INVESTIGATING THE USE OF LEARNING OBJECTIVES AS AIDS TO SRL IN STUDY AND RESTUDY ACTIVITIES

by

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ABSTRACT

With the significant growth of online course delivery in post-secondary education where students do the preponderance of studying on their own, it is crucial to help them study effectively. Supporting their self-regulated learning may contribute to this end. Successful self-regulated learners (SRL) set goals before studying then return to these goals and adapt them as necessary, suggesting value in examining how we might support this process. Learning objectives are one instructional variable that may enhance elements of the self-regulation cycle, including setting goals, selecting appropriate tactics and strategies, and enabling learners to assess progress and decide whether to continue or create a new plan. The goal of this research was to investigate how learning objectives might support various facets of SRL when students studied and restudied material.

Seventy-nine university students studied a 1247 word anthropological passage in nStudy, software designed to research and support self-regulated learning. Participants were randomly assigned to one of three treatment groups: learning objectives and pre-seeded tags, learning objectives and pre-seeded notes, learning objectives and both pre-seeded notes and tags. In a fourth group, participants had neither learning objectives nor pre-seeded tags or notes. Participants returned after at least a 24-hour break to restudy using the same nStudy environment as their initial study session.

Data on study behaviour were collected through an online-questionnaire. Study behaviours were logged by nStudy. Participants wrote an achievement-test after completing the second study session.

Results suggest four significant findings. During study, three indicators of self-regulated learning – frequent note taking and views of learning objectives, and review of learning objectives in both study sessions – were associated with higher scores on the achievement test. Higher achievement was also evidenced by participants who stated the benefit of learning objectives prior to the initial study session, suggesting learners were prepared to regulate learning by metacognitively monitoring content during study and restudy.

These results suggest we can better support learners to productively self-regulate learning by teaching the relevance of learning objectives. They also suggest it is possible to support self-regulated learning in online learning environments by encouraging frequent note-taking, and presenting learning objectives throughout study materials.

Keywords: Learning Objectives; Cognitive Functions; Goals; Self Regulated Learning; Curriculum; Strategies; Instructional Design; Online Learning; Tools For Study; Note Taking; Restudy; Highlighting; Study Behaviour; Achievement

DEDICATION

To my family, and especially my children, may this inspire you to always be better people and to never, ever give up.

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CHAPTER 1 – INTRODUCTION AND RATIONALE

Self-regulated learning (SRL) is the iterative process involving both cognitive and metacognitive activities used by learners to successfully complete learning goals. I have selected the Winne & Hadwin (1998) four-phase model of SRL due to its concise process-based perspective that can be closely associated with the goals of learning objectives.

Although considerable research has investigated and identified, self-regulated learning processes, there is still little general agreement on the cognitive process(es) employed in learning regulation during study. We do know however, that effective self-regulating learners “have a thirst for learning” (Paris & Byrnes, 1989, p. 173), and “seek challenges and overcome obstacles with persistence and sometimes with inventive problem solving. They approach academic tasks with confidence and purpose. The combination of positive expectations, motivation, and diverse strategies for problem solving are virtues of self-regulated learners” (Paris & Byrnes, 1989, p.169). This understanding of what a good self-regulating student *is*, is only part of what is required to best scaffold and support learners in becoming effective self-regulators. I posit that more research is needed to help determine *how* students enact the phases critical to self-regulating when they study and restudy material. Such an understanding is necessary to better support learners since “most students have

trouble regulating their learning which severely affects their learning of challenging topics" (Azevedo, Moos, Greene, Winters, & Cromley, 2008, p. 46).

One way that instructional designers and teachers structure curriculum to guide learners towards achieving curricular goals is to use learning objectives. Research on learning objectives is abundant (Hamilton, 1985) and can be separated into many categories. This research focuses on topics related to the processes learning objectives should initiate for a learner, as I hypothesize that such processes support or scaffold SRL. It should be noted that although learning objectives in themselves typically only describe the intended result of instruction, by accomplishing the objective leaner's must engage in an active and self-regulated learning process. Currently there is a gap in research "on the impact of instructional objective interventions on learning processes and outcomes" (Zhou, Leacock, & Winne, 2008, p.1). This research will help close that gap by investigating which SRL activities learners enact in relation to learning objectives while they study and restudy material.

In the context of this research the term "restudy" refers to a learner returning to study material already reviewed in some manner in which they have engaged in behaviours related to learning. Research in the area of restudying is limited, and has mostly focused on issues related to periods of time between initial and secondary study sessions. This research aims to investigate restudy actions or behaviours. Each learner has a toolbox of cognitive activities from which they are able to draw while engaging in study and restudy, ranging from common low-level activities such as highlighting to higher level cognitive

processes such as translating the content into their own wording, or developing their own questions to test themselves on their comprehension. How and when these processes are engaged, and more importantly *when* and *why* the learner decides to change which action they have selected is key to modelling how the SRL process unfolds during study and restudy activities.

Certain cognitive operations such as translating, encoding, rehearsing, or selecting specific portions of text to identify with some form of a tag, are known to aid students in being more successful in studying content for achievement tests (Fowler & Barker, 1974; Wolfe & Neuwirth, 2001). However, more research is necessary to increase understanding of what is actually done by the learner with these self-created learning objects once they have been created. Research on marginalia suggests that learners benefit from creating their own notations (Jackson, 2001), while research on tagging, such as highlighting, suggests that when a learner actively highlights they are making conscientious decisions about which information to select, thus requiring some level of extra cognitive engagement with the material. However research by Igo, Bruning, & McCrudden (2005) has suggested that it is even more effective for learners to be forced to be discerning in what material they “tag” or highlight.

I conjecture that learning objectives are often not effectively implemented by instructional designers or used by students to support SRL in study and restudy situations. The aim of this research is to explore whether learners are using learning objectives to aid self-regulation in study and restudy situations, and whether such use of learning objectives benefits student achievement.

CHAPTER 2 – LITERATURE REVIEW

This review of literature contains four main sections, learning objectives; self regulated learning, studying and restudying behaviour and concludes with a brief section on methodological issues.

LEARNING OBJECTIVES

> *"educational objectives are not only the goals towards which the curriculum is shaped and toward which instruction is guided, but they are also the goals that provide the detailed specification for the construction and use of evaluative technique" (Bloom, 1956, p. 27).*

This review of the learning objective literature will introduce learning objectives, review the history of learning objectives, their perceived utility, present a brief critique of their purpose (use), and then discuss how learning objectives can be used to aid SRL, in particular the four phase model of SRL proposed by Winne and Hadwin (1998). This model is described in more detail in the following section of this literature review.

This review of learning objectives dichotomizes the argument on whether learning objectives are beneficial or detrimental to learning, however there is a set of literature that states "it depends", suggesting that in certain situations or environments learning objectives can either be helpful or a detriment. To keep this discussion brief I have focussed on reviewing the "learning objective are good" and "learning objectives are bad" literature.

Learning objectives have been called many things over the years including aims, purposes, goals, guiding outcomes, and instructional objectives (Anderson, Krathwohl, & Bloom, 2001). The definition of learning objectives that will be used in this research and literature review speaks specifically to instructional statements made preceding learners' engagement with curriculum that are specifically designed as aids to scaffold or direct the learning process.

We use objectives in life to guide us towards goals; they enable us to "focus our attentions and our efforts" (Anderson, et al., 2001, p.3). Objectives also enable us to gauge our success in achieving our goals and then adapting our behaviours according to our perceptions of success, changes, or failures. Goals may range from long-term life-oriented goals, such as being a person who contributes to the betterment of society; or short-term action oriented goals, such as going to the cafeteria to buy a muffin for a snack. Within this diverse and large area of research, this review will focus on educational learning objectives. More specifically, I review how learning objectives indicate what we want students to learn; the "explicit formulations of the ways in which students are expected to be changed by the educative process" (Bloom, 1956, as cited in Anderson, Krathwohl, & Bloom, 2001, p. 3). I will argue that this direct instruction to learners can aid SRL, particularly during phases 2 and 3 of the Winne & Hadwin (1998) model.

History of learning objectives

Due to the diverse terminology used to describe learning objectives, searching and reviewing the literature required searching journal databases for

the terms mentioned earlier, in particular, aims, purposes, goals, guiding outcomes, and instructional objectives. From those results, I judged whether the definition used in the publications referred to the definition I address here, which is to provide guidance or scaffolding to the learner preceding study of content.

The basis for the majority of recent literature on learning objectives has focused on what has become known as “Bloom’s Taxonomy”. This taxonomy came from a seminal publication on learning objectives that was intended to be the first of a series of handbooks on what were at the time, thought to be the domains of learning, the cognitive, psychomotor, and affective (Bloom et al, 1956). Bloom and colleagues began with the development of the taxonomy for the cognitive domain. The original purpose was to develop a “common framework for classifying intended student learning outcomes [that] could promote the exchange of test items, testing procedures, and ideas about testing” (Anderson, et al., 2001 p.xxvii).

This taxonomy was updated by Anderson and colleagues, in 2001 (Anderson, et al., 2001) with some minor but significant changes. The six levels of the original taxonomy, which were thought to be sequential, building upon the previous step or level, consisted of; knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom, 1956). The updated version, among other changes, adapted those nouns to verbs and re-ordered and renamed synthesis. The new version (Anderson, et al., 2001) consisted of; remembering, understanding, applying, analyzing, evaluating, and creating. This change took into consideration advances in cognitive psychology over the intervening half

century that provided evidence that there are two dimensions to learning, the knowledge dimension and the cognitive process dimension (Anderson, et al., 2001).

Purpose/Utility of learning objectives

As an instructional designer at a post secondary institution, part of my role is to assist other institutions to articulate our distance education courses. Often all that is requested from another institution is a list of the intended learning objectives and the name of the textbook used. The premise underlying this practice is that the learning objectives are carefully and accurately mapped onto the curriculum and tested through assignments and exams, which was the initial goal for Bloom et al (1956) in developing the taxonomy.

As Gronlund & Brookhart (2009) suggest, “there is [supposed to be] a one-to-one relation between the stated objective, the teaching, and the testing procedure” (p.5). Too often, in my experience, courses are developed with the first two points, aligning the learning objectives with the curriculum, but miss the critical third point in the trajectory, which is to ensure the use of proper assessment techniques matched to the stated instructional objectives.

Learning objectives can be beneficial to instructional designers and curriculum developers by clearly articulating in precise language learning goals under specifically stated conditions. Such precision is intended to enable learners to focus their attention on the specific skills, knowledge or conceptions (Mager, 1984). Wiley, Griffin and Thiede argue that readers “need specific information about what sort of test they are preparing for, and when they have this

information, their monitoring accuracy improves" (2008, p. 819). Well-written learning objectives can provide such information by outlining the expectations prior to the learner engaging with the material, at the stage when the learner begins to define the task.

Another benefit of learning objectives is that they have been shown to be beneficial in laying out a "road map" for learners to proceed through in a scaffolded or supported manner (Combs, Gibson, Hays, Saly, & Wendt, 2008).This is also Mager's (1984) view: "[the] advantage of clearly defined learning objectives is that they provide students with the means to organize their own efforts towards accomplishment of those objectives" (p. 6). Such organization potentially sets a stage for students to develop a plan for successfully accomplishing the outlined task, which as described later, realizes part of the second of the four stage model of SRL proposed by Winne and Hadwin (1998).

Mager (1984) also states "the most useful objective is the one that allows us to make the largest number of decisions relevant to its achievement and measurement" (p. 19). This suggests that a learner must exercise agency in the process, and that merely understanding the learning objectives is only the first step in the path to accomplishing the objective. Once again, this step of succeeding in achieving the learning objective can be linked to the first phase of the Winne & Hadwin (1998) model of SRL, where the learner must define the task.

Critique of learning objectives

As Mager (1997) suggests, learning objectives assist the learner by scaffolding focus of their attention on specific content. Such focus and specificity of selected portions of the presented curriculum is a concern for those who oppose learning objectives on the basis that learners may focus too specifically on material directly stated in a learning objective (Klauer, 1984). However, in well written learning objectives the learner isn't directed with such specificity, they are only told what they need to accomplish to demonstrate that they have *learned* the intended skill, knowledge, or process, and under which conditions success will be measured.

Another concern is that the use of learning objectives may cause the learner to focus on the course content only, which doesn't aid students in developing better problem solving skills and other higher-level outcomes (Gronlund & Brookhart, 2009). Focusing only on the course content is also "apt to overemphasize the recall of factual information" (Gronlund & Brookhart, 2009, p. 4). This is at odds with contemporary research that suggests learners need to be better at solving problems in multiple settings (Britton & et al., 1985; Choi & Hannafin, 1995).

Empirically, Klauer (1984) found that learning objectives help goal-relevant learning, but decrease goal-irrelevant learning (Schonfeld, Rasmussen, Nieto, & Sims, 1988). Therefore, as an instructional designer, one must consider whether to address all overarching learning goals in the learning objectives, otherwise there is potential for such content to be missed by the student as they may not

focus on any content not specifically addressed by the learning objectives. Winne (2004) suggests that instructional designers also make assumptions about the manner in which learning objectives are used by the learner, suggesting that there is a belief that learners “use objectives provided as standards for metacognitively monitoring comprehension,” (p. 468). Such assumptions suggest that more information is needed by both instructional designers and learners to better use learning objectives to assist learners in being successful.

Another common critique of learning objectives is that historically they have not been properly developed or employed in the learning curriculum. At times “specific behavioural objectives were once the focus of classroom instruction. This resulted in long, unmanageable lists of specific objectives that emphasized simple knowledge and skill outcomes to the neglect of more complex learning outcomes” (Gronlund & Brookhart, 2009, p. 6). Such critiques ignore two critical facets of learning objective use, first that they cannot guarantee learner success, and second, that students are agents who select on their own learning tactics or strategies based upon *their* understanding and definiton of the learning objective.

A proviso of learning objectives that is important to note is that learning objectives are not a “substitute for effective teaching” (Schonfeld, et al., 1988) but that learning objectives may be a “useful adjunct to teaching” (Schonfeld, et al., 1988).

Critics of learning objectives suggest that the early tack of focusing on specific tasks isn’t beneficial to learners, particularly in developing higher-level

problem solving skills (Gronlund et al, 2009). However, this was not the original intent of learning objectives as described by Bloom et al (1956), who suggested that learning objectives were meant to be “explicit formulations of the ways in which students are expected to be changed by the educative process” (p. 26). The metaphor of a road map can be used here to suggest that the learning objectives are written with an understanding of where the learner currently is, where they need to go, and how it will be determined they have arrived, not *how* the journey will be orchestrated. We now understand that “with simple learning outcomes the objectives and tasks may be similar, but with complex learning outcomes they are likely to differ considerably” (Gronlund & Brookhart, 2009, p.6). Such differentiations are important to instructional designers who should strive to provide variation in forms of assessment.

The concern over requiring higher level learning outcomes comes from the advances in understanding the role of cognitive processes in learning (Gronlund et al., 2009). Research in the area of cognitive psychology suggests that “thinking, reasoning, and complex problem solving can occur at all levels of learning if students are actively engaged in constructing meaning from their experiences” (Gronlund & Brookhart, 2009, p. 6). When Bloom et al. developed the taxonomy for the cognitive domain, we knew little about self regulation, cognitive load, or issues with multimedia content delivery such as dual coding and the split attention effect. Recent advances in the area of cognitive psychology suggest that learners process information in very specific ways, moving new information from working memory into a schema that exits within

long-term memory, and that there are limited cognitive resources for completing these tasks (Darabi & Nelson, 2004; Mayer, 2005; Sadoski, Paivio, & Goetz, 1991; van Gerven, Paas, van Merrienboer, & Schmidt, 2000; van Merrienboer & Paas, 1990).

Those who are critical of learning objectives, such as Arnstine (1964), Atkin (1968), Einser (1967), Oakeshott (1962) and Raths (1971), argue that directing the learner to specific parts of the curriculum constrains incidental learning (Zhou, Leacock, & Winne, 2008). What is often neglected in these critiques of learning objectives are the actions the learner engages in with the objectives. The learning objectives don't instruct the learner in which tactics or strategies they should employ, they merely outline what is going to be assessed and under what conditions the assessment will take place. How learning objectives may be beneficial is in providing a scaffold for a learner to engage in more self-regulatory behaviour by providing an anchor from which SRL can both begin and be referred to later in the SRL model presented by Winne and Hadwin (1998).

How learning objectives can relate to SRL

Supporters of Mager's (1962) account of instructional objectives claim that learning objectives provide anchors that "enhance relevant/intentional learning by clearly indicating what is required of students (Zhou, et al., 2008). Having such an "anchor" from which to base ones self-regulatory process has been suggested in the learning objective literature, however, this typically this has not been described as SRL. Although Gronlund & Brookhart (2000) approximate this in

stating, “instructional objectives also provide a basis for student self-assessment of learning progress” (Gronlund & Brookhart, 2009). Using a learning objective as an anchoring point enables the learner to both start and complete the cycle of self-regulating by suggesting a goal they can later use to compare to their actual achievement. Without such an anchor the last two phases of the Winne-Hadwin model cannot be completed with any degree of efficiency. Learners need to develop a model of the task (Phase 1 of the Winne-Hadwin model) and learning objectives are one potential scaffold that supports such development. Learning objective are also beneficial in enabling the second and third phases of the Winne-Hadwin (1998) model to be completed, setting a goal and and applying tactics and strategies. Then, the learner may engage in Phase 4 where they monitor their implementation of large-scale strategies and tactics in achieving the goals necessary to complete the task they modelled in Phase 1. This process is iterative and should continue until the learner finds the appropriate strategies that are most efficient. A potential result of the present research will be to better understand how learners use learning objectives to study and restudy, and how and when learners use various strategies to self-regulate learning.

As described earlier, many studies suggest learning objectives are beneficial, and that "… even with a variety of learning goals and objectives used, the majority of experiments found significant positive effects" (Hamilton, 1985, p.74).” However, these results only indicate a benefit from using learning objectives; they don’t explain *why* learning objectives are beneficial. I

hypothesize learning objectives aid students in their learning activities by providing a structure to support SRL.

Britton et al (1985) state that “instructional objectives improve the recall of objective-relevant content in text, more importantly, however, is that it has now been shown that instructional objectives also increase the amount of time that students spend reading the objective-related content, as well as the amount of cognitive capacity students bring to bear on the content” (p.111). I hypothesize that learning objectives provide the scaffolding for SRL activities to occur, which may increase the time spend studying, this research will attempt to identify *how* students use that time, and whether the time is consumed through the conduction of activities that support SRL.

Conclusions about Learning objectives

Benefits of providing learning objectives are supported by several camps of educational researchers. Constructivists feel that the learner has a choice whether or not to select learning objectives, and that if selected may guide the learner from where they are to where they need to be; SRL theorists speak to the need to develop a model of the task (Pintrich, 2000; Winne & Hadwin, 1998; Zimmerman & Schunk, 2001), which may be defined by learning objectives. Cognitive theorists suggest that learners need to actively integrate new information with prior knowledge, which learning objectives may support by triggering prior domain knowledge from existing schemas. Although there is criticism that learning objectives direct the learner to focus on specific portions of the curriculum, and that such specific focus may depress opportunity for

incidental learning (Schonfeld, et al., 1988), it can still be argued that learning objectives may be an effective means of guiding or scaffolding learners.

SRL

Introduction

Self-regulated learning is a broad area that describes the process of a learner being an active participant in “activate[ing] and sustain[ing] cognitions, affects, and behaviours that are systematically oriented toward the attainment of learning goals” (Schunk & Zimmerman, 2008). My research, and therefore the literature that I will focus on, takes the perspective of the information processing SRL model presented by Winne and Hadwin, (1998; Winne, 2001). This model, as discussed earlier, contains four phases: first, defining the task; second, setting goals and planning strategies or tactics; third, execution of their plan; and then, fourth, monitoring and adapting metacognition. In this last phase the learner optionally reviews how successful the execution of the overall plan has been and then makes a decision to either continue or adapt it (Winne, 2004). The first two phases of this model are particularly related to learning objectives as they help the learner define the task and then provide a framework or scaffolding for the learner to then set their own goals and develop a plan on how to achieve these goals.

This next section will look at each of the four phases of SRL outlined by Winne & Hadwin (1998, Winne, 2001), and discuss how each of these phases may relate to the use of learning objectives in curriculum.

Phase 1 – Perceiving the task

"In the phase of task perception, students scan their environment, including tasks set by the teacher, exercises posed by the textbook's author, and knowledge they have about themselves" (Winne & Hadwin, 2008, p. 298) – the learning objectives may help frame this by informing the student what exactly it is that will be expected of them to successfully achieve the learning goals. In the Winne and Hadwin model (1998) this task definition contains both task conditions and cognitive conditions. Task conditions consist of resources, instructional cues, time, and social context. Learning objectives are one example of instructional cues, however, other instructional cues may also be available to the learner such as instructions provided by the teacher, information provided by the textbook to help guide them through the chapter or sample tests provided for review. A learner will also take account of what resources are available to assist them in being successful. At this point the learner may also be triggered to draw upon their prior domain knowledge or experiences with the subject domain. This falls into the cognitive conditions, which consist of beliefs, dispositions, and styles, motivational factors and orientations, domain knowledge, knowledge of the task, and knowledge of study tactics and strategies.

At the point where the learner makes an assessment of which resources are available it should be noted that these resources may be specific study aids such as the tools available in software such as nStudy (described later in this chapter) or other academic resources such as their peers, websites, the library, or their notebooks or textbooks from related courses.

Phase 2 – Setting Goals

Understanding that each learner is an agent may help with understanding the role of goal setting that takes place in the second phase of the Winne & Hadwin (1998) model. Goals are not necessarily always learner-created; other sources can be effective, such as the teacher, the curriculum or textbook author. Research suggests that “effective goals can be assigned by social mediators, such as parents or teacher, if they convey a plausible rational for their goals” (Zimmerman, 2008, p. 273), however it is up to the learner to accept, modify or reject those goals, thus exercising agency in their own goal setting. More on learner agency follows the discussion on Phase 4.

Goal setting should not be confused with goal orientation, which “focus[es] on reasons for engaging in academic tasks”. (Zimmerman, 2008, p 268). Goal setting, specifically in SRL, relates directly to the end points of a learner’s plans for enacting specific tactics or strategies but it is not limited to these. As Winne and Hadwin (2008) state, “goals can refer to overt behaviours, forms of cognitive engagement, changes in motivation, or all three” (p. 298). Further, Locke & Latham (2002), suggest that a goal is the “object or aim of an action, for example, to attain a specific standard of proficiency, usually within a specified time limit” (p. 705). The activities that surround and support such goal setting may be described as components of SRL.

Research on goal setting has found that “specific goals are more effective than general or vague goals because progress toward specific goals is easier to gauge” (Zimmerman, 2008, p. 269). Specific, acheivable goals not only helps the

learner gauge their success incrementally, but research also suggests it may help with a learners' efficacy in being successful (Bandura, 1991).

Learning objectives may be one method of supporting the creation of goals by a learner, a starting point for learners to begin goal-setting activities. Understanding both the purpose of learning objectives as well as how to effectively use them may therefore be one possible way to assist learners to engage in SRL.

Phase 3 – Enacting Tactics

During the third phase of SRL, the learner begins to implement specific tactics they have chosen to use to accomplish goals they set during the second phase of the model. In this third phase, a knowledge product is created that can be assessed relative to goals. This process can be iterative such that successive fine-grained adaptations may be made to task conditions (resources, time, assistance) or cognitive conditions (beliefs, dispositions, styles, motivational factors, review their understanding of the task, review their repertoire of study tactics and strategies), and tactics or strategies (Winne & Hadwin, 1998).

In this third stage of the model (Winne & Hadwin, 1998) the external evaluation that is required in the process of gauging their performance may be in accordance with achieving the learning objectives provided within the curriculum, or another evaluation imposed by the curriculum or instructor. These external evaluations may provide an anchor which the learner can then use to monitor the

success of tactic selection and implementation, and to judge goals set as described in the second phase.

Phase 4 – Adapting and Monitoring Tactics for SRL

Within the Winne and Hadwin (1998) model it is during the fourth and optional phase where the learner monitors their large-scale succes. This may lead the student to take one of two potential paths depending upon their judgement. If they feel they are **not** succeeding, the may begin the SRL process again by starting at the first phase of reviewing their task definition and then either set different goals or select different tactics or strategies to employ. If the learner is meeting goals, they can then continue on with their SRL process or seek to tune their work to be more efficient.

However, there are two major concerns with metacogntivie monitoring. First, learners may be inefficient and inaccurate at monitoring which tactics they apply (Winne, 2004; Winne & Jamieson-Noel, 2002). Second, learners often do not “engage in frequent enough metacogntive monitoring” (Nesbit & Winne, 2006). Wiley et al. also found that learners are not adept at accurately monitoring their metacomprehension accuracy (2008). This research suggests that learners need “appropriate cues to judge whether or not they have understood a text” (p. 817). Such problems with learners’ metagcognitive monitoring suggest that more research is necessary to understand how people engage in SRL behaviour while studying and restudying. In particular, how do learners make judgements and then what they do once they have made such a decision?

Azevedo et al. (2004) posit that SRL is a recursive process that requires active participation (decisions) by the learner as they proceed through the learning task. This reflects the view that self-regulating learners are agents who "consciously control[ling] and interven[ing] in their learning" (Winne & Hadwin, 2008, p. 297). At each of the four phases the learner must make decisions about their learning and then act accordingly.

In my research participants will be able to choose to use learning objectives, or choose to use proxy tags (explained in detail in chapter 3). For self-regulation to be productive, learners need to understand the choices available to them to make choices and good decisions.

In the Winne and Hadwin model (1998) agency begins when the learner develops a plan for the task, then once again in the next phase as they begin goal setting, tactic selection, and tactic implementation. In the third and fourth phases, when learners monitor tactics and strategies, judgments of learning (JOL) can play a key role in a learners' regulation.

Study and Restudy Behaviour

It is commonly understood that "studying is a metacognitively powered self-regulated learning process" (Winne & Hadwin, 1998, p. 13). We also understand that this SRL process evolves over multiple study sessions (Perry & Winne, 2006). However, as Winne & Leacock (2009) discovered, there are several gaps in the literature on restudy behaviour, and as Hadwin et al. found (2004) "we know little about how SRL develops while students actually study, or how they adapt studying across studying episodes" (p. 367). Winne and Leacock

(2009) suggest that more research is needed to have a more complete understanding of restudy behaviour which may enable eudcators, software designers and curriculum developers to better support learners.

In their review Winne and Leacock (2009) discuss five major deficits in the literature on restudy activities. First, most studies use “non-meaningful information” such as paired associates (e.g., fish-book, phone-rock) in experimental settings that were nothing similar to “real life” study situations where a learner is required to study content consisting of longer pieces of text such as a journal article or textbook chapter. Also, other formats of content delivery such as multimedia have not be been researched. Second, most studies used recall as the measure. No studies were found requiring learners to produce cogent content such as an essay or summary of the material they studied. Third, no studies looked at the interaction between the tactics a learner employs in the initial study session and those employed during the restudy period. Fourth, very little is currently understood about what learners actually *do* in a restudy application. Fifth, and last, Winne and Leacock (2009) found that in almost every study on restudy participants were sophisticated learners such as first year university psychology majors.

The little that is known about restudy activity is that often learners fail to make good decisions about what material to restudy (Wiley et al., 2008). Also, learners are moderately inaccurate in recalling how they had studied (Winne & Jamieson-Noel, 2002), and that “when learners are poorly calibrated about how they study, they are in a weak position with respect to knowing what to change”

(Nesbit & Winne, 2006, p. 12). Having a more in-depth understanding of restudy activity may help develop theories of why learners often make poor decisions and are unsuccessful in understanding and adjusting their restudy behaviour. With such understandings we may be better able to assist students in making more accurate assessments of the nature of study tactics since “without accurately tracking study tactics, it is very difficult to make effective repairs” (Nesbit & Winne, 2006, p. 12).

Research methodology

A software tool called nStudy will be used to collect data. The benefit of using software to collect data, and in particular nStudy, is that it can collect traces of many of the actions a learner performs while interacting with content. This unobtrusive data collection method enables me to research very detailed log files post-hoc, without disturbing the learning process.

Description of nStudy tools and their relation to SRL

Notes Editor

The ease at which material can be copied and pasted in a computer environment has both benefits and disadvantages. Students are able to quickly create notes or annotations by copying text and reorganizing it in a different place, however they are likely not necessarily cognitively processing the material deeply (Igo, Bruning, & McCrudden, 2005). nStudy encourages learners to do more than merely select text, it provides editable fields that require the learner to interact with the content and potentially create linkages to prior domain

knowledge. Such selection and interaction with content through the creation of a note in nStudy may be more effective than non-structured note taking. According to Glover and colleagues (Glover & et al., 1990) “organizer schema provide the reader with heuristics for attending to various aspects of the text and to how they will relate the incoming information to information held in long term memory” (p. 295). Once a nStudy user has made the decision that content requires annotating s/he selects the note tool, then selects the note type (pre loaded template, or perhaps a template they have created on their own) and then follows the provided structure such as providing elaboration or categorization of the selected material. Such actions require the student to metacognitively monitor the content and then act metacognitively as they categorize and annotate the material (Winne, 2006). Such actions have been shown to enable easier retrieval and use of such content when it has been more deeply processed (King, 1992).

Tag Editor

Tagging is a method of categorizing content, it may be binary, such as highlight or not highlight, or it may entail more advanced labelling strategies utilizing different colours of text and highlighting, and a variety of text formats to create numerous categories. Research shows that learners are behaving in a self-regulatory way when they first recognize that the particular material needs to be identified, then second, predict that labelling this material will have some value to them, third, select the method of labelling or identifying the content and finally conduct the act of labelling the material.

The act of creating labels is usually a low level task that requires minimal cognitive engagement, however learning is likely enhanced once users begin to use multiple labels or identifying systems, or when they return and cognitively review the identified material. nStudy supports deeper engagement of content through the processing the learner through a variety of steps to categorize and organize the labelled information.

Highlighting Tool

The benefits of creating notes, as stated earlier, are that this process requires deep processing and considerable cognitive resources as it requires the learner to be more engaged through metacognitively monitoring of how the notes should be constructed, linked, or categorized, however not all instances of annotating material require such cognitively demanding activities. An advantage of highlighting is that it draws students' attention to identify content that requires some sort of elaboration or personal reference that links to prior domain knowledge, while having minimal impact on a learner's cognitive load as little distraction occurs.

Research has shown the benefits of providing supportive aids for students to engage more deeply with content, however there are instances when the learner needs the ability to create objects without impediments such as structures and supportive aids. When a learner is cognitively overwhelmed by either the interface that is presenting the content, the content presentation format (extraneous cognitive load), or the complexity of the material (intrinsic cognitive load), a cognitive overload may result, impeding the student from integrating new

content into existing schemas, or creating new ones (Paas & Van Merrinboer, 1994; Sweller, 1994; Sweller & Chandler, 1991). The highlighting tool was created to provide such a tool that enables the learner to engage the content without requiring a large amount of cognitive resources, enabling the learner to quickly move along with minimal distraction.

Conclusion

Having discussed the potential of learning objectives, it should be noted, that although they may be beneficial in aiding SRL, they are not a requirement for SRL to occur. Potential benefits of learning objectives may exist during all four phases of the Winne-Hadwin model (1998) of SRL, in Phase 1 where the task is defined with both task conditions, and cognitive conditions, in Phase 2 when the goals are set and a plan devised to accomplish the goals to execute the plan, then during Phase 3 and Phase 4 where the plan is executed and monitored.

Research has provided evidence that learners are not accurate in either their estimations of the amount of time they spend studying or the degree to which they understand the material they have studied (Winne & Jamieson-Noel, 2002). With such inaccuracies in reports of study behaviour it can be questioned whether methodologies employed for researching study behaviour may also contain flaws. Innovations in content delivery methods and tools to support learning behaviour may solve some of these concerns. Using unobtrusive technologies such as nStudy that record and track all online interactions a learner has with the curriculum being studied may potentially reduce extraneous

cognitive load a learner requires to keep records of their study action and behaviour (Leacock & Nesbit, 2007).

In this study learners were not asked to use a think aloud protocol (Ericsson & Simon, 1993) in an effort to minimize cognitive load. Online survey instruments were administered both pre and post-study. By using various instruments this research collected both process (log files) and product data (log files, questionnaires, and achievement tests) in an effort to triangulate results and capture the usefulness of learning objectives in supporting SRL.

The aim of my results will be to identify the usefulness of learning objectives and predict their usefulness in supporting learners to self-regulate, or provide information on how to better implement learning objectives so that students get the most benefit from them in study and restudy situations.

CHAPTER 3: METHOD

Participants

The participants were 79 students consisting primarily of undergraduate students drawn from various faculties (46 women and 33 men). Their ages ranged from 19 to 42 years (*M*=24.29 *SD*=5.71) with 18 percent in first year (n=15), 15% in second year (n=12), 15% in third year (n= 12), 12% in fourth year (n=10), and 24% beyond fourth year enrolled in the University's teacher education program (n=19), 16% (n=13) did not report their level. The participants had a mean reported GPA of 3.04 out of 4.33 (*SD*=.62); 8 did not provide their GPA.

Treatments

Participants read an article titled "Hobbits of Flores Island". In group 1, the article did not contain a link to access a set of learning objectives or any other customized tools for studying the text. The other three groups were provided a link to learning objectives plus additional tool support; pre-seeded tags (group 2), note templates (group 3), or both note templates and pre-seeded tags (group 4). Pre-seeded tags and note templates are further described in the section on Materials.

The four learning objectives were presented with a link to advance to the next learning objective. This method helped participants focus on one objective at a time and enabled nStudy to log which learning objective a participant viewed

by indicating which linked page was “in focus”. Participants were instructed to not resize windows within nStudy to prevent them from viewing the learning objectives as well as the Hobbit text concurrently.

Assignment to Treatments

Participants were assigned to groups in sets of four. The first participant to arrive was asked to choose one of four pieces of playing card sized paper arranged face down on a table. Written on each piece of paper was a number, 1 to 4, corresponding to each one of the four treatment groups. Each successively arriving participant in the set of four was assigned to a group in sequential order from the number chosen by the first participant in a set. Randomization thus resulted from (a) the first participant’s choice and (b) who showed up at which time.

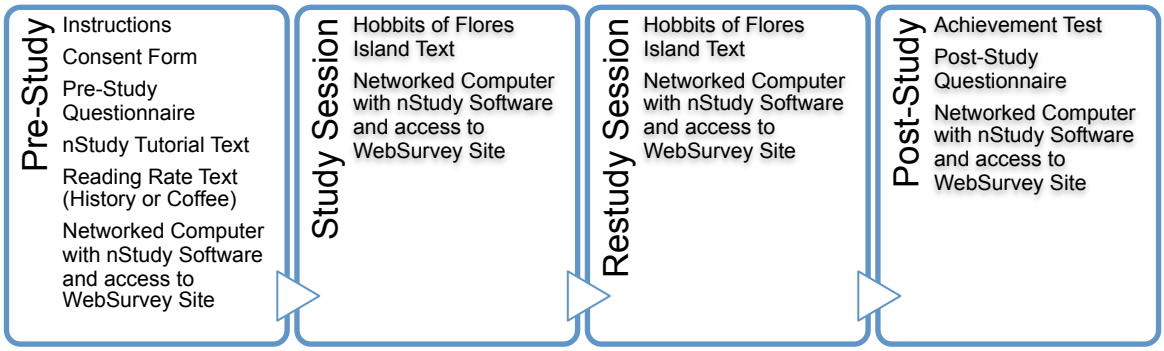
Some nStudy data representing treatment groups became corrupt during the data collection phase. This resulted from accounts being used by multiple participants. These participants’ logs were discarded from the analysis phase. As a result, participants were sometimes grouped based on the working accounts available. To equalize group sizes, on the following day participants were assigned to groups excluding the group that had been over-subscribed the prior day. The account corruption led to slightly uneven group participation with 27 participants in *group 1* (no learning objectives or cues), 17 participants in *group 2* (learning objectives and pre-stocked tags based on the learning objectives), 20 participants in *group 3* (learning objectives and notes complete with scaffolding to support the learning objectives), and 18 participants in *group 4* (learning

objectives, with both the notes with templates and pre-stocked tags based on the learning objectives). Three participants did not complete all components of the study and their data were discarded.

Materials

All participants completed four phases of this study, pre-study, study, restudy, and post-study. Through the four phases 10 items were used in the study as materials; instructions, informed consent form, pre-study questionnaire, nStudy software, tutorial text, reading rate text, study content, achievement test, post study questionnaire, and the computers used in the lab. See figure 1 for a list of materials used in each of the four phases of the study.

Figure 1: Materials used in each phase of the study.



Instructions

The following instructions were read through sequentially to each participant.

"I'm interested in how you study a passage of text on which you will be tested for recall. You'll be given a text (2400 words) that I want you to read and study as you normally would using the nStudy tool. You will need to then return

within 24-48 hours to restudy the text you have annotated and marked up using the tools available in nStudy. Once you have restudied the material you will be given a short free response quiz. **You can use as much time as you need** to read and study the text on each study opportunity.

You will first sign an ethics form that gives me permission to observe and record your studying in this research project. I will then give you a short tutorial on the software. Next you will read a 1000-word text in the software to help me gauge your regular reading speed. You will then read a text in the software and use tools available to study it. Once you have finished studying I will require you to return within 24-48 hours to study the same text complete with any highlights and notes you made the first time you studied the text.

You should aim to score at least 80% on the knowledge test at the end of studying."

Consent Form

Participants were given a consent form (See Appendix A) that described the study but did not indicate that data would be sought about study and restudy behaviour, or mention learning objectives in any manner. This was done intentionally to avoid the Hawthorne Effect, a form of reactivity whereby participants behave differently to either improve or modify an aspect of their behavior being experimentally measured due to knowing that they are being studied" (McCarney, et al., 2007).

Pre-Study Questionnaire

Participants first completed an online pre-study questionnaire. Wording was designed to minimize the Hawthorne Effect by not using words related to SRL such as task, plan, goal, monitor, tactics, adapt or anything related to learning objectives. Pre-study questions elicited information regarding participants' typical study and restudy behaviours. The following questions were included:

1. What is your participant number from nStudy?
2. What do you do when you study material for the first time? Please briefly describe your study process.
3. Briefly describe your behaviour when restudying material. What do you do when you review material you have already studied?
4. How effective are your study methods?
5. Are there any methods that you do to study that aren't as effective as you would like, what are they? Be as descriptive as possible in answering this question please.
6. Why do you use the methods you mentioned in the last question, and why are these methods not effective?
7. What would be a more effective method of studying, and why don't you do that?

nStudy

nStudy was used to collect data for this research. nStudy is software that has been developed by a team of educational and cognitive scientists as both a content delivery system and data collection tool. The software is designed to record learner's interactions to the millisecond with various types of content such as web pages, concept maps, videos, or images. A variety of tools are available to provide scaffolds to learners enabling them to choose cognitive activities such as indexing, annotating, analyzing, classifying, organizing, evaluating, cross-referencing, or searching (Nenniger, 2006). These cognitive operations are

engaged through tools such as notes, tags, links, terms, and concept maps. This study focused on the use of the highlighting and tagging tools, as well as the note tool due to time limitations for training participants. These three tools were thought to parallel the most common study behaviours such as note creation (marginalia), tagging (using different colours for highlights) and generic highlighting (or underlining).

nStudy Tutorial

Upon completing the pre-study questionnaire a brief tutorial on how to use nStudy was then provided individually to each participant. The nStudy tutorial environment was identical to the research environment apart from the unique content. Four separate tutorials were provided with slight variations. Participants in the control group without proxy tags or note templates were shown how to log in to nStudy and then how to use the highlighting, tagging and note tools. No pre-set tags or note forms were visible in this group's tutorial, as it was believed they may have potentially caused confusion once they logged into their controlled study environment that did not have such features. The three remaining groups all completed the same tutorial with one group being shown the pre-set note-tags feature, one group being shown the note-form templates, and the fourth group shown both the note-tags and note-forms. All participants were shown how to navigate through the various windows of nStudy and how to navigate from window to window.

Reading Rate Passage

Participants read online a 1000-word text on the history of coffee (Appendix B) to obtain their reading rate. The text was of similar readability to experimental text with a Flesch Reading Ease score of 38.4 and a Flesch-Kincaid Grade Level of 12.0. Reading rates were obtained to use as a baseline to assist in determining whether a participant was taking an unduly long time to study due to task features or whether they were merely a slower reader.

Study Content

The text titled “The Hobbits of Flores Island” (Appendix C) was a 2453 word anthropological piece chosen because it had a Flesch Reading Ease score of 43.3, and a Flesch-Kincaid Grade Level of 12.0, which was believed to be suitable for university students. Further, the text was a unique topic that was unlikely to be familiar to the participants.

Four learning objectives were presented to the three Learning Objectives groups. They were written to cover a range of learning objectives categories. Two groups also received brief prompts within nStudy that were representative of the learning objectives and are referred to as proxy tags. These prompts, were available to the participants by selecting text they wished to both identify and categorize and right clicking the mouse, a contextual menu appeared (Figure 2) enabling the participant to select either an existing tag or to create their own unique tag by selecting “Tag…”. Each learning objective corresponded to an assessment question on the post-test.

Learning objective documents were available to 3 of the four groups (groups 2, 3 & 4), each learning objective was on it's own page with a link to the next learning objective and for learning objective 2, 3, and 4 a link was also provided to return to the previous learning objective. The learning objective window was large enough that it obscured the entire content page and participants had been instructed not to resize any windows during the study session. This enabled me to look at the log files to see which window was "in focus" at any given time, as both the content frame and learning objective were not able to be viewed concurrently.

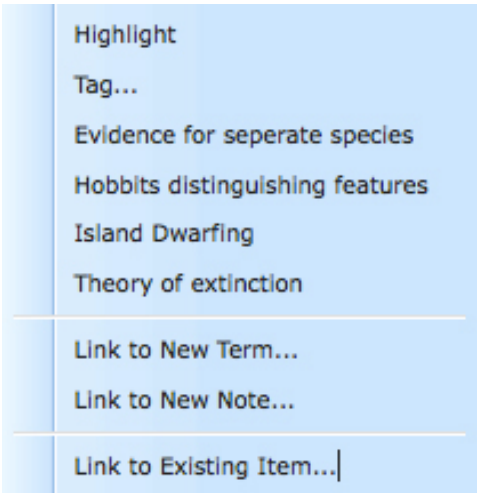


Figure 2: Note the contextual menu that has been activated, in this menu the four Proxy Tags are available to the user below Tag…

Below is a table that lists the four learning objectives, the proxy tags used to represent the learning objective, the note templates, and the assessment measure questions. There is a possible effect in relation to learning objective 3 and learning objective 4 not being completely aligned with the assessment question, however participants in the pilot study were able to answer the questions with a respectable level of achievement.

Table 1: Learning objectives, with corresponding tags, note templates and measure questions.

Learning objective	Tag	Note Template	Measure
Describe the concept of Island Dwarfing	Island dwarfing	Concept/Example or Elaboration	Explain island dwarfing, providing three examples of when island dwarfing has taken place in other contexts
Describe the distinguishing features of the hobbits found on Flores Island	Hobbits distinguishing features	What is the feature/What makes it distinguishable	List as many of the features as you can recall of the hobbits of Flores Island
Analyze the evidence that the hobbits are a separate species.	Evidence for separate species	Supports separate species theory/ Refutes separate species theory	Are hobbits a separate species from humans, yes or no. Provide as much evidence as possible to support your position.
Provide a theory of why the hobbits became extinct	Theory for extinction	Hypothesis/Evidence	Explain why the researchers believe the hobbits became extinct

Restudy Phase

The restudy session took place 24-48 hrs later in the same lab environment where the initial study session took place. Participants were logged into their individual nStudy accounts and given access to the Hobbits text complete with all tags, highlights and notes they had created in the initial study .

Post–Study Achievement Test

Achievement questions were developed in direct relation to each of the specific learning objectives. A rubric to assess the 5-question Achievement Test was constructed and tested in the pilot study. An interrater reliability test was conducted on three Achievement Tests with a colleague (Andrea Hankinson) and yielded results that were within one mark on all three tests.

For both the achievement test and pre and post study questionnaires a computer based survey was used as it provided the opportunity run multiple participants concurrently, did not require transcription, and also because it has been suggested that such a means of data collection is “less intimidating” in certain circumstances (Hadwin, et al., 2005). Research suggests that in certain circumstances human interviews are more desirable if the participant believes it can lead to more help being made available (Hadwin, et al., 2005). Given that the topic of study and restudy behaviour is low risk, and that it was not part of any particular curricular goals the students were trying to achieve I believed it would produce honest responses.

Another potential benefit of the online survey was that participants may have felt more anonymous and were able to describe their experiences to a computer, not the researcher or anyone else involved in collecting the data, which may have reduced the possibility of participants making statements they felt the researcher “wanted to hear.”

The following questions were presented in an online format using a web-based questionnaire. Response length was not limited, and each test was marked using a rubric.

Questions and Rubric for Achievement Test:

1. Explain island dwarfing, providing three examples of when island dwarfing has taken place in other contexts.
   A. Island dwarfing is a reduction in size when gene pool is limited to an island. (1/2) point if gene pool is not mentioned.
   B. Dinosaurs
   C. Elephants (or Stegodons)
   D. Deer

E. Island Fox – Channel Island Fox
(1 mark for each of B, C, D, and E)
Total out of 7.

2. List as many of the features as you can recall of the hobbits of Flores Island.
   A. Skull shape similar to Homo erectus
   B. odd formation of teeth
   C. absence of a chin
   D. low twist in the forearm
   E. average height a metre tall (1.09m)
   F. small brain (417 cm^3)
   G. Average weight 22.7 Kg
   H. Highly developed brain

Total out of 8

3. Are hobbits a separate species from humans, yes or no. Provide as much evidence as possible to support your position.
   A. For same species:
      a. Similar bodies to humans
      b. Used tools
      c. Island dwarfing made them smaller
      d. Similar body size to others living in the region whose size can vary substantially.
      e. Used fire
      f. Despite small brain size, area associated with self-awareness is about the same size as modern humans
   B. Against same species
      a. Skeletons are so much smaller than even the smallest modern humans (pygmies, 1.5 m)
      b. So much smaller than Homo erectus
      c. Much different brain to body mass ratio
      d. No transitional species has been found on Flores or anywhere else in the world.
      e. Brain size was not caused by disease.
      f. Wrists were indistinguishable from an African Ape or Homo erectus and nothing like modern humans
      g. Average size so much smaller (1.09 m tall, 22.7 kg)

Total out of 13

4. Explain why the researchers believe the hobbits became extinct.
   B. A local volcanic eruption happened 12 000 years ago.
   C. If they were microcephalic, life expectancy is shorter.
   D. Introduction of foreigners could have introduced diseases that the island dwarfed species could not survive or adapt to.
   E. They may have emigrated due to lack of food.
   Total out of 4

5. What else is important about this topic?
   No marks were given for the response to question 5.

Post-Study Questionnaire

To gain an understanding of participants' knowledge of the usefulness or utility of learning objectives a series of tasks and questions were provided in an online questionnaire following the achievement test. Participants were asked to demonstrate how they would use learning objectives as well as asked about their understanding of learning objectives.

Following are the list of questions posed to participants to elicit more information on their understanding of learning objectives.

Provide short answers to the following questions (1 or 2 sentences).

1. What do you believe is the purpose of learning objectives?
2. Do learning objectives direct your actions for studying in any way? How?
3. How would you go about your studying (what activities would you do) if you were provided the following learning objective? *Compare the two theories about how stars form.*
4. How would you go about your studying (what activities would you do) if you were provided the following learning objective? *Solve a quadratic equation using the quadratic formula.*
5. How would you go about your studying (what activities would you do) if you were provided the following learning objective? *Demonstrate your understanding of photosynthesis.*

Equipment – Study environment

The study took place in a computer lab with 8 computers and a large centre table. A second study was taking place concurrently in the same lab and many of the participants participated in both studies. Participants were not permitted to participate in both studies on the same day as we were aware of

cognitive fatigue issues. The other study used an entirely different interface for nStudy and required no tool use, therefore there was little if any potential for contamination across studies. All participants used iMac computers with Firefox as the browser used to interact with nStudy.

nStudy logs

nStudy collects detailed logs of users' text selection, button clicks, keyboard input, window focus, and actions on the content, such as highlighting, note taking and the like. These detailed logs are time encoded and are presented in a text output that can be imported into a spreadsheet for re-sorting and re-ordering as desired.

Once the data were imported into a spreadsheet the file was then colour coded according to specific actions (combinations of font and highlight colours). Participants' event logs ranged in size from as few as 100 events to as many as 1166 events depending on how active they were with the various tools and content. By using colour coding in combination with custom filters in the spreadsheet, various tallies and sorts were conducted to investigate individual, group, or all participants for study patterns.

Pilot Study

Three colleagues, two graduate students and one university graduate participated in a pilot study. Pilot study data indicated that the initial study session would take about 35 minutes and the second session would take about 30 minutes. Initially the post-study interview questionnaire was to be done as an

interview, however the pilot study demonstrated that an online questionnaire was effective in obtaining multiple concurrent participant responses.

Procedure

Recruitment

Participants were drawn from the university community. As mentioned earlier, a fellow graduate student was conducting research concurrently in the same lab. Consequently all recruitment was done for both studies, with the provision that participants were not permitted to participate in both studies back to back on the same day due to cognitive fatigue. Initial strategies to recruit participants included inviting students enrolled in 36 face-to-face education undergraduate classes to participate in the studies, and advertising across the campus through posters and on the university CCTV system. Participants were promised financial remuneration in the amount of $20 for their time, with a 35$ bonus to the high score offered as an incentive for them to do well. Initially the response to our requests for participants was slow so we developed a more active recruitment procedure. I sat in a busy thoroughfare with signs advertising the studies, and encouraged those passing by to consider participating in the studies, while the other researcher ran the participants through the studies in the lab. This method proved to be very successful. Through our combined efforts we gathered data from 200 participants in 4 weeks.

Prestudy

nStudy Tutorial

The tutorial lasted approximately 10 minutes, depending on user comfort with using a laboratory computer (Macintosh iMac) and their familiarity with control clicking to produce contextual menus. A computer literacy test was not conducted, as participants were only required to complete the most basic of tasks that are ubiquitous in word processing, email, and web browsing. After the tutorial, participants were given time to play in a practice environment with dummy text to ensure they were comfortable and competent using nStudy. The majority of participants only required a few minutes to practice using nStudy since the features being used were familiar enough and were all activated in the same manner of control-clicking on the target text.

Reading Rate Task

Participants were instructed that the reading rate task was to obtain a baseline reading rate and they were not to study the document, however a few participants reported that they misunderstood the task and spent longer reading the text than if they were merely reading the material opposed to studying. Participants mean reading speed was 255.32 words per minute (WPM) (SD = 149.36). The relatively large deviation of this score may have resulted from some participants either leaving the window open for an excessive period of time, or, less commonly, participants using a language translation dictionary to look up many words. Additionally, there were also participants who progressed through the reading sample extremely quickly, for example, three participants obtained

reading rates over 700 WPM. However the mean reading rate for the participants was close to the average reading speed of 250 WPM for educated adults (Kleinmann, Lewandowski, Tucker, & Codding, 2003). Once participants reported that they had finished the reading rate task they were instructed to study the Hobbit text and to take as much time as needed.

Study phase

Participants were reminded of the instructions to: “Study this material as you normally would for a five-question free recall test. When you return to restudy, your study environment will be exactly as you leave it today, all objects you create will be available. You have as much time as you need, use any of the tools demonstrated to you, and should you have questions - raise your hand.”

Users were asked not to use any external resources (i.e., searching on Wikipedia for further information). However two international students reported that they used an online dictionary while they studied as this was representative of their typical study behaviour for their university courses. Participants were also instructed not to resize any windows that opened during the study session. This was to dissuade participants from having a learning objective open while concurrently studying the material.

Once participants indicated they had finished studying the Hobbits text they were booked for a second session between 24 - 48 hours later for an opportunity to restudy the Hobbit text, complete with any self-created annotations (highlights, tags, notes) within nStudy.

Restudy Phase

When participants returned they were logged into their nStudy accounts and had access to the environment they had edited during their first study session. For the second study session, participants were once again instructed to take as much time to study as they needed, and to only use the resources within nStudy (ie. don't navigate to Wikipedia to find out further information). Participants were also reminded that they were studying for a five-question, free response test.

Post Study Phase

Achievement Test

Once participants indicated they had completed their restudy application they were given a link to the online achievement test. Participants were reminded to aim for at least 80% and that there was a bonus for the highest score. They were also informed that they had as much time as they needed to write the test.

Post Study Questionnaire

Upon completion of the Achievement Test participants were presented with a link to the post-study questionnaire. Upon completion of the post-study questionnaire participants were paid for their time and recruited for the other study concurrently taking place in the same lab.

CHAPTER 4 – RESULTS

nStudy collects an immense amount of data in the log-files including every mouse click or keyboard stroke down to the millisecond. Several techniques were employed to analyze this data which offered varying perspectives on self-regulation and study behaviour. This chapter contains 8 sections that separate the types of data and types of analyses that were conducted into individual sections.

Overview

Observing how students interact and engage with learning objectives and study content over two study sessions may help us understand which tools best support learners to study in an effective self-regulatory manner. I hypothesized that learning objectives may support learners in being better at self-regulating by providing an anchor from which the learner initially sets goals and begins to select and then enact study tactics or strategies. Learning objectives may then be used again when the learner returns to compare achievement to those initially set goals. This comparison of performance or results to goals is referred to as calibration. Winne & Jamieson-Noel (2003) found that students are often “only moderately calibrated about how they study” (p. 274). I suspect learning objectives may help learners calibrate by providing a point from which they both initiate their study behaviour and return to when comparing their success or progress.

There are many ways to characterize SRL. In this research I focused on observing actions conducted by learners such as taking notes, tagging, and highlighting in relation to specific learning objectives. These three actions were chosen because they related to SRL and were features available in nStudy that were logged and analyzed according to both frequency and order. These three tools, the notes editor, tag editor, and highlighting tools were demonstrated to all participants for the study. Analyses were conducted on the use of each of these tools across both study sessions and including each of the four study groups.

Three of the four groups had access to four learning objectives throughout both study sessions. An analysis of the frequency of views of each of these four learning objectives was conducted across the three groups by session.

Since I am interpreting SRL as changes in behaviour between study session one and study session two, such as frequency of learning objective views or tool use, a section of this chapter will then discuss study patterns that were observed.

As few participants actively engaged with the material (defined as frequent tool use), a series of case studies will conclude the chapter to give a deeper description of four types of participants.

Participants

Seventy-nine participants completed the study; 53 females (67%) and 26 males (33%), their age ranged from 19 to 42 years (M=24.38 years, SD=5.67) with the majority of participants being under 25 (N=50). There were 6 extreme cases (age ≥ 39). This distribution is slightly leptokurtic (*kurtosis* = 2.99,

SE=.53) and positively skewed (*skewness*=1.78, *SE*=.27). This parallels the undergraduate university population where the majority of students are in their early twenties with a smaller population of mature students (Simon Fraser University, Institutional Research and Planning, 2010). With this in mind, all the cases were kept (see Figure 1 for the frequency of age distribution).

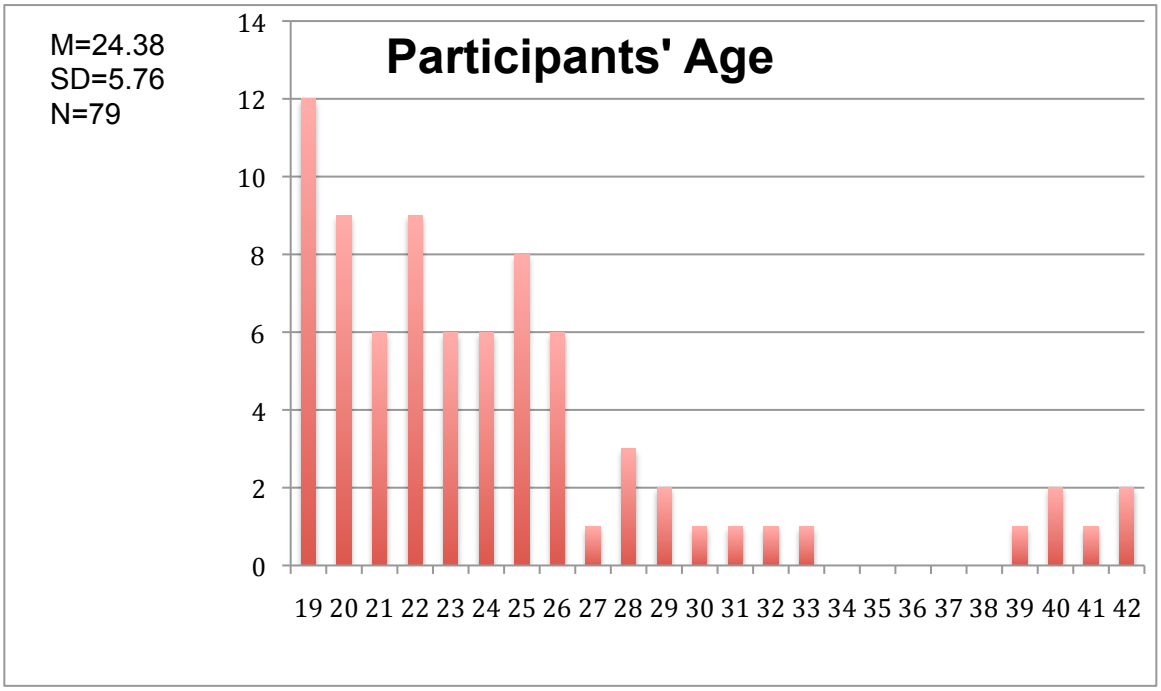


Figure 3: Participants' age distribution.

Education Background and Majors

Participants varied in their intended or stated majors (see Table 2), with 22 different majors being stated and one participant not indicating a major.

Table 2: Participants' stated majors.

Arts	1		**Engineering**	6		**Kinesiology**	1
Biology	2		**English**	10		**Linguistics**	2
Business	10		**French**	1		**Math**	4
Chemistry	2		**General Studies**	1		**Political Science**	1
Computing Science	5		**Geography**	1		**Psychology**	9
Criminology	1		**Health Sciences**	5		**Science**	1
Economics	3		**History**	1		**Sociology**	1
Education	8		**International Studies**	2		**Undeclared**	1

Participant GPA was reported by 68 of the 79 participants and ranged from 1.30 to 4.18 (*M*=3.06, *SD*=.62). Number of credits was reported by 69 of 79 participants, ranging from 9 to 180 (*M*=79.29, *SD*=47.2). This large variance is largely due to the 16 participants who were entered in the Postgraduate Professional Development Program.

Participants' first language

Participants reported 15 different first languages, with the majority speaking English as their first language (see Table 3). The study material was presented in English and was selected to have a Flesch-Kincaid Grade Level of 12.0 and a Flesch Reading Ease Score of 38.4 typical for most required readings in a first year university course.

Table 3: Participants' first language.

Cantonese	5		Mandarin	7
Chinese	8		Polish	1
English	42		Punjabi	2
Farsi	2		Shona	1
Filipino	1		Spanish	1
Hindi	1		Tagalog	3
Japanese	1		Urdu	2
Korean	1		Unreported	1

Data Analysis

A total of 90 participants took part in the experiment. Data from 11 were discarded due to incompleteness, such as not completing the restudy session. nStudy logs alone provide an immense amount of data, these combined with the pre-study questionnaire, post study questionnaire, demographic data, and achievement results produced more data than were necessary for the scope of this study. Due to time and project limitations only selective data that pertained to my research questions were analyzed. Additional data collected may be used for further analysis and more research at a later date.

The variety of data collected helped to reduce interpretations of the behaviours conducted by participants. If a participant stated in the pre-study questionnaire that they perform a certain activity while studying, the nStudy logs were reviewed to determine whether or not that activity was present. Future research using eye-tracking software may be beneficial to further triangulate the statements, activity, and cognitive processes (to some degree).

Survey data

The survey data were collated into an excel spreadsheet and then each question was imported into Atlas-TI for qualitative analysis. Each question was reviewed for patterns and terms expected in relation to SRL as well as unexpected terms that I had not anticipated. As new codes were created, Atlas-TI would systematically code previous responses created. A list of codes is provided in Appendix D. The “auto-coding” feature available in Atlas-TI was used

to search for ‘wild cards’ such as “writ* note*” or “highli*” to get highlite, highlight, highlighting, highlights and the like.

An analysis was conducted to review categorizations of codes based on actions, reasons, temporal or conceptual distance - such as a participant stating “I first skim over the entire text, look for headings or objectives, then I highlight what I determine to be key points. When I restudy I first review the learning objectives then I review the headings and then my highlights.” In this example the order in which the participant studies (skim, look for heading/objectives, highlight) and then restudies (review learning objectives, headings then highlights) was detectable within the nStudy logs. Determining whether a participant who uses the learning objectives at a particular time or frequency while studying may be useful in determining whether or not they are self regulating effectively.

Participant responses to the question “What do you believe is the purpose of learning objectives?” were coded using Atlas-TI to investigate for patterns and to look for any clues to participants’ behaviour in nStudy. Two categories were created: analytical/expansive and superficial/descriptive. Responses that indicated a deeper comprehension of learning objectives or elaborated how learning objectives were used during study behaviour were coded as analytical/expansive, while responses that fundamentally paraphrased the concept, such as “provide a guide”, “understand what we need to learn”, or “highlight areas of importance”, were coded as superficial/descriptive.

nStudy Logs and Log Analyzer

A critical component of nStudy is the ability to log user activity. These logs record each keystroke, window navigation, focus, and any user interaction with the content within nStudy. A single 30-minute study session may produce several thousand lines of logs for each user. The log analyzer enables researchers to enter specific parameters into a query such as “list all new items created by a user or a group, within a specific period of time”, or even more detailed reports such as “provide all the text from a specific document that was highlighted by a particular user in a particular session”. These queries are made using a series of Rules based on attributes and values, enabling the researcher to be as general or specific as needed. In the following example (see Figure 2) titled Creating Highlights the first tab called Analysis Settings specified who is being analyzed, in this case a particular group, the visible tab, Event Types, is where it is specified exactly which actions are to be analyzed. This example shows all “Actions” that are “LinkedActions” AND have a destination-io-type of “TAG”. In the upper right corner of the window it shows that there are 395 results from the 9247 log file entries for this group that consist of both “LinkedAction” AND “TAG”. The next tab titled Partitions is where the 395 results can be broken into further groupings based on other parameters such as by user, content page, or which content has been selected. The Sessions tab enables the researcher to specify values that represent a “session” such as how long the interaction took, or which day the actions took place. The final tab, called Reports, is where access is provided to links to each type of log report, such as either as a large basic report

that has all the data, or specific reports such as by Partition or Session as specified earlier.

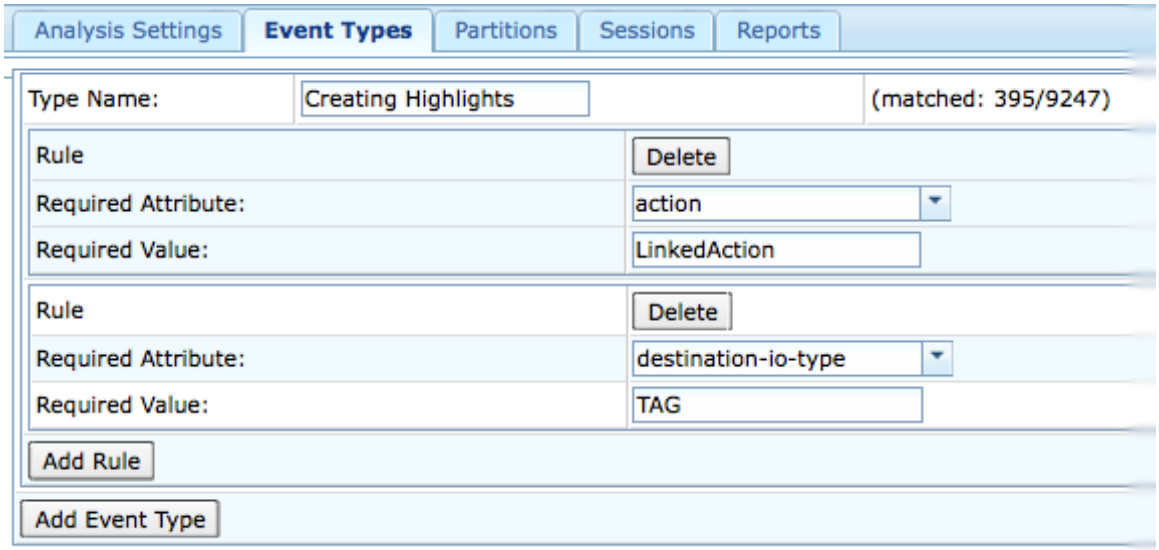


Figure 4: Log analyzer being used to obtain results for creating highlights.

Study Behaviour

Views and Reviews of Learning Objectives

Learning objective documents were available to 3 of the four groups (groups 2, 3 & 4), each learning objective was on it's own page with a link to the next learning objective and for learning objective 2, 3, and 4 a link was also provided to return to the previous learning objective. The learning objective window was large enough that it obscured the entire content page and participants had been instructed not to resize any windows during the study session. This enabled me to look at the log files to see which window was "in focus" at any given time, as both the content frame and learning objective were not able to be viewed concurrently.

A learning objective "view" consisted of the participant opening the learning objective window and having the window open longer than 3 seconds. This calculation was based on the mean reading rate of the participants being 255.32 WPM and the learning objectives being between 5 and 11 words. The estimated mean reading rate per objective is 2.07 seconds: learning objective 1, 5 words, 1.17 seconds; learning objective 2, 11 words, 2.6 seconds; learning objective 3, 10 words, 2.4 seconds; learning objective 4, 9 words, 2.14 seconds. Estimating a brief time required to close the window, this was rounded up to 3 seconds. Of 682 total views 133 did not meet that threshold.

A total of 549 views of the learning objectives took place over both study sessions by 37 participants; 14 of the 52 participants who had access to learning objectives did not view any learning objectives during either session 1 or session

2. During study session two, 37 of the 52 participants never accessed the learning objectives. Across both study sessions learning objective 1 was viewed the greatest number of times (n=159), with learning objective 2 and learning objective 3 not far behind, n=144 and n=145, respectively. Learning objective 4 (n=102) received the fewest views. Unexpectedly, group 4 had the least number of learning objective views in all instances with the exception of group 3's views of learning objective 4 which was (n=19) while group 4 had one more view (n=20). To account for variations in group size (group 1, n= 27, group 2, n=17, group 3, n= 16, group 4, n=19) a ratio of learning objective view to participants is included in table 4 to show the distribution of learning objective view by group and session.

Table 4: Total views of learning objectives by group and study session.

		Session 1 Views	Percentages of total views from session 1	Ratio of views to group participants	Session 2 Views	Percentages of total views from session 2	Ratio of views to group participants	Total Views	Total ratio of views to group participants	Percentage of total views
Learning objective 1	Group 2	42	10%	2.47	18	**3%**	1.05	60	3.52	11%
	Group 3	41	9%	2.56	10	**2%**	.625	51	3.18	9%
	Group 4	45	10%	2.36	2	**0%**	.10	47	2.47	9%
	Total	**128**	29%	**2.46**	**30**	**5%**	**.57**	**158**	**3.03**	**29%**
Learning objective 2	Group 2	43	10%	2.52	17	**3%**	1	60	3.52	11%
	Group 3	37	8%	2.3	11	**2%**	.68	48	2.66	9%
	Group 4	35	8%	1.84	1	**0%**	.05	36	1.89	7%
	Total	**115**	26%	**2.21**	**29**	**5%**	**.55**	**144**	**2.76**	**26%**
Learning objective 3	Group 2	44	10%	2.58	21	**4%**	1.23	65	3.82	12%
	Group 3	30	7%	1.87	10	**2%**	.62	40	2.5	7%
	Group 4	39	9%	2.05	1	**0%**	.05	40	2.10	7%
	Total	**113**	26%	**2.17**	**32**	**6%**	**.61**	**145**	**2.78**	**26%**
Learning objective 4	Group 2	28	6%	1.64	10	**2%**	.58	38	2.23	7%
	Group 3	23	5%	1.43	6	**1%**	.37	29	1.81	5%
	Group 4	34	8%	1.78	1	**0%**	.05	35	1.84	6%
	Total	**85**	19%	**1.63**	**17**	**3%**	**.32**	**102**	**1.96**	**19%**
Grand Totals		**441**	**100%**	**8.47**	**108**	**100%**	**2.07**	**549**	**10.55**	**100%**

Initial Study Session

The majority of learning objective views (n=496) took place during the initial study session with the remaining 142 taking place during the restudy application. These 496 views in the initial study session were not equally distributed between users or learning objectives. Learning objective 1 was the most frequently viewed learning objective, (views= 219) by 42 unique participants[1], with a steady decline through the remaining three learning objectives; learning objective 2 (views=119) with 34 unique participants, learning objective 3 (views=103) with 31 unique participants, and learning objective 4 having the fewest views (views=55) with 26 unique participants.

Restudy Application

Frequency and distribution of learning objective views also varied during the restudy application. This variance occurred both in the number of unique participant's viewing the learning objectives and also how often each individual learning objective was viewed. The 142 learning objective views were distributed as follows: learning objective 1 (views=57), with 18 unique participants; learning objective 2 (views=40) with 18 unique participants; learning objective 3 (views=34), with 16 unique participants; and learning objective 4 (views=11) with only 4 unique participants views. The Cohen's *d* effect size of the achievement score of those who viewed learning objective and those who did not is 0.67 with the effect-size correlation, r_{YI} .31.

[1] The term "unique" refers to one participant – such that 42 different participants made 219 views, with some participants viewing this learning objective more frequently than others.

Tool use within nStudy

Participants were taught how to use three different tools in the nStudy tutorial, the notes tool, highlighter, and tag editor. These three tools were used 1635 times across both study sessions, with the majority of actions taking place during the initial study session (tool usages=1533). In conducting the analysis a usage instance was counted if the action was completed, for example, in some instances a user began to create a note and then closed the note without having entered either a title or any content, this was not considered a tool use instance in any of my analyses.

Of the 79 participants, 5 chose not to use any of the available tools during either study session (notes, tags or highlights). These 5 participants scored lower than the mean and scored between 6 and 17 (M=13.20 SD=4.43). The top five object creators created between 45 and 111 items (M=67.80, SD=26.93) and had a higher mean score (M=17.20, SD=5.89) ranging from 12 to 25. When comparing these two means a Cohen's d of .76, r_{YI} .35 was detected. When conducting a median split it was apparent that participants who were more frequent tool users (M=16.13, SD=5.85) had higher achievement than less frequent tool users (M=13.67, SD=4.46). The Cohen's d for mean score of these two groups is .47, r_{YI} .23.

Notes

Group three and four were provided with pre-seeded note templates, however only 4 of these 35 participants used the templates made available to them, all other notes were created using the basic note template which included the snip of selected text, and a box titled “description”. Group 1, who had no access to learning objectives and no pre-seeded notes or tags in nStudy were the most frequent note creators (11 of 27 group 1 participants created 63 notes across both sessions). However, when a ratio was created to account for group size variance group 4 were the most frequent note creators. A total of 141 notes were created over both study sessions, 96 during the initial study session and 45 in the restudy session. Only 28 of the 79 participants created notes, of those, 11 were group 1, 5 in group 2, 3 in group 3, and 9 in group 4. The number of notes created by these 28 participants ranged from 1 to 25 (*M*=5.04, *SD*=6.59). See Table 5 for totals of note creation by group and session. Due to variance in group population a ratio of notes to participants has been included in the table.

Table 5: Note creation use by group and session.

Notes	Session 1	Session 1 Ratio	Session 2	Session 2 Ratio	Total	Total Ratio
Group 1	36	1.33	9	0.33	45	1.66
Group 2	13	0.76	0	0.00	13	0.76
Group 3	17	1.06	29	1.70	46	2.87
Group 4	30	1.57	7	0.36	37	1.94
Total	96	1.21	45	0.56	141	1.78

Of the 28 participants who created notes only 5 did so in the second study session, with 1 of those participants creating 18 of those 45 notes. Conducting a median split on the number of notes created indicated that those who created 2

or more notes (n=17) scored higher (*M*=18.06, *SD*=4.49) than those who created less (n=62) than 2 notes (*M*=14.05, *SD*=5.24) in both study sessions. Due to the significant variance in sample size a Cohen's *d* was calculated for the mean score of those who created 2 or more notes and those who created less than two notes (0.82, r_{YI} .38).

With exiguous note creation during both study sessions I wanted to investigate whether those who were active note creators were any more or less likely to score higher on the achievement test. Participants who created 4 or more notes during both sessions (n=8) had a significantly higher achievement score (*M*=19.75, *SD*=4.74) in comparison to the overall mean (*M*=14.91, *SD*=5.33), the remaining 20 participants created a single note (n=11), two notes (n=7), or three notes (n=2). The Cohen's *d* effect size of the frequent note creators and the infrequent note takers achievement score was 0.95 with the effect-size correlation, r_{YI} .43. I selected four notes as the cutoff as this represented the 90th percentile.

Throughout the analysis phase both the 90th percentile and a median spilt were used as cut-off points. The 90th percentile was selected as it represented the extremes in participant activity, while the median split was a way of dichotomizing the data to look at larger pools of participants.

In the second study sessions the number of unique participants creating notes dropped significantly with the exception of group 3 where only 3 unique participants created notes in the initial session and 2 in the restudy application.

See Table 6 for the breakdown of unique participants who created notes by session.

Table 6: Unique participants creating notes by group and session.

	Session 1	Percentage of Group	Session 2	Percentage of Group
Group 1	11	41%	2	41%
Group 2	5	29%	0	29%
Group 3	3	19%	2	19%
Group 4	9	47%	1	47%

Highlights

The highlight tag feature was used 926 times during the study by 60 of the 79 participants. The vast majority of highlights were created in session 1 (highlights=906). Group use of highlights varied between groups with the most highlights being created by members of group 1 (highlights =376), and the least from group 3 (highlights =161) with group 2 and group 4 creating (highlights =207) and (highlights =182) respectively. Interestingly, one member of group 2 (participant 39[2]) created 104 of the total 207 highlights for group 2. See Table 7 for a breakdown of highlights by session and group.

[2] A case study of participant 39 is provided later in this chapter.

Table 7: Highlight use by group, session and unique members of each group who created highlights.

Highlights	Session 1 Total	Unique group members	% of Group	Session 2 Total	Unique group members	% of Group	Total
Group 1	368	23	85%	8	5	18%	376
Group 2	207	13	76%	0	0	0%	207
Group 3	156	11	69%	5	2	12%	161
Group 4	175	12	64%	7	3	16%	182
Total	906			20			926

A further analysis was conducted on participants' highlights to investigate patterns in the number of words selected to highlight (*M*=12.65, *SD*=12.73), with a range of 1 to 107 words being selected, with the mode being 2 words. Little variation was detected when analyzing the mean of the number of words highlighted in comparison to scores. A median split of mean words highlighted was conducted and those whose mean was 10 or fewer words (n=38) had a mean score of 14.63 (*SD*=5.36), while those who highlighted 11 or more words (n=41) had a mean score of 15.17, *SD*=5.35. The Cohen's *d* effect size for achievement score and mean words highlighted above and below the median was 0.10 with the effect-size correlation, r_{YI}.05.

I investigated the optimal mean number of words to highlighted in relation to participants achievement and found that those in the 90th percentile (n=13) typically scored lower (*M*=13.00, *SD*=6.06) than the mean (*M*=14.91, *SD*=5.33). The Cohen's *d* effect size for the score of those who highlighted 22 or more words on average and the score of those who highlighted less than a mean of 22 words was 0.35 with the effect-size correlation, r_{YI}.17.

The 17 participants who had a mean number of words highlighted between 11 and 16 were found to have a slightly higher mean score (*M*=16.94, *SD*=3.94) than those outside this range (*M*=14.31, *SD*=5.58). The Cohen's *d* effect size for these two groups was 0.54 with the effect-size correlation, r_{YI} .26.

A series of regressions were conducted to further investigate any relationships between the mean number of words highlighted and either score or total study time. Little relationship was found between mean words highlighted and total study time (r^2.01, *p*. 39). When attempting to transform the data by removing the participants who never used the highlight tool (n=57) and the one participant whose mean words highlighted was 62 (this participant made only two rather lengthy highlights), the results were slightly more significant (r^2.07, *p*.04). Interestingly, when selecting the participants who had a mean of 25 or more words highlighted (n=8) a stronger relationship was found between score and words highlighted (r^2 .24, *p.* 18). As I was interested in observing for the extreme cases a cut-off of 25 or more words was selected because it represented the 90th percentile. A regression was conducted on those in the 10th percentile as well with similar insignificant results (r^2 .017, *p.54).*

Tags

A total of 568 tags were created by 47 unique participants. The majority of tags were created during session 1 (tags=531). Of the 568 tags, 193 tags were pre-seeded tags only available to group 2 and 4. Tag use varied both by group and session, (see Table 8). The two pre-seeded tags, "Evidence for separate species" and "Hobbits distinguishing features" were the most frequently used of

the four pre-seeded tags, accounting for 123 of the 181 pre-seeded tag uses (see Table 9).

Table 8: Tag use by session, group, and unique participants from each group.

Tag Use	Session 1 Total	Unique participants creating tags Session 1	% of Group	% of Total Tags	Session 2 Total	Unique participants creating tags Session 2	% of Group	% of Total Tags	Total
Group 1	136	16	59%	100%	0	0	0%	0%	136
Group 2	125	16	94%	88%	17	4	24%	12%	142
Group 3	149	11	69%	94%	9	2	13%	6%	158
Group 4	121	10	53%	92%	11	2	11%	8%	132
Total	531				37			7%	568

Table 9: Pre-seeded tag use by group and unique users.

Tag	Total uses	Group 2 Uses	Group 4 Uses	Unique Tag Creators	Total % Of Unique Tag Use
Theory for extinction	24	11	13	11	13%
Evidence for separate species	60	22	38	12	33%
Hobbits distinguishing features	63	36	27	13	35%
Island dwarfing[3]	34	17	17	18	19%
Totals	181	86	95		100%

[3] The 12 unaccounted viewings come from two users in group 1 (n=4) and 3 participants in group 3 (n=8) from users who created their own “Island Dwarfing” tag. Interestingly, group 1 did not receive learning objectives and two unique participants created this tag (participant 11 and participant 9).

Glossary items

The glossary tool was not demonstrated or explained to participants during the nStudy tutorial however it was used 9 times by 4 users (6 times by one participant, the remaining three participants each used it once).

Mention learning objectives in questionnaires

Pre-study questionnaire

Five participants mentioned using learning objectives to aid their study behaviour on the pre study questionnaire. The scores for these 5 participants had a higher mean (M=22.00, SD=3.31) than remaining participants mean (M=14.91, SD 5.33, t=4.73, p=.01). The responses were all in relation to the question “What do you do when you study material for the first time? Please briefly describe your study process.” The Cohen’s d effect size for the score of those who mentioned learning objectives in the pre-study questionnaire and the score of those who made no mention of learning objectives was 1.59 with the effect-size correlation, r_{YI} .62.

Post-study questionnaire

Two of the 79 participants mentioned using learning objectives in their post-study interview in response to the question “Did you do anything differently while using nStudy than you typically do when you study? If so, what caused you to vary your typical way of studying?” Both participants were members of group 2, and were unique from the five participants who mentioned learning objectives in the pre-study questionnaire. These two participants scored slightly higher than

the overall mean (*M*=16.00, *SD*=1.41). Participant 207 made the comment “I thought it was interesting how the learning objectives guided my studying. Without them, I think I would've had more difficulty deciding what to focus on when highlighting or text-tagging”. This participant created 11 total items, 5 tags, 1 note, and 5 highlights and viewed the learning objective 23 times over both sessions (n=14 session 1, n=9 session 2).

Five participants who did not mention learning objectives in the pre-study questionnaire mentioned them in the post-study questionnaire when asked to describe how they re-study material they have already studied. All 5 participants who mentioned learning objective in the pre-study questionnaire mentioned them again in the post-study questionnaire. These 10 participants scored higher (*M*=19.10, *SD*=4.45) than the group mean (*M*=14.91, *SD* 5.33). The Cohen’s *d* effect size for the score of those who mentioned learning objectives in the post-study questionnaire and the score of those who made no mention of learning objectives was .85 with the effect-size correlation, r_{YI} .39.

When investigating the responses to the question “What do you believe is the purpose of learning objectives?” the majority, 66 of 79 participants, responded with a superficial or descriptive response. These responses described the purpose of learning objectives to help “focus” the learner (*n*=21) or to ”identify the main ideas” or “key topics” (*n*=23). Other common phrases were “set goals” (n=10), “guide your study” (*n*=7) and “direct students” (*n*=5).

Participants who responded with analytical/expansive comments to the question on the purpose of learning objectives scored slightly higher (*M*=16.14,

SD=4.74*)* than the mean of the remaining participants (*M*=14.79, *SD*=5.39*).* Cohen's *d* effect size comparing those whose responses indicated analytical/expansive understanding of learning objectives in the questionnaire to those whose responses were more superficial/descriptive and their achievement score was .26 with the effect-size correlation, r_{YI}.13.

An investigation into the study behaviour of the group of 7 participants whose responses suggested analytical/expansive understanding of learning objectives in the questionnaire found that only one participant created notes. However, the overall mean number of learning objective views was significantly higher (*M*=24.67, *SD*=11.01) than the mean of those who were superficial/descriptive in their response to this question (*M*=14.95, *SD*=9.54*).* Total Study time was also significantly different with these 7 participants having a mean total study time of *(M*=59:48*, SD*=37:48) compared to the remaining participants mean (*M*=45:55*, SD*=21:54).

Six participant responses were not coded as either superficial/descriptive or analytic/expansive as they were either left blank or contained responses such as "yes, I believe" which did not fit into either category.

Study behaviour patterns

The log file analyzer tool was used to obtain a log of all participant events producing a file containing over 32 000 events[4] for the 79 participants. These 32 000 events consist of a sum of the creation of the 1634 items and 550 learning

[4] It should be noted that one specific action, such as creating a note, creates up to 6 events including the action of selecting the text, selecting the Note tool, creating a title for the note, adding any additional content, concluding with closing and saving the note.

objective views. These 1634 items were created by 75 of the 79 participants (*M*=22.69, *SD*=17.81) ranging from 1 item to 111. Four participants did not view any learning objectives or create any tags, highlights or notes, these 4 participants had a lower mean score (*M*=13.20, *SD*=4.43) than the group mean (*M*=14.91, *SD*=5.33). The Cohen's *d* effect size for the score of participants who were completely passive in their use of the tools and accessing learning objectives in nStudy and the score of those who were "active" participants was .34 with the effect-size correlation, r_{YI} .17.

The log file was imported into a spreadsheet and colour coded according to actions. Numerous variations of highlight and font colours were used to create a file that was then visually inspected for patterns. Participants who weren't active in nStudy with either the tools or accessing the learning objectives, or did not have access (group 1 members) to the learning objectives had as few as 110 events over both study session, while active participants, such as participant 309 who created 29 notes, 13 highlights, and viewed the learning objectives 30 times had 1166 total events.

This colour coding of study activities in the nStudy log files presented a graphic illustration of study behaviour that illuminated various study behaviour patterns. Three obvious patterns were observable from this view, tag selection and use (order), learning objective views (order, frequency and sequence), and restudy views of the learning objectives.

Tag selection and use (order)

The highlight tool was the most frequently used tool (highlights=926) by 59 participants while the tagging tool was used 568 times by 52 participants. The majority of participants initially began their interaction with the study material using the highlight tool, then after using the highlight tool a few times they began to use the tagging tool to either use the pre-seeded tags or create their own tags. Highlighting then trailed off as tag use increased.

A total of 141 custom tags (see Appendix E for a list of these 141 unique tags complete with their usage totals) were used 434 times by 47 participants. These custom tags fell into 3 general categories, identifiers (ie. “LO 1: Island dwarfing”, “Paragraph Chief Idea”, “key”, or “key words or terms”), categorizations (ie. “definitions”, “descriptions”), and self questions (ie. “how old” and “how were they found”). Tag creation by group was not evenly distributed, with group 3 creating the majority of custom tags (tags=179 by 15/16 group 3 participants). The other three groups created the remaining 255 custom tags; group 1 (tags=118 by 11/27 participants) group 2, (tags=76, by 13/17 participants), group 4 (tags=61, by 8/19 participants).

Typically these custom tag creators began using the existing tags if they were available, and then created their own tags and used those tags predominantly for the remainder of the study session. Of the 43 participants who didn’t have access to the pre-existing tags (groups 1 and 3) 26 (11 members of group 1, 15 members of group 2) created custom tags. More than one participant created tags with the same title. Examples of these commonly created tags were

"interesting", used 29 times by 3 participants, "anatomy" used 25 times by 6 participants,, "evidence of…" used 12 times by 6 users, "extinction…" used 5 times by 4 users, and "small brains [or] bodies", used 17 times by 5 users.

Learning objective view frequency

Eight participants viewed learning objective more than 25 times. These participants typically scored higher (*M*=20.50, *SD*=3.54) than the total mean (*M*=14.91, *SD*=5.33). Twenty-five learning objective views was selected as the cutoff as it represented 90th percentile. Reviewing study times of these frequent learning objective viewers showed a slightly higher total study time ranging from 33:57 to 1:37:59 (*M*=56:04, *SD*=22:26) compared to the entire group of 79 participants whose overall study time which ranged from 13:11 to 2:11:57 (*M*=43.30, *SD*=21:37). The Cohen's *d* effect size for the total time spent studying by frequent learning objective viewers and those who were less frequent viewers of learning objectives was .58 with the effect-size correlation, r_{YI} .28.

Further analysis of these 8 participants' reading rate was conducted to determine whether the cause of their longer study time was the result of being slower readers. Results indicate that this groups mean WPM reading rate (*M*=262.12*, SD*=71.68*)* was higher than the total mean (*M*=255.32, *SD* = 149.36) with a Cohen's *d of .05,* r_{YI} .02.

The 14 participants who had access to learning objective but chose not to view them typically scored less (*M*=12.29, *SD*=5.58) than the mean of the remaining 65 participants (*M*=15.48, *SD*=5.14). The Cohen's *d* effect size for the score of those who had access to the learning objectives but chose not to use

them and the score of the participants was.59 with the effect-size correlation, r_{YI}.28.

In contrast to the group of participants who were frequent learning objective viewers, reviewing study times showed no apparent pattern, and was very close to the overall mean (*M*=43.30, *SD*=21:37) with total study time ranging from 14:51 to 2:11:57 (*M*=45.05, *SD*=30:41). The Cohen's *d* effect size for the total time spent studying of those who frequently accessed the learning objectives and the overall mean total study time was.06 with the effect-size correlation, r_{YI}.03.

Members of Group 1 who didn't have access to the learning objectives had a mean study time (*M*=40:38, *SD*=18:00) that was shorter than the overall mean (*M*=44:00, *SD*=21:23). Use of the note, tag and highlighting tool by group 1 was close to the means of the three groups who had access to learning objectives, see Table 10 for means and comparison. The Cohen's *d* effect size for total study time by members of group one who did not have access to the learning objectives and the remainder of participants was.18 with the effect-size correlation, r_{YI} .09.

Table 10: Comparison of object creation by Group 1 to entire group.

Group		Score	Total Study Time (mm:ss)	Total Highlights	Total Learning Objective Views	Total Notes	Total Tags
1	Mean	13.70	40:38	13.93	N/A	1.67	5.04
	N	27	27	27	N/A	27	27
	SD	4.81	18:00	14.58	N/A	4.20	6.26
2	Mean	15.88	48:10	12.18	13.12	.76	8.35
	N	17	17	17	17	17	17
	SD	4.67	20:25	24.65	11.54	1.60	8.20
3	Mean	15.81	37:00	10.06	10.50	2.88	9.88
	N	16	16	16	16	16	16
	SD	5.890	16:09	10.68	11.91	7.56	12.47
4	Mean	15.00	51:16	10.63	9.32	1.95	7.37
	N	19	19	19	19	19	19
	SD	6.119	27:28	13.17	8.36	3.61	10.22
Total	Mean	14.91	44:00	11.97	10.92	1.78	7.29
	N	79	79	79	52	79	79
	SD	5.33	21:23	16.13	10.53	4.57	9.18

Restudy Session - Learning objective views

Learning objectives were viewed infrequently during study session 2, only 120 times by 16 participants, compared to the 443 times by 38 participants in study session 1. These 16 participants scored higher (*M*=17.19 *SD*=4.26) than the mean (*M*=14.91, *SD*=5.33, Cohen's *d* .47, r_Yl .22) and had a slightly longer overall study time (*M*=.47.05, *SD*=21.6) compared to the overall mean (*M*=.45.00, *SD*=23.52, Cohen's *d* .09, r_Yl .04) while session two study time (*M*=16.45, *SD*=11.76) closely matched the overall mean (*M*=16.39, *SD*=16.32, Cohen's *d* .004, r_Yl .002).

Participants from groups 2 and 4 potentially skipped viewing the learning objectives as they had cues built into the pre-seeded tags. To determine whether these pre-seeded tags had an influence I reviewed the behaviour and results of group 3, who did not have access to any pre-seeded tags holding cues to the learning objectives. Participants in this group who viewed learning objectives in the second session still scored slightly higher (*M*=16.80, *SD*, 6.05) than those who did not review the learning objective in the second session (*M*=15.36, *SD*=6.05, Cohen's *d*=.23, r.11).

Score

High scoring participants

When investigating the relationship of total time studying with participants who scored in the top one-third (n=25, scored 18-25, 7 from each of group 1, 2 & 3, and 4 members of group 4) the relationship was not statistically detectable, *r2* =. 049 (*p* = .195). However, when an analysis was conducted to investigate the relationship between these same high scoring participants a statistically detectable relationship was found in relation to the total number of objects created plus total learning objective views as an aggregate of both session, r^2 = .254 (*p* = .01).

Low scoring participants

Among low scoring participants (n=31, score range 5-13, group 1 (n=12), group 2 (n=6), group 3 (n=5), group 4 (n=8)), the results differ. Using conventional thresholds for the type 1 error, time did not predict achievement, r^2

= .101 (p = .113); nor did total items created plus learning objective views and total items created were not, r^2 = .000 (p = .95) or total items created, r^2 = .000 (p = .93).

Table 11: Score – participants were divided into three groups based on score, high scoring participants were in the top 1/3 while low scoring participants were in the bottom 1/3 on the Achievement Test.

DV: Achievement Score	Predictors	Total Study Time	Total Items Created + Learning Objective Views
Group			
High Scoring Participants (n=25)		r^2 .049 p=.195	r^2 .254 p=.010
Low Scoring Participants (n=31)		r^2. 101 p=.113	r^2 .000 p=.950

Activity (Learning objective view + objects created)

Participants were divided into two groups based on the median number of items created (18), with one group of "high activity" participants (n=36), and one group of "low activity" participants (n=39). Four participants scoring at the median were excluded. Two regressions were conducted on each group to predict participant score from (a) total time studying, and (b) total items created plus learning objective views. A third regression predicted total time studying using total items created plus learning objective views as predictors.

High activity group

The high activity group showed a stronger relationship in all three analyses (participant score/total study time, r^2.055 (p=.168), participant

score/total items including learning objective views, r^2 .147 (p=.021), and total time studying/items created plus learning objective views, r^2 .055, p=.17).

Low activity group

The low activity group showed a minimal relationship between two of the analysis, participant score/total study time, (r^2 .009, p=.56), and total time studying/items created plus learning objective views, (r^2.001, p=.86), however a relationship was detected between participant score/total items including learning objective views (r^2.086, p=.07), although significant, this relationship was lower than the high activity group.

Table 12: Activity – a median split was conducted on the number of objects created (highlights, tags, and notes). High activity participants created ≥18 items while Low Activity participants created <18 items during both study sessions.

DV: Achievement Score	Predictors	Total Study Time	Total Items Created + Learning Objective Views	Total Study Time + Total Items Created + Total Learning Objective Views
Group				
High Activity Participants (n=36)		r^2 .055 p=.168	r^2 .147 p=.021	r^2 .055 p=.170
Low Activity Participants (n=39)		r^2. 009 p=.560	r^2 .086 p=.07	r^2 .001 p=.860

Learning objective views

Participants were divided into four groups, those who had learning objectives and viewed them frequently (n=17), those who had learning objectives and didn't view them frequently (n=21), those who had learning objectives and never viewed them (n=14) and those who didn't have access to learning

objectives (n=27). Frequent learning objective viewing was determined by splitting the median of those who viewed learning objectives.

Four regression analysis were conducted on each of these four groups, see Table 11 for the results.

Table 13: Regression results of learning objective views, dependent variable achievement score.

DV: Achievement Score	**Predictors**	**Total Study Time**	**Total learning objective views**	**Total items created**	**Total Items Created + learning objective views**
Group					
Active learning objective viewers		r^2 .330 p=.016	r^2 .217 p=.059	r^2 .272 p=.032	r^2 .310 p=.020
Low learning objective viewers		r^2. 000 p=.937	r^2 .141 p=.093	r^2 .317 p=.008	r^2 .407 p=.002
Non learning objective viewers who had access		r^2. 120 p=.225	n/a	r^2 .066 p=.374	n/a
Group 1 participants – no learning objectives		r^2.040 p=.316	n/a	r^2 .049 p=.268	n/a

Session Study Times

Because of the large variation in study times (see table 12) a ratio was for the two study sessions (Study Session 2 Time/Study Session 1 Time). This ratio (M=.730, SD=.808) ranged from .02 to 5.62, meaning that one participant spent a mere fraction of time studying in the second session when compared to the first session while another participant spent between 5 and 6 times longer studying in the second session than they did in the initial study session.

Table 14: Participant study time (h:mm:ss).

N=79	Study Session 1	Study Session 2	Total Study Time
Mean	0:28:12	0:15:18	0:43:48
Median	0:24:00	0:11:17	0:39:47
SD	0:17:06	0:11:38	0:21:22
Minimum	0:05:35	0:00:17	0:13:11
Maximum	1:40:12	1:06:34	2:11:31

Correlations were conducted (see tables 13-17) using this ratio to investigate patterns in tool use and achievement scores. The results were not definitive; there is some suggestion that a time ratio may be a worthwhile variable to explore further, since time on task is a well-established predictor of achievement. Where the investigations are not expensive and the hypotheses are not radical it appears it might be worthwhile to continue to explore this variable, in situations otherwise, a more conservative approach would be to observe the traditional p= .05 cutoff.

Table 15: Correlations to TimeRatio variable. (N=79)

		TimeRatio	Score	Total Highlights	Total LO Views	Total Notes	Total Tags
TimeRatio	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	79					
Score	Pearson Correlation	-.154	1				
	Sig. (2-tailed)	.175					
	N	79	79				
Total Highlights	Pearson Correlation	-.037	.186	1			
	Sig. (2-tailed)	.745	.101				
	N	79	79	79			
Total LO Views	Pearson Correlation	-.196	.409**	.255	1		
	Sig. (2-tailed)	.164	.003	.068			
	N	52	52	52	52		
Total Notes	Pearson Correlation	-.171	.305**	.092	.156	1	
	Sig. (2-tailed)	.131	.006	.418	.268		
	N	79	79	79	52	79	
Total Tags	Pearson Correlation	-.073	.108	-.174	-.014	-.067	1
	Sig. (2-tailed)	.523	.343	.125	.920	.555	
	N	79	79	79	52	79	79

**. Correlation is significant at the 0.01 level (2-tailed).

Table 16: Correlations to TimeRatio variable; lowest 1/3 of learning objective views (between 1 and 10 learning objective views, n=11).

		TimeRatio	Score	Total Highlights	Total LO Views	Total Notes	Total Tags
TimeRatio	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	11					
Score	Pearson Correlation	-.070	1				
	Sig. (2-tailed)	.839					
	N	11	11				
Total Highlights	Pearson Correlation	-.241	.132	1			
	Sig. (2-tailed)	.475	.698				
	N	11	11	11			
Total LO Views	Pearson Correlation	-.224	.427	.451	1		
	Sig. (2-tailed)	.507	.191	.164			
	N	11	11	11	11		
Total Notes	Pearson Correlation	-.437	.519	.494	.431	1	
	Sig. (2-tailed)	.179	.102	.122	.186		
	N	11	11	11	11	11	
Total Tags	Pearson Correlation	.016	.476	-.394	.380	-.223	1
	Sig. (2-tailed)	.963	.139	.231	.249	.510	
	N	11	11	11	11	11	11

Table 17: Correlations to TimeRatio variable; highest 1/3 of learning objective views (over 20, n=14).

		TimeRatio	Score	Total Highlights	Total LO Views	Total Notes	Total Tags
TimeRatio	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	14					
Score	Pearson Correlation	.166	1				
	Sig. (2-tailed)	.570					
	N	14	14				
Total Highlights	Pearson Correlation	.221	.535*	1			
	Sig. (2-tailed)	.448	.049				
	N	14	14	14			
Total LO Views	Pearson Correlation	-.326	.514	.160	1		
	Sig. (2-tailed)	.255	.060	.586			
	N	14	14	14	14		
Total Notes	Pearson Correlation	.120	.327	.130	.326	1	
	Sig. (2-tailed)	.682	.253	.657	.256		
	N	14	14	14	14	14	
Total Tags	Pearson Correlation	-.438	-.117	-.179	-.218	-.362	1
	Sig. (2-tailed)	.117	.691	.540	.455	.204	
	N	14	14	14	14	14	14

*. Correlation is significant at the 0.05 level (2-tailed).

Table 18: Correlations to TimeRatio variable; lowest 1/3 of scores (<=13, n=31).

		TimeRatio	Score	Total Highlights	Total LO Views	Total Notes	Total Tags
TimeRatio	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	31					
Score	Pearson Correlation	.029	1				
	Sig. (2-tailed)	.876					
	N	31	31				
Total Highlights	Pearson Correlation	-.138	.148	1			
	Sig. (2-tailed)	.461	.426				
	N	31	31	31			
Total LO Views	Pearson Correlation	-.062	.361	-.057	1		
	Sig. (2-tailed)	.801	.129	.815			
	N	19	19	19	19		
Total Notes	Pearson Correlation	.010	.385*	-.050	.165	1	
	Sig. (2-tailed)	.956	.032	.791	.501		
	N	31	31	31	19	31	
Total Tags	Pearson Correlation	-.045	-.009	-.069	.244	-.019	1
	Sig. (2-tailed)	.812	.960	.712	.314	.921	
	N	31	31	31	19	31	31

*. Correlation is significant at the 0.05 level (2-tailed).

Table 19: Correlations to TimeRatio variable; highest 1/3 of scores (>=19, n=21).

		TimeRatio	Score	Total Highlights	Total LO Views	Total Notes	Total Tags
TimeRatio	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	21					
Score	Pearson Correlation	.169	1				
	Sig. (2-tailed)	.463					
	N	21	21				
Total Highlights	Pearson Correlation	.176	.528*	1			
	Sig. (2-tailed)	.446	.014				
	N	21	21	21			
Total LO Views	Pearson Correlation	-.056	.039	.347	1		
	Sig. (2-tailed)	.831	.883	.172	17		
	N	17	17	17			
Total Notes	Pearson Correlation	-.177	.188	.092	.170	1	
	Sig. (2-tailed)	.442	.415	.693	.513	21	
	N	21	21	21	17		
Total Tags	Pearson Correlation	-.015	-.114	-.380	-.188	-.262	1
	Sig. (2-tailed)	.949	.624	.090	.471	.251	21
	N	21	21	21	17	21	

*. Correlation is significant at the 0.05 level (2-tailed).

Case Studies

This chapter concludes with four participants I investigated in greater detail, one from each cell of a 2 x 2 table contrasting access to the learning objective (yes/no) and achievement score (high/low). Table 18 shows the activity, time, and scores for each of these four participants. There were 5 participants who scored 25 and 5 participants who scored 6 (two participants scored 5, but as these participants really didn't actively participate I chose 2 from the next lowest score, 6. The two participants from each of the high and low score were selected using a purposeful sampling of the "extreme of deviant cases" (Patton, 2002, p. 243). This method is used for "learning from unusual manifestations of the phenomenon of interest, for example, outstanding successes/notable failures; top of the class/dropouts; exotic events; crises" (Patton, 2002, p. 243).

Table 20: Case study subjects' scores and action counts.

	Participant #	Total learning objective views	Total Notes	Tags	Highlights	Objects created + learning objective views	Score	Session 1 Study Time (mm:ss)	Session 2 Study Time (mm:ss)	Total Study Time (h:mm:ss)
Access to learning objectives										
High Score	39	27	6	1	104	138	25	60:57	37:02	1:37:59
Low Score	401	0	0	31	5	36	6	37:00	06:49	0:43:49
No access to learning objectives										
High Score	22	0	3	2	28	33	25	18:04	05:52	0:23:56
Low Score	7	0	1	4	21	26	6	19:41	07:10	0:26:51

High achiever with access to learning objectives (participant 39)

Participant 39, from group 2 (had learning objectives and pre-seeded tags) was a middle aged female from the Faculty of Arts. She reported more than 120 credits, a B GPA and English was her stated first language. Relative to the sample mean (M=255.32, SD = 149.36) her reading rate was 316 WPM (z=.384), which placed her at the 65th percentile. She studied just over one hour during the

initial study session and 37:02 minutes the second study session for a combined study time of 1:37:59. This was significantly longer than the mean for both sessions (session 1, *M*=28:20, *SD*=17:10, Session 2, *M*=16:39, *SD*=16:20).

During the initial study session participant 39 created 6 notes, 1 tag, and highlighted 104 times. She began by reading the learning objectives, then for the next 25 minutes created successive highlights (a total of 104 were created in the initial study session). After twenty-five minutes the participant created her first note. She then oscillated between highlighting and note creating for a few minutes. After this period of creating notes and highlights she returned to the learning objectives (24 minutes after the initial view), then returned to her behaviour of highlighting and creating notes. She concluded her initial study session by reviewing learning objective 3 and 4 and one of her notes. Learning objectives were viewed a total 10 times during this session (learning objective 1, n=2, learning objective 2 n=2, learning objective 3 n=3, learning objective 4, n=3).

Participant 39 began the review session by reviewing the learning objectives. She then oscillated between reviewing notes and learning objectives for the entire session. No new objects were created, however learning objectives were reviewed 17 times (learning objective 1, n=4, learning objective 2 n=4, learning objective 3 n=6, learning objective 4, n=3), and notes were reviewed 8 times.

In the pre-study questionnaire participant 39 stated that “I read until I am comfortable with my understanding of the text, take brief notes, move on to the next section. Typically I will read a paragraph to a page, rereading for clarity,

before taking notes - and then add or edit my notes as necessary." This description is congruent with her behaviour in study session one. In response to the question about how she studies material she has already studied she responded, "I tend to focus on any material that I highlighted or the bulleted - and grouped by headings using key terms. I may also rewrite some of my notes, without referring directly to the notes, and then compare to see if I captured the information correctly." This statement is also congruent with her behaviour in session 2.

Low achiever with access to learning objectives (participant 401)

Participant 401, from group 4 (had learning objectives, plus both pre-seeded tags and notes) was a middle aged male, whose first language was not English, and was currently enrolled in a doctoral program. His reported GPA was between an A and A+. Relative to the sample mean (*M*=255.32, *SD*=149.36) his reading rate was 254 WPM (*z*=-.027), which placed him at the 40th percentile. He studied for 37:00 minutes the first session, 6:49 for the second session for a total study time of 43:49, which was slightly shorter the mean (*M*=45:00, *SD*=23:33). Participant 401 was from group 4, this group has the learning objectives as well as both the pre-seeded tags and pre-seeded note templates for use in their studying.

During the initial study session the participant 401 created 31 tags and highlighted 5 times, never reviewing the learning objectives or creating any notes. The majority of his actions were dispersed in time; his 5 highlights occurred roughly every 10 minutes (two occurred within 2 minutes). His first tag was

created almost immediately, and then there was consistent tagging at a rate of roughly one tag per minute.

During the second study session participant 401 didn't create any new objects and only reviewed the content pane No links were clicked or any other actions were completed. It was a short re-study period, lasting just under 7 minutes.

In the pre-study questionnaire participant 401 stated "In my regular study, I like to group similar concepts or ideas together by using different colours (which allows me to do effortlessly that I can't do via my regular study method)." This is congruent with his activity of creating 6 unique tags, and using 4 of the pre-seeded tags to identify aspects of the content he wished to emphasize.

High achiever without access to learning objectives (participant 22)

Participant 22, from group 1 (no learning objectives) was a young female, whose first language was not English. She was currently enrolled in her third year of Engineering with a B- GPA. Relative to the sample mean (*M*=255.32, *SD*=149.36) her reading rate was 239 WPM (*z*=.072), which placed her at the 76th percentile. She studied for 18:04 minutes the first session, 5:52 for the second session for a total study time of 23:56, which was considerably shorter than the mean (*M*=45:00, *SD*=23:33). Participant 22 was from group 2, this group had the learning objectives as well as pre-seeded tags for use in their studying.

During the initial study session participant 22 created all 38 of her objects (2 notes, 33 highlights, 3 tags). The two notes were created within the first 10

minutes of her 18-minute study session, with the remainder of the activity occurring relatively uniformly for the entire session.

Participant 22 reviewed two unique tags (self-created) and one highlight in study session 2, studying for less than 6 minutes. No other objects were viewed, and no links were activated during this brief second study session.

In the pre-study questionnaire participant 22 stated that when she initially studies material she “Read[s] and highlight[s], reread, and draw a diagram of parts I need to focus on.” When she restudies material she “reread[s] the highlighted material. Then find a friend to talk to about what I am studying to see if I can explain and teach it to them.”

Low achiever without access to learning objectives (participant 7)

Participant 7, from group 1 (no learning objectives) was a middle aged female whose first language was not English. She was enrolled in her third year of psychology with a B+ GPA. Relative to the sample mean (*M*=255.32, *SD*=149.36) her reading rate was 160 WPM (*z*=-.651), which placed her at the 26th percentile. She studied for 19:41 minutes the first session, 7:10 for the second session for a total study time of 26:51, which was considerably shorter than the mean (*M*=45:00, *SD*=23:33). Participant 7 was from group 1, this group did not have access to the learning objectives or either the pre-seeded tags or notes for use in their studying.

During the initial study session the participant 7 created 26 objects: 4 tags, 1 note, and 21 highlights. In the first 8 minutes of her study session she began by

creating 8 highlights and then a note. After creating the note she switched to tagging, creating 4 unique tags, each only used once.

During the second study session participant 7 spent the first 5 minutes reviewing the content and then the last two minutes reviewing her note and one tag.

In the pre-study questionnaire participant 7 reported that she “read[s] material over and over again and make a mental note which part I do not understand. If I do not understand right away, I will ask someone (friends, a prof) for help.” When restudying material she stated that she “Tr[ies] to find out which part I understand and explain to someone else if it does not work then, I will study the material again until it make sense to someone.”

CHAPTER 5 – DISCUSSION

The aim of this research was to investigate the use of learning objectives in aiding SRL behaviour of students studying and restudying in an online learning environment. I hypothesized that learning objectives are often not effectively used by students to support SRL in these situations. This research addressed a gap in the literature on the uses of learning objectives in scaffolding self regulation and restudy behaviour. The results of this research may help guide future studies in the area of study and restudy, and on the use of learning objective in aiding SRL.

Overview

This chapter will discuss the results, implications, and limitations of this study, and on how learning objectives may be used to aid SRL in study and restudy behaviour.

Results suggest four significant findings that warrant further investigation. During students' studying, three indicators of self-regulated learning – frequent note taking, frequent views of learning objectives, and review of learning objectives in both study sessions – were associated with higher scores on an achievement test. Higher achievement was also evidenced by participants who stated the benefit of learning objectives prior to the initial study session, suggesting these learners may have been more prepared to regulate their

learning by metacognitively monitoring their behaviour during study and restudy than other learners.

Further research should employ a larger sample, and if possible, the integration of more data collection methods such as the think-aloud protocol, screen capture, or an eye-tracking system to better understand students' intentions, assumptions, and behaviours. Having a larger sample will increase the statistical power of analyses and more types of data may triangulate results and strengthen interpretations of participants' study behaviour(s) represented by data in nStudy log files and surveys. As this research was conducted over a short period with non-course related content it created an artificial learning situation. It may be valuable to conduct further research over a longer period of time in a natural environment such as a classroom.

Increased achievement

Participant achievement on the posttest had a large variance (5 to 25/33). It is apparent from viewing the log files that some participants had extremely low engagement as evidenced by the number of objects created, learning objective views (if available) and time spent studying. With this large natural variance and small sample size, statistical analyses had limited power to detect relationships and differences. However the results suggest that frequent note taking, reviewing learning objectives often and during both study sessions, and having an understanding of the purpose of learning objectives may increase achievement.

The use of other nStudy tools apart from the note editor, such as the highlighter and tagging tool were positively correlated with achievement. However, statistical tests indicated that they were not related.

Unexpectedly time on task showed little relationship to achievement, contrary to literature on the topic (Stallings, 1980). Using a larger sample may have produced different results in this regard; however, this result may reflect the fact that investing more time in studying without self-regulating behaviours may not ultimately produce higher achievement. This result will be discussed further in a subsequent section.

Frequent note taking

Results indicate that participants who were active in creating notes in both study sessions scored significantly higher on the achievement test than those who chose not to use the note tool at all. Note taking in nStudy may lead to greater recall because as Glover and colleagues (1990) assert, an “organizer schema provide[s] the reader with heuristics for attending to various aspects of the text and to how they will relate the incoming information to information held in long term memory” (p. 295). Similarly, once an nStudy user has made the decision that content merits annotating, s/he selects the note tool, then selects the note type (a pre-loaded template, or a template they have created on their own) and elaborates the selected material in terms of categories offered by the template. This support provided by nStudy may augment encoding and the process of assembling that information with quotes of the text that was selected for annotation. These actions invite metacognitive monitoring of content

according to multiple standards (Winne, 2006). Such actions have been shown to enhance retrieval and use of content because it has been “processed more deeply” (King, 1992).

Research has been conducted on various note taking forms and techniques (Igo, Riccomini, Bruning & Pope, 2006; Roskelley et al, 1991). Results of these studies suggest writing out notes is optimal when compared to copying text and pasting it into a blank field (Igo et al, 2006, p. 90), and that those who review notes outperform those who do not (Kiewra, 1985). While nStudy allows a significant amount of material to be copied and pasted into a note without requiring extensive cognitive engagement, choosing a note form invites more metacognitive monitoring than merely highlighting. The significant difference in total study time and elevated achievement scores suggests students were engaged in more metacognitive monitoring when they constructed notes.

Many participants took notes later in the initial study session. According to the pre-and post study interviews, 58 participants stated they initially scan material they are required to study and then go back do a more thorough read or study of it. This may explain the behaviour of participants typically taking notes later in the study session. A second potential reason for delayed note taking is that this study took place in an artificial study environment, which required participants to study unique content over a short period of time. This differs from typical study endeavours where learners already have schema for “this next chapter” and familiarity with the discipline’s nomenclature. With a short study period and shorter study text participants potentially didn’t have time to gain

sufficient comfort in using the language to write their own notes. Since it is understood that note taking requires more cognitive processing than other study methods, it is possible that this accounts for participants overwhelmingly opting for easier cognitive tasks such as highlighting and tagging where translating or encoding was not required.

An investigation into frequent note takers' study time to determine which components of the note taking activity increases study time may be beneficial to understanding the benefits of such functions as note-taking. Increased study time caused by creating notes may be the result of technical features required to make notes, or may relate to deeper cognitive processing involved in processing content. Using concurrent data collection technologies such as eye-tracking or a screen capture may enable researchers to develop a clearer understanding of what aspects of note taking lead to increased performance.

Learning objective views

Frequent learning objective views

I hypothesized that participants who viewed learning objectives would learn more because self-regulation was supported by having an initial goal and standards for monitoring engagement, as per phases 2 and 3 of the Winne and Hadwin (1998) model of SRL. Consistent with my hypothesis, participants who viewed the learning objectives scored statistically detectably higher than the mean on the achievement test. Learning objectives have long been known to be beneficial to learners (Hamilton, 1985). This research further supports the notion that paying attention to learning objectives increases student success.

Future research investigating online learning environments could explore whether providing various types of learning objective prompts throughout an online study unit is beneficial to learners. Such research could investigate variations of learning objective presentation formats such as presenting all the learning objectives at once or just the most relevant objectives related to a particular page, or a combination of each version as a pop-up window prompting the learner each time they log into the system to begin a study session. Current instructional design practice for online courses has transferred the print paradigm of providing the learning objectives once at the beginning of a unit. This may not be the most effective method, particularly with the changes in learning management systems. These systems have the ability for the learner to create bookmarks that return them directly to where they left off studying in the last study session, thereby bypassing the learning objectives altogether. This has an impact on how we design courses, as learning objectives have typically been presented once at the start of a study unit. Such small but significant changes in the technology require a paradigm shift in the method in which we design and present curriculum for online delivery.

Review of learning objective in both study sessions

As previously stated, I hypothesized that objectives would assist in both the 2nd and 3rd phases of the Winne and Hadwin (1998) model in which the learner sets goals and engages in learning. I also hypothesize that objectives can help learners in the final optional phase where the learner adapts and monitors their selected tactics for SRL. Specifically, to complete the fourth phase of this

recursive model, the learner needs to review the learning objectives to make a determination whether there is need for adapting their plan or tactic selection or its implementation.

Consistent with my hypothesis, participants who viewed learning objectives in the second re-study session scored statistically detectably better than those who did not conduct such a review. Reviewing learning objectives in the second re-study session indicates the learner was likely self-regulating by metacognitively monitoring goals or their plan for engagement. Results of such metacognitive monitoring can be behavioural adaptations or continuance of behaviours judged successful. Unfortunately, it was difficult to determine the latter form of metacognitive control in this study due to methodological design, which will be discussed in the section on limitations of this study.

The finding that frequent learning objective views and reviews was associated with higher achievement suggests that instructional designers of online courses should use hyperlinks throughout a study unit to provide easy links to the learning objectives. The finding that many participants in this study chose not to view the learning objectives at all perhaps suggests that learners also should be cued to access the learning objectives throughout the study unit.

Although the sample was small and contained much variance, participants who chose to review learning objectives in the second study session had a higher mean score than those who chose not to review the learning objectives. This result suggests that there is a benefit in conducting such a review of learning objectives each time a learner engages in studying material. However, future

research is needed to determine whether other underlying variables accounted for this increased achievement.

My findings suggest that participants who were actively engaged with learning objectives have higher achievement scores. However, more research is needed to determine which components of SRL were enacted and what motivates learners to behave in certain manners at certain times. Knowing not only what the learner is doing, but also what cues certain behaviours would be beneficial to understanding SRL. In hindsight, collecting other forms of data may have allowed a better understanding of why the learner returned to the learning objectives. Research is warranted to address these questions, but would require using more synchronous data collection technologies and perhaps more intrusive methods of research, such as asking the learner why they are returning to the learning objective while the study is taking place.

Implications of these findings on frequency and timing of learning objective viewing suggest that a study skills course might aim to help learners understand resources available – including learning objectives, chapter outlines, headings, and sidebars and other common features of textbooks – that can assist students to metacognitively monitor their learning. We often make assumptions that university students are effective learners; however, 14 of the 52 participants who had access to learning objectives never viewed them. In light of my findings I posit that more support and education are necessary to teach students to be better at SRL and better learners.

Understanding the benefits of learning objectives

Few participants reported using any type of supportive structures provided in study materials such as headings, outlines or learning objectives in their pre-study questionnaire. It is not known whether these participants were not aware of the benefits of using supportive structures, or were aware and chose not to use them. Participants who stated the benefit of learning objectives prior to the initial study session scored higher on the achievement test than those who did not. It is possible that those who did make such a statement had taken an Introductory Educational Psychology course and were aware of the benefits. However, it is unfortunate that these data were not collected, as it would support the case for requiring all undergraduates, or at least those on academic probation to enrol in a study skills course given that using such structures benefits learning (Lorch & Lorch, 1996).

Participants who made more analytical/expansive comments to the question asking what they believed the purpose of learning objectives were in the study questionnaire (*n*=7) often spoke of learning objectives in concert with statements on how these objectives guided their study behaviour. Two examples were “learning objectives are a good way to look at the point of what is being learned and to be able to adapt your study habits appropriately to them”, and “they helped focus the attention of the reader to find what is important. I looked over them [learning objectives] quickly at first before reading [the] text, and when I got to a part that a question [objective] asked for, my mind itself [I] took special

note". Such responses indicate these participants may be metacognitively monitoring their study behaviour, a critical component of SRL.

Implications for learners understanding the benefit of learning objectives further supports the idea that a study skills course would be beneficial to university students in learning how to be better self-regulators, potentially increasing student success and reducing attrition.

Time

Contrary to literature which suggests time on task is a significant predictor of student success (Ericsson, Krampe, & Tesch-Römer, 1993), the results of this research did not strongly support this outcome. This research was not designed to investigate which variables caused variations in study time; this finding is surprising and may have resulted from the artificial study environment. Understanding which variables influence learners to slow down and potentially improve their performance would be beneficial to educators in assisting learners to be better self-regulators. Future research with more data collection methods would help identify what caused the significant variance in study time found in this study. Such research could investigate which processes slow a learner down, and potentially identify whether a cost-recovery point exists where learners can operate optimally at a given pace.

The WPM reading rate variable is commonly recognized by reading researchers (Kleinmann, Lewandowski, Tucker, & Codding, 2003)., however in my search of the literature no "study rate" variable has been used. Perhaps this is due to complexities of obtaining such a variable given the diversity of activities

that may constitute a “study activity”. Types of content, forms of content, and environmental and individual differences may all influence WPM reading rate during study. However, future SRL research (metacognitive monitoring particularly), would benefit from a WPM study rate variable to account for difference between reading and studying. Once a variance in reading rate during study is detected researchers can gather data such as log files, think-aloud, screen-capture or eye-tracking data to determine the cause.

Tool Use

The tools available in nStudy were helpful to participants. Those who used the tools frequently had slightly higher achievement; however, with the small sample and large variance, statistical analyses are interpreted with caution. These results suggest that learners who are active in creating objects such as notes, tags and highlights are more engaged in self-regulation as they interact with the study material.

Creating objects such as highlights and tags may have a surface appearance of low-level cognitive activities; however, results of this study may indicate that potentially deeper cognitive processes may underlie such activities. Learners become agents in their regulation when they initially discriminate content that they judge is important and merits identification through highlighting, tagging or linking to a note. Such conscious control by the learner shows evidence of metacognitive monitoring and SRL, regardless if it is binary decision.

Learners are self regulating when making a choice to use a tool, regardless of how deeply they process the content they have chosen to tag,

highlight or link to as a note. We know that tasks such as creating annotations or notes requires deeper cognitive processing (Kiewra, 1987), and as discussed the results of this research suggest that creating notes in an online learning environment does have an impact on achievement. However, we could benefit from further research investigating specifically which activities are most helpful to learners, and in particular, which components of SRL are being enacted during these deeper cognitive processes.

Research has shown the benefits of both highlighting (Barker & Fowler, 1974, Peterson, 1992) and note taking (Kiewra, 1985) when students generate pen and paper annotations. Further, recent studies have suggested these results may also be applicable in the online learning environment (de Koning, Tabbers, Rikers, & Paas, 2009, Quayyum, 2008). One concern unique to the electronic contexts however, is that creating digital notes may involve less cognitive processing if students merely copy and paste (Igo et al., 2006). Encouraging learners to elaborate or otherwise assemble new information as they encode notes is more beneficial for learning than merely copying and pasting.

A review of web annotation software presents numerous options of freely available tools for creating annotations such as notes, tags and highlights to digital content. This study suggests that when and how students use these tools has an impact on their achievement. Preparing students will require both training and continued support if we are to gain the most from online learning environments. University administrations are supporting, and in cases encouraging the move to online course delivery. However, what is required is

more support for both instructors and students in using such tools effectively should we expect any significant benefit in improving the teaching and learning experience.

As the WWW evolves it will have an effect on online learning systems. One recent development that is significant is Web 2.0. This is the new form of the WWW that facilitates interactive information sharing. Learners now have the ability to “mashup” their study materials; create new content that combines material from a variety of sources and forms of media. As an instructional designer of online materials it is important to understand how students are using these tools so that we can deploy the content in a form that is easily adapted, changed or moved. The instructions for the study were to only use the supplied material. However, numerous participants asked to use external resources during the study sessions and in the study questionnaires 17 participants mentioned using external resources such as friends, online web results, and other textbooks while studying.

These findings suggest that one method of supporting students in online learning environments is to provide scaffolding in relation to tool use. Ensuring that students understand the purpose and benefits of tools such as a tag, note editors or a highlighting tool may lead to increased success.

Preparing and supporting students in the use of the various tools available in our online learning systems may increase student success, as the results of this research suggest frequent note takers and those who use tagging and highlighting have a higher achievement. Research has suggested that students

need support in learning how to be effective self-regulators, and this research suggests that those who were self-regulating, as defined by tool use and learning objective views, typically experienced higher achievement, suggesting more support and guidance is necessary for learners to be more efficient in their study behaviour.

Limitations

Two main limitations of this research were the artificial environment in which the data were collected and the data collection methods themselves. Each of these will be discussed in further detail below. Another limitation that created difficulty in analyzing the results was that the data contained large variances in aspects such as time spent studying, achievement scores, use of various tools in nStudy, and interaction with the learning objectives. Such large variances in small samples make inferences grounded in statistical computations fragile. Also, in this research as in all other research, we can only conjecture what the participant was actually doing based on patterns of behaviour observed during the study sessions.

Data collection methods

This research was an exploratory study as the body of literature that exists on restudy behaviour is limited. The key variables associated with learning objectives and SRL were assumed, but unknown when the study was designed. In hindsight a series of other variables and data-collection methods, such as those discussed next, would have been beneficial.

Due to financial and time limitations, various other data collection methods such as eye-tracking, think-aloud, and screen capture data were not used. After reviewing the data, it was evident that these kinds of data would have been beneficial in interpreting participant behaviour, particularly during the restudy session where learning objective views were infrequent.

During the study, it was unknown whether participants were using other cues of the learning objectives, such as activating, but not using the available pre-seeded tags. Such events wouldn't show up in the study logs. Participants may have also been merely focusing (literally and figuratively) on content marked up with tags or highlights created during the initial study session. Such activity would also not be evident in the nStudy log data as no interaction with the content would have taken place. These activities would have been useful to distinguish adaptation/change in tactics from continuation of prior tactics; however, this study was not set up to determine which form was being employed by the learner while studying. This research presented the opportunity to observe change, such as editing a previously created note or tag. However not having the insight into how to look for metacognitive control expressed as continuance of a tactic when this study was designed limits this investigation.

Advances have been made in methods for collecting data from learners concurrently while they study. One such example is the log-file data collected by nStudy; however, as detailed and beneficial as these data are, it is my opinion that researchers would benefit from triangulating this datum with other forms of data such as think-aloud reports, eye-tracking data, screen captures, and pre-

and post-study questionnaires and interviews. Such triangulation may enable a more nuanced understanding of not only *what* the learner is doing but more importantly *why* they are behaving in a certain manner.

Artificial Study Environment

The artificial study environment created for this research had only one restudy application. This limitation produced a situation where it was not feasible to assess metacognitive monitoring (as seen by changes in behaviour, either adaptations or change versus continuance of behaviour). Some patterns or changes were detected. However due to the short study time and with only two study applications it is difficult to make assumptions that behaviour changed due to the participant engaging in self-regulation.

A cash incentive was offered to encourage participants to do well with a bonus awarded to the highest scoring individual. Perhaps financial remuneration tied to performance rather than merely showing up twice to “study” would have been a better incentive. Conducting this research in a classroom environment, where incentives are “natural,” would perhaps be more beneficial for advancing our understanding of both theoretical and practical understandings of study behaviour.

Conducting a similar study over a longer period of time with a larger sample may provide the researcher with the ability to identify pattern changes in study behaviour and potentially determine whether the learner adapts or continues using study tactics or strategies. Determining what causes the learner

to make these decisions, to either continue or to adapt, would be useful in understanding whether and how cues such as learning objectives influence SRL.

Conclusion

This was the first study to investigate in detail learners' behaviour in both an initial study session and a follow up study session. This exploratory study provides some initial insights, as well as additional questions, which will guide my own future research, as well as provides a research agenda for others.

Future research should further investigate both my significant findings as well as those that were surprisingly insignificant but atypical, such as the lack of a significant relationship between time on task and achievement.

The results of this study suggest we can better support learners to self-regulate productively by teaching the relevance and purpose of learning objectives. These findings also suggest that it is possible to support self-regulated learning in online learning environments by encouraging frequent note taking, and by presenting learning objectives throughout the study material. These results have pragmatic implications.

An extensive body of research has shown the benefits of self-regulation for learners, and it is my hope that my research will add to that literature. I also hope it will encourage university administrators and faculty to consider the benefit of providing classes that teach students study skills, persuade instructors to take the time needed to focus on supporting learners in being better self-regulators, and convince students to take the time to learn how to be better students, and encourage instructional designers to develop online courses to scaffold self-

regulatory behaviours through the use of learning objectives. As an instructional designer, the results of this study will undoubtedly change how I design courses to better support students.

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APPENDIX A – INFORMED CONSENT FORM

Project: Self-regulation in study and restudy behaviour.
Investigators: Rob McTavish, Philip H. Winne
Department: Faculty of Education

The goal of this project is to obtain data on study behaviour. You will study material in a web-based learning environment over two visits. We ask that you use your normal study activities. You will be asked to read a 1000 word piece of text to gauge your reading rate, and then you will begin your first of the two study sessions. Upon completion of the second study session you will be asked to complete a web based questionnaire about your study experience. You will also be asked to complete a short questionnaire about study methods you typically use when reading course material.

Your study sessions will be online within a delivery tool called nStudy. nStudy is a tool that collects data on behaviors associated with self-regulated learning. There are a variety of tools available within nStudy that can assist a learner by supporting their study behaviour, as a participant you will have access to these tools. nStudy tracks (to the millisecond) most actions conducted in the learning environment, such as mouse clicks, contents of notes, windows opened, and highlights created and used. Detailed action logs are then analyzed for patterns of learner interaction with study materials.

Some data will be collected using the SFU WebSurvey system, which requires you to log in with your campus computing ID. This login procedure ensures that all data collected by this system is securely stored in SFU's on-site servers and completely controlled by the University's privacy policies regarding personal data.

Some participants will be asked to study using an eye-tracking system that will monitor visual focus on the computer monitor. The system used will be a Tobii 120 eye-tracking computer screen, there is no physical interaction between you and the system other than using a standard mouse and keyboard, the built in cameras will watch your eyes and record their movement.

Benefits: Participation in this project will contribute to deeper understanding of study and restudy behaviour.

Risks: No risks have been identified.

I agree to the following (check if appropriate):

Release of data to investigators: demographic information, reading rate, test scores, questionnaire responses, and log file data from either or both nStudy and the Tobii 120 eye-tracking system.

Gratuity: $20 cash after completing all activities in the experiment. Highest score on the post study test will receive an additional $30. If there are multiple high scores entries a random draw of those with the high score will be conducted.

To ensure confidentiality, you will be provided a random identity number that will be matched to your student number and your name will not appear on any documentation other than this consent form. Data collected in this study will only be used for research and may be used in presentations and publications resulting from this research. All data will be kept for a period of three years after the completion of the research, in accordance with SFU Policy.

I understand that I may withdraw my participation at any time and may register any complaint with the Director of Research Ethics, Burnaby, B.C., Canada, V5A 1S6, (Dr. Hal Weinberg, 778-782-6593, hal_weinberg@sfu.ca, 778 782 6593). Refusal to participate or withdrawal after agreeing to participate will have no adverse effects on your grades or any evaluation in the classroom or coursework. Upon withdrawal from the study all collected data will be destroyed.

I understand I can obtain copies of the results of this project upon its completion by contacting mctavish@sfu.ca.

I certify that I have read this form and I understand the procedures to be used in this project.

Last Name: _____ First Name: _____
Email Address: _____ Phone Number (optional)_____
First Language: _____ Year of Birth: _____
Major: _____ GPA :_____
Credits Completed: _____
Signature: _____ Date: _____
Student Number:_____
Signature Witness: _____ Name of Witness: _____

APPENDIX B – READING RATE TEXT

History of Coffee

Colombia.
In Colombia, coffee is the principal crop grown for export. It is produced in nearly all counties at elevations ranging from 3,500 feet to 6,500 feet. Chief among the coffee-growing counties are Antioquia (capital, Medellin); Caldas (capital, Manizales); Magdalena (capital, Santa Marta); Santander (capital, Bucaramanga); Tolima (capital, Ibague); and the Federal District (capital, Bogota). The county of Cundinamarca produces a coffee that is counted one of the best of Colombian grades. The finest grades are grown in the foot-hills of the Andes, in altitudes from 3,500 to 4,500 feet above sea level.

While *Coffea arabica* has been mostly cultivated in Colombia, as in the other countries of South America, the *liberica* variety has not been neglected. Seeds of the *liberica* tree were planted here soon after 1880, and were moderately successful. Since 1900, more attention has been given to *liberica*, and attempts have been made to grow it upon banana and rubber plantations, which seem to provide all the shade protection that is needed. *Liberica* coffee trees begin to bear in their third year. From the fifth year, when a crop of about 650 pounds to the acre can reasonably be expected, the productiveness steadily increases until after fifteen or sixteen years, when a maximum of over one thousand pounds an acre is attained.

Antioquia is the largest coffee producing county in the republic, and its coffee is of the highest grade grown. Medellin, the capital, where the business interests of the industry are concentrated, is a handsome city located on the banks of the Aburra river, in a picturesque valley that is overlooked by the high peaks of the Andean range. It is a town of about 80, 000 inhabitants, thriving as a manufacturing center, abundant in modern improvements, and is the center of a coffee production of 500,000 bags known in the market as Medellin and Manizales. Another center in this coffee region is the town of Manizales, perched on the crest of the Andean spurs to dominate the valley extending to Medellin and the Cauca valley to the Pacific. There-about many small coffee growers are settled, and several hundred thousand bags of the beans pass through annually.

One of the interesting plantations of the country was started a few years ago in a remote region by an enterprising American investor. It was located on the slopes of the Sierra Nevada mountains 3,000 to 5,000 feet above sea-level, about twenty-five miles from the city of Santa Marta. An extended acreage of forest-covered land was acquired, about 600 acres of which were cleared and either planted in coffee or reserved for pasturage and other kinds of agriculture.

When the plantation came to maturity, it had nearly 300,000 trees. In 1919, there were 425,000 trees producing 3,600 hundred-weight of coffee.

A typical Colombian plantation is the Namay, owned by one of the bankers of the Banco de Colombia of Bogota. It is located a good half day's travel by rail and horseback from the city, about 5,000 feet above the level of the sea. There are 1,000 acres in the plantation, with 250,000 trees having an ultimate productive capacity of nearly 2,000 bags a year. During crop times, which are from May to July, about two hundred families are needed on an estate of this size.

Venezuela.

Seeds of the coffee plant were brought into Venezuela from Martinique in 1784 by a priest who started a small plantation near Caracas. Five years later, the first export of the bean was made, 233 bags, or about 30,000 pounds. Within fifty years, production had increased to upward of 50,000,000 pounds annually; and by the end of the nineteenth century, to more than 100, 000, 000 pounds.

Situated between the equator and the twelfth parallel of north latitude, in the world's coffee belt, this country has an area equal to that of all the United States east of the Mississippi river and north of the Ohio and Potomac rivers, or greater than that of France, Germany, and the Netherlands combined—599,533 square miles.

The chain of the Maritime Andes, reaching eastward across Colombia and Venezuela, approaches the Caribbean coast in the latter country. Along the slopes and foot-hills of these mountains are produced some of the finest grades of South American coffee. Here the best coffee grows in the *tierra templada* and in the lower part of the *tierra fria*, and is known as the *café de tierra fria*, or coffee of the cold. In these regions the equable climate, the constant and adequate moisture, the rich and well-drained soil, and the protecting forest shade afford the conditions under which the plant grows and thrives best. On the fertile lowland valleys nearer the coast grows the *café de tierra caliente*, or coffee of the hot land.

Coffee growing has become the main agricultural pursuit of the country. In 1839 it was estimated that there were 8,900 acres of land planted in coffee, and in 1888 there were 168, 000, 000 coffee trees in the country on 346, 000 acres of land. In the opening years of the twentieth century not far from 250, 000 acres were devoted to this cultivation, comprised in upward of 33, 000 plantations. The trees are usually planted from two to two and a quarter meters apart, and this gives about 800 trees to the acre. The triangle system is unknown at this time. In this country, the coffee tree bears its first crop when four or five years old. The trees are not subject to unusual hazards from the attacks of injurious insects and animals or from serious parasitic diseases. On the best managed estates there are not more than 1,000 trees to a *fanegada*—about one and three-quarters acres of land—and it is calculated that an average annual yield for such a *fanegada* should be about twenty quintals, a little more than 2,032 pounds of merchantable coffee. However, that the average yield per tree throughout Venezuela is low. Ukers (1922).

APPENDIX C – STUDY TEXT

The ‘Hobbits’ of Flores Island

In 2003, two scientists made a surprising discovery on Indonesia’s Flores Island. Buried in the floor of an ancient cave they found parts of several hominid skeletons that are shorter and have smaller skulls than other hominids such as Neanderthals and modern humans. The age of the skeletons was estimated to range from 18,000 to 74,000 years. Stone tools dating to the same period were found nearby. Because they would have been about the same size as creatures featured in *The Lord of the Rings*, they have been nicknamed the Hobbits of Flores.

Discovery

The first specimens were discovered by a joint Australian-Indonesian team of anthropologists and archaeologists led by Peter Brown. They were looking for evidence on Flores of the original human migration from Asia into Australia. Because the people who first migrated into Australia are theorized to have bodies similar to modern humans, the researchers were surprised when they recovered the nearly complete skeleton of a miniature hominid. The researchers found seven additional skeletons, 38,000 to 13,000 years old, from the same limestone cave on Flores. One separate arm bone is about 74,000 years old. Also widely present in the cave were small but sophisticated stone tools or weapons that are 95,000 to 13,000 years old. The tools were found among the remains of dwarf Stegodons, an elephant-like species.

The specimens were not fossilized, but were described as having "the consistency of wet paper." Once exposed, the bones had to be left to dry before they could be dug up. Researchers hope to find preserved DNA to compare with samples from Neanderthals and modern humans. It is unlikely that useful DNA specimens exist in the available sample, as DNA degrades rapidly in warm tropical environments.

Anatomy

The most important and obvious identifying features of the Hobbits are their small bodies and small skulls. Brown and colleagues also identified a number of additional unique features including odd formations of teeth, the absence of a chin, and an unusually low twist in the forearm bones. Each of these distinguishing features has been discussed by the scientific community, with different research groups reaching differing conclusions as to the origin and cause of these features.

Small bodies

There is a fairly complete skeleton proposed to belong to a 30-year-old female, nicknamed *Little Lady of Flores* or *Flo*, which is about 1.06 meters in height. This short stature is also supported by the height estimates derived from the tibia of a

second skeleton, which might have stood 1.09 meters. These estimates are outside the range of normal modern human height and are considerably shorter than the average adult height of even the physically smallest populations of modern humans, such as the African Pygmies who average 1.5 meters. The skeletons are so much smaller than modern humans that some anthropologists believe the Hobbits of Flores are a different hominid species. The Hobbits were also much smaller than *Homo erectus.* Brown and his colleagues believe that except for the size difference, the specimens closely resemble Homo erectus, indicating that the hobbits may be descendants of *Homo erectus*. However, the remains of *Homo erectus* or transitional forms between *Homo erectus* and the Hobbits have not been found on Flores Island or anywhere else. Regardless of the origin of the Hobbits of Flores, their skeletons are the shortest and smallest of any group of hominids discovered thus far.
To explain the small stature of the Hobbits, Brown and colleagues have suggested that in the limited food environment on Flores *Homo erectus* underwent island dwarfing, a form of speciation also seen on Flores in several animal species. Dwarf stagodons found nearby skeletons of the Hobbits on the Flores Island may be descendants of larger, normal-sized Stegodons which were widespread throughout Asia at that time. The island dwarfing theory has been criticized by Professor Teuku Jacob, chief paleontologist of the Indonesian Gadjah Mada University who argues that the skeleton bodies are similar to those of modern humans living in the region, whose size can vary substantially.

Small brains
In addition to a small body size, the Hobbits would have had quite small brains. In fact, their skull size is in the lower range of chimpanzee skull size. The Hobbits' brains would have been considerably smaller than that of *Homo erectus*, which at 980 cm3 had more than twice the Hobbits' brain volume. The estimated brain to body mass ratio of the skeletons lies between that of *Homo erectus* and the great apes.
In 2005, Dean Falk and colleagues published an article in the respected journal *Science* reporting how they completed a CT scan of Flo's skull and created a computer-generated model. The authors reported that the skull did not show malformation due to disease. Similarly, Bill Jungers, a morphologist from Stony Brook University, examined the skull and concluded that the skeleton displays "no trace of disease."
Teuku Jacob and some other anthropologists do not place the new finds into a new species of *Homo*, stating instead that they are the remains of *Homo sapiens*. Jacob has put forward a disease theory which contends that the small skull is that of a mentally defective human suffering from microcephaly, a genetic disorder which produces a small brain and skull.

Brown and colleagues believe that the Hobbits showed advanced behaviors. There is evidence of the use of fire for cooking, and evidence of cut marks on the *Stegodon* bones. The Hobbit skeletons were found with stone tools of the more sophisticated Upper Paleolithic tradition typically associated with modern

humans. Some of these tools were apparently used in the cooperative hunting of local dwarf *Stegodon* by the hobbits. Despite the much smaller overall size of the brain, the area associated with self-awareness is about the same size as that of modern humans.

Chins, arms and legs

Additional features used to argue that the finds come from a population of previously unidentified hominid include the absence of a chin, the relatively low twist of the arm bones, and the width of the leg bones relative to their length. The presence of each of these features has been confirmed by independent investigators but their significance has been disputed. For example, Jacob and colleagues believe that each of these unusual features indicates some form of disease.

In 2007, Matthew Tocheri of the Smithsonian Institution published an analysis which concluded that the bones in the hobbits wrists were "indistinguishable from an African ape or *Homo erectus* and nothing at all like that seen in modern humans and Neanderthals." He said that although there are diseases that can affect the wrist, he isn't aware of any that can change the wrist of a human into that of an extinct proto-human or a modern day African ape.

We can judge the different theories about the Hobbits by comparing their features with known species of hominids and apes. This can be done in a simple comparison chart that shows when they lived and their location, height, weight and brain size. Scientists have done more sophisticated analyses by performing comparisons of skull shapes.

Recent extinction

If the Hobbits are a separate species it is possible that they became extinct as recently as a century ago. Local stories told by Indonesians living on the islands of Flores and Sumatra tell of small human-like creatures living in remote parts of the islands. Some researchers think that the source of these stories might be interactions between humans and the Hobbits living on the same islands.

Flores Island is separated from neighboring islands by a deep channel. This has led the Hobbit discoverers to conclude the species, or its ancestors, could only have reached the isolated island by water transport, perhaps arriving in bamboo rafts between one million and 100,000 years ago. Geologists found that a volcanic eruption occurred on Flores approximately 12,000 years ago. It has been suggested that the eruption may have caused the extinction of the Hobbits, along with other local animals such the dwarf *Stegodon*.

Flores is the small island highlighted in yellow. The remainder of Indonesia is show in green.

The Neanderthals were an early type of human who lived in Europe and parts of western and central Asia during the Stone Age.

The tibia is the larger and stronger of the two bones in the leg below the knee. It connects the knee with the ankle bones.
Pygmies are small people who form tribes in central Africa.
Homo erectus (Latin: “upright man”) is an extinct species of hominid who lived 1,600,000 to 250,000 years ago. They are ancestors of modern humans.
Island dwarfing is the reduction in size of animals when their gene pool is limited to an island. The effect has been reported in dinosaurs and modern animals such as elephants and deer. Island dwarfing may occur because the animals cannot move to another location when the food resources on the island become limited. Instead, they either evolve smaller bodies or grow smaller as a reaction to food stress. Island dwarfing may help a species to survive because smaller bodies need fewer calories to live.
The Island Fox, which lives on the Channel Islands of California, is one example of island dwarfing. The Island Fox is about the same size as a housecat, much smaller than the Grey Fox from which it is descended. Because the Island Fox has been geographically isolated for thousands of years, it has little immunity to parasites and diseases brought to the island by domestic dogs. Animal species that evolve on an island face serious danger from diseases imported by related species that travel to the island.
Speciation is the evolutionary process by which new biological species are created.
Brain to body mass ratio is a rough estimate of the possible intelligence of an organism. The larger the brain is relative to the body, the more brain mass might be available for complex cognitive tasks. Unlike the method of simply measuring brain mass alone, the brain to body mass ratio puts humans near the top of the list.
A morphologist is someone who studies one branch of biology, morphology, which deals with the form and structure of organisms.
Homo sapiens is the species to which modern humans belong. They originated in Africa about 200,000 years old. *Homo sapiens* is one of several species grouped into the genus *Homo*, but it is the only one that is not extinct.
Microcephaly is a neurological disorder in which the circumference of the head is significantly smaller than average for the person's age and sex. Microcephaly may be caused by abnormal growth of the brain or genetic diseases that show up in the first few years of life.
Infants with microcephaly are born with either a normal or reduced head size. Subsequently the head fails to grow while the face continues to develop at a normal rate, producing a child with a small head and a receding forehead, and a loose, often wrinkled scalp. As the child grows older, the smallness of the skull becomes more obvious, although the entire body also is often underweight and dwarfed. Development of motor functions and speech may be delayed. Hyperactivity and low mental ability are commonly associated with microcephaly. Convulsions may also occur. In general, life expectancy for individuals with microcephaly is reduced.
In 2005, Science published a study authored by Alfred Czarnetzki and colleagues which concluded that Flo’s skull is consistent with microcephaly. Also in 2006 in

an article in the Proceedings of the National Academy of Sciences, a group of scientists from Indonesia, Australia, and the United States came to the same conclusion as Dr. Martin by examining bone and skull structure. In 2007, Hershkovitz and other researchers published a paper arguing that the morphological features of the Hobbits are essentially indistinguishable from those of a genetic disease called Laron syndrome, which causes short stature.
The Upper Paleolithic is the last subdivision of the Old Stone Age. Very broadly it dates to between 40,000 and 10,000 years ago, roughly coinciding with the appearance of "high" culture (behavioral modernity) and before the advent of agriculture.

APPENDIX D – ATLAS-TI CODES

Adapt Your Study Behaviour
Analytical/Expansion
Ask For Help
Associating
Conclusion
Create Summary
Depends On The Material
Descriptions Of Terms
Detailed Notes
Direct Students
Discuss It With Others
Don't Understand
Draw A Diagram Of Parts
Easily Distracted
Effective
Entire
Examples And Diagrams
Explain To Someone Else
Flash Cards
Focus
Formulate Questions
Free Recall
Further Research
Gauge My Understanding
Guide Your Study
Have Previously Identified "Important Passages"
Headings
Highlight Material
I Feel That I Would Study Better
Identify Gaps In Understanding
Identify Important Concepts
Images Or Diagrams
Ineffective
Integrate
Interesting
Learning Objectives
Listen To Recorded Lectures
Main Points/Ideas
Marginalia
Memorize
Metacognitive Process
Need To Rewrite To Be Effective
Pneumonic Devices
Objectives
Organize It Into Groups Of Similar
Overall Sense
Paraphrasing
Plan
Practice Question
Prioritize
Re-Write Notes
Read Material
Read The Content Of The Page O..
Read The Summary
Repetition
Reread
Review
Review Highlighted Material
Review Or Look For Learning Objectives
Review Own Notes Or Material
Room For Improvement
Set Goals
Situate Content
Skim
Sometimes I Highlight Too Much...
Strategies
Studying
Summarize
Superficial/Descriptive
Talk To Myself
Too Much Information
Translat*
Underline
Write Notes
Write Out My Notes Again

APPENDIX E – UNIQUE TAGS CREATED BY PARTICIPANTS AND USAGE COUNTS

1- concept of island dwarfing	2
2- characteristics of Dwarfs	5
3- evidence separate species	2
4-why extinct	1
a suggestion to how the hobbits went extinct	3
Additional unique features of the Hobbits	2
Advanced behaviours	1
advanced behaviours	1
African pygmies	1
age of skeletons	1
anatomy	1
Anatomy	2
Anatomy	2
Anatomy	5
anatomy	6
ANATOMY	9
and your point is? why is this important?	1
appearance	1
Archaeological fact	5
argument made against theory	1
argument on new species	1
arm	1
arms and legs	1
background info	3
basis of theory	1
Brown's view	3
chin	1
Chins	1
compared to what?	1
comparing Hobbits and other species	3
complete skeleton	1
concept of island dwarfing	2
Confusing	1
Counter to disease theory	1
criticisms to article hypothesis	2
Dates	2
dates	4
Dean Falk	7
DEFINITIONS	11
description	3
description of hobbits	7
dicovered first specimens.	1
Diff from other humanoids	1
Diff species together w cromagnon	1
Different from humans?	1
Discoverer of first specimens	2
discoverers	1
discovery	1
discovery	1
Discovery	2
DISCOVERY	5
discovery on Flores Island	3
disease jacob	1
distinguishing features	1
distinguishing features2	1
Evidence #1 Hobits as separate species	1
Evidence #2 height differences	1
Evidence agains separate species	3
evidence of advanced behaviors	2
Evidence of advanced evolution (higher than apes)	1
EVIDENCE OF HOBITS AS SEPARATE SPECIES	1
EVIDENCE OF SEPARATE SPECIES	2
Evidence of unique species	1
EXPLAINATION FOR SMALL STATURE	1
Extinct?	1
extinction	1
extinction	2

Extinction of the Hobbits	2
Facts	5
Feature of Hobbits	1
features	9
Final Study	1
Flores	4
Flores Island	1
Hobbit characteristics	4
Hobbit discoverers	2
Hobbit extinction reasons	2
Hobbit Features	4
Homo erectus	1
Homo erectus	3
How old?	1
how they looked	3
How were they found?	1
important features of Hobbits	3
important info	4
IMPORTANT!	5
intelligence	1
Interesting	3
interesting	4
interesting	22
Island speciation	1
Jacob's view	3
Judging the theories	1
Key	14
key words or terms	18
Learning Objective 1	1
Like Homo E. but smaller	1
limited food brown	1
LO 1: Island dwarfing	2
LO 2: Distinguishing features	1
LO 2: How they are different from Neaderthals	1
LO 3: (more evidence) Are NOT a separate species	1
LO 3: Are NOT a separate species	5
LO 4: Evidence for extinction	1
LO 4: Further evidence for extinction	1
LO#1 - Island Dwarfing	1
LO#2 - Features	9
LO#3 - Separate species evidence	4
LO#4 - Theory of extinction	1
Matthew Tocheri (2007)	1

Microcephaly	2
Microcephaly	2
Morphologist	1
names	2
new species	1
no disease	2
no DNA	3
not a disease!	1
Note	1
numbers	2
Numbers	5
Objective	1
Objective	2
origin	1
Paragraph Chief Idea	16
perhaps	2
Possible Disease?	3
purpose	1
questionable claim	1
READ	2
READA	2
really? (interesting)	1
Reason	3
reasons for dwarfism	1
recent extinction	1
Remains	1
resons for hobbits	3
separate species	5
separate species?	1
seperate specise	2
small bodies	1
SMALL BODIES	1
Small bodies	3
small bodies-little lady of flores or flo	1
Small brains	1
Small brains	4
Small brains	6
special features	2
Stressed	2
support for theory that own species??	1
terms	19
The obvious features of the Hobbits	6
Theory of dwarfing	1
tibia of another skeleton proves shortness	1

unique features.	1
Upper paleolithic	1
When/where?	1

Wiki	3
WWWWW	4
years	2