
(Attach another sheet if necessary)

~~Please reflect on your goal for Q3~~

Nevermind I wrote this before looking at your typed reflection!

Future focus on attaining this goal, if it has not been achieved:

Quarter 4 Goal Statement #2 (date: 5/11/09):
My goal is to read over labs before Monday Lab days in order to get a better understanding and be more successful and accurate when completing the labs.

Reflection on meeting this goal (date:):
(Attach another sheet if necessary)

Included in Final reflection

Future focus on attaining this goal, if it has not been achieved:

3

[redacted]

Acid Rain Paper Reflection

I think I did really well on my acid rain paper. I got a 24 out of 25. I took a lot of time writing it and it paid off. It took me about three hours to write it and find articles. I lost point because I had a few punctuation and spelling errors. To prevent that I could have reread the paper a few more times. However, I'm not too good at catching grammar mistakes.

I was happy with the way I approached the paper. I first answered all of the questions given on the assignment sheet using information from my notes and the Internet. From there I figured out how I would group and organize my three paragraphs. I then just pieced the paper together and added a few sentences. I think this helped me make sure I include all of the information and have a well-organized paper.

From this assignment, I learned that my class notes I took from a PowerPoint, plus Internet sources helped me a lot with finding good information. In addition, the way I approached the paper worked really well for me.

[redacted]

Empirical Formula Lab

In this lab, we measured the change in mass of Cobalt (II) Sulfate after heating it in a crucible. I got a 23 out of a possible 25 points. I cannot complain, I am happy. Performing this lab was simple and there was not a lot of error. However, the calculations were a different story.

I really struggled with calculating the moles of water and Anhydrous. I also had trouble initially figuring out how to calculate the mass of the sample and the change in the sample.

I learned that although I may understand how to do the empirical formula in an isolated problem I tend to have trouble applying it to labs. I also learned that one small calculation could throw off every single other calculation. For example, when I calculated the mass of the sample that led to incorrect data about the percent water and anhydrous sulfate.

[redacted]

Test Reflection

This test was on unit 8 calculations. It covered molar mass, percent composition, conversions, the empirical formula and the molecular formula. I did well on this test. My grade was an A. At the beginning of this unit I struggled at first with some of the homework worksheets, however, I eventually figured out how to be successful at them. I practiced the steps for each type of problem, thusly making me more secure and comfortable with handing the wide range of problems. I studied for this test by reviewing my notes and homework worksheets; I also worked through more complex problems that had to do with molecular formula.

Most of the mistakes I made on this test were simple. One mistake was just forgetting to put parentheses on number 3 around the hydroxide ion. That led to mistakes when calculating the molar mass. The next mistake I made was on problem number 6. I just had a simple calculation error, meaning I must have plugged it into the calculator incorrectly. My final mistake was on problem 8. I did not read the question carefully so I didn't fully complete the problem. Next time I will make sure, I slow down when reading word problems before jumping right in.

I learned that I prepare well for tests and it usually pays off. I do struggle very much with learning chemistry. It takes me a while to catch on sometimes. However, I'm thankful that once I understand it, I get it. I also learned that I need to read test questions more carefully instead of quickly starting calculations. Overall, I feel like this test was a success and that I truly understood the material and didn't just memorize it for the test sort-a-thing.

[redacted]

Chapter 13: Gas Laws Test

This was my poorest test grade all year. I received a 66%. The content covered was information on the gas laws and calculations. On the multiple-choice section in a few cases, I narrowed it down to two possible answers and then picked the incorrect one. I didn't study the vocabulary on this section because I was so occupied with the calculation portion. Next, were the calculations where I struggled the most. I was tricked by question #8 that included extra, unnecessary information. When taking tests I always assume that all the information is important and therefore attempted to use it all giving me an incorrect answer. I also made a bunch of small errors on the calculation portion such as: using the wrong labels, misplacing the decimal point and forgetting to balance the equation. The final part of the test was the short answer portion I got points off for not answering the question fully. While taking the test I thought explaining how gases exert pressure and how increasing the temperature would affect the gas particles and the pressure would infer what happens when the temperature is decreased. I should have explained clearly, what happened when it was decreased since that is what the question asked.

From this test, I learned that the vocabulary is equally important as the calculations. I also learned that some questions can be tricky so reading them over carefully and not rushing is key. Finally, I learned when answering essays I should ensure I am responding the exact question appropriately.

I studied very hard for this test. I really had trouble with this chapter. I did my best, but next time I will definitely be careful and make sure I am answering the questions appropriately and not making any simple errors. If I didn't make those errors my grade probably could have been a C+ instead of a D+.