SOFTWARE-SUPPORTED SELF-REGULATED LEARNING STRATEGIES IN AN ACADEMIC SETTING

by

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ABSTRACT

Research on learning strategies and tactics has become important to explain students' self-regulated learning. This study, informed by Winne's self-regulated learning model, investigated students' use of strategies and tactics in an authentic learning environment. Participants were 176 students in an introductory educational psychology course. Students used cognitive tools in gStudy, an educational software application, to facilitate learning.

The Motivated Strategies for Learning Questionnaire (MSLQ) was used to identify strategies and tactics reported by students. A cluster analysis was conducted to select representative students for qualitative content analysis of notes made while studying. The analysis identified two clusters, high-regulators and low-regulators. For each cluster, three representative participants were selected whose MSLQ reports were near the cluster centre. Content analysis of the six participants' notes was conducted to qualitatively describe the learning strategies of the high-regulators and low-regulators.

Keywords: Self-regulated learning, learning strategy, gStudy

DEDICATION

I want to thank my dearest wife Ying. In the journey of conducting this study, I want to acknowledge Ying's whole-hearted encouragement and support. I owe a monumental "Thank You" for what you have done for my life.

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GLOSSARY

AGQ	Achievement Goals Questionnaire
COPES	Conditions–Operations–Products–Evaluations–Standards
EBI	Epistemic Beliefs Inventory
LASSI	Learning And Study Strategies Inventory
MAI	Metacognitive Awareness Inventory
MSLQ	Motivated Strategies for Learning Questionnaire
SRL	Self-Regulated Learning

CHAPTER 1: INTRODUCTION

1.1 Value of Research

The way in which students control their learning is an important factor which affects students' performance both in the academic settings and throughout their working lives (Zimmerman, 2002). As learning is a life-long journey, self-regulatory skills may create more opportunities for developing life-long learning skills, and self-regulated learners may be better able to actively and autonomously guide their own learning and update their learning skills as necessary (Zimmerman, 2002).

Zimmerman (1990) assumed that students are strategic toward the attainment of their learning goals and they adapt their own learning strategies for challenging learning tasks and activities. Schunk (2005) suggested that students have capability to better manage their learning processes which help them to achieve higher academic performance. However, Zimmerman (2002) discovered that many students have insufficient knowledge to self-regulate their learning effectively in academic settings. Furthermore, in many learning situations, Winne (1997) found that when engaging in academic learning tasks, students choose and adapt study tactics and learning strategies with little or no help. When applying tactic and strategies, they often experience problems such as misunderstanding learning tasks, mis-targeting learning goals and misperception of the effectiveness of specific strategies and tactics (Butler & Winne, 1995).

From this perspective it is particularly desirable that we seek to understand students' self-regulated learning processes to provide them with help and support in some key process in SRL such as goal setting, planning learning strategies use, applying learning strategies effectively, self-monitoring and self-evaluating.

Research has indicated that the way in which students adopt specific processes personally and adapt them for various learning tasks is an important factor in determining academic performance (Zimmerman, 1990; Pintrich, 1990). As students become better able to use learning strategies, they will become more successful in academic settings (Pintrich & Zusho, 2002). However, several basic questions remain: How do learning strategies work in self-regulated learning? Are students aware of appropriate learning strategies while confronting various learning tasks? Which learning strategies do students choose and apply and in which circumstances? Are those learning strategies related to academic success? Can these self-regulated dimensions of academic functioning be defined and measured?

To tackle the above questions, how students choose and adapt learning strategies becomes a critical area in need of exploration. Portraying the characteristics of self-regulated students' learning process as well as their use of learning strategies in real time and context is becoming increasingly important. Moreover, it is crucial to consider what factors can facilitate or constrain effective learning strategies use.

1.2 Limitation of Previous Research

Much research on self-regulated learning has relied on self-report data, asking students to summarize their learning activities and rate their performance across varied settings and contexts. Self-report instruments such as the MSLQ (Motivated Strategies for Learning Questionnaire, Pintrich, Smith, Garcia & McKeachie, 1991) and LASSI (Learning And Study Strategies Inventory , Weinstein, Palmer, & Schulte, 1987) have been frequently used for assessing learning processes in SRL. However, these instruments may not provide precise measurements for context-specific learning processes because they ignore context (Perry, 2002). For example, the questionnaire protocol may presume that students have knowledge of various study tactics or strategies and are able to rate their importance, despite the likelihood that students relate their judgements to a particular context but exclude others.

Although self-report instruments reveal that the components of effective learning strategies use are associated with goal orientation, motivational beliefs, self-monitoring, self-evaluation and so on, they do not explicitly investigate the link between learning strategies and learning contexts (Winne & Perry, 2002). More specifically, they do not relate context to how and why specific learning strategies are chosen to approach certain learning goals.

Furthermore, Zimmerman and Martinez-Pons (1988) observed that students are often unable to monitor and report accurately on their cognitive processes. Winne and Jamieson-Noel (2002) found that the correlations between students' self-reports and their actual use of study tactics were low, suggesting that self-reported data do not give a very accurate picture of how students actually use study tactics, and self-report methods may not be reliable to analyze study tactics when students engage in different learning tasks. Therefore, we need to use authentic and objective methods to capture the dynamic, multifaceted and procedural nature of self-regulation.

There is abundant research investigating students' general attributes in SRL, however there is little research that has gathered and analyzed data about contextualized self-regulated learning, consequently we have insufficient knowledge available that sheds light on how students enact specific tactics and learning strategies to approach learning goals when facing different learning tasks (Winne & Hadwin, 1998).

Although fine-grained research on how students choose and adapt learning strategies in SRL has emerged as an important issue, we have few instruments to capture and analyze the small-grained cognitive progresses when learning unfolds (Pintrich, Wolters & Baxter, 2000; Winne & Perry, 2000). Winne and Perry (2000) also noted that little research has viewed SRL as a progression of events that evolve over time and measured SRL as an event (Winne, 2001).

There also remain some challenges for researchers. For example, the cognitive processes during learning events probably occur simultaneously, interactively and in rapid succession. It challenges researchers to observe students' cognitive engagement in specific learning contexts and gather relevant data when learning processes progress.

Previous research (Pintrich & Zusho, 2002; Zimmerman & Martinez-Pons, 1988) also revealed a variety of complexly interacting factors that affect students' academic development and strategies and tactics use. For example, Pintrich and Zusho (2002) revealed that students showing greater personal interest in the learning tasks use learning strategies more adaptively. Winne (1998, p. 107) argued that "the number and complexity of factors multiplies when students enact study tactics to bootstrap more productive forms of self-regulated learning". Thus we need to obtain valid measures of the covert small-grained self-regulatory activities to explore how students adapt learning strategies in their self-regulated learning processes.

1.3 Purpose of this Research

Winne and Hadwin's model (1998) of SRL is applied to help understand the dynamics of learning processes and contextual differences in SRL. In the four stages of Winne and Hadwin's model: (1) a learning task is interpreted by students in terms of what they know and believe; (2) students form goals based on the perception and choose tactics or strategies that they predict can help reach the goals; (3) students apply the tactics or strategies; and (4) observe the results and modify their strategies and tactics accordingly. By constantly monitoring the match between the products ensued from study tactics use and the standards that they planned to achieve, students generate internal and external feedback in their learning processes and revise plans and beliefs based on the feedback (Winne & Hadwin, 1998).

To study the actual use of learning strategies and tactics in the learning process, students enrolled in an introductory Educational Psychology course were introduced to gStudy, a software application designed to facilitate SRL when students engage in academic learning tasks. gStudy is also designed to function as a set of cognitive tools and help students develop new tactics for studying diverse learning materials. gStudy enables students to effectively use study tactics, better plan and organize learning strategies and tactics, adapt learning strategies and study tactics to approach learning goals and enhance learning experiences (Winne, Hadwin, Nesbit, Kumar & Beaudoin, 2005). As a research tool, gStudy collects trace data by recording students' learning activities in real time and context. For example, when a student makes notes in gStudy, trace data are recorded simultaneously in the course of the student's learning process which indicate occurrences of certain cognitive engagement within the specific learning task.

When trace data are complemented with students' self-report data collected by the MSLQ instrument, it greatly helps to gain empirical understanding of how students use self-regulated learning strategies.

The main objective of this study is to investigate the use of learning strategies and tactics when students engage in academic tasks using gStudy. It aimed to gain both theoretical and empirical understanding of questions such as how use of learning strategies is related to academic achievement, how learning strategies function in authentic contexts of learning, and how students differ in using learning strategies in their learning episodes.

1.4 Research Question

To investigate the relation between the use of self-regulated learning strategies and performance and achievements in academic settings, this study is investigating the following questions:

1. Is students' achievement associated with their self-reported use of learning strategies when using gStudy?
2. How do learning strategies and tactics function in authentic contexts of learning? What tactics and strategies are mostly used when students engage in learning tasks? What factors affect students in choosing the use of tactics and strategies?

3. What's the difference between high self-regulating students and low self-regulating students?

1.5 Structure of Thesis

This thesis consists of six chapters. In Chapter 1, I introduce the purpose of this research, limitations of previous research, and the research questions. In Chapter 2, I review the background of self-regulated learning, and provide a literature review on learning strategies, study tactics, and Winne and Hadwin's model of self-regulated learning. In Chapter 3, I describe gStudy as a set of cognitive tools and research tool. In Chapter 4, I present the research methodologies used in this study. I discuss the qualitative and quantitative nature of the present study, the description of the subjects, and the choice of the research method. I also describe how the data were collected in this study. In chapter 5, I present the data analysis procedure, the nature and content of each instrument used and how the analysis was conducted in detail. Also in that chapter I present results obtained from the cluster analysis and content analysis. In Chapter 6, I summarize the results from the data analysis in this study, review the limitations of the study and propose future research.

CHAPTER 2: LITERATURE REVIEW

2.1 What is Self-regulated Learning?

Self-regulated learning (SRL) generally refers to the ways that students take control of their own learning. Research on how learners self-regulate their own learning processes has been conducted increasingly over the past two decades. There are a variety of definitions based on several self-regulated learning models offering different perspectives on how self-regulation develops and operates (Zimmerman, 1998; Pintrich, 2000; Winne, 1998). The nature of the present study is learning strategies oriented. In the literature review I discuss students' self-regulated learning strategies use in the models proposed by Zimmerman, Pintrich, and Winne and Hadwin respectively, based on the fact that learning strategies use is considered an important factor in those models.

In the present study, I chose university students to represent self-regulated learners as a basis for addressing issues about how SRL develops. The focus in the present study is not over the life span, but is instead on self-regulation of people in an age range and situation in which they engage in various and abundant learning tasks and have control over their time and means to attain their learning goals.

2.1.1 Zimmerman's SRL Model

As mentioned above, researchers presented the definition of SRL from their specific research perspectives. From a social cognitive view, Zimmerman (1990, p. 4) defined self-regulated learners as "metacognitively, motivationally, and behaviorally active participants in their own learning". Metacognitively, self-regulated learners set learning goals, plan specific strategies, organize their time and environment, self-monitor their learning performance and self-evaluate the effectiveness of their learning strategies. Motivationally, expert self-regulated learners evaluate their learning outcomes, experience satisfaction with their efforts, attribute causation to results and build up positive beliefs about their capability. Behaviourally, self-regulated learners select and establish a physical learning environment, ask assistance from peers, parents, teachers, and seek information from other social sources. (Zimmerman, 1990)

Zimmerman (1998, 2002) proposed a cyclical, three-phase self-regulation model, consisting of a forethought phase, a performance phase and self-reflection phase. The forethought phase has two types of processes: task analysis and self-motivation. In task analysis, students analyze the requirements of a learning task, perceive information pertinent to learning goals, and plan learning strategies for task engagement. In self-motivation, students develop self-efficacy beliefs about their capability to learn and anticipate their learning outcomes.

In the performance phase, there are two types of processes: self-control and self-observation. Self-control refers to applying the strategies planned in the forethought phase to attain the learning goals. The self-observation involves keeping records of one's own learning process and finding out the effectiveness of learning strategies in their learning episodes.

The self-reflection phase also has two types of processes: self-judgment and self-reaction. In self-judgment, students evaluate their performance against some standards they expect to achieve. Then they self-reflect the causes of errors and attempt to attribute their errors or successes to particular causes. In self-reaction, they respond to their performance by increasing or decreasing self-satisfaction and make adjustments on the effectiveness of the learning strategies they applied in their learning process.

2.1.2 Pintrich's SRL Model

Also from a social cognitive view, Pintrich (2000, p. 453) defined self-regulated learning as "an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behaviour, guided and constrained by their goals and contextual features in the environment".

Pintrich (2000) proposed a four-phase self-regulated learning model comprised of forethought, monitoring, control and reflection. For each phase, there are four possible areas that specify self-regulatory activities, namely, cognition, motivation, behavior and context areas.

In the forethought phase, students set learning goals, activate prior content knowledge, and provoke the awareness of one's own weakness and strength regarding the learning task (cognitive area). They develop motivational beliefs about self-efficacy and adopt goal orientation based on task value and personal interest (motivational area). They plan time and effort for the tasks and subsequent self-observation (behavioral area) and develop perceptions of tasks and context (context area).

In the monitoring phase, students become aware of their comprehension and learning progress, and monitor their cognition (cognitive area). They also become aware of their motivation (motivational area) and their own behaviour (behavioral area) as well as task and context conditions (context area).

In the control phase, students select and adapt cognitive strategies for learning (cognitive area), use metacognitive learning strategies to adapt cognitive strategies, monitor their motivation (motivational area), control time and their effort (behavioral area), and change task and context conditions (context area).

In the reflection phase, students make cognitive judgments about the task engagement (cognitive area), evaluate them against their standards, attribute the errors or successes to the particular causes and relate affective reactions to the learning outcome (motivational area), choose subsequent behaviour (behavioral area) and evaluate task and context (context area).

2.1.3 Winne and Hadwin's SRL Model

Winne (2001) viewed self-regulated learning through the lens of information processing. Winne and Hadwin (1998, p. 278) defined self-regulated learning as "a metacognitively powered and governed process" in which self-regulated learners develop perceptions of the learning tasks, set goals and plan how to learn, and then apply and adapt study tactics and learning strategies to achieve the learning goals.

Winne and Hadwin's model (1998) comprises four main stages for each learning event. Each stage shares the same general structure of five dimensions, known as COPES (Conditions, Operations, Products, Evaluations, Standards).

Conditions are the attributes of the learning task which determine how the learning task is consequently engaged, for example, students' personal interest in the task, accessible physical and social resources, time constraints, their prior knowledge in regard to the learning task, and their knowledge about their repertoire of study tactics. These attributes may affect students' consequent self-regulatory engagement.

Operations are referred to as the cognitive processes about how information is processed. Students may apply different tactics and strategies to tackle the learning task. For example, they search for information, self-question, make comparisons, elaborate the learning material, or construct concept maps.

Products are new information created by operations. They exist in two forms: internal and external. Internal products are students' perceptions of the learning task originated from the up-to-date state in their learning processes and their new plans for adapting the study tactics. External products are the output of study tactics such as notes, highlighting, labeling, or concept maps when learning unfolds. Different products are thus created at each stage.

Evaluations are feedback about products. They can be generated from external sources such as changing of the learning environment, and comments received from peers and teachers. They can also be generated internally when students monitor products' attributes against the standards they intended to achieve.

Standards are qualities of products students expected to meet. Standards represent students' learning goals and provide students with criteria against which the products are monitored (Winne & Hadwin, 1998).

In stage 1, students develop perceptions of the learning task. They survey learning materials, physical and social resources, check constraints in the learning environment, estimate time to accomplish the task and access prior knowledge to develop a perception about what the learning task is, what constraints may affect the task engagement and whether available resources are in place.

In stage 2, students form goals. They specify the learning goal as profiles of standards which can be used as criteria against the successive products created in the learning process. Once the learning goal is set, students retrieve information of a study tactic or an array of tactics they predict that can assist in attaining the learning goal and then coordinate these tactics into a learning strategy to reach their goals.

In stage 3, students engage in the learning task by enacting the study tactics and strategies. They may highlight some regions of text in the learning material, label some paragraphs and link them to their prior knowledge. All the time, students metacognitively monitor the effectiveness of the study tactics applied and plan for alternative study tactics. They also monitor the match between the products and standards to adjust the standards, plan for altering the conditions of the learning task or carry out more operations.

Stage 4 is optional. In this stage, students may make major adaptations for self-regulatory engagement occurring in any of the preceding stages to attain the learning goal. They make judgements on their understanding of the learning task, goal, and tactics. They may redesign their plan for study tactics use or choose a different standard to monitor how they learn and how well they learn. They may re-evaluate resources to which they resort for future learning tasks.

According to Winne, this model is recursive, in that products generated in a given stage may not satisfy the standards, it thus iterates in the same stage until there is a match or standards are altered. Also this model is weakly sequenced in that the products of preceding stages may affect the conditions for successive task engagement, therefore student may proceed with the next stage or continue in the same stage (Winne & Hadwin, 1998).

2.1.4 Common Views on SRL

Although the terms vary from one model to another, researchers commonly view self-regulated learners as intelligent agents who select, shape, and add information to construct personal meaning, set their learning goals, select learning strategies and use them to achieve goals (Zimmerman, 1990 & 1998; Pintrich, 2000; Winne, 1998). Unlike passive recipients of information, self-regulated students actively seek information from internet or accessible resources and relate the information to their prior knowledge to construct personal meaning. They set attainable learning goals based on their perception and beliefs, and then apply various learning strategies to achieve their goals in favour of their personal choices. Then they monitor their own learning progress in relation to the goals and manage their time and efforts according to progressively updated feedback and motivation. In summary, all the researchers above agree that self-regulation is guided by strategic action, metacognition and motivation (Pintrich, 1990; Winne, 1997, Zimmerman, 1990).

Rather than delving into specifics that distinguish different models, in the present study I focused on how learning strategies are being applied in the self-regulated learning process. Learning strategies use is recognized as an important factor in the aforementioned self-regulated learning models. It has emerged as a crucial issue to understand the self-regulated learning process. Researching how a self-regulated learner forms goals, develops principles about how to learn, chooses and adapts strategies and tactics, and keeps track of learning outcomes becomes pivotal in capturing the dynamic, multifaceted and procedural nature of self-regulation (Zimmerman, 1990; Pintrich, 2000; Winne, 1998).

To better explore how students shape self-regulatory engagement to construct knowledge, research must focus on how variables like use of learning strategies, cognitive and metacognitive processes, prior domain knowledge, motivation and goal orientation are linked and interact in specific learning contexts. To tackle the research questions, I focus the research lens on learning events in which students apply study tactics and learning strategies and how they interact with other factors.

2.2 Learning Strategies

Strategies are defined as the implementation of a set of tactics or plans to accomplish predefined goals (Collins dictionary). A learning strategy thus can be described as a procedure or specific steps designed for a particular learning goal to accomplish learning tasks. Learning strategies manifest the way in which students monitor their learning outcome and control their learning endeavours to achieve learning goals (Zimmerman, 1994).

2.2.1 Learning Strategies in Zimmerman's model

Zimmerman (1990, p. 5) referred to learning strategies as "actions and processes directed at acquisition of information or skills that involve agency, purpose, and instrumentality perceptions of learners". Those strategies include organizing, goal setting and planning, seeking, coding and monitoring information, rehearsing or memorizing information, self-evaluating, self-reinforcing, and seeking advice from social sources when it is needed.

Zimmerman conducted much research (Zimmerman & Martinez-Pons, 1986 & 1988) investigating the relationship between students' learning strategies use and academic achievement. They reported that high achieving students used more self-regulated learning strategies.

In their study, Zimmerman and Martinez-Pons (1988) used a structured open-ended interview procedure to investigate relationship between students' use of learning strategies and academic achievement in school. Students' responses in the interview were tallied in a category that comprises the following learning strategies: self-evaluation, organization and transformation, goal setting and planning, information seeking, record keeping, self-monitoring, environmental structuring, giving self-consequences, rehearsing and memorizing, seeking social assistance, and reviewing. After correlating the students' strategy reports with their achievement in school, they found that students' learning strategies use was strongly associated with higher academic achievement, and that the students with lower achievement used fewer learning strategies due to their lack of self-regulatory initiative rather than lack of general ability.

In Zimmerman's model, learning strategies use is an important factor of self-regulated learning. Zimmerman (1990, p. 6) defined three features of self-regulated learning of learners: "their use of self-regulated strategies, their responsiveness to self-oriented feedback about learning effectiveness, and their interdependent motivational processes".

Learning strategies appear throughout Zimmerman's 3-phase self-regulating model. In the forethought phase, students plan learning strategies for task engagement based on student's understanding of learning tasks and their learning goals, and they predict how effective the learning strategies might be. In the performance phase, students apply the learning strategies planned and observe how they learn with the learning strategies. In the self-reflection phase, students make judgements on the learning strategies use in their learning episodes.

When students monitor their learning strategies use and their learning outcomes, they generate feedback on the effectiveness of the specific learning strategy, then students respond to the feedback to change learning strategies use. Students' awareness of learning outcomes is critical to learning strategies use in Zimmerman's model. Zimmerman also addressed that students' academic achievements benefit from students' awareness of effective learning strategies use and self-efficacy beliefs ensued (Zimmerman, 1990).

2.2.2 Learning Strategies in Pintrich's Model

Much of Pintrich's studies reported relationships between students' motivational orientation, self-regulation and academic achievement. Research has revealed that high achievers reported more use of self-regulated learning strategies than lower achieving students (Pintrich & DeGroot, 1990).

Pintrich's model (1990) is concerned with cognitive strategies by which students engage in learning tasks as well as metacognitive strategies by which students regulate their cognition and switch different cognitive strategies to accomplish the learning tasks.

There are three general types of cognitive strategies in Pintrich's model: rehearsal, elaboration and organization (Weinstein & Mayer, 1986).

Rehearsal strategies include students' repetition to memorize learning materials by copying it over or reproducing it without attaching personal meaning. Rehearsal strategies can be activities such as rote learning or copying learning materials directly. Elaboration strategies are students' attempts to summarize the content in the learning material or put the learning material into one's own words. Elaboration strategies can be activities such as summarizing, paraphrasing, and relating new information to prior knowledge. Organizational strategies involve making connections among the content in the learning material to better organize and understand the learning material. Organizational strategies can be activities such as grouping and categorizing information, drawing diagrams, and developing concept maps (Weinstein & Mayer, 1986).

In addition to these general cognitive strategies, Pintrich (2002) stressed that students have capabilities to apply various metacognitive strategies in planning, monitoring, and controlling and critical thinking. Metacognitive strategies include setting learning goals, monitoring one's comprehension, evaluating the learning process, and regulating one's time and effort. Pintrich and his colleges developed the Motivated Strategies for Learning Questionnaire (MSLQ) based on those four types of strategies (Pintrich, Smith, Garcia & McKeachie, 1991).

In Pintrich's model, cognitive strategies are applied mainly in control phases. Students use metacognitive knowledge to make decisions such as whether to keep using the current learning strategy or switch to another (Pintrich, 2002). Students not only need various strategies to regulate their cognition and learning, they must also have motivation to use the strategies.

Furthermore, the feedback system connects goals and strategies use. Pintrich noted that "monitoring, control, reaction can be ongoing simultaneously and dynamically as the goals and plans are changed and updated based on the feedback from the monitoring, control and reaction" (p. 455).

2.2.3 Learning Strategies in Winne and Hadwin's Model

Hadwin and Winne (1996) also linked strategy use with goals. They demonstrated that "the term strategy use refers to occasions when students define their own short-term goals and overall goals for studying and select and coordinate alternative study tactics they expect will be helpful in achieving those goals" (p. 694).

In Winne and Hadwin's model, students self-evaluate and make judgements on how they learn and whether they are on track in their learning process based on the feedback generated from their perceptions and self-evaluations of the learning task and discrepancies between expected learning goals and their up-to-date accomplishments (Winne & Hadwin, 2001). Each stage in the model constructs new information and products, therefore students engage in the learning task with metacognitively monitoring and control.

Metacognitive monitoring and control is a central element in Winne and Hadwin's model, producing internal feedback about the discrepancy between products and standards at each stage and external feedback about physical and social resources.

That feedback further serves as a basis for future self-regulatory activities (Winne & Perry, 2000).

2.3 Tactics

The classifications of learning strategies and how strategies use differed in various self-regulated learning models are useful for understanding different dimensions of learning strategies. However they may lack the sensitivity in differentiating the characteristics of the self-regulatory activities within diverse contexts (Perry, 2002). To investigate the use of learning strategies, much previous research has utilized self-report questionnaires like MSLQ (Pintrich, Smith, Garcia & McKeachie, 1991), LASSI (Weinstein, Palmer & Schulte, 1987) and structured interviews to measure self-regulated learning and create a profile of a student or a group of students. Those data normally are global attributes of students with respect to students' general actions in self-regulated learning process rather than actions engaged in a specific learning event or context (Winne & Perry, 2000).

Moreover, self-regulatory activity involves interacting cognitive, metacognitive and motivational factors (Pintrich, 2000; Butler & Winne, 1995; Winne & Stockley, 1998). Butler and Winne (1995) suggested that research on SRL at a larger grain size often failed to reflect how these factors are regulated in the learning process. In light of this, Winne and Perry (2000) suggested moving from studying aptitudes to studying situated learning events and shifting the grain size to a smaller level. Strategy, as a large grain-sized representation form of self-regulated learning process comprised of one or more cognitive processes, may be too complicated to investigate the cognition processes at each step when students engage in a learning task in real time. If we assume that self-regulatory activities evolve when students study in the course of engaging in learning tasks, a smaller grain-sized representation is necessary. Therefore, Winne (1996) distinguished between larger grain-sized learning strategies and smaller grain-sized tactics by defining strategy as an array of specific tactics. A tactic is a specific study technique such as underlining, note-taking, outlining, labeling, paraphrasing, or summarizing. Strategy, on the other hand, is a composition of these more specific tactics in which tactics have been coordinated (Winne, 2001). According to Winne and Perry, students "approach challenging tasks by choosing from a repertoire of tactics that they believe are best suited to the situation, and applying those tactics appropriately" (Winne & Perry, 2000, p. 533).

Winne (1998) proposed that self-regulated learning can be analyzed into two different activities: metacognitive monitoring and metacognitive control. Metacognitive monitoring is the cognitive operation by which student evaluate two inputs and generate feedback. One input is a profile of attributes of current products, and the other is a profile of attributes of the standards for these products. Students examine the degree of the discrepancies between the two inputs and generate feedback serving to regulate their further engagement. Metacognitive monitoring is omnipresent during any stage of the learning process in which students examine that which conditions of the current state of a task are in relation to standards that constitute goal. Metacognitive control is the cognitive mechanism that accounts for students corresponding to the discrepancies progressively generated by metacognitive monitoring. Winne and Hadwin (1998) modelled the discrepancies as IFs in an IF-THEN rule.

IF-THEN rules, also called condition-action rules, link metacognitive monitoring to metacognitive control. IF the current conditions of a learning task have certain attributes, THEN a specific operation is carried out. The package of an IF-THEN rule is a tactic (Winne, 1997). More specifically, tactics are bundles of cognitions that can be modelled in IFs, conditional knowledge that characterize a tactic's effectiveness to tackle certain learning tasks, and THENs, cognitive operations that construct new information and products. For example, IF uncertain about the meaning of a sentence in the textbook, THEN highlight it and make a question mark for further review. Strategies, comprising a bundle of IF-THENs, extend the structure of IF-THEN rules to a more adaptive IF-THEN-ELSE form. IF conditions are satisfied, THEN students engage in the learning task with a particular tactic; ELSE, students engage with an alternative tactic based on the feedback generated.

Tactics for learning are general rules for manipulating information. Winne (1997) elaborated tactics in his COPES model. When students engage in a particular learning task, there are three slots waiting to be filled with specific information about the task: a conditional slot, an operational slot, and a production slot. When students perceive the specific conditions that characterize the task and enact particular cognitive operations to approach the learning goal, they create products for the task. Feedback generated externally or internally will be triggered for them to compare the attributes of the products with the standards the student expected before. The monitoring process is omnipresent and serves to generate the feedback. One standards slot will be required to record the standards; another evaluations slot will be required to record the evaluations, which mark whether an attribute is on target, or if not, how much off target it is. All the slots are updated interactively and simultaneously on the progressively generated feedback. How a student COPES with tasks in context is a tactic (Winne, 1997).

CHAPTER 3: GSTUDY TOOL

3.1 gStudy as Cognitive Tools

3.1.1 Overview

Software applications supporting multimedia, navigation and interaction are being increasingly used by researchers to provide learners with authentic learning environments. Lajoie (1993) proposed that cognitive tools can assist learners to engage cognitive and metacognitive learning processes. Cognitive tools help to share the cognitive load and enact deep reflective thinking by supporting learners in their cognitive activities such as retaining learning material in memory or visualizing the information.

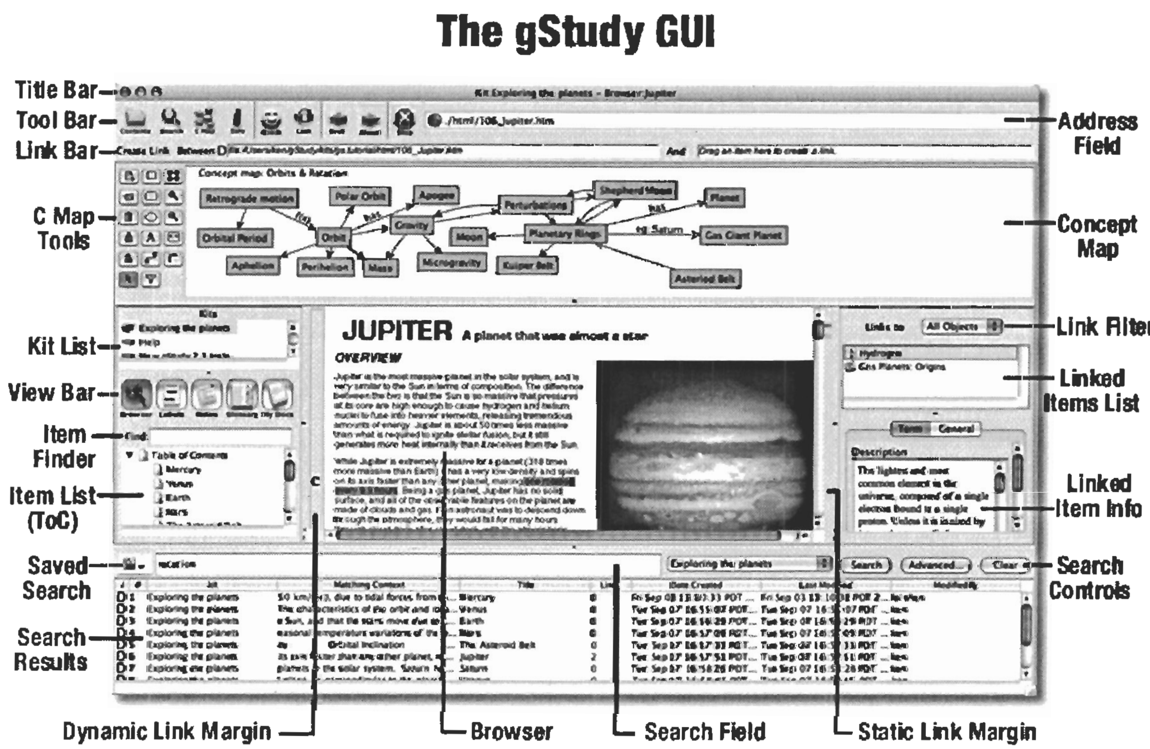
gStudy (Winne, Hadwin, Nesbit, Kumar, & Beaudoin, 2005) is a "general study" tool. It is a software application that presents learning materials to students as learning kits. Learning kits include media available such as text, images, video and audio clips that are assembled into a package. Students use gStudy to engage with the content in the learning kits, in which students create "information objects" (Winne, 2006) by highlighting, labeling, summarizing and creating links among information objects.

As an interactive learning environment, gStudy provides students with a wide variety of utilities for exercising SRL and scaffolding their learning activities as they navigate across a range of learning tasks and contexts. gStudy also gives students a variety of options to engage with learning kits such as highlighting, taking notes, self-questioning, explaining, planning, goal setting, creating links and reviewing.

Furthermore, gStudy is an information management system with which students are able to attach their personal understanding of a specific topic in the learning kits, and then organize that information into texts, tables or glossaries. Students then relate the information to their prior knowledge by creating links among the information objects. Students also are allowed to categorize the information into a hierarchical presentation. All the information objects can be easily searched and retrieved for further review. In addition, gStudy has a concept mapping tool that assists in actively constructing and visualizing the relation among the information objects.

3.1.2 gStudy GUI

Figure 3-1 gStudy GUI



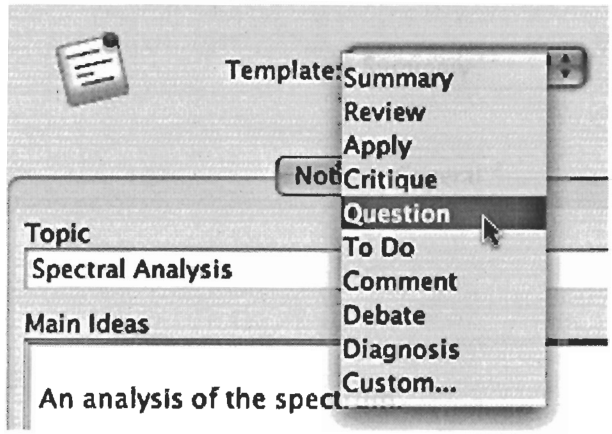
Source: www.learningkit.sfu.ca, reprinted with permission of owner

After students login to gStudy, a gStudy window opens on the screen (see Fig 3-1). Students are able to switch between different views to work with learning kits. In the Browser view, the item list panel on the left screen displays the HTML formatted documents organized as a hierarchical table of contents. In the Notes view, the list panel contains a list of notes made by the students. In the Glossary view, the item list panel contains a list of glossary terms predefined by instruction designers or added by students. In My Docs view, the item list panel displays the list of all the documents students create on their own in gStudy.

3.1.3 Note-taking

Note-taking is an important feature in gStudy. Students can create a note with or without linking to other content or select a section of text, graphic or video and link it to a note. Each note has a unique template. Students choose a template, such as "Summary", "Review", "To do", etc., (see Figure 3-5) and then create the note by filling in the template's topic and main ideas fields. Note templates can be designed by instructional designers, teachers and researchers or customized by students to structure the note content. Students are encouraged to use the templates because they provide students with a guide when taking notes. Notes can be easily retrieved later on for review according to the type of template.

Figure 3-2 Templates of Note



With the support provided by gStudy, students may take notes for various reasons and in different contexts. For example, students may be searching and gathering information for solving a problem, keeping records of useful resources, or reviewing learning materials to prepare for an exam. If students want to keep track of their own understandings on one specific topic in their learning episodes, gStudy enables them to present their thinking in the notes. In addition, students may log their perceptions about the learning tasks, their plans to accomplish learning goals and their difficulties when confronting some specific learning tasks.

3.1.4 Glossary

Each learning kit has a glossary that helps students reduce the cognitive load for storing some definitions or detailed information for specific terms so that students can enact deeper reflection and more complex cognitive processing. Students are able to add any term to the glossary and create a definition for the term. The instruction designer of the learning kit can predefine the glossary with some key definitions and then students may extend the glossary by creating their own definitions. Anytime in their learning process, students can click on a term listed in alphabetical order appearing in the Glossary view to view its definition or add more information to the term.

3.1.5 Other Features

When navigating and studying in gStudy, students often click and drag across the text to highlight it or label the learning material. Students not only are able to select a section of text, they also can select a region in a graphic or video.

For the selected content, students have an option to categorize it with a predefined or customized label such as "important", "I disagree" or "example" etc., or highlight the content without an associated label for further review. Labeling works like a highlighter pen in that it allows students to create meaningful colored selections in the text or graphics of a document. gStudy displays all the contents that has a label applied into Labels View.

Students also can create links between sections of text, graphics or video in one or more learning kits by using the linking feature of gStudy to connect related ideas and activate prior knowledge. Students can link any selection of text, graphic region or video frame to notes or glossary entries by drag-and-drop. They can also create new links for one note to connect it with other notes.

gStudy also provides students with options to create concept maps. Every information object students create such as note, glossary, label, or link can be assembled in the concept maps for students to better organize and visualize the information. Students also have an option to launch the chat feature to contact their peers or instructors online. In the present study, I mainly focused the data about the notes and glossaries created by students when they engage with gStudy.

3.2 gStudy as a Research Tool

gStudy is also designed as a research tool to investigate how students construct knowledge as they engage in various academic learning tasks aiming for providing more accurate data about how learning processes proceed in SRL.

The way in which gStudy collects data overcomes the limitations of traditional data gathering methods such as paper-and-pencil, audio and video recording. For example, it is extremely time and labour consuming for researchers to gather data related to students' cognitive activities in SRL. Furthermore, it will be extremely hard for researchers to observe groups of students' work in detail and real time. Researchers may also miss observations or observe subjects with bias as well. To gather fine-grained and time-sequenced data that trace students' learning processes, gStudy meticulously, indefatigably and reliably collects data on the fly and without interference.

Moreover, gStudy provides students with an authentic motivational learning environment. In the present study, students were provided with the Education 220 Learning Kit which was composed of two chapters from the textbook (Woolfolk, Winne & Perry, 2003) for their introductory Educational Psychology course. Subjects were required to use this learning kit in gStudy to finish certain course assignments after they became familiar with gStudy. Not limited to the Education 220 learning kit, gStudy allows students to study any learning kit about any topic. Some other learning kits are provided in gStudy by default.

During students' study sessions, gStudy records abundant data when students interact with the cognitive tools, explore the learning material, and actively construct knowledge. When students highlight and label text, make notes, link information objects or create their own documents, their uses of strategies and tactics are exposed by their navigation activity recorded into log data as they process various kinds of information to achieve their learning goals. For example, while a student uses gStudy to create a note, gStudy traces all the activities in very fine-grained detail: which texts or area of an image or video was selected; whether the note was created directly or it was linked to other notes; which note template the student chose to use; what content was typed in and how long it took. All these data are traces of the student's self-regulatory engagement with the learning kit (Nesbit, Winne, et al. 2005).

Each learning activity is recorded as a time-stamped event. Every student may generate a large amount of events in a few sessions. Trace data is composed of the data recorded in those learning events about how students engage in learning tasks and which learning tactics and strategies they adapt.

A log file recording the trace data is saved in XML format on the client side at first for each student and study session (see Figure 3-6). The file traces and timestamps every instance of the students' active engagement with the learning kits in gStudy when students perform actions such as making notes, labeling or linking. The content the students enter is also collected. The above data make up a large data set to reveal students' use of strategies and tactics, goals and motivations. When a study session ends, the log file will be sent to a central database on the server.

Figure 3-3 Example of log file


```
- <ModelEvent action="created" target="note" timeStamp="2005-03-01T12:21:22.308">
  - <targetObject kitID="2cd8d4_1009b1b53c5__7fff" kitName="Educational Psychology 220">
    - <Note author="          " dateCreated="2005-03-01T12:21:22.261-08:00" dateModified="2005-03-01T12:21:2
        templateRef="Summary" xmlns="http://www.sfu.ca/edu/gStudy/generated/xml/gstudy/model/note'
      - <ns1:Fields xmlns:ns1="http://www.sfu.ca/edu/gStudy/generated/xml/gstudy/model">
        - <ns1:PlainText fieldTemplateRef="Topic">
            <ns1:Value>Note_1</ns1:Value>
          </ns1:PlainText>
        - <ns1:PlainText fieldTemplateRef="Main Ideas">
            <ns1:Value />
          </ns1:PlainText>
        - <ns1:PlainText fieldTemplateRef="Key Details">
            <ns1:Value />
          </ns1:PlainText>
        </ns1:Fields>
      </Note>
    </targetObject>
  </ModelEvent>
- <ModelEvent action="created" target="link" timeStamp="2005-03-01T12:21:22.370">
  - <targetObject kitID="2cd8d4_1009b1b53c5__7fff" kitName="Educational Psychology 220">
    - <link author="          " dateCreated="2005-03-01T12:21:22.323-08:00" dateModified="2005-03-01T12:21:22
        templateRef="" xmlns="http://www.sfu.ca/edu/gStudy/generated/xml/gstudy/model/link">
        <docOrigin QTmedia="false" endpointX="114" endpointY="366" image="false" rangeEnd="1743" rangeStart="1
          startpointY="351" useRange="true" />
      - <destination>
          <modelObject moClass="note" targetID="1560" targetKitID="2cd8d4_1009b1b53c5__7fff" />
        </destination>
      </link>
    </targetObject>
  </ModelEvent>
```

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Aptitudes and Events

Winne and Perry (2000) characterized aptitudes and events as information at different levels of grain size. Data about aptitudes describe "global and relatively enduring attributes of students" (Winne & Perry, 2000, p. 534). Typically, SRL is measured as an aptitude by self-report questionnaire such as MSLQ. For example, when students answer questions such as whether they expect to do well in a class, they report on a 7-point scale from (1 = not at all true of me) to (7 = very true of me). If the score is high, we might predict that they will try to invest more effort in the course. Those data are fairly stable and consistent across different times and settings (Nesbit & Hadwin, 2006).

However, aptitude data are normally collected by asking students to report their engagement across settings rather than observing the students' engagement in learning tasks in real context. Winne (1997) argued that SRL could be measured as learning events which expose a series of cognitive processes over the course of a procession of self-regulatory activities. Data about events describe the students' state or action at a particular point in real time and are contextualized within a specific context (Winne, 1997; Nesbit & Hadwin, 2006).

How might a student decide which tactic to use? Is there a specific sequence or a certain array of tactics to compose a strategy? To tackle these issues, we need to examine the self-regulating events. Students' self-regulatory activities could be analyzed by interpreting traces that students make in self-regulated learning process, such as the notes they take and the contents they highlight or label.

The present study measured self-regulated learning both as an aptitude and an event. Self-report instrument MSLQ was used for measuring SRL learning as an aptitude. In the data collection procedure, students reported their perceptions of their actions when facing in a certain learning task and rated their performance of cognitive and metacognitive processes.

Hadwin, Winne, Stockley, Nesbit and Woszczyna (2001) found that students' self-reports about their tactics and strategies use varied when students engage in different learning tasks. The variance in students' self-reports about their strategies use may suggest that students strategically adapt tactics and strategies to the learning context. To reveal the actual study tactics and learning strategies use, data about events recorded by gStudy are the direct evidence of what students are exactly doing in the learning task. gStudy provides the trace data of study tactics and learning strategies, which are essential to explore SRL. Trace data, data about events, are fine-grained data recording students' self-regulatory activities in their learning processes, which could lead to better research about how students engage in SRL (Winne, 1997).

4.2 MSLQ

Grain size has become an important metric issue of research in educational psychology when researchers measure SRL. Although more researchers recently are paying more attention to shifting from larger grain size to finer grain size, there are few instruments to analyze the small grain-sized and dynamic learning events. Instead, there are abundant self-report instruments continuing to play an important role which capture students' attributes in general and global learning contexts. The self-report instruments may not have powerful strength in helping us investigate learning strategies use in real time and context, but they can help us predict and discern whether there is any cognitive and metacognitive strategies use taking place when learning unfolds (Winne & Perry, 2000). These measures are helpful in distinguishing which study tactics and learning strategies occur in the self-regulated learning process before we investigate how they take effects.

A frequently used self-report instrument, the Motivated Strategies for Learning Questionnaire (MSLQ), was developed by Pintrich and his colleagues (Pintrich, Smith, Garcia & McKeachie, 1991) to assess college students' motivation and use of different learning strategies. The MSLQ consists of a motivation section and a learning strategies section: the motivation section consists of 31 items that assess students' goals, beliefs and their anxiety about tests. The learning strategies section is divided into 2 scales. The cognitive and meta-cognitive scale includes 5 subscales, namely, rehearsal, elaboration, organization, critical thinking and metacognitive self-regulation. It contains 31 items with respect to students' different cognitive and metacognitive strategies use. The resource management strategies scale includes 4 subscales - time and study environment, effort regulation, peer learning and help seeking - and consists of 19 items regarding students' management of different resources. Items are simple declarations like "In a class like this, I prefer course material that really challenges me so I can learn new things" and conditional relations like "If I study in appropriate ways, then I will be able to learn the material in this course". Items are scored on a 7-point Likert scale, from 1 (not at all true of me) to 7 (very true of me).

In much research conducted recently, rehearsal, elaboration, organization, critical thinking and metacognitive self-regulation subscales are used to measure learning strategies use (Pintrich, Smith, Garcia & McKeachie, 1991). Rehearsal strategies are used to repeat the learning material and recall the information later on. Rehearsal strategies work adequately for simple tasks but are less useful when students need to integrate information with prior knowledge. Elaboration strategies, like paraphrasing, summarizing, making notes and creating analogies, help store information in long-term memory by assembling information with prior knowledge. Organization strategies, like outlining, creating tables and selecting main ideas, help coordinate information from diverse learning resources (Weinstein, Palmer, & Schulte, 1987). The critical thinking strategies help students evaluate their learning strategies use or deeply reflect on their thoughts. Metacognitive self-regulation strategies help students set learning goals, plan tactics and strategies use, monitor and manage their learning processes.

MSLQ was developed using a social-cognitive view of motivation and learning strategies. Pintrich et al. (1993) suggested that MSLQ may represent a useful, reliable and valid measure for assessing college students' motivation and learning strategies use. Due to the lack of fine-grained instruments in investigating learning events within specific contexts, I chose to analyze MSLQ scores because the questionnaire is well established as an efficient and practical measure for studying learning strategies use.

4.3 Trace

SRL researchers frequently use aptitude data consisting of self-reports of motivations, beliefs, learning preferences and learning experience, however they often scarcely use event data. In addition to the aptitudes data collected by MSLQ instrument, it is very important to collect behavioral data reflecting students' perceptions and cognitive activities as they carry out learning tasks. Researchers have commonly found, however, that collecting this type of data is very time consuming and laborious.

Winne (1982) proposed that traces of dynamic cognitive processes recorded while students are highlighting, labeling and taking notes could reveal more about SRL "as it happens". Trace data present a panorama of learning processes by exposing how students study. For example, if students finish one study session, trace data keep records of whether and when they scroll back and forth through the learning material, highlight and label some sections of texts or take some notes for specific topics. When trace data are complemented with other forms of data about aptitudes, researchers can gain a more detailed empirical understanding of students' actual engagement in their self-regulatory learning process (Winne, 1997). Trace data also enable researchers to investigate how and why students regulate learning and reveal more accurately about whether, when and how students access prior knowledge and their perceptions of the learning tasks.

Logging, or event tracing, is the way in which software applications collect trace data about how and when students engage in learning tasks without being interfered with (Hadwin & Winne, 2001). Traced data presented in log files may provide more accurate data about study tactics than self-report data (Winne, Jamieson-Noel & Muis, 2002; Jamieson-Noel & Winne, 2003). With well-designed trace methods, researchers are able to theoretically guide software applications to capture the unobservable cognitive processes in which students construct knowledge and carry out SRL. In comparison to self-report data and other forms of data collected in traditional research, trace data are finer grained and provide more reliable interpretation of what students do in learning (Winne, 1998).

Trace data can portray how students metacognitively monitor and regulate their learning within and between stages of studying in Winne and Hadwin's model. For example, each time when a student interacts with a learning kit, gStudy observes and logs all those activities. Furthermore, it records which text or the region of graphic or video the student highlighted and labeled, whether personal understanding of the topic is attached, and the duration of each learning event in the study session. Those time-stamped records of how students interact with learning kits in gStudy support grounded interpretations about how a student constructs knowledge and model SRL as a series of condition knowledge (IFs) and subsequent actions carried out (THENs) (Winne, 2006). In that case, researchers may be able to construct a more comprehensive and complete model of students' self-regulatory processes and significantly reduce under- or misspecification (Nesbit, Winne et al., 2005).

4.4 Cluster Analysis

In the present study, I applied a data-driven approach to analyze the data about aptitudes and events. I hypothesized that group or cluster identification could lead to discern the characteristics of different clusters. Cluster analysis is a recommended statistical technique for identifying "patterns" or "profiles" on a set of variables (Hair, Anderson, Tatham & Black, 1998). This technique has been widely used to sort cases such as people, products, events into groups or clusters, so that the members of one cluster share some common characteristics whereas members of different clusters are dissimilar with each other.

Cluster analysis can be used as an exploratory data analysis method. In an explorative way, it simply discovers structures in data without specifying certain characteristics of the clusters in advance. Cluster analysis only requires a set of variables to determine how the cases are clustered. It is not necessary to assign the number of clusters to be generated as it can be determined by the hierarchical technique.

Cluster analysis tries to discover how cases may or may not be combined, provides more insight into how data are structured and helps discern the pattern or profile emerged. In a sense, cluster analysis helps to find the meaningful and possible solutions, and the associations and structure revealed by cluster analysis are useful and sensible.

According to Wishart, the cluster analysis can contribute much to the interpretation of research evidence. In the present study, cluster analysis helped to reveal a classification scheme in students' self-regulated learning processes, and it helped in selecting sample cases to represent the clusters (Wishart, 1998).

4.5 Content Analysis

"Content analysis is any technique for making inferences by objectively and systematically identifying specified characteristics of messages" (Holsti, 1969, p. 14). In this study, trace data such as students' records of learning activities and notes potentially consist of precise traces of students' self-regulatory engagement with gStudy (Winne, Gupta, & Nesbit, 1994), thus I conducted a content analysis to examine students' self-regulated learning processes more deeply.

Content analysis often starts with collecting relevant data, choosing samples and reducing the sample size. Then researchers need to look through the texts meticulously, decide the unit of analysis, develop content categories for coding, distinguish among categories concepts, and then apply rules for coding the texts. The process of coding is arduous. After classifying the text into content categories, researchers need to focus on and stay alert to specific texts or patterns for a higher level of interpretation.

Winne (1995) addressed that students are agents who self-regulate their learning processes and choose their repertoire of study tactics and learning strategies they apply to study, therefore the trace data of how they study facilitate an empirical understanding of what students actually do and how different cognitive processes interact.

Content analysis was conducted on students' notes recorded by gStudy. Students' notes were analyzed to describe the typical patterns or characteristics of the content and identify important relationships among the contents examined. The notes were coded according to the principles of qualitative content analysis (Chi, 1997) which provided an effective approach for qualitative coding of the contents.

Chi provided a practical guide to conduct analysis on verbal data or observational data, which consists of eight steps: reducing the data to be coded, segmenting the data according to the grain size, developing the coding scheme, applying the coding scheme to code the data, analyzing the coded data and depicting the result, seeking patterns emerged and interpreting the pattern (Chi, 1997).

4.6 Triangulation

Known as parallel mixed analysis, triangulation of quantitative and qualitative data is a widely used mixed data analysis strategy in the social and behavioural research (Hair, Anderson, Tatham & Black, 1998). In the present study, I undertook a mixed method approach to explore the qualitative data of selected cases.

Quantitative approaches help us to discover the potential patterns or tendency of a population as a whole or which occurred merely by chance (Chi, 1997). For example, quantitative approaches are often used to investigate research questions in SRL about frequency or degree, and those data gathered are usually subjected to powerful statistical examinations. Although quantitative analysis is effective in generalizing similarities and differences among the samples of a population, it is limited to answer the how, why and when questions when examining the learning strategies use in real time and context.

In light of this, qualitative approaches are often utilized to enrich the understanding of specific situations and provide a more contextual perspective to empirical studies in educational psychology (Anderman & Anderman, 2000). Qualitative approaches involve rich, holistic descriptions of the context-specific learning situations in which students regulate their cognitive processes to engage in the learning task (Eisner, 1998).

Quantitative and qualitative techniques were used sequentially in the present study: quantitative analysis was used to observe a large set of students and distinguish relationships between learning strategies use and achievement with its statistical power, and then classify subjects into groups to seek emergent patterns and identify cases for further qualitative analysis; content analysis was then applied to closely observe a small set of selected students to build richer portraits that depict what occurred.

More specifically, both quantitative and qualitative analysis methods were applied according to the research questions and the nature of the data. An initial quantitative data analysis investigating the relation between self-reported use of learning strategies and students' academic performance was conducted to establish the reliability of the data set and reveal what tactics and strategies reported by the students were correlated with students' achievement.

To select representative samples from the students, a cluster analysis was conducted which led to the identification of clusters of students who are similar to each other in some respect. As an exploratory data analysis tool, cluster analysis helped to discern the different characteristics between clusters. Cases were divided into two clusters based on the quantitative methods. Three representative students were selected from each cluster. Their gStudy trace data were examined by content analysis to answer complex questions about how learning occurs in context.

4.7 Data Gathering Procedure

These data were gathered by the course instructor, Prof. John C. Nesbit, who granted permission to analyze and present them for the purpose of this thesis.

4.7.1 Participants

Undergraduates were recruited from a second-year 13-week introductory Educational Psychology course at a Canadian university during the school year of 2005 spring semester. 178 of the 208 students, of whom 67% were female (n=140) and 33%

were male (n=68), agreed to release their coursework and exam scores to the research project. These students, mainly from arts background (n=158), were given a consent form that clearly described the purpose and nature of the study. The learning kit was assembled into gStudy tool by researchers and instructors from the course material. Two students did not report some items in MSLQ which comprises the data set I analyzed subsequently. Rather than assuming a blank value was intended, I deleted those two students from our sample. Therefore the original sample size was reduced from 178 students to 176.

4.7.2 Instruments and Activities

During the initial weeks of the course, students completed self-reported questionnaires:

• Achievement Goals Questionnaire (AGQ, Elliot & MacGregor, 2001)

• Epistemic Beliefs Inventory (EBI, Bendixen, Schraw, & Dunkle, 1998)

• Metacognitive Awareness Inventory (MAI, Schraw & Dennison, 1994)

• Motivated Strategies for Learning Questionnaire (MSLQ, Pintrich, Smith, Garcia, & McKeachie, 1993)

The present study dealt with only one of these questionnaires – the MSLQ. MSLQ was administered through WebQuestionnaire, a web-based assessment tool that allows students to respond to diverse question types like Likert scales, multiple-choice, short answers and other forms.

The 81 items from the MSLQ were administrated in week 3 of the course through WebQuestionnaire. The order of items in MSLQ manual (see Appendix 1) was used to order the questions within WebQuestionnaire.

The application selected for this study was gStudy version 2.0. The Education 220 learning kit was comprised of two chapters from textbook (Woolfolk, Winne & Perry, 2003). Textbook chapters were converted into electronic format and packaged into gStudy as a learning kit. A pre-defined glossary that defined important terms for the chapters was provided as part of the learning kit.

4.7.3 Procedure

The introductory Educational Psychology course is 3-credit (3 contact hours) course where students are introduced to theories and issues with respect to teaching and learning. Data were collected as students participated in activities and assessments throughout the 13-week course. The course consisted of lectures, tutorials, textbook readings, one written assignment and two multiple choice exams. The 3 contact hours were divided into two 50-minute lectures and one 50-minute tutorial. There were three teaching assistants for the course who were responsible for leading the tutorials.

Students were asked to complete a midterm exam, a final exam and a study reflection assignment. Midterm and final exams for the course were multiple-choice tests based on the textbook and lectures. The midterm exam consisting of 48 multiple-choice items was administered in week 6. A final exam consisting of 60 multiple-choice items was administered approximately one week after the last lecture.

Students were asked to study one chapter (chapter 7) for a period of two hours over two study sessions using gStudy, and then summarized how they studied and reflected on the relation between their questionnaire scores and study methods. They were graded not on how they studied with the tool, instead, on the summarization and the reflection.

Students received usernames and passwords for WebQuestionnaire and gStudy in the first week of class. The MSLQ was completed in week 3. In week 5 students were introduced to gStudy in a 50-minute tutorial session where a research assistant demonstrated students various features of gStudy including: how to assess gStudy and how to navigate through various sections of content, make notes, utilize the existing template to create quicknote, edit and add new items to glossary, and make links across notes and glossary items. In that session, students were shown how to use a learning kit. Some instructions linked to the Education 220 learning kit (Chapter 7 content) were provided in gStudy as well. After the tutorial session, the students were encouraged to use gStudy on their own at home or on campus. Any inquiries and questions they raised about how to use gStudy tools were redirected to the technical support and research assistant and were answered in a timely manner.

Students acquired and manipulated large amounts of information in the Education 220 learning kit. Small-grained cognition processes were recorded as trace data in gStudy. Traces (Winne, 1982) are observable evidence of particular cognitions that are obtained at points where a cognitive process is applied while completing a task. For example, highlighting text creates a trace when the students select particular information within a text.

Students were expected to study the chapter 7 content for at least 2 hours on their own time to complete the study reflection assignment. Students chose to study the content from one single session to up to 4 sessions. During students' study sessions, gStudy recorded everything students did as they interacted with, explored, searched and actively constructed knowledge when they highlighted and labelled text, made notes, linked information objects or created their own documents. Students were offered participation in a lottery to win a $100 gift certificate for releasing their questionnaire responses, log data and other information to the research project.

CHAPTER 5: DATA ANALYSIS AND RESULTS

5.1 Results

5.1.1 Descriptive Data

In educational psychology research, achievement is often one of the most important variables to indicate how well a student has learned. The midterm exam was completed in week 6 and the final exam was completed in the end of the course. Students' grades were collected as a measure of participants' course performance. Students' grades for the midterm and final exams were calculated based on a point system; their final letter grades were determined by summing up the midterm grades, final exam grades and the grades for the reflection assignment.

The learning strategies section in MSLQ is based on a general cognitive model of learning and information processing. Students completed each item of the MSLQ using a seven-point Likert-type scale with ranges from "not at all true of me = 1 point" to "very true of me = 7 points".

There were 9 subscales that concern learning strategies. Students reported their scores on each item, and then the subscale score was calculated by the average of the items comprising the corresponding subscale. For example, the rehearsal subscale has four items. The subscale score was calculated by adding up the scores on all the items and then dividing the total score by the number of items in that subscale. There were some items with a "reverse" mark indicating that they were negatively worded. Before calculating the subscale score, scores for these items were reversed. The means and standard deviations for the variables before clustering are provided in Table 5.1.

Table 5.1 Descriptive Statistics (N=176)

	Mean	SD
Midterm grade	30.13	7.32
Final grade	38.66	8.63
Rehearsal	4.67	1.20
Elaboration	5.14	.95
Organization	4.55	1.17
Critical thinking	4.23	1.08
Metacognitive self-regulation	4.48	.77
Time and study environment	4.77	1.02
Effort regulation	4.95	1.03
Peel learning	3.08	1.38
Help seeking	3.64	1.25

Before conducting a further analysis, internal-consistency estimates of reliability (coefficient alphas) were computed to ensure that the items comprising each subscale are reliable. Nesbit and Hadwin (2006) noted that for research purposes internal consistency values below .7 are regarded as poor, while vales between .7 and .8 are regarded as adequate. In this study Cronbach's alpha coefficients for the learning strategies subscales are shown in Table 5.2. Effort regulation (.62) and help seeking (.63) had more variability in students' responses. With most of the coefficient alphas averaging above 0.70, the alphas for the learning strategies subscales indicated a reasonable representation of the data. I also compared it with the original coefficients reported in the MSLQ manual (Pintrich et al., 1991), and the result indicated a similar pattern.

Table 5.2 Coefficient Alphas and Items Comprising the Learning Strategy Subscales

Learning Strategies Subscales	Items Comprising the Subscale	α	α*
Rehearsal	39, 46, 59, 72	.72	.69
Elaboration	53, 62, 64, 67, 69, 81	.77	.76
Organization	32, 42, 49, 63	.70	.64
Critical thinking	38, 47, 51, 66, 71	.79	.80
Metacognitive self-regulation	33r, 36, 41, 44, 54, 55, 56, 57r, 61, 76, 78, 79	.74	.79
Time and study environment management	35, 43, 52r, 65, 70, 73, 77r, 80r	.81	.76
Effort regulation	37r, 48, 60r, 74	.62	.69
Peer learning	34, 45, 50	.72	.76
Help seeking	40r, 58, 68, 75	.63	.52

α* Original coefficient alphas (Pintrich et al., 1991)

5.1.2 Correlation between Achievement and Learning Strategies Subscales

The Pearson correlation coefficients measure the degree and the direction of the linear relation between two variables. A significant result indicates that the correlation between sample variables is more than what would be expected by chance. Midterm and final exams assessed how well students learned in this course. I used correlation to estimate the extent to which students' achievement and learning strategies use were related.

The MSLQ learning strategies scale consists of 9 subscales and 50 items. After correlating the subscales with students' midterm and final exam grades, most of the learning strategies subscales showed the expected correlations with midterm and final grades (see Table 5.3). The MSLQ was administrated in week 3 in the course, which was closer to when midterm exam was completed. The results in Table 5.3 suggested that the midterm exam grade was more correlated with MSLQ subscales than final exam grade.

The correlation suggested that students who reported relying on deeper processing strategies like elaboration, critical thinking, metacognitive self-regulation, time and study environment management and effort regulation were more likely to receive higher grades in the course. Rehearsal strategies were not correlated significantly with midterm and final grades, and the peer learning and help seeking were not related to midterm and final exam grades.

Table 5.3 Correlation between achievement and learning strategies scales

	1	2	3	4	5	6	7	8	9	10
1. Midterm grade	-									
2. Final grade	.72**	-								
3. Rehearsal	.16*	.04	-							
4. Elaboration	.22**	.11	.41**	-						
5. Organization	.15*	.10	.59**	.51**	-					
6. Critical thinking	.21**	.11	.29**	.62**	.32**	-				
7. Metacognitive self-regulation	.33**	.18*	.53**	.68**	.59**	.54**	-			
8. Time and study environment	.26**	.22**	.28**	.48**	.33**	.32**	.66**	-		
9. Effort regulation	.29**	.22**	.20**	.34**	.23**	.25**	.49**	.66**	-	
10. Peer learning	-.09	-.16*	.23**	.18*	.21**	.12	.21**	.06	-.01	-
11. Help seeking	.00	.01	.14	.32**	.20**	.22**	.31**	.19*	.13	.63**

**. $p < .01$, *. $p < .05$

Besides the correlation with midterm grades and the MSLQ subscales, the correlation among the MSLQ subscales suggested that the students who are proficient in using elaboration strategies were more inclined to use organization and critical thinking strategies. They also successfully managed their own time and study environment, as well as metacognitively self-regulated their learning processes. Moreover, students using metacognitive self-regulation tended to use more elaboration, organization, critical thinking strategies.

5.1.3 Cluster Analysis

The correlation analysis demonstrated that self-report of learning strategies use was correlated with achievement. I hypothesized that the students occupy different clusters in which cluster members share similar patterns of learning strategies use, and that profiling students on the basis of cluster membership may provide additional information.

I used cluster analysis to identify and arrange students into different clusters according to the MSLQ learning strategy subscales. Then, by examining the learning strategies use of the resultant clusters, I characterized each cluster. As Yin (1991) suggested, comparisons across various groups or clusters of cases can help to predict and discern emerging patterns, therefore identifying such clusters and understanding what characterizes them with respect to other aspects of SRL may give us empirical understandings of comprehensive self-regulated learning process from a new vantage point.

From the results in Table 5.3, peer learning and help seeking strategies did not show significant correlation with students' academic performance. In this study, students' self-regulatory activities were examined from an individual point of view. Therefore I did not use these two subscales. The learning strategies subscales I used to identify the clusters in the data analysis were: rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment and effort regulation.

To form learning strategy clusters, I used Ward's minimum variance hierarchical clustering technique (Ward, 1963). This technique has been widely used in different research areas to recover the underlying structure of data. A hierarchical method was used as I assumed that there could be clusters of students whose learning strategies use would be unique, but they would still share same characteristics with the total sample. One advantage of hierarchical clustering methods over non-hierarchical methods is that I do not have to know the appropriate number of clusters in advance.

Ward's method was used to classify the minimum variance criterion to profile students on the basis of their learning strategies use and then examine the characteristics of the resultant clusters in regard to learning strategies use. Similarity of students' profiles was determined by measuring the unstandardized Euclidian distance between the learning strategy subscales.

In the present study, I used several methods to determine the appropriate number of clusters. Graphical representations of the data in the form of dendrograms (tree like diagrams) were examined to help determine the appropriate number of clusters. The branches of a dendrogram represent the clusters in a hierarchical formation and suggest the similarity among the clusters. Dendrograms illustrated the gaps between clusters and suggested an appropriate number of meaningful clusters. The resultant dendrogram was provided in Appendix-2, which showed the hierarchy between several distinct clusters of students profiled on the measure of learning strategies use and suggested two, three or four cluster solutions to best represent the data.

Clusters for each of these potential solutions were created so that each cluster solution could be assessed. I tested all potential cluster solutions. For the 2-cluster, 3-cluster and 4-cluster solution, it was found that the higher the midterm and final exam grades the students from different clusters achieved, the higher scores of the subscales they reported.

The same pattern emerged from all the possible solutions suggested that the data distribution was in a linear way. I chose a two-cluster solution to classify the data in this study and conducted further analyses on this two-cluster solution.

For the two-cluster solution, I conducted a discriminant analysis as a means to validate a cluster solution (see Table 5.4). The percentage of correct predictions should be high for a valid solution. For the 2-cluster solutions, cluster membership was correctly predicted for at least 93.2% of the data.

Table 5.4 Discriminant Analysis - Classification Results

		2 clusters	Predicted Group Membership		Total
			1	2	
Original	Count	1	86.0	7.0	93.0
		2	5.0	78.0	83.0
	%	1	92.5	7.5	100.0
		2	6.0	94.0	100.0

93.2% of original grouped cases correctly classified.

Table 5.5 Means and Standard deviations for 2-cluster solution

Measures	Low self-regulating students (N=93)		High self-regulating students (N=83)		F
	Mean	SD	Mean	SD	
Rehearsal	4.03	1.03	5.34	0.95	82.56***
Elaboration	4.65	0.87	5.68	0.71	74.35***
Organization	3.92	1.00	5.26	0.92	84.99***
Critical thinking	3.74	0.97	4.77	0.94	50.92***
Metacognitive self-Regulation	4.00	0.63	5.01	0.52	133.10***
Time and study environment	4.30	0.83	5.29	0.97	52.81***
Effort regulation	4.46	0.80	5.45	0.99	58.75***
Midterm grade	27.77	7.02	32.77	6.75	23.03***
Final exam grade	36.32	8.63	41.29	7.88	15.76***

*** $p < .001$

ANOVA among the clusters with regard to the clustering variables was also applied to examine whether there were significant differences among the clusters on measures of students' academic achievement and learning strategies use. I conducted an ANOVA with MSLQ subscales as the dependent variables and cluster membership as the independent variable. The result indicated that there were significant differences among the two clusters with respect to students' academic achievement and the use of learning strategies (see Table 5.5).

Results in table 5.5 also indicated that all the selected learning strategy subscales were significantly different between the high self-regulating cluster and low self-regulating cluster. Low self-regulating students self-reported much lower rehearsal learning strategy use (M = 4.03, SD = 1.03) than high self-regulating students (M = 5.34, SD = 0.95), $F(1,174) = 82.56$, $p<.001$. The ANOVAs also indicated that there were significant differences on each subscale between the two clusters, elaboration, $F(1,174) = 74.35$, $p<.001$; organization, $F(1,174) = 84.99$, $p<.001$; critical thinking, $F(1,174) = 50.92$, $p<.001$; Metacognitive self-Regulation, $F(1,174) = 133.10$, $p<.001$; time and study environment, $F(1,174) = 52.81$, $p<.001$; effort regulation, $F(1,174) = 58.75$, $p<.001$; midterm grade, $F(1,174) = 23.03$, $p<0.001$; final exam grade, $F(1,174) = 15.76$, $p<.001$.

5.1.4 Case Selection

Cluster analysis with different learning strategies subscales showed that the two resultant clusters differed significantly, moreover, those clusters can be characterized by a consistent pattern - students' academic achievement increases in proportion to learning strategy subscale. In other words, while the students with high learning strategies use achieved higher grades: midterm grade (M = 32.77, SD = 6.75) and final exam grade (M = 41.29, SD = 7.88), the low self-regulating students with low use of learning strategies were characterized by lower academic achievement: midterm grade (M = 22.77, SD = 7.02) and final exam grade (M = 36.32, SD = 8.63). I labelled the two clusters as high self-regulating cluster and low self-regulating cluster. The high self-regulating cluster was comprised of 93 students, while the low self-regulating cluster consisted of 83 students.

The comparison of means (see Figure 5-1) on midterm grades statistically detected that low self-regulating students scored lower than high self-regulating students: midterm grade, $F(1,174) = 23.03$, $p<0.001$; final exam grade, $F(1,174) = 15.76$, $p<.001$. The mean of midterm grade of low self-regulating cluster (cluster1) is 27.77, and final grade is 36.32. If these percentage grades are converted to final letter grades, they approximately range from C to C+ for the low self-regulating cluster. For the high self-regulating cluster (cluster 2), the mean of midterm grade is 32.77 and final grade is 41.29, the final letter grades approximately range from B+ to A. It showed that there was an outstanding difference of the academic achievement between those two clusters.

Figure 5-1 Mean of grade for 2-cluster solution

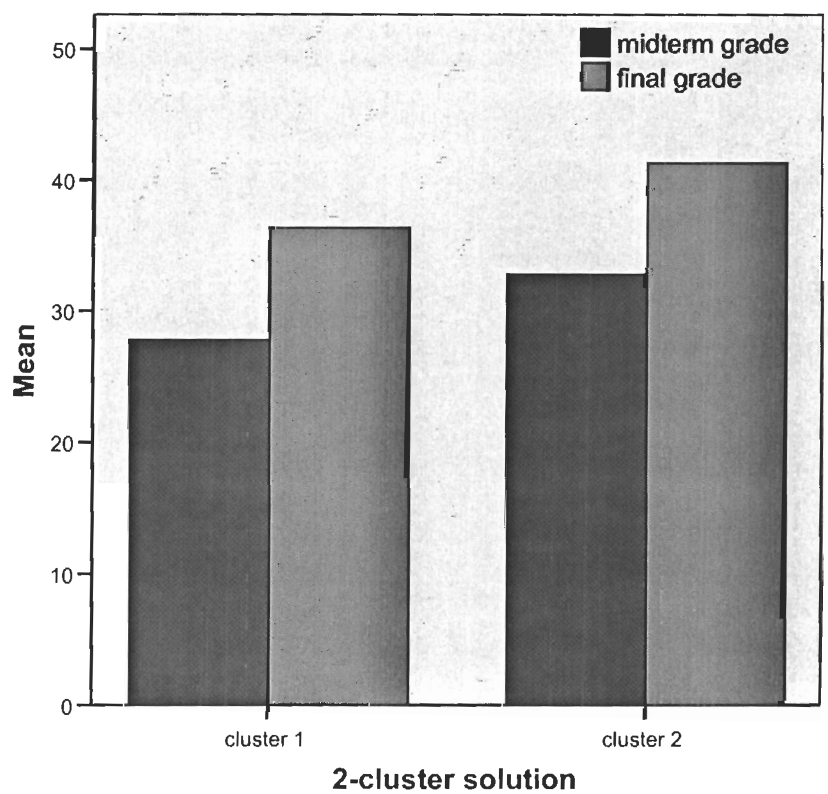


Figure 5-2 Means of learning strategy subscales for 2-cluster solution

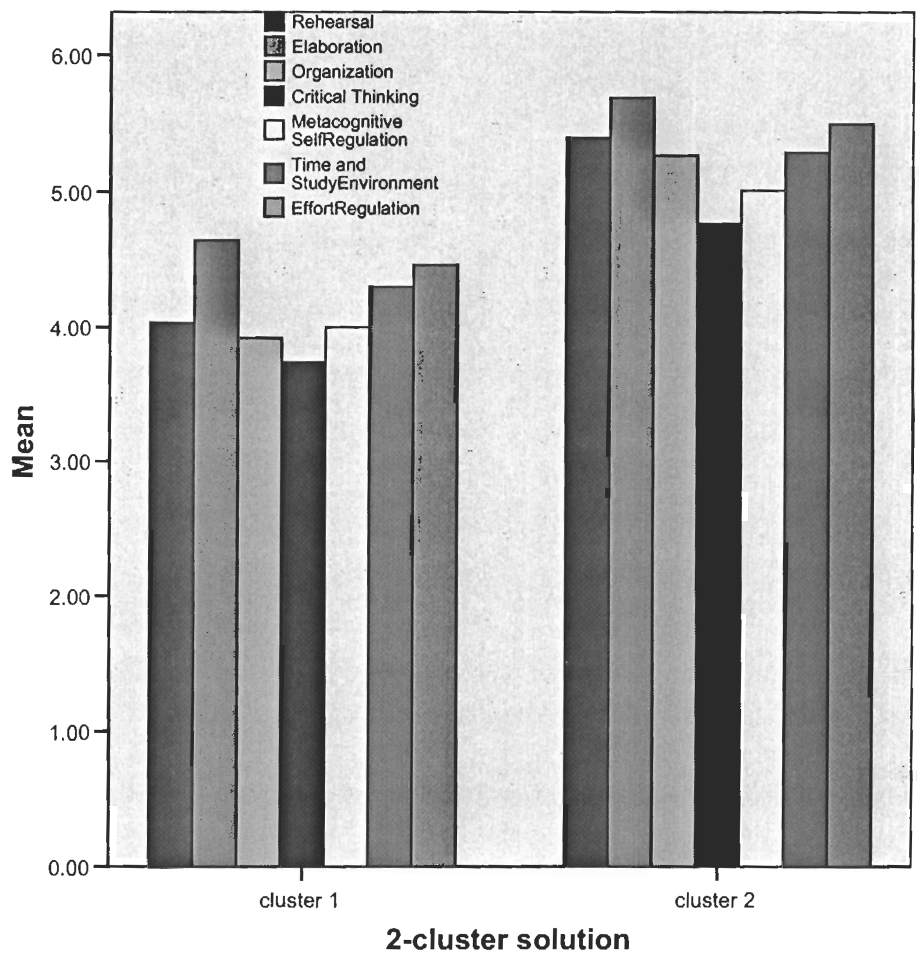


Figure 5-2 shows that, on all the analysed subscales, the low self-regulating cluster scored lower than the high self-regulating cluster.

5.1.5 Content Analysis

Based on the results from quantitative analysis, MSLQ data revealed the extent to which the use of learning strategies self-reported by students related to their academic achievement. However the data did not explicitly indicate that those actual learning strategies and study tactics were used corresponding to the learning context. In light of this, I conducted a content analysis to examine the content the students entered in the notes field to better understand the learning strategies use in learning contexts.

As gStudy meticulously recorded all the students' learning activities, even a short study session would generate hundreds of events. The massive data set challenged us to filter and analyze. Due to the time-consuming nature of content analysis, it is hard to scrutinize all the data, therefore I selected three representative students from the high self-regulating cluster and low self-regulating cluster each, based on the following criteria: (1) A proximity matrix returned by the cluster analysis was used to identify those cases which are closest to the centre of each cluster. The positions of those selected cases must be as close as possible to the centroid of the cluster in order to better represent the whole cluster. (2) When log files were collected from all students, it was found that some participants did not spend a long time using gStudy to complete the assignment. To increase the authenticity of the log data as records of learning activities, only those students who used gStudy to study for at least two sessions that lasted greater than 20 minutes were selected for content analysis.

Six students were chosen for this study based on the above criteria. The pseudonyms of those from the low self-regulating cluster were Larry, Lucy, and Lydia; and their final letter grades in this course were C+, B-, and C+ respectively. Henry, Hailey, and Hector were pseudonyms from high self-regulating cluster; and their final letter grades in this course were A-, B+, and A- respectively. I used the first letter of their pseudonyms to indicate which cluster they were from.

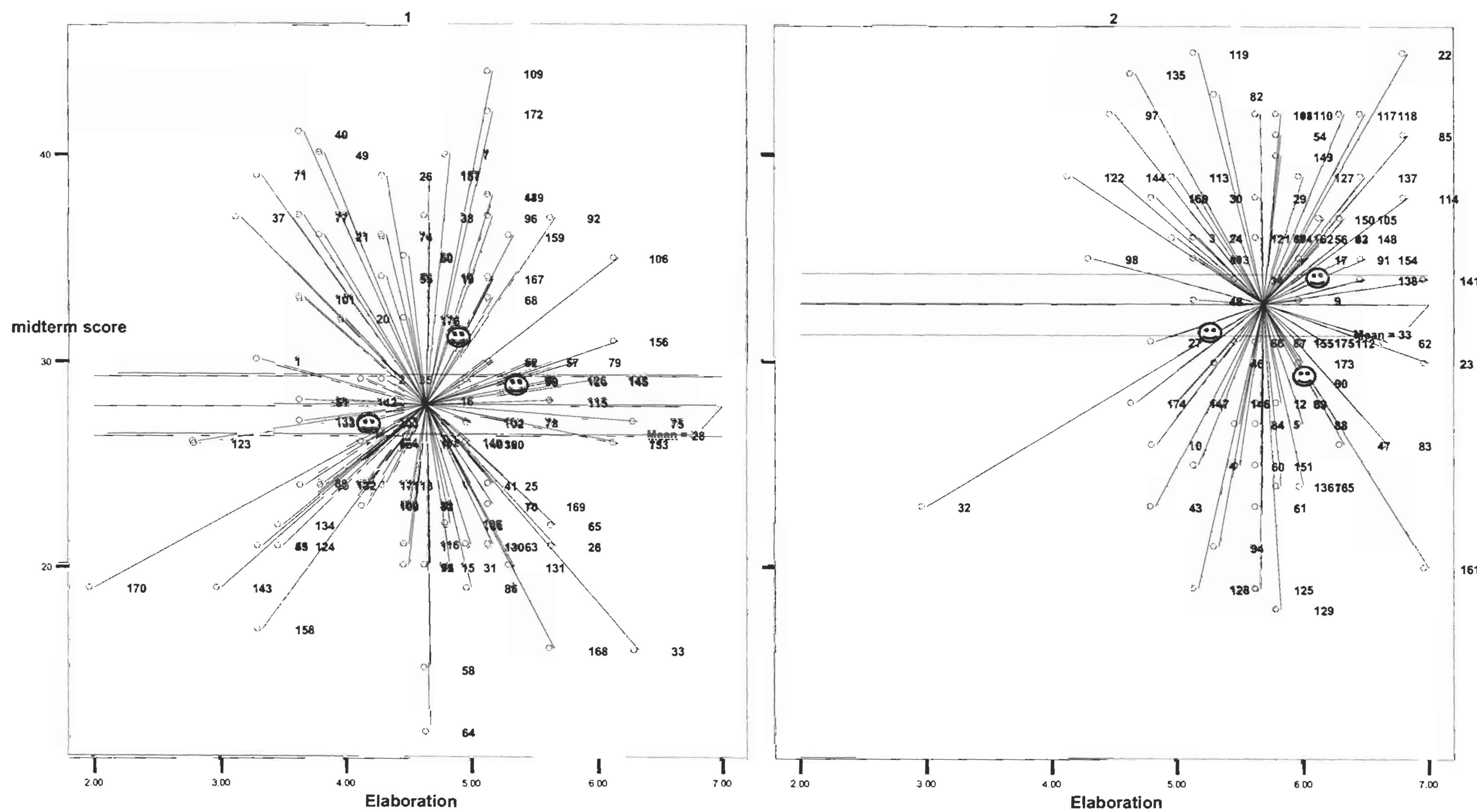
To ensure that those students are representative of their clusters and that they are close to the center point of the clusters, a scatter plot graph was generated (see Figure 5-3) to check the distance between students' particular locations and centroid of the cluster.

Scatter plots often help us reveal the relation between two sets of data. Figure 5-3 represents the scatter plots of high and low self-regulating students according to the relation between elaboration subscale and midterm grades of two sets of data. The elaboration subscale score was plotted along the X axis, and the data about midterm grades was plotted along the Y axis. The middle line represents the cluster mean for the midterm scores. The upper and lower lines indicate the 95% confidence interval.

The elaboration subscale was used for Figure 5-3 because comprehending texts in the learning material is an important way to acquire knowledge. Students who construct knowledge using more elaboration strategy to paraphrase the text and relate the text to prior knowledge were more likely to have higher academic achievement. It was confirmed by the correlations found between midterm grades and the elaboration subscale ($r = 0.22$) in this study.

The positions of Larry (case number: 52), Lucy (case number: 41) and Lydia (case number: 89) in the scatter plot graph were close to the centroid of low self-regulating cluster. Likewise, the positions of Henry (case number: 27), Hailey (case number: 90), and Hector (case number: 17) in the scatter plot graph were close to the centroid of high self-regulating cluster.

Figure 5-3 Scatter plot graph for 2-cluster solution



To understand in detail how students' self-regulatory activities take place and differ between the two clusters, detailed qualitative content analysis was conducted on the notes made by high self-regulating students and low self-regulating students and aimed at analyzing students' context-specific strategies use and establishing the possible reasons for carrying out certain strategic actions in different phases according to Winne and Hadwin's model.

Students' self-regulatory activities were based on their cognitive processes (Winne, 1997; Zimmerman, 1994). As Chi (1997) stated that students' cognitive processes cannot be captured directly, it is necessary to find out students' prior knowledge and then analyze how this knowledge influenced the subsequent students' actions. In this study, students' self-regulatory activities were approached from interpretations of students' notes from the trace data recorded in gStudy. Trace data made it possible to investigate the students' self-regulating processes and students' actual self-regulatory activities which cannot be investigated by traditional observational research. Trace data containing students' notes were coded according to Chi's principles of qualitative content analysis (Chi, 1997).

The coding scheme was developed in two cycles. In the first analysis cycle, I reviewed classifications of strategies formed in earlier studies (Van Dijk & Kintsch, 1983; Zimmerman & Martinez-Pons, 1986; Pintrich & DeGroot, 1990; Howard-Rose & Winne, 2001; Entwistle, 1988; Pintrich, 2000; Weinstein & Mayer, 1986). For example, Weinstein and Mayer (1986) introduced the categorization of general learning strategies in which strategies are classified into rehearsal, elaboration, organizational, metacognitive and affective strategies.

Entwistle (1988) proposed to use deep processing and surface processing strategies to differentiate different types of learning strategies. Surface processing strategies involve rote learning, rehearsal and repeating learning material. Deeper processing strategies involve elaborating, relating learning material to prior knowledge, critical thinking. Surface processing strategies are effective for easy, small amounts of information but result in limited retention and understanding. On the contrary, deeper processing strategies help construct meaningful understanding with prior knowledge (Entwistle, 1988).

In addition to these classifications, Winne (2000) observed that "Metacognition is the awareness learners have about their general academic strengths and weaknesses, cognitive resource they can apply to meet the demands of particular tasks, and their knowledge about how to regulate engagement in tasks to optimize learning processes and outcomes" (p. 533). The distinction between general cognitive strategies and meta-cognitive strategies is important in that the simultaneous metacognitive monitoring and control processes help the students to gain feedback in their learning processes, and thus direct students to carry out subsequent actions such as choosing an alternative tactic or revising their standards of the learning goal.

The preliminary coding scheme (see Table 5.6) listed the theory guided categories which were derived from the aforementioned earlier studies and Winne and Hadwin's model in mapping the possible categories focused on both cognitive and metacognitive strategies.

Table 5.6 Preliminary coding scheme

Strategy	Description	Example
Activate prior knowledge and establish standards	Statements indicating activation of prior knowledge	"I already knew the information of the topic" . . .
Rehearsing and memorizing	Overt or covert rehearsing, memorizing the learning content	creating acronyms, or copying material . . .
Elaborating	Logging information in an external form about conditions, operations and products	rephrasing or explaining the content attaching information into a personally meaningful context . . .
Organizing and transforming	Selecting and organizing the most important things from the text, making marks to the text	grouping information, organizing information into meaningful categories . . .
Self-evaluation	Statements judging ones own effectiveness; monitoring products relative to standards	"At the moment I'm having difficulties in solving the problem, but I will keep trying" . . .
Metacognitive monitoring	Statements indicating metacognitive judgements	"I learned some important things about this topic, for example . . . "

To enable coding, students' notes were analyzed qualitatively to reveal the students' context-specific interpretations of their strategy use. The notes were analyzed in two phases. In the first phase, the occurrences related to strategy use were identified from students' notes. In the second phase, these occurrences were coded into six categories listed in Table 5.6. When a single note seemed to imply the existence of more than one strategy it was categorized under each of the appropriate categories. For example, "I found it useful" implied that metacognition occurs. A note such as "I found it useful because it helped me understand …" implied both metacognitive and elaboration strategies were used.

In the coding process it was found that the students did not report all the strategies that were expected from theory, and there were some notes that could not be covered by the theory-guided categories. For example, from a theoretical point of view, students need to engage in making choices between different types of strategies and tactics according to their prior knowledge of the learning tasks and self-evaluate the products with the standards while completing the tasks. However, I did not find enough notes related to prior knowledge activation and self-evaluation. Therefore, the coding scheme needed to modified to reflect learning strategies that students actually used.

The prior knowledge activation and self-evaluation categories included infrequent data, thus they were merged into metacognitive monitoring and control in the final coding scheme (see Table 5.7). Rehearsing and memorizing, elaborating, organizing and transforming, and metacognitive monitoring included frequent data and they were kept for later coding.

The development of the coding scheme was guided by Winne and Hadwin's SRL model and modified to incorporate emergent categories. The final coding scheme (see Table 5.7) was developed by combining the theory-guided and data-driven categories.

Table 5.7 Final coding scheme

Strategy	Description	Example
Rehearsing and memorizing	Overt or covert rehearsing, memorizing the learning content	creating acronyms, underlining information, or copying material

		. . .
Elaborating	Logging information in an external form about conditions, operations and products	rephrasing or explaining the content attaching information into a personally meaningful context . . .
Organizing and transforming	Selecting and organizing the most important information from the text	grouping information, organizing information into meaningful categories . . .
Metacognitive monitoring and control	Statements indicating metacognitive judgements Self-questioning and reflecting one's understanding Monitoring the learning process	"I learned some important things about the topic, for example . . . " "At the moment I'm having difficulties in solving the problem, but I will keep trying"

The notes were coded into the final categories using the MAXQDA2 qualitative analysis software. MAXQDA2 provides support for performing qualitative data analysis, especially for conducting content analysis on texts.

Some quantitative analyses generated from the qualitative content analysis were reported in a visualized graphical form to make the comparison between the high self-regulating and low self-regulating clusters. That is, once the data were coded, I summarized the results in a visualized graphical form instead of quantifying the frequencies of students' notes in each category. This kind of mixed-method approach was chosen to enable effective comparisons of the high self-regulating and low self-regulating clusters.

5.2 Students' Learning Processes

In answering the research question regarding students' use of learning strategies within specific learning tasks, I investigated students' context-specific strategies to establish possible reasons for choosing certain strategies. In order to distinguish the difference between the notes made by students from the high self-regulating cluster and low self-regulating cluster, I described the students' self-regulated learning processes based on their notes extracted from the trace data recorded in gStudy.

5.2.1 Low Self-regulating Cluster

Larry (pseudonym)

His final grade in this course was a C+. He made 30 notes in his gStudy session: 25 rehearsal strategies, 2 metacognitive strategies, 1 elaboration strategy and 2 organization strategies.

As one goal of learning from the text, comprehending the major information in the learning kit and integrating it with prior knowledge, seemed to be a demanding task for Larry. Thus Larry intensively used rehearsal strategies in his studying episodes.

For example, Larry noted: "*Declarative knowledge: knowledge that can be declared; usually in words, through lectures, books, writing, verbal exchange, Braille, sign language, mathmatical* [*sic*] *notation, etc.; is "knowing that" something is the case; Robert Gagne (1985) calls this category verbal information. Procedural knowledge: knowing how to perform a task. Conditional knowledge: knowing when and why to apply your declarative and procedural knowledge*". All the sentences can be exactly found in the learning material, which indicated that Larry just copied it over and put it together, and there were very few transformation in Larry's annotation from the original learning material.

Larry understood the possibilities to use other learning strategies. In the above note, he also used organization strategy to group information, but he completed the note rather in mainly surface processing. Though he made another note using elaboration strategy, he ended up using predominantly rehearsal strategies.

When Larry was thinking over the learning material as the learning task unfolded, he annotated "*Important Note: Thoroughly processed information becomes part of long-term memory and can be activated at any time to return to working memory*". To make that judgment, I presume that he monitored the current state of the task. It was inferred that Larry's judgment of task importance exceeded what was expected. Thereby he classified that task as "important" and wrote so as a consequence of his perception. However, he did not pursue a higher level of information processing, rather he just copied the sentence over from the original learning material and there were no further notes related to this topic. In other words, he noticed that the note was important but he didn't put any effort into further understanding it.

In summary, Larry used rehearsal learning strategies intensively in a surface processing way by copying information. He was not aware of or not willing to use the appropriate learning strategies which were more likely to help him succeed.

Lucy (pseudonym)

Her grade in this course was a B-. She made 7 notes in her gStudy session, including 2 rehearsal strategies and 5 elaboration strategies.

Lucy appeared to struggle with learning in gStudy since she was reluctant to use learning strategies in gStudy. She was the student who made the least amount of notes.

Lucy's notes jumped drastically from one topic in the learning material to another. It seemed that she relied heavily on skimming the learning material. For example, the first note she made was regarding the topic at the beginning of the learning material, the second one she made was regarding the topic at the end of the learning material. Then the third note was related to the middle part of the learning material.

All the notes Lucy made were about some definitions of the terminology. For example, "*conditional knowledge - knowing when and why to apply your declarative and procedural knowledge*". Her engagement was directed in large part at glimpsing the learning kit or focusing on the superficial aspects of the learning tasks rather than understanding the texts.

Lucy appeared to be unaware of the available strategic possibilities of the learning situation. She only applied some rehearsal and elaboration strategies in her study session and the strategies use was at a surface level. For example, she wrote: "*Procedural knowledge - knowing how to perform something*", which indicated that she tried to rephrase the content from the learning material with her own words but could not recall the "something". She was reluctant to go further to review and acquire more information from the learning material.

In summary, Lucy did not make many notes, and the domination of a surface-level approach in Lucy's notes may indicate a lack of conditional knowledge about the strategies in a novel learning situation. Another explanation may be that strategic adaptation to the learning practices takes time and effort, and Lucy was unable to maintain the motivation to sustain the arduous learning process. As Pintrich and DeGroot (1990) reported, knowledge of learning strategies merely does not enhance academic performance; students should have motivation to use those learning strategies.

Lydia (pseudonym)

Her grade in this course was a C+. She made 26 notes and glossaries in her gStudy session: 5 rehearsal strategies, 4 metacognitive strategies, 10 elaboration strategies and 7 organization strategies.

In Lydia's notes, organization strategies were heavily used. Regrouping the content in the learning kit signalled that she assembled information into larger units. For example, she developed a summary of the learning material: "*3 skills for metacognitive ... planning, monitoring, evaluation*" and "*3 types of knowledge , declarative knowledge, procedural knowledge, conditional knowledge*". With 7 other organizational notes, I inferred that organizing was an automated tactic for Lydia when engaging in the learning task. She was very active in looking at the key concepts embedded in the learning material and regrouping the information.

However, when Lydia was organizing information, she directly copied over the relevant information from the learning material and didn't attach any meaningful and personal explanation. The way she organized the information appeared to be more like reproducing the information with little elaboration.

Like Larry, Lydia also was aware of the strategic demands of the learning task. For example, she wrote "*this is important to know for teaching because students should have things that are eye catching to help them learn*". Such a note suggested that metacognitive control was exercised and then elaboration strategy was applied. This note may allow an inference that, when the student was monitoring the condition of the task, she was aware of the importance of the topic, so she marked it important. This was confirmed by the successive elaboration strategy that was applied.

Later, Lydia drew an analogy in an elaborative note, "*Computer Model - computer is like a human mind to look at how we take info in, process it and then hold it*", to help interpret the term "computer model". This note indicated that Lydia adjusted her cognitive learning strategies and self-regulation efforts according to her perceptions of the learning task and she was even able to come up with new ways to elaborate the topic in order to fulfill the needs in the learning context.

5.2.2 High Self-regulating Cluster

Henry (pseudonym)

His grade in this course was an A-. He made 14 notes in his gStudy session: 1 rehearsal strategy, 3 metacognitive strategies, 7 elaboration strategies and 3 organization strategies.

When Henry was reading the text in the learning kit, he made one note on sensory memory; "*very important distinction to keep in my mind*", signalling that he discriminated the content from other information. Later on, he made another note regarding that topic, "*sensory memory store properties, has very large capacity but things exist there for very breif* [*sic*] *time period; sensory memory=large+breif* [*sic*]", which may indicate that when Henry first read that topic, he perceived a demand to remember and understand the topic, so he marked it down for easy reviewing at a later time. Later on he reviewed that topic and reinforced the understanding by making more notes on it. There was one other note regarding the same topic, "*gathering and represnting* [*sic*] *information into sensory system*", indicating that he spent much effort on the topic and deemed it to be important.

Henry was primarily focusing on elaborating strategies to interpret information within the learning content. For example, "*Gestalt -epistemology that people organize perceptions into meaningful wholes; gestalt = wholes>pieces*" indicated that when he was trying to understand the underlying concept of learning material, therefore he transformed the content by using the symbols "=", "+", and ">" to help him elaborate the text in the learning material. He used this technique to generate his own presentation of the content in many other notes.

In sum, Henry's annotation revealed that he was able to better monitor his standards and make judgements on where to focus his efforts in relation to his current knowledge, and his notes were consistent with his self-regulatory process.

Hailey (pseudonym)

Her grade in this course was a B+. She made 55 notes in her gStudy session: 13 rehearsal strategies, 16 metacognitive strategies, 18 elaboration strategies and 8 organization strategies.

Hailey was the most active student among the 6 students. She elaborated on concepts and ideas in the learning material and augmented the elaboration by making examples, such as "*Example of Cognitive learning... plan our responses, use strategies to help us remember, and organize the material we are learning in our own unique ways*" and making comparisons between different concepts such as, "*Declarative: general knowledge : hours the library is open and Rules of grammar; Procedural: General knowledge: How to use your word processor and How to drive; Conditional: General: When to give up and try another approach and when to skim and when to read carefullly* [*sic*]".

Constantly applying a variety of learning strategies to process information, her reflection prepared her to set her own goals and plan strategy use. For example, she used elaboration strategy: "*A way to explain learning and memory, alternative to behavioursm* [*sic*]. *Cognitive theorists believe that learning is the result of our attempts to make sense of the world. We use all of our mental tools.*", organization strategy: "*Old Cog Psyc* [*sic*] *- the nature of knowledge, value of reason, contents of the mind New Cog Psyc* [*sic*] *- Well-developments of complex human skills, computers, understanding language development*", metacognitive strategy: "*THis* [*sic*] *was very important- stimulus must be analyzed into features or components and assembled into a meaningfull* [*sic*] *pattern*" . Being motivated to use appropriate learning strategies resulted in a greater proliferation of ideas that, in turn, enhanced her capacity to engage in metacognitive strategies in her learning practice.

I inferred that when Hailey was reading the text, her goal was to understand the learning material rather than to merely finish the reading assignment. When she monitored her comprehension, the monitoring process provided her with information about the need to switch learning strategies, so Hailey was able to adjust her cognitive learning strategies and self-regulation efforts according to the feedback generated in the monitoring process.

Hector (pseudonym)

His grade in this course was an A-. He made 43 notes in his gStudy session: 6 rehearsal strategies, 13 metacognitive strategies, 13 elaboration strategies and 11 organization strategies.

When engaging in academic tasks, Hector drew on his prior knowledge to self-question himself and build up an interpretation of the task's properties. For example, he wrote "*How do cognitive and behavioural views differ in their assumptions about what is learned? -- In the cognitive view, knowledge is learned, and changes in knowledge make changes in behaviour possible...*" On most occasions, he self-questioned himself with the "how" and "what" questions. According to Winne and Hadwin's model, it appeared that based on the interpretation of the task, his goal was approached by applying various learning strategies which generated more elaborative products. He monitored these processes of engagement actively and then progressively updated products according to the feedback generated, and this feedback provided more information for reinterpreting his perception and belief of the task and thereby making decisions for subsequent engagement.

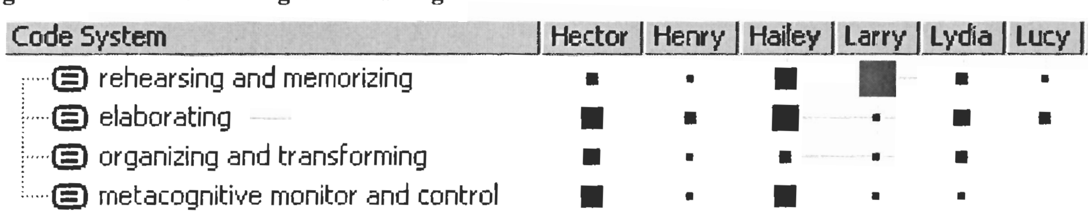
In sum, reflection played an important role in Hector's self-regulated learning. He mainly focused on two aspects of reflection. Firstly, he reflected on the content, for example, "*How did Recht and Leslie (1988) show the importance of knowledge in understanding and remembering new information? They divided a group of young readers into two groups by reading ability: poor readers and good readers*". Hector marked out the information that needed to be remembered. Rather than staying close to the original text in the learning material, he added a lot of information in rephrasing the text and relating to examples.

Secondly, Hector also focused on the purpose of a learning task, for example, "*How does knowledge affect learning? - Knowledge provides a framework in which new information is incorporated. This is why "making it meaningful" is such a powerful way to remember information, and why experts have less trouble learning new information within a given domain than novice learners do*". He metacognitively engaged in the learning task by self-questioning. The more he reflected on how he learned, the more effective he was at making links between his knowledge about the learning task, his own resources, the strategies available and how to match them. The feedback generated consequently maintained ongoing reflection.

5.2.3 Difference between High Self-regulators and Low Self-regulators

Due to the small number of subjects analyzed (N=6), it was not possibly to statistically compare the high self-regulators with the low self-regulators. Therefore, instead of using statistical procedures to represent findings to be generalized, I used a graphical form to help in focussing on important aspects of the qualitative data.

Figure 5-4 Pattern of high/low self-regulators



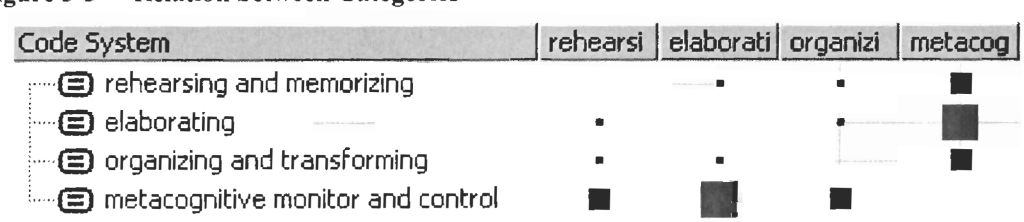
The matrix provided an overview of how many text segments from students' notes were assigned within a specific category. The size and color of the square illustrated how many text segments were assigned within each particular category. The larger the size of square, the more text segments were assigned to the category.

Hector, Henry, and Hailey were from the high self-regulating cluster, and Larry, Lydia and Lucy were from the low self-regulating cluster. The pattern in Figure 5-4 suggests that all students were able to use basic or complex cognitive strategies, and most students except Lucy were able to use basic or complex metacognitive strategies.

The results derived from qualitative content analysis of the students' notes indicated that low self-regulating students did not use learning strategies in a balanced way. For example, Larry mainly relied on rehearsal and Lucy didn't use organizing and metacognitive strategies. In contrast, high self-regulators made more elaborative notes with more metacognitive contents. They also were more proficient in adjusting cognitive strategies according to contextual demands than students from the low self-regulating cluster.

5.2.4 Relation between Categories

Figure 5-5 Relation between Categories



Like the pattern of high/low self-regulators, Figure 5-5 is the visualization of the relation between codes showing the co-occurrences of codes assigned to segments of text. The square at the intersection of every two codes indicates how many text segments were coded within both of those categories. The size of each square illustrated the amount of text segments.

Figure 5-5 suggests that in this study students using more metacognitive strategies tended to use other strategies and adapt metacognitive strategies to monitor and control their cognition. This finding supported Winne and Hadwin's model of self-regulated learning. According to Winne and Hadwin's model, students work with six major kinds of information as they learn: 1. the content, the subject matter to study and learn, 2. students' perceptions of conditions characterizing learning tasks, 3. standards that characterize goals for the content and learning processes, 4. learning strategies comprised of study tactics that students applied on content, 5. products in the course of reaching goals, 6. evaluations of how well products correspond to standards. Metacognitively monitoring and control play an important role when students engage with these kinds of information (Winne & Hadwin, 1998). Students who actively perceive, accurately interpret and metacognitively monitor all these kinds of information conduct more productive self-regulated learning.

This finding also suggested that most students not only know what cognitive strategies are, but also know the metacognitive strategies about monitoring learning tasks and adapting learning strategies to accomplish their academic tasks. Furthermore, from the qualitative analysis of students' notes, it suggested that students' attempts to monitor and control played an important role in self-regulated learning process, and cognitive strategies use interacted closely with metacognitively monitoring and controlling processes. (Pintrich, 2000)

5.3 Discussion

5.3.1 Relation between Achievement and Self-reported Use of Learning Strategies

In the present study, the correlation between the learning strategy subscales and grades was presented in Table 5.3. Statistically significant correlations were found between midterm grades and elaboration (r = 0.22), critical thinking (r = 0.21), metacognitive self-regulation (r = 0.33), time and study environment (r = 0.26), and effort regulation (r = 0.29). This finding suggested that students used cognitive and metacognitive strategies in their individual practice and that use of appropriate learning strategies had a positive influence on their learning performance.

The results also showed that midterm grades were most positively related to metacognitive self-regulated learning strategies (r=0.33) and effort regulation (r=0.29) in this study. Comparing to other learning strategies, rehearsal was shown not significantly correlated with midterm grades (r=0.16).

This finding suggested that those students who know the metacognitive strategies about how and when to use them to accomplish their academic tasks achieved higher academic performance. According to Pintrich (2002), rehearsal, elaboration, and organization learning strategies are deemed as general cognitive strategies. Metacognitive control and monitoring based on students' progressively generated feedback help students to switch from one cognitive strategy to another.

In summary, these results are in line with previous research: the use of learning strategies is essential for academic performance when students engage in various types of academic tasks. It suggested that if students have higher metacognitive strategies proficiency, they are more likely to apply appropriate cognitive learning strategies to improve their academic achievement.

It also demonstrated important linkages between cognitive learning strategies and academic performance. It suggested that not only the frequency of the learning strategy use, but also effective and appropriate learning strategy use could lead to higher academic achievement.

5.3.2 Similarities between Two Clusters

In Table 5.1, I presented means and standard deviations of students' self-reported use of learning strategies when they engage in academic learning tasks. Among the learning strategies, elaboration strategy was the most frequently self-reported strategy (M = 5.14, SD = .95 for all the subjects; M=5.68, SD = .71 for the high self-regulators; and M = 4.65, SD = .88 for the low self-regulators). This was later confirmed by examining students' notes, which revealed that the notes students made in gStudy were largely elaborative.

It suggested that students may recognize elaboration as the most appropriate learning strategy in this study. Elaboration assisted students in comprehending by attaching personal understanding. With various cognitive tools available, gStudy provided students with a wide range of ways to fully utilize this learning strategy.

Although cognitive learning strategies provides students with a variety of means to regulate their cognitive processes, students still need to use metacognitive strategies to monitor and make choices between different types of tactics and strategies according to their perception of the learning tasks (Pintrich, 2002). In this study, use of metacognitive strategy was found in 5 students' notes, which suggested that most of the students were aware of the use of metacognitive strategies. This finding from the qualitative analysis was also confirmed by the quantitative analysis from the correlation between metacognitive self-regulated learning strategies and midterm grades (r=0.33), which is the subscale most correlated to the students' midterm grades.

5.3.3 Difference between Two Clusters

Many researchers agree that SRL is guided by strategic action, metacognition, and motivation (Pintrich, 1990; Winne, 1997: Zimmerman, 1990). This was evidenced by the qualitative analysis of students' notes: it was found that all the students except Lucy used a variety of cognitive learning strategies as learning tasks unfolded and that most of the students used metacognitive strategies to monitor their learning process. Furthermore, high self-regulating students like Hector and Hailey were more proficient in using metacognitive strategies to continuously monitor and evaluate the effectiveness of their chosen strategies.

Qualitative exploration revealed that, in comparison to those low self-regulating students, high self-regulating students who have more learning strategy practices were more likely to apply learning strategies effectively.

In particular, from the qualitative analysis, it was found that Hector perceived learning tasks accurately and regulated his engagement by setting sub-goals. He was aware of available learning strategies and chose the more productive ones. For example, Hector effectively changed learning strategies among rehearsal, elaboration and organization strategies to approach the sub-goals set by self-questioning. He generated feedback by metacognitive monitoring. When the feedback was provided, he judged whether the standards were satisfied, and consequently the recursive monitoring process helped him in constructing knowledge.

The only student who did not apply the metacognitive strategies, Lucy, might have difficulties in trying to set a learning goal and responding to the strategic demands when engaging in the learning task. Due to the lack of a plan, she only applied a few surface level learning strategies and was reluctant to go further to acquire more information from the learning material. This finding is in line with the finding in Hadwin's (2000) study that students may experience difficulties to identify tasks and set standards. Task misunderstanding and failure to perceive learning tasks may be the obstacles for many undergraduate students. Students need to apply their learning strategies and self-regulatory efforts adaptively in various learning situations.

The clusters also differed in a number of ways: how often students used learning strategies in their learning, the types of learning strategies they chose to accomplish the learning tasks, the quality of learning strategies students applied, whether they used them consistently, whether they could state a purpose for using the learning strategies and whether they sustained motivation that kept them using learning strategies, and so on.

More qualitative analyses of more participants need to be conducted to explain their success and failure in academic settings.

5.3.4 Peer Learning and Help Seeking

No correlation has been found between midterm grades and peer learning (r= -0.09) and help seeking (r = 0.00). Students used help-seeking and peer-learning strategies to a less extent than cognitive and metacognitive strategies. This may suggest that students face barriers in establishing social networks with their teachers and fellow students.

This study found little evidence that students collaborated with fellow students, suggesting that they experienced difficulties in obtaining this type of help. In this context, gStudy should provide more opportunities for helping students to create an environment in which they can not only seek assistance from other students and other resources, but also benefit from hearing different perspectives regarding a particular task at hand.

CHAPTER 6: CONCLUSION AND FUTURE WORK

6.1 Conclusion

In this study, I used both quantitative and qualitative methods to explore students' use of study tactics and learning strategies in an academic setting supported by gStudy and the relationship between students' strategies use and academic achievement.

Quantitative analysis was conducted on the students' self-reported MSLQ data and students' achievement in the Educational Psychology course. Before conducting further analysis, I used internal consistency estimates of reliability (coefficient alpha) to ensure that the MSLQ subscale scores were reliable in this study. Most of the coefficients alphas for the learning strategies subscales were between .7 and .8 (see Table 5.2), therefore I regarded them as reasonable (Nesbit & Hadwin, 2006). Also, the results of coefficient alphas revealed a similar pattern with the original coefficients reported in the MSLQ manual (Pintrich et al., 1991).

Quantitative analysis indicated the relevance of MSLQ to the research questions. The relation between self-reported use of learning strategies and students' academic achievement found in the present study was in line with previous research (Pintrich, 2000; Paris, 2001) in that the use of learning strategies were correlated to the course grades (see Table 5.3). MSLQ in this context provided reliable measures on seven learning strategy subscales: rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment management and effort regulation. MSLQ may be a valid and reliable means for assessing the use of learning strategies with gStudy. Although MSLQ is useful for understanding and predicting academic achievement, due to the fact that students may not accurately self-report some aspects of SRL, MSLQ may not be appropriate for analyzing finer grained-size data.

To deeply understand the relation between MSLQ and students' achievement, and select representative cases for the qualitative analysis, I applied cluster analysis to recover the underlying structure of the data. Ward's minimum variance hierarchical clustering technique (Ward, 1963) was used to find the appropriate solution on measures of the seven abovementioned learning strategy subscales. Clusters for each of these potential solutions were created and each cluster solution was assessed. Graphical representations of the data in the form of dendrograms were examined to help determine the appropriate number of clusters. The resultant dendrogram suggested two, three or four cluster solutions to best represent the data. For all the solutions, the pattern that emerged from the data suggested that the higher a subscale score, the higher the midterm and final exam grades a students achieved. I chose a two-cluster solution to classify the data in this study. A discriminant analysis was conducted as a means to validate the cluster solution (see Table 5.4). The result suggested that students were classified into two clusters in which the members are similar with each other in the same cluster and dissimilar in different clusters.

After identifying the above clusters, ANOVAs were conducted to examine whether the clusters differed on the self-report and achievement variables. The result indicated that the use of learning strategies, midterm grade and final exam grade were significantly different between the two clusters (see Table 5.5)

The result from the quantitative analysis provided a valid means to identify the difference between two clusters and select representative cases for further qualitative analysis. Qualitative comparison of the learning strategy use between the cases from each cluster was made. Three students were selected from each cluster according to the case selection criteria and the scatter plot graph suggested that the cases selected were close to the centre point of each cluster and may be representative samples from the cluster.

For the students selected from the high self-regulating cluster and low self-regulating cluster, I investigated their context-specific learning strategies use to establish possible reasons for choosing certain strategies. Results indicated that high self-regulating students tended to use deep processing learning strategies more than low self-regulating students and those high self-regulating students were more metacognitive than the low self-regulating students.

The content analysis of students' notes traced by gStudy also indicated that students from each cluster differed in a number of ways: how often students used learning strategies in their learning, the types of learning strategies they choose to accomplish the learning tasks, the quality of learning strategies students applied, and whether they used them consistently.

These differences suggested that the way in which students use different strategies to regulate their own learning is an important factor in determining academic performance. These results greatly helped gain empirical understanding of how students use self-regulated learning strategies when engaging in learning tasks to construct a more complete model of student's self-regulatory processes.

gStudy, an software application, provided students with help and support to effectively use the learning strategies by performing tactics like note-taking and outlining in the present study. Researchers have argued that, though the ways in which students self-regulate their learning often differ over time and across different settings, all students can learn how to be self-regulating regardless of their age, gender, and background (Winne, 1998; Pintrich, 1995). This is supported by the students' different learning strategies use in gStudy. Although their self-regulatory processes differed at different levels, gStudy's cognitive tools helped students control their learning by giving more opportunities to effectively engage in various academic tasks.

To enhance understanding of students' self-regulated learning, I used gStudy as a research tool and recorded abundant data when students interacted with its cognitive tools gStudy provided valuable data capturing students' self-regulatory activities in real time and context, which complemented the self-report data of students' learning strategies obtained from the MSLQ.

6.2 Limitation and Future Research

Even though the results of this study expanded the understanding of how learning strategies are applied among high self-regulating students and low self-regulating students with gStudy, there are a number of limitations that need to be considered.

Due to the small number of subjects in this study, the results and conclusions were restricted in generalizability. In order to confirm the regularities in the data, we need to investigate more subjects, situations and use other research methods to see whether the same patterns recur. Also, repeated studies using similar variables are needed to replicate the findings.

In this study, I investigated learning strategy use and its relation to achievement. However, it has been highlighted that not only do students need to know how, when and what strategies to apply, but also do they need to be motivated to use strategies (Pintrich, 1990). I acknowledge that motivation is an important variable that should be taken into account, but a full investigation of types of motivations was beyond the scope of this present study. In future research, I plan to investigate the relation between the use of learning strategy and motivations.

Theoretically, students need to engage in making choices between different types of strategies and behaviours according to their prior knowledge of the learning task. They need to self-evaluate their performance while completing the task. However, I did not find enough notes related to prior knowledge activation and self-evaluation categories. Future research should investigate the role of these strategies in SRL.

Content analysis was used to explore students' cognitive process by examining their notes. Specifically, I compared the notes with the source text to examine the degree of transformation between the original texts and students' annotation. If students put the text into their own words, I examined whether the degree of the students' processing of the learning material was at a surface level or deep level.

Content analysis examined students' written products directly in the learning process, thus it provided us with valuable insights into complex models of the self-regulation process. However, content analysis also presented some disadvantages.

Content analysis is very time-consuming. In this study, much inference was made on students' cognitive learning processes. To make the inference appropriately, the researcher must understand the subject matter profoundly and focus on students' individual and contextualized self-regulatory activities without bias.

The result of the content analysis is limited to the quality of the notes. As noted in the coding process, I found insufficient data to deeply examine some aspects of self-regulated learning. To investigate learning strategies and other factors in future research, we need to apply other qualitative methods.

APPENDICES

Appendix 1 – MSLQ Scales and Items

Motivation scales

1. Intrinsic Goal Orientation 1, 16, 22, 24
2. Extrinsic Goal Orientation 7, 11, 13, 30
3. Task Value 4, 10, 17, 23, 26, 27
4. Control of Learning Beliefs 2, 9, 18, 25
5. Self-Efficacy for Learning and Performance 5, 6, 12, 15, 20, 21, 29, 31
6. Test Anxiety 3, 8, 14, 19, 28

Learning strategies scales

1. Rehearsal 39, 46, 59, 72
2. Elaboration 53, 62, 64, 67, 69, 81
3. Organization 32, 42, 49, 63
4. Critical Thinking 38, 47, 51, 66, 71
5. Metacognitive Self-Regulation 33r, 36, 41, 44, 54, 55, 56, 57r, 61, 76, 78, 79
6. Time and Study Environment Management 35, 43, 52r, 65, 70, 73, 77r, 80r
7. Effort Regulation 37r, 48, 60r, 74
8. Peer Learning 34, 45, 50
9. Help Seeking 40r, 58, 68, 75

Part A: Motivation

1. In a class like this, I prefer course material that really challenges me so I can learn new things.
2. If I study in appropriate ways, then I will be able to learn the material in this course.
3. When I take a test I think about how poorly I am doing compared with other students.
4. I think I will be able to use what I learn in this course in other courses.
5. I believe I will receive an excellent grade in this class.
6. I'm certain I can understand the most difficult material presented in the readings for this course.
7. Getting a good grade in this class is the most satisfying thing for me right now.
8. When I take a test I think about items on other parts of the test I can't answer.
9. It is my own fault if I don't learn the material in this course.
10. It is important for me to learn the course material in this class.
11. The most important thing for me right now is improving my overall grade point average, so my main concern in this class is getting a good grade.
12. I'm confident I can learn the basic concepts taught in this course.
13. If I can, I want to get better grades in this class than most of the other students.
14. When I take tests I think of the consequences of failing.
15. I'm confident I can understand the most complex material presented by the instructor in this course.
16. In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.
17. I am very interested in the content area of this course.
18. If I try hard enough, then I will understand the course material.

19. I have an uneasy, upset feeling when I take an exam.
20. I'm confident I can do an excellent job on the assignments and tests in this course.
21. I expect to do well in this class.
22. The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible.
23. I think the course material in this class is useful for me to learn.
24. When I have the opportunity in this class, I choose course assignments that I can learn from even if they don't guarantee a good grade.
25. If I don't understand the course material, it is because I didn't try hard enough.
26. I like the subject matter of this course.
27. Understanding the subject matter of this course is very important to me.
28. I feel my heart beating fast when I take an exam.
29. I'm certain I can master the skills being taught in this class.
30. I want to do well in this class because it is important to show my ability to my family, friends, employer, or others.
31. Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class.

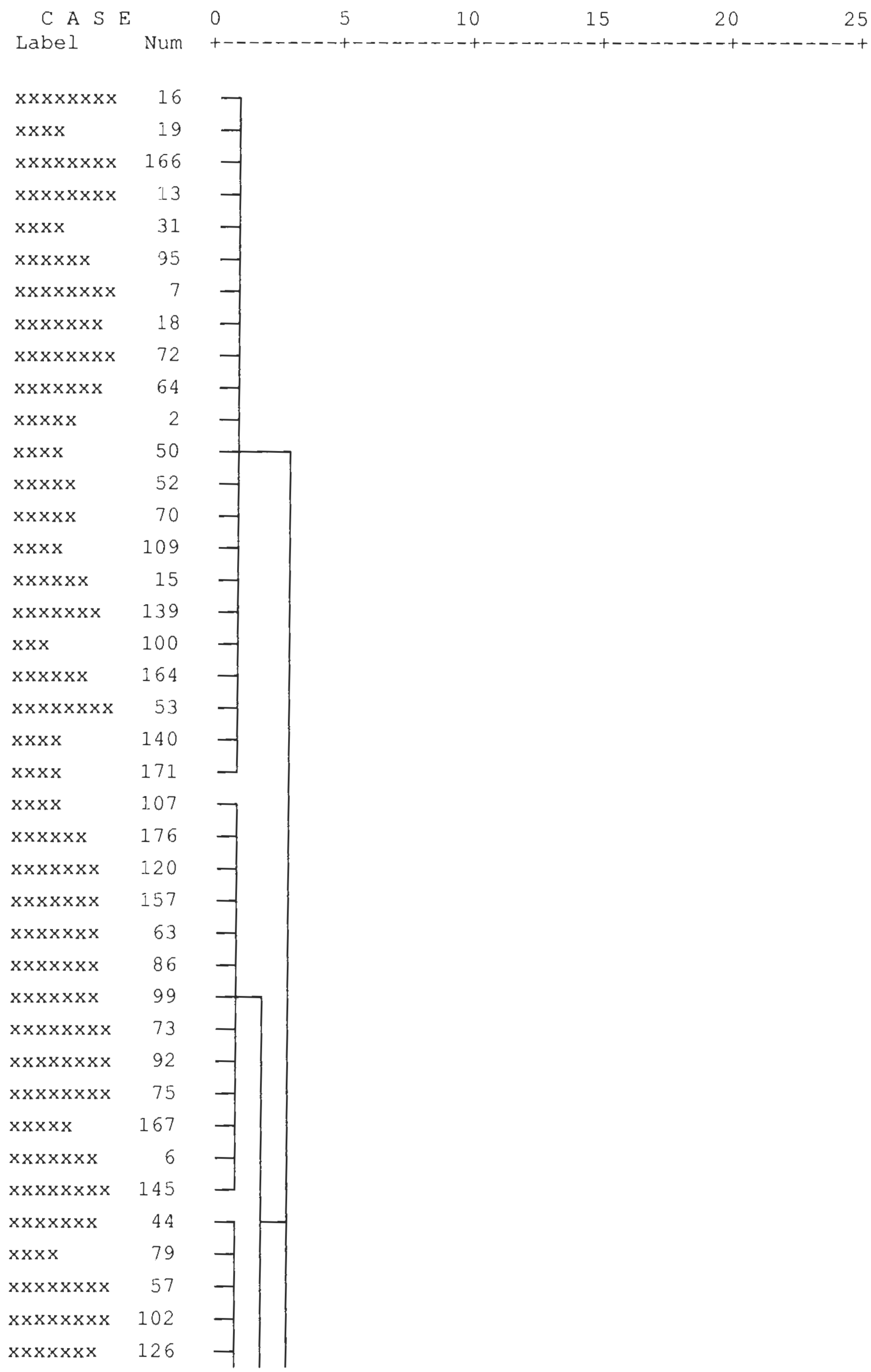
Part B: Learning Strategies

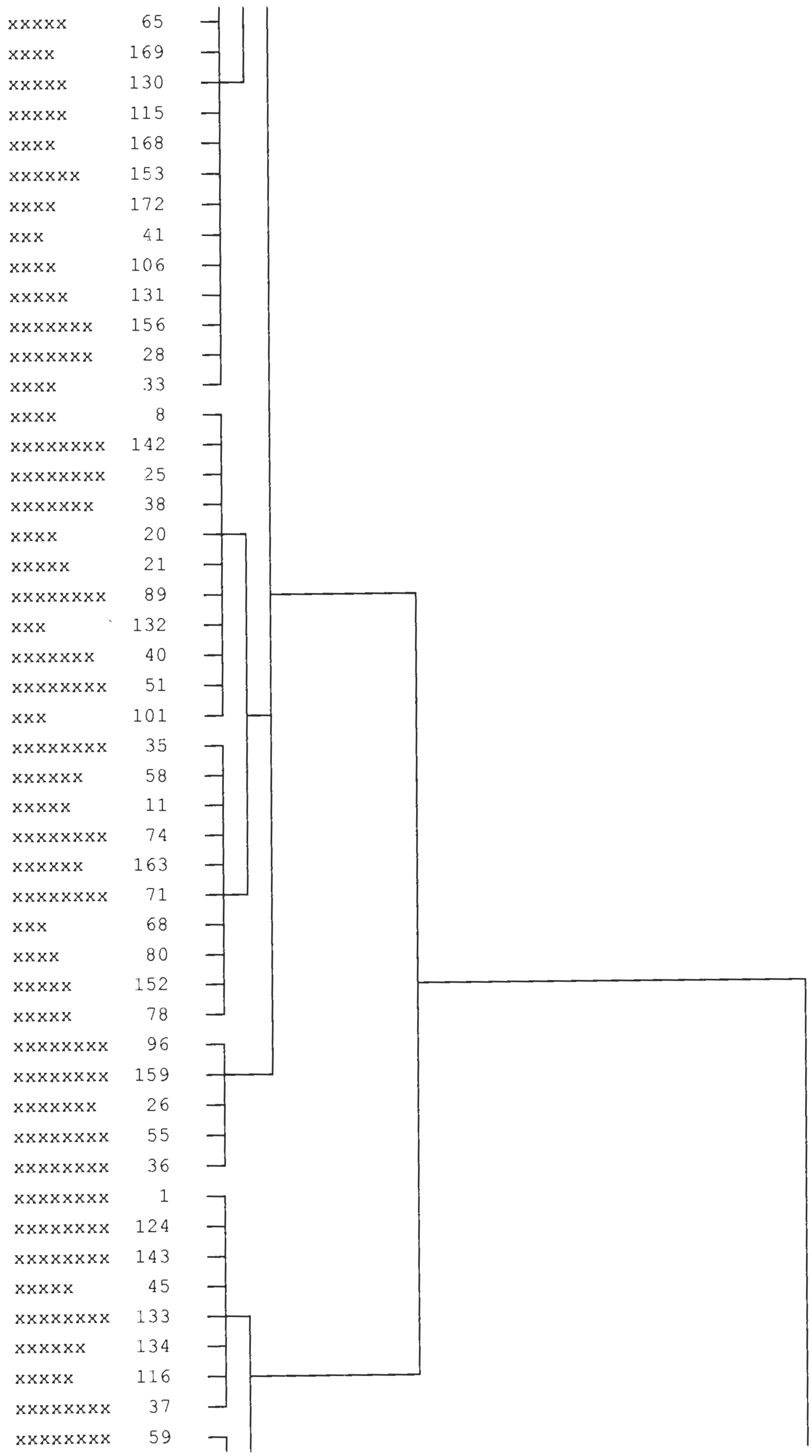
32. When I study the readings for this course, I outline the material to help me organize my thoughts.
33. During class time I often miss important points because I'm thinking of other things. (REVERSED)
34. When studying for this course, I often try to explain the material to a classmate or friend.
35. I usually study in a place where I can concentrate on my course work.
36. When reading for this course, I make up questions to help focus my reading.
37. I often feel so lazy or bored when I study for this class that I quit before I finish what I planned to do. (REVERSED)
38. I often find myself questioning things I hear or read in this course to decide if I find them convincing.
39. When I study for this class, I practice saying the material to myself over and over.
40. Even if I have trouble learning the material in this class, I try to do the work on my own, without help from anyone. (REVERSED)
41. When I become confused about something I'm reading for this class, I go back and try to figure it out.
42. When I study for this course, I go through the readings and my class notes and try to find the most important ideas.
43. I make good use of my study time for this course.
44. If course readings are difficult to understand, I change the way I read the material.
45. I try to work with other students from this class to complete the course assignments.
46. When studying for this course, I read my class notes and the course readings over and over again.
47. When a theory, interpretation, or conclusion is presented in class or in the readings, I try to decide if there is good supporting evidence.
48. I work hard to do well in this class even if I don't like what we are doing.

49. I make simple charts, diagrams, or tables to help me organize course material.
50. When studying for this course, I often set aside time to discuss course material with a group of students from the class.
51. I treat the course material as a starting point and try to develop my own ideas about it.
52. I find it hard to stick to a study schedule. (REVERSED)
53. When I study for this class, I pull together information from different sources, such as lectures, readings, and discussions.
54. Before I study new course material thoroughly, I often skim it to see how it is organized.
55. I ask myself questions to make sure I understand the material I have been studying in this class.
56. I try to change the way I study in order to fit the course requirements and the instructor's teaching style.
57. I often find that I have been reading for this class but don't know what it was all about. (REVERSED)
58. I ask the instructor to clarify concepts I don't understand well.
59. I memorize key words to remind me of important concepts in this class.
60. When course work is difficult, I either give up or only study the easy parts. (REVERSED)
61. I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying for this course.
62. I try to relate ideas in this subject to those in other courses whenever possible.
63. When I study for this course, I go over my class notes and make an outline of important concepts.
64. When reading for this class, I try to relate the material to what I already know.
65. I have a regular place set aside for studying.
66. I try to play around with ideas of my own related to what I am learning in this course.
67. When I study for this course, I write brief summaries of the main ideas from the readings and my class notes.
68. When I can't understand the material in this course, I ask another student in this class for help.
69. I try to understand the material in this class by making connections between the readings and the concepts from the lectures.
70. I make sure that I keep up with the weekly readings and assignments for this course.
71. Whenever I read or hear an assertion or conclusion in this class, I think about possible alternatives.
72. I make lists of important items for this course and memorize the lists.
73. I attend this class regularly.
74. Even when course materials are dull and uninteresting, I manage to keep working until I finish.
75. I try to identify students in this class whom I can ask for help if necessary.
76. When studying for this course I try to determine which concepts I don't understand well.
77. I often find that I don't spend very much time on this course because of other activities. (REVERSED)

78. When I study for this class, I set goals for myself in order to direct my activities in each study period.
79. If I get confused taking notes in class, I make sure I sort it out afterwards.
80. I rarely find time to review my notes or readings before an exam. (REVERSED)
81. I try to apply ideas from course readings in other class activities such as lecture and discussion.

Appendix 2 – Dendrogram using Ward Method

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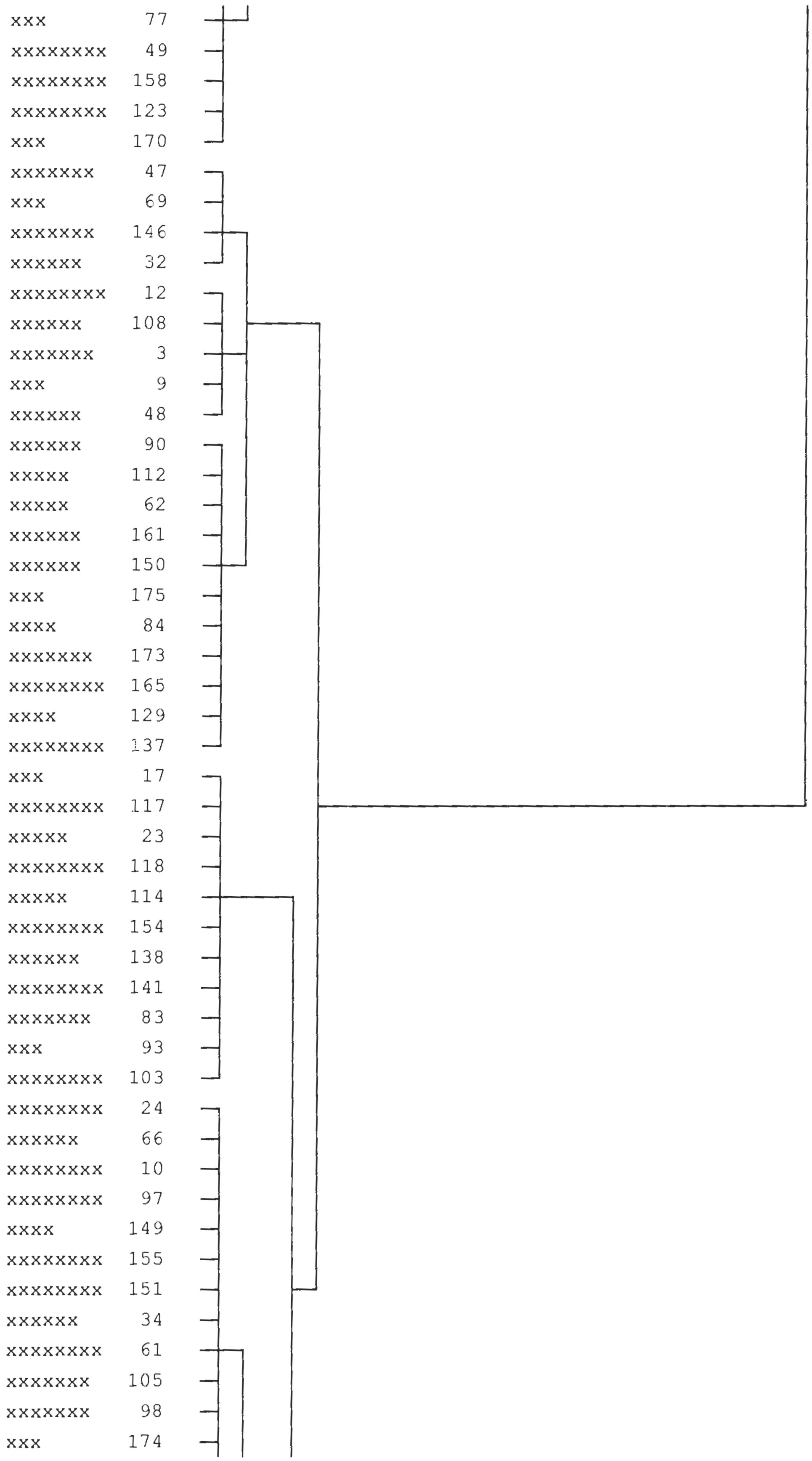
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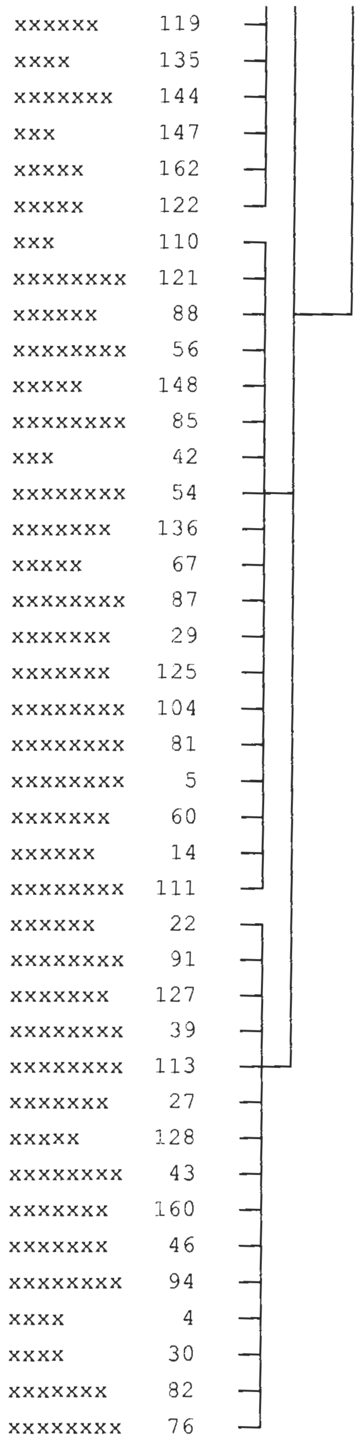
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