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Implications of task structure on self-regulated learning and achievement

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School tasks interact with student motivation, cognition, and instruction to influence learning and achievement. Heeding calls for additional research linking motivational and cognitive factors in learning and instruction on specific tasks within authentic classroom settings we quantitatively and qualitatively track 90 tenth-grade science students' motivation, reported use of learning strategies, achievement, calibration, and task perceptions as they engage in a well-structured task (WST) and an ill-structured task (IST). Students achieved higher grades on, and reported more ease and value for, the WST whereas they utilised critical thinking and peer learning strategies more on the IST. Lower academic achievers calibrated their achievement less accurately on each task and experienced lower grades, interest, ease, and management capability on the IST. Conversely, higher academic achieving students reported more self-efficacy and effort regulation and lower anxiety and elaboration on the IST. Motivation – notably less intrinsic goal orientation in low academic achievers and higher task value and self-efficacy – predicted performance on the IST. The structure of tasks may provide prompts that illicit unique self-regulated learning responses in students.

Keywords: task value; motivation; learning strategies; cognition

Research indicates that school tasks interact with student motivation, cognition, and instruction to influence learning and achievement (Blumenfeld et al., 1991; Doyle, 1983; Winne & Marx, 1982). Social cognitive theory posits that behavioural, environmental, and personal factors interact reciprocally as students regulate their learning on academic tasks (Bandura, 1986). Capable self-regulation of cognitions, behaviours, affect, social environment, and goals during interactions with tasks improves classroom learning (Butler & Winne, 1995). For example, when both motivational and cognitive learning strategies are implemented on tasks, academic performance and critical thinking skills tend to improve (e.g., Bruning, Schraw & Ronning, 1995; Schutz, 1991). Unfortunately, not all styles of student self-regulating practices are productive (Winne, 1995) and neither are many of the tasks which teachers design and assign (Doyle, 1983).This is evident when students with suitable strategic knowledge use inappropriate learning strategies on tasks while other highly motivated students, learn and perform poorly on tasks (Winne & Marx, 1982). Heeding calls for additional research linking motivational and cognitive factors in learning and instruction on

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specific tasks within authentic classroom settings (e.g., Winne & Hadwin, 1998) we apply social cognitive theory in an investigation of how students' levels of motivation, strategic learning, and performance differ during and after the completion of two differently structured learning tasks during science class.

Task structure

Doyle (1983) describes tasks as the basic instructional unit in classrooms. Indeed, much of learning involves students 'constructing' understanding while working on different goal-oriented tasks. In other words, tasks are embedded with instructional cues that provide key information about how students should engage with both the task and resources associated with those tasks. As work on the task unfolds, products are created that provide information to help students calibrate whether they are reaching desired goals or outcomes. If not, students have to make decisions about how they want to adapt their approaches to completing a task to reach desired goals. Tasks that are too confusing, irrelevant, and complex for students can constrain understanding and motivation (Doyle, 1983; Lodewyk & Winne, 2005). In such cases, students may need a motivational catalyst to sustain efforts in completing a task or resolve to not adapt and accept the consequences.

Tasks have been defined according to how structured they are in content and form. For example, compared to an ill-structured task (IST), a well-structured task (WST) usually involves a linear and hierarchical procedural routine (e.g., worksheet, report on a clearly defined topic), is presented with necessary resources and useful information or sub-goals (e.g., detailed requirements), may have more identifiable factual (e.g., right or wrong) answers, includes more precise criteria (e.g., rubric) indicating how the product will be assessed, and is completed more efficiently when a system of general principles or algorithms are applied (Frederickson, 1984; Spiro, Coulson, Feltovich, & Anderson, 1988). In contrast, an IST involves more of an ambiguous problem in which the learner must connect or synthesise information, apply knowledge to an authentic context, seek out additional resources and information, consider multiple perspectives, and have fewer sub-goals or algorithms (e.g., outline of requirements) embedded in the assignment description or assessment criteria to aid the learner in calibrating success or progress. Spiro et al. (1988) relate such less-structured tasks to a landscape that can be best understood when 'explored from many directions, to traverse it first this way and then that' (p. 187). Despite their differences, tasks share features of the other so there is no distinct dividing point between them (Frederickson, 1984). In other words, tasks can be moderately ill- or well-structured depending on the degree they characterise each of these features.

Self-regulated learning and calibration

Winne (1997) proposes more research that 'elaborates a concept of difficulty beyond being a normative or absolute property of a task, such as a psychometric difficulty index or a count of steps, to one addressing its informational value in self-regulated learning' (p. 408). Some of this information is evident in how students manage the task, how they monitor and adapt their goals and tactics on it, perceive certain features of a task as difficult or easy, and how they value and feel confident to succeed on it. Self-regulated learning is 'not a mental ability or an academic skill; rather, it is the self-directive process through which learners transform their mental abilities into academic skills' (Zimmerman, 1998, p. 2). There is general agreement that 'self-regulation refers to a multi-component, interactive, self-steering process that targets one's own cognitions, feelings, and actions, as well as features of the environment for modulation in the service of one's own goals (Boekaerts & Cascallar, 2006, p. 199). We concur with Butler and Cartier (2004) that 'students are engaged in task work when they practice active reflective coordination of learning processes (i.e., self-regulation) in light of meta-cognitive knowledge and motivational beliefs' (p. 1732).

In Winne and Hadwin's (1998) recursive and loosely sequenced model of self-regulated learning, such meta-cognitive activity occurs during the definition, goal-setting/planning, enactment, and adaptation stages of task work. During these phases students identify, monitor, and regulate the conditions, operations, products, evaluations, and standards (goals) (COPES) of the task. Thus, students consider information such as the conditions (e.g., necessary resources) of the task, their knowledge of the task, potential tactics and strategies to implement in the task, and their beliefs and motivations for completing the task. More specifically, whenever a student is considering a tactic to use, they tacitly or consciously assess and programme each of these COPES features to decide on their next step. Failure to perceive and define accurately each of these facets may prompt learners to 'deviate from the objectives of the task often resulting in further setbacks, frustration and anxiety with the task' (Winne & Hadwin, 1998, p. 290). This can be particularly challenging for students if the task on which they are working has less structure and may be a result of not understanding which skills are required to accomplish different tasks or focusing too much on irrelevant details within the task (Doyle, 1983; Schunk, 1991).

Achievement calibration – the correlation between what students believe they have performed and their actual performance – is important in effective self-regulation (Winne & Jamieson-Noel, 2002). It tends to be weak in most students, particularly lower achievers who tend to be over-confident on difficult tasks and under-confident on easier tasks (Glenberg, Sanocki, Epstein, & Morris, 1987). Students generally self-regulate and calibrate tasks more effectively when they use their knowledge and beliefs to formulate conceptions about the characteristics and demands of a task and make continuous and useful adjustments based on those perceptions (Butler & Winne, 1995; Winne & Jamieson-Noel, 2002). In other words, as students work on tasks, they self-regulate their learning in diverse ways that include meta-cognitively defining the task and implementing strategies and tactics by acquiring information from their own stores of knowledge and from monitoring factors associated with the task and themselves (Butler & Cartier, 2004). This feedback allows students to make judgments (calibrate) about progress and mastery and with this, make decisions about whether to maintain the same pattern of strategies or adapt approaches to address gaps in processing the task and creating task products. Research on calibration using tasks of varying difficulties has been welcomed (Winne & Jamieson-Noel, 2002).

Motivated learning

From a social-cognitive perspective, motivation is a proactive goal-oriented process that stimulates achievement (Pintrich & Schunk, 1996), tends to 'interact with cognitive processes in a synergistic or transactive manner within a self-directed contextual process' (Schutz, 1994, p. 135) and can affect perceptions that limit readiness for learning when engaging with, adapting towards, and sustaining effort on a task (Winne & Hadwin, 1998). For example, self-efficacy beliefs, defined by

Bandura (1986) as 'people's judgments of their capabilities to organise and execute courses of action that is required to attain designated types of performances' (p. 391), seem to impact cognitive processes by mediating motivation, information-processing operations, anxiety, social influences, and the ability to self-regulate learning (Wigfield & Eccles, 1992). Thus, motivation seems to influence knowledge and action during task work by serving as a 'filter through which new phenomena are interpreted and subsequent behaviour mediated' (Pajares, 1996, p. 544).

Research has supported a fundamental assertion within social cognitive theory that personal beliefs about ability, effort, and outcomes influence the attainment of goals (e.g., knowledge, achievement) by influencing how much a student senses control in the learning environment and how well they self-regulate such factors as their anxiety and progress (Bandura, 1986; Duncan & McKeachie, 2005). Personal control (students' feelings that their effort will result in advantageous learning outcomes) and task value (one's evaluation of the how interesting, important, useful, and costly pursuit of an outcome is relative to one's goals) have also been empirically validated in correlation studies and influence cognitive processing and behaviours such as choice, persistence, and academic achievement (Bandura, 1986; Pintrich & Schunk, 1996; Wigfield & Eccles, 1992). Additionally, students who are anxious about learning and achieving in school are prone to 'freezing' cognitively when writing tests and tend to regulate their learning and attention less effectively, particularly if to-be-learned content is unorganised or needs to be memorised (Woolfolk, Winne & Perry, 2000). In one study (Wigfield & Eccles, 1989), 25% of schooled children suffered from the harmful effects of anxiety such as the fear of performing poorly on a test. If, however, learners value tasks and feel efficacious and in control of their performance on tasks, they will be less anxious and more likely to put forth the necessary strategic and purposeful effect to meet their task goals (Pintrich, Marx & Boyle, 1993).

Another key motivational construct within social cognitive theory is goal orientation – standards that students typically set and use to judge their academic achievement – which has also been linked to cognitive, affective, and behavioural outcomes (Pintrich & Schunk, 1996). Compared with intrinsic-oriented (mastery) learners, extrinsic-oriented (outcome) learners tend to pursue goals based on ability rather than effort, perform tasks to perform more than to learn, are motivated by a desire to avoid failure and challenging tasks, and tend to use short-term or superficial learning strategies (Ames, 1992). These learners tend to be more anxious, less cognitively engaged, have less value for, and perform worse on learning tasks (Pintrich & Schunk, 1996). There is a need for more research investigating how students' motivational levels fluctuate as they work on differently structured tasks (Lodewyk & Winne, 2005; Pajares, 1996).

Strategic learning

As students perceive the demands of the task, they implement recursive goals, sub-goals, and learning strategies – gathering resources, making notes, asking questions – that can help them succeed (Winne, 1995). Research (e.g., Pintrich et al., 1993) has reported the achievement value of these learning strategies in certain settings. If students engage adaptively with tasks, it tends to facilitate sustained effort and improved learning and achievement despite challenges (Boekaerts & Cascallar, 2006; Winne, 1995). Of course, the demands of the task must be accurately perceived by students so they make prudent choices about how to learn strategically and perform on the task. For example, some learners misinterpret tasks emphasising comprehension with memory tasks and apply a less effective learning strategy like rehearsal to it (Flavell, Miller, & Miller, 1993). Further, only certain students – usually the more successful students – take advantage of useful learning strategies (Winne, 1995). Instead, many use simple trial-and-error (or 'hacking') strategies that rely on low-level procedural knowledge and a 'least-effort principle' when striving to comprehend the content (Cope & Simmons, 1994).

Several learning strategies have been empirically linked to learning and performance outcomes (Duncan & McKeachie, 2005). Among these are cognitive (rehearsal, organising, elaborating, critical thinking), meta-cognitive self-regulation (planning, monitoring, regulating), and resource management (time and study environment, effort-regulation, peer-learning, and help-seeking) strategies. Hofer, Yu, and Pintrich (1998) explain these three cognitive strategies that have been linked to achievement on various academic tasks: rehearsal (e.g., repeating information to retain it in working memory), organising (e.g., outlining, creating a flow chart), and elaborating (e.g., 'paraphrasing or summarising the material to be learned, creating analogies, generative note taking wherein the student actually reorganises and connect ideas in their notes in contrast to passive linear note taking') (p. 67). Mayer (1992) reports that learning is enhanced when the individual organises and summarises the content concisely (small numbers of words, parts and actions), coherently (sequential cause and effect chains), and in a coordinated way (corresponding illustrations and words presented together) by engaging the learner in cognitive processes. Compared with rehearsal, organising and elaboration tend to result in more profound comprehension of content (Hofer et al., 1998).

Critical thinking is a learning strategy that aids the learner to process and integrate information more deeply. Ennis (1987) defines it as 'reasonable and reflective thinking that is focused on deciding what to believe or do' (p. 10). Similar to problem-solving, critical thinking applies 'goal-directed procedures that are planfully or intentionally evoked either prior to, during, or after the performance of a task' (Alexander & Judy, 1988, p. 376). Within certain settings, critical thinking can facilitate learning and achievement through improvements in gathering, interpreting, evaluating, and selecting information so students can make more informed decisions (Bruning et al., 1995).

A strategy that helps learners to monitor (evaluate) how they are coping with a task and then to control (regulate) cognition by adjusting this coping mechanism, is meta-cognitive self-regulation (Winne & Hadwin, 1998). As students meta-cognitively self-regulate during work on tasks they monitor feedback (IF) upon which they control volitional responses (THEN) in an IF–THEN relationship during a task (Winne & Stockley, 1998). For instance, before and during work on tasks students meta-cognitively plan and monitor their progress on the task using feedback from evaluating their products relative to their standards (goals) which leads to changes in how they operate with the task which enables them to sense control over their learning and potentially improve their performance. In this way meta-cognitive self regulation involves not only planning (e.g., trying to comprehend the task, setting goals for engaging with it, and creating self-check questions) but also monitoring (e.g., understanding or arousal when taking a test or listening to a presentation) and regulating (e.g., adjusting tactics like re-reading a passage or answering self-check questions) to enhance comprehension.

In addition, several learning strategies have focused more generally on managing learning resources like peers, teachers, effort, time, and the study environment. Among these are effort regulation (persistence in the face of challenges), peer-learning (working with others to increase learning and improve performance), help-seeking (asking for help from peers or the teacher when necessary), and managing resources for studying (e.g., distractions, space). For example, help-seeking – clarifying procedures and instructions and to master the content rather than seeking help to speed task completion and attain the solution – is generally considered instrumental because the help that is sought improves the ability of the learner to solve the problem independently (Ryan & Pintrich, 1997). Additional research into how students' strategic learning varies across various tasks has been welcomed (Boekaerts & Cascallar, 2006).

Implications of task structure on self-regulated learning and achievement

ISTs are often perceived by students to be considerably more complex than those more well-structured (Frederickson, 1984; Spiro et al., 1988) because they lack clear procedures, have numerous possible answers and processes, do not make desired or necessary 'scaffolds' salient to the learner, and require more resources (information, knowledge, heuristic problem-solving strategies, materials, and skills) to complete them successfully. Lodewyk and Winne (2005) found that students were typically more self-efficacious during work on a WST and that moderate academic achievers experienced the most difficulty with an IST. Students also appear to perform better more often from tasks that are well-structured since they are embedded with more encoding and retrieval supports than those ambiguously designed (Spiro et al., 1988). However, tasks that require students to construct arguments from multiple sources promote more understanding than those that prompt students to memorise text (Wiley & Voss, 1999). In conditions of complex problem-solving when students are forced to set their own sub-goals rather than having sub-goals clearly labelled for them, learners are often stimulated to seek helpful contributions from others (Cohen, 1994) and more effectively regulate their learning (Catrambone, 1995).

Students may perform better on WSTs, yet such tasks may not optimally challenge students to process information and to monitor and control their learning if the task requirements are too specific and if students' domain knowledge is weak (Winne & Hadwin, 1998). In other words, highly structured tasks having little flexibility or ingenuity tend to impede cognitive processing and limit opportunity for learners to exercise their self-determination (Pintrich & Schunk, 1996). Such tasks may prompt students to spend more time focusing on completing relatively complex procedures like gathering and preparing materials or submitting a neat product than on explaining or understanding the complexity of the content to be learned (Blumenfeld, Mergendoller & Swarthout, 1987). As a result, educational researchers have expressed concern over how regularly teachers assign tasks emphasising low-level facts and encouraging shallow cognitive processing through worksheets and rote memory from textbooks (e.g., Doyle, 1983; Blumenfeld et al., 1987) since, particularly in the social, political, economic, and scientific domains, people are forced to deal with more ill-structured problems than well-structured problems (Simon, 1973). An over-reliance on WSTs may promote unproductive educational attitudes and dampen understanding of content and processes necessary to develop much of the self-regulation required, and may hinder transfer of learning to other contexts (Blumenfeld et al., 1991; Simon, 1973). Additional research is needed that investigates 'self-regulated learning as larger, temporally patterned cognitive operations that students apply over the course of one or a series of instructional activities' (Winne & Stockley, 1998, p. 109).

Rationale

In response to calls for more research into how students strategically and motivationally cope with various features of learning tasks during school (e.g., Frederickson, 1984; Spiro et al., 1988), we use an authentic classroom setting to explore quantitatively and qualitatively how students' motivation, use of learning strategies, achievement, calibration, and task perceptions differ during and after their completion of a WST and an IST. We begin by conducting a psychometric analysis of the quantitative portion of a new measure that is used repeatedly in this study to assess how students cope with each task. Next, we use data collected during and after each task to compare how students value and manage the tasks. Since research has reported that students are more familiar with a WST than an IST (e.g., Blumenfeld et al., 1991; Doyle, 1983; Frederickson, 1984; Spiro et al., 1988) and that an IST tends to be more cognitively demanding to most students than a WST (Butler & Winne, 1995; Doyle, 1983; Lodewyk & Winne, 2005; Spiro et al., 1988), we posit four hypotheses: Most students – particularly lower academic achievers – will: (1) perform worse; (2) be less motivated on; (3) calibrate their performance less accurately; and (4) regulate their learning less strategically on an IST than on a WST. This may be due to the unique features of each task that lead higher overall achieving students to, we anticipate, be more motivated on the IST, more accurately calibrate achievement, report increased use of strategies like rehearsal, organisation, and elaboration strategies on the more inductive WST, and apply more critical thinking, meta-cognitive self regulation, help-seeking, and effort regulation to respond to the more ambiguous IST.

Methods

Procedure

The four grade-10 science classes in this study comprised all of the regularly scheduled year long science classes in one school, met in the same classroom during different times on the same day, and were all taught by the same male teacher. Prior to completing learning tasks, each student completed a short *Demographic questionnaire*, administered by the first author, on which they reported demographic information (e.g., gender, date of birth, ethnicity, and learning disability). A within-subject study design was used in which all of the students completed both an IST and a WST. First, students in each class were assigned either the IST or the WST. They worked on the task for two 80-minute periods in their regular science classroom. To gain insights into how students were coping on the task, students completed a short *Self and task perception questionnaire* (STPQ) administered by the classroom teacher six times (in intervals of approximately 25 minutes). This process was then repeated for the other task (counterbalanced by task and class). Students (approximately 50%) who had not completed each task by the end of the time length provided were permitted to take their work files home to complete and submit the project and their final STPQ at the beginning of the next class. Since students were all in the final stage of completing the task (e.g., typing the final product), had submitted their final STPQ, and finishing tasks at home was a regular practice, it was not considered to be a legitimate threat to the study's validity. It is, nevertheless, noted as a caution. To assess students' motivation and use of learning strategies relative to each task, students completed a *Motivated strategies for learning questionnaire* (MSLQ) after each task. This survey was administered by the first author in the students' regular science classroom. A pilot test using each of the measures described in this study was conducted on 24 tenth-grade science students.

Participants

Following minor revisions of the items on the measures to ensure suitability for use with this sample of tenth-grade students, 94 volunteer students comprising all of the tenth-grade science students (M_{age}= 15.3 years) from four classes at an independent secondary school in an urban setting of western Canada participated in the study. Data were excluded from two truant students and three who failed to submit completed tasks. The remaining 89 students consisted of 45 males (50.56 %) and 44 females (49.44%), who were from mainly middle-class socioeconomic status, had a mean age of 15.3 years, lived mainly (77%) in an urban setting rather than a rural one, and were of Caucasian-Canadian (82%), Asian-Canadian (14.6%) or other (3.3%) ethnicity. Consultation with the school's director of learning assistance revealed that 12% of the students had a learning disability. These students were integrated into the regular science class but had access to services in the learning assistance centre whenever needed. There were no discrepancies between classes in size or any of these demographic variables.

Topics

Tasks were designed by the first author in close consultation with the classroom teacher and with existing theory on task structure (e.g., Blumenfeld et al., 1987; Doyle, 1983; Fredericksen, 1984; Spiro et al., 1988). The topic of both the IST and WST was cancer. The WST was titled 'Personal Lifestyle Plan'. It was designed for students to gather information and gain knowledge about a chosen form of cancer. Students were provided with a template that asked them to list the causes, symptoms and treatments of the chosen form of cancer, determine and explain their risk for that form of cancer, and suggest possible behaviours to reduce their risk for it. This task was purposely structured 'moderately' well by including an advance organiser to promote self-reflection of one's risk for cancer, a packet of necessary resources, and specific objectives with clear criteria on grading, format, and style of a final report that students would hand in to the teacher for marking. Requirements for each task were given to students in a detailed outline so they would have explicit sub-goals to guide their self-regulation on the task.

The IST was entitled 'Task-Force Issue'. It was designed to stimulate critical thinking about the issue of how government funding should be allocated across preventative efforts versus treatment programmes in the battle against cancer. Students were to be members of a task force assigned by the government to decide how best to combat cancer. In other words, they had to justify how the government should respond to cancer based on perceived priorities for battling it. Resources for this task were available on a table in the classroom. The IST prompted students to process more complex information, included very few structural cues (e.g., progressive questioning, outline) for self-regulation of learning, did not include specific criteria for grading (rubric), and required students to search for and gather their own useful information and resources within the classroom. This task was considered moderately ill-structured because a modest number of instructional cues, resources, and explicit feedback (e.g., clarification of expectations) were provided for students as they worked on the projects.

Measures

Motivation and use of learning strategies

To assess students' motivation and perceived use of learning strategies on each task, students completed an MSLQ (Pintrich, Smith, Garcia & McKeachie, 1991) after completing each task. The MSLQ is a valid self-report instrument used extensively within educational research to assess college and high-school students' motivational orientations and use of learning strategies in various domains, courses, ethnicities, and instructional settings (see Duncan & McKeachie (2005) for a review of its use and validity). It presents 81 statements that invite students to self-diagnose various qualities of their approaches to learning and to self-regulating that learning on a seven-point scale ranging from 'not at all true of me' (1) to 'very true of me' (7). References to 'this course' were altered to 'this task' to ensure the instrument assessed motivation and use of learning strategies for the task.

The motivational scales consist of 30 items assessing intrinsic goal orientation (IGO), extrinsic goal orientation (EGO), task value (TV), control beliefs for learning (CB), self-efficacy (SE), and test anxiety (TA). These were defined earlier. A sample item for each scale is: 'If I can, I want to get better grades on this task than most of the other students' (EGO); 'On a task like this, I liked the material that made me more curious, even if it was hard to learn' (IGO); 'I think the material in this task was good for me to learn' (TV); 'If I tried hard enough, then I could learn the material for this task' (CB); 'I'm confident I performed the most difficult material taught by the teacher for this task' (SE); and 'I had an uneasy, upset feeling about being graded on this task' (TA).

Use of learning strategies consist of the remaining items that measure rehearsal (R), elaboration (E), organisation (O), critical thinking (CT), meta-cognitive self regulation (MSR), management of time and study environment (TSE), effort regulation (ER), peer learning (PL), and help-seeking (HS). These were defined earlier. A sample item for each scale is: 'I made a list of important terms for this task and memorised the list' (R); 'When I work on this task, I wrote brief summaries of the main ideas from the readings' (E); 'During work on this task, I went over my notes and made an outline of the important concepts' (O); 'Whenever I heard an opinion or idea in this class, I thought about other possibilities besides that one' (CT); 'When I tried to learn during this task, I set goals for myself in order to direct my activities' (MSR); 'I made good use of my study time for this task' (TSE); 'I worked hard to do well on this task even if I didn't like what we are doing' (ER); 'I worked hard to do well on this task even if I didn't like what we were doing'(ER); 'When working on this task, I often set aside time to discuss the task material with a group of students from this class' (PL); 'When I couldn't understand the material for this task, I asked another student in this class for help' (HS); and 'When I couldn't understand the material in this task, I asked someone else for help' (HS).

Self and task perception questionnaire

Students' perceptions about the task and their perceptions and responses to it during and after each project were assessed by the STPQ. This instrument was designed by the first two authors and had two main sections. In the first section, students were asked to report features of the task that they were finding difficult or easy, state where in the task it was, and explain why it was easy or difficult for them. Asking students to identify the ease with which one is completing task components or the difficulties one is experiencing while completing the task provides useful information about what and how students are regulating their learning on the task (Winne & Hadwin, 1998). Another objective of this first section was to have students qualitatively access and activate their perceptions about each task and about their learning for the completion of section 2.

The first section was assessed by the first author using the qualitative analysis method framework developed in the 1980s at the National Centre for Social Research (Ritchie, Spencer & O'Connor, 2003). To summarise, data were first previewed for emergent themes (e.g., finding useful information) within the 'easy' and 'difficult' categories of each task. Data were reexamined and each response was manually and numerically coded according to the task (IST and WST), stage of the task (1–6), and student's level of overall academic achievement (OAA) (low, moderate, or high). When necessary, additional themes were added to reflect students' responses most specifically. These coded data were entered into a matrix under the appropriate theme and tabulated quantitatively. When necessary, statements that represented more than one theme were coded and entered into each of the relevant themes within the matrix. Students' statements that characterised a particular theme were included as examples within that theme. Prominent themes were identified by task form and stage by their frequency and presented in the results.

The second section consisted of 20 short statements (using a five-point Likert scale ranging from 'very much not true of me' (1) to 'very much true of me' (5)) that was designed to measure their task perceptions quantitatively. Eight of the items comprised part of another study, leaving 12 items that were retained and used in this investigation. Four of these items, taken from the TV sub-scale of the MSLQ (Pintrich et al., 1991), were: (1) 'In a project like this, I prefer material that really challenges me so I can learn new things'; (2) 'Understanding the material of this project is very important to me'; (3) 'I am enjoying the learning in this project'; and (4) 'I am very interested in the material of this project'. The remaining eight statements assessed students' ability to cope with (Winne & Hadwin, 1998) or manage the work required in academic tasks. Examples of these are: (1) 'At this point, I understand the requirements of this project. They are clear to me'; (2) 'At this point, I'm not sure which methods of studying are best for this project'; (3) 'The information I need to succeed in this project right now is difficult to get'; and (4) 'I know which mental techniques would best meet the needs of this project'.

Post-task questionnaire

A *Post-tasks questionnaire* (PTQ) was developed by the first author and administered by the same following the completion of both tasks. The PTQ had four items asking students to state which task (IST or WST) they found more difficult, which task was more interesting, and to provide an estimate (calibration) of what they expected their final grade (%) to be on each task.

Achievement

Task performance was the grade each student received on each project. The projects were marked by the first author using detailed scoring rubrics. The WST project was marked according to how well students fulfilled the requirements outlined in their original project descriptions. For example, relatively equal weight was allotted to how well students reported information (e.g., description, cause, symptoms, treatments) on their chosen cancer topic, responded to their personal (e.g., lifestyle, family, environmental factors) risk for the cancer, and for the format (e.g., appearance, spelling, expression) of the final product. The grade for the IST project was determined through use of the five essay-scoring criteria used in the British Columbia Ministry of Education (1998) *History 12 examination specifications* assessed on a scale from 1–5 (1 = unsatisfactory; 2 = limited; 3 = acceptable; 4 = proficient; 5 = excellent; 0 = cannot be evaluated). The five criteria were: content (i.e., thoroughly addresses the question), organisation (i.e., clear, effective, deliberate), expression (i.e., fluent, controlled, with appropriate selection of supporting details), judgment (i.e., demonstrates awareness of complexities or contradictions in the issue), and format (typed, title page, margins, font, headings, appropriately structured citations, spelling). The teacher also graded each task. Inter-grader correlation was .80 for the IST and .87 for the WST.

Students' OAA in grades 9 and 10 was represented by a weighted score: 40% of their previous year's general academic grade point average and 60% of the mean of their two most recent academic terms. To determine levels of OAA, students ($N = 84$) were assigned a rating of high, medium, and low OAA based on their OAA percentile so that sample size and variance of the high and low groups were relatively balanced. The levels consisted of low OAA ($n = 24$; < twenty-seventh percentile), moderate OAA ($n = 38$; twenty-eighth to sixty-ninth percentiles), and high OAA ($n = 27$; > seventieth percentile).

Results

We sought to analyse psychometrically the quantitative portion of the STPQ that was used repeatedly in this study to assess how students coped with each task. Secondly, we hypothesised that most students – particularly lower academic achievers – would perform worse, be less motivated, calibrate their performance less accurately, and regulate their learning less strategically on an IST than on a WST.

Factor structure

Using version 16 the Statistical Package for the Social Sciences (SPSS) we discerned the factor structure of the quantitative portion (Section 2) of the STPQ for this sample by pooling the results of each of its 12 administrations across both tasks (N=1012), randomly dividing into two samples (n=500; n=512) for separate exploratory and confirmatory factor analysis. The exploratory principal axis factor analysis with oblimin rotation, loading on two factors, and entering all 12 items extracted two factors accounting for 38.6% of the variance. These factors comprised four TV items (21.0%) and seven Task Management (TM) items (18.6%). To examine how well the data from this sample fit this proposed interrelated two-factor model a confirmatory factor analysis using Structural Equation Modeling Software (EQS) 6.1 was conducted. The results showed a very good fit to the data (comparative fit index = .932, goodness of fit index = .950, root mean square error of approximation = .075, standardised root mean residual = .058) and all items loaded significantly ($p < .05$) onto the prescribed factors. Therefore, the hypothesised two-factor model of the STPQ adequately fits the data in this sample. TV represents how interested, enjoyable, and useful students perceive the task. Students high in TM perceive themselves to be appropriately managing the demands (e.g., requirements, methods for studying, accessing information, satisfaction with progress, regulating time) of the task. The factor structure and loadings along with the internal consistency reliability coefficients for each factor are provided in Table 1. Scale reliability coefficients at each assessment point were satisfactory (Tabachnick & Fidell, 2007) in ranging from .71 to .82 (TV) and .64 to .78 (TM).

Relations among task performance, motivation, and learning strategies

To determine effects due to the order of completing each task, we computed a *t*-test comparing students who were assigned the IST first and second [t (81) = −1.19, p = .24] and the same test for those who completed the WST first and second [t (87) = .65, p = .52]. Task order was not a factor. We used the same statistical analysis to determine if students' task performance differed. Performance on the WST (M = 71.08, SD = 19.24) differed statistically [t (88) = 2.15, p = .04] from performance on the IST (M = 66.67, SD = 19.20).

The predictive strength of the motivation and learning strategy self-report variables (see descriptive statistics in Table 2) on task performance was investigated using separate multiple regressions ($p < .05$) for entering motivation, cognitive and metacognitive strategies, and resource management strategies for each task. The sole collective predictor was motivation on the IST [R^2 = .21, F(6, 81) = 3.57, p = .003]. Individually, only IGO negatively [β = −.55, p = .003], TV [β = .44, p = .02], and SE positively [β = .34, p = .008] predicted performance on the IST. None of the other motivation or learning strategies predicted performance on either task. To investigate further the negative predictive association between IGO and IST performance, the

Table 1. Exploratory factor loadings from the self and task perception questionnaire (n = 500).

Items	Task value	Task management
1. In a project like this, I prefer material that really challenges me so I can learn new things.	.73	
2. Understanding the material of this project is very important to me.	.60	
3. I am enjoying the learning in this project.	.78	
4. I am very interested in the material of this project.	.86	
5. At this point, I understand the requirements of this project. They are clear to me.		.58
6. At this point, I'm not sure which methods of studying are best for this project.		.48
7. I am frustrated because most of the others are doing better than I am on this project.		.50
8. I am being given enough time to complete this project.		.47
9. I am satisfied with the results I have produced so far in this project.		.61
10. The information I need to succeed in this project right now is difficult to get.		.58
11. I know which mental techniques would best meet the needs of this project.		.42
% Variance	21.0	17.57

Note. Eigenvalues > 1.00; items 6, 7, and 10 are reversed coded.

Table 2. Descriptive statistics and reliability coefficients for the motivated strategies for learning questionnaire on each task.

Scales	Post-IST (n = 88)			Post-WST (n = 85)			
Motivation	*M*	*SD*	α	*M*	*SD*	α	Between-task difference
1. Intrinsic goal orientation	4.45	1.13	.78	4.57	1.19	.81	.13
2. Extrinsic goal orientation	4.93	1.30	.76	5.11	1.33	.80	.18
3. Task value beliefs	5.02	.98	.84	5.28	1.01	.86	.26
4. Control beliefs for learning	5.24	.97	.57	5.39	.97	.73	.15
5. Perceptions of self-efficacy	5.09	1.02	.91	5.33	.95	.91	.24
6. Test anxiety	2.82	1.32	.81	2.67	1.27	.79	−.15
Use of learning strategies							
Cognitive and metacognitive strategies							
1. Rehearsal	3.35	1.09	.50	3.49	1.30	.70	.14
2. Elaboration	4.12	1.08	.74	3.93	1.03	.68	−.19
3. Organisation	3.20	1.20	.65	3.24	1.17	.65	.04
4. Critical thinking	4.46	1.14	.77	3.92	1.26	.82	−.54**
5. Metacognitive self-regulation	3.74	.88	.81	3.77	.76	.67	.03
Resource management strategies							
6. Time and study environment	4.07	1.00	.70	4.29	.97	.69	.22
7. Effort regulation	4.76	1.26	.78	4.84	1.22	.72	.08
8. Peer learning	3.58	1.23	.46	3.20	1.24	.55	−.38*
9. Help-seeking	4.08	1.33	.62	3.99	1.37	.66	−.09

Note: * $p < .05$; ** $p < .01$.

same regression analysis was conducted within each level of OAA. Results revealed that IGO (lower) predicted ($p < .05$) IST (higher) performance only in the low OAA group (β = −.84, p = .005), not in the moderate OAA (β = −.35, p = .32) or high OAA (β = −.10, p = .81) groups. Thus, motivation – notably less IGO in low OAA and higher TV and SE – predicted performance on the IST, whereas learning strategies did not predict achievement on either task.

During-task results

Quantitative analysis

We tested the relative differences between tasks in the means of TV and TM that were repeatedly measured during each task (one on the IST vs. one on the WST, and so forth). Difference scores involving these repeated measures might reflect real changes or compounded error variance as the questionnaires may have encouraged learners to reflect more on their TV and TM than usual, thereby influencing their levels on these scales. To compensate, we adopted a conservative p-level (≤ .01). Descriptive statistics for each scale at each of the six assessment times during each task are presented in Table 3 and illustrated in Figure 1.

To test whether TV would differ between the WST and the IST, a simple multivariate analysis of variance (MANOVA) was performed using the six in-task assessments of TV as the dependent variable and task (IST and WST) as the independent

Table 3. Descriptive statistics for each assessment point of task value and management on each task.

	Ill-structured task (IST)						Well-structured task (WST)					
Stage	1	2	3	4	5	6	1	2	3	4	5	6
						Task value						
M	3.47**	3.43**	3.41**	3.57*	3.59*	3.65*	3.75**	3.85**	3.79**	3.77*	3.74*	3.89*
SD	.88	.90	.88	.88	.90	.95	.66	.79	.76	.83	.83	.83
α	.82	.86	.86	.88	.84	.86	.71	.85	.82	.85	.87	.86
						Task management						
M	3.39	3.14**	3.24**	3.45*	3.54*	3.67*	3.54	3.76**	3.68**	3.74*	3.80*	3.91*
SD	.66	.72	.66	.72	.75	.72	.62	.70	.71	.70	.59	.62
α	.64	.74	.68	.77	.78	.78	.64	.73	.77	.77	.65	.69
N	89	87	85	83	77	77	89	89	86	87	80	77

Note: Statistical difference between IST and WST: * $p < .01$; ** $p < .001$.

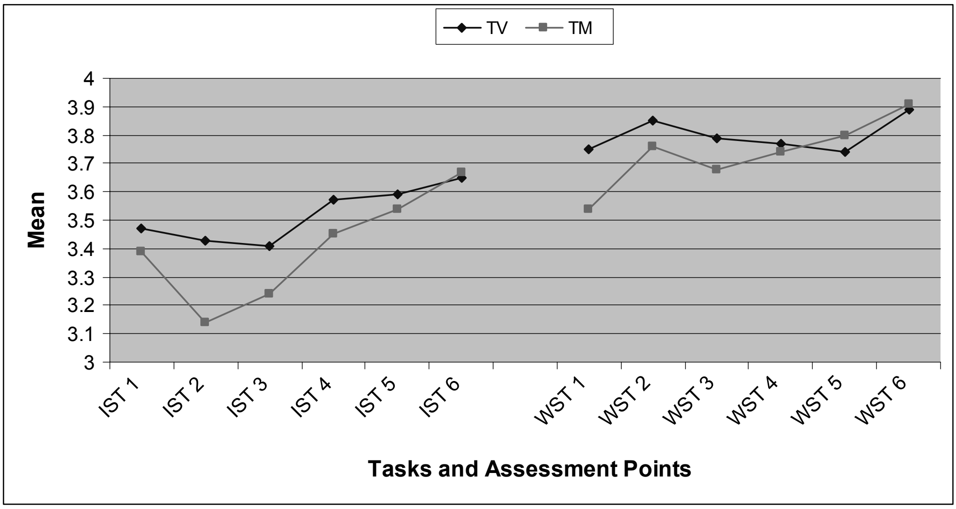

Figure 1. Changes in task value (TV) and management (TM) on the ill-structured (IST) and well-structured tasks (WST).

variable. A MANOVA was performed rather than a repeated measures analysis because differences between the WST and IST in either TV or TM were being assessed, rather than differences across the repeated measures of either TV or TM. Results indicated that TV [$F(6, 58) = 5.28$, $p < .001$, $\eta^2 = .35$] was significantly higher on the WST than on the IST. *Post-hoc* t-tests ($p < .01$) revealed statistically higher TV on the WST at each assessment time: Time 1, $t(88) = 4.03$, $p < .001$; Time 2, $t(86) = 4.94$, $p < .001$; Time 3, $t(81) = 4.78$, $p < .001$; Time 4, $t(80) = 2.92$, $p = .005$; Time 5, $t(70) = 2.60$, $p = .01$; Time 6, $t(67) = 3.11$, $p = .003$. At all stages during task work students reported less value for the IST than the WST.

As in the previous analysis with TV, differences in TM between the WST and the IST were computed using MANOVA. Results indicated that TM [$F(6, 58) = 8.78$, $p < .001$, $\eta^2 = .48$] was statistically higher on the WST than on the IST. *Post-hoc* tests (see Table 3) signalled higher TM on the WST at each assessment time except Time one: Time 1, $t(88) = 1.99$, $p = .05$; Time 2, $t(86) = 7.16$, $p < .001$; Time 3, $t(81) = 5.55$, $p < .001$; Time 4, $t(80) = 3.59$, $p = .001$; Time 5, $t(70) = 3.43$, $p = .001$; Time 6, $t(67) = 3.46$, $p = .001$. With the exception of the first stage, students managed less comfortably with the IST than the WST.

Qualitative analysis

Well-structured task. Students reported little difficulty during early work with the WST. In stage 1, respondents highlighted the ease in understanding the 'basic and straight-forward requirements of the project' ($n = 11$), 'selecting the topic for the project' ($n = 25$), and 'information gathering' ($n = 20$). The few students with a concern in this initial stage reported difficulty with 'organising the overwhelming amount of information into specific categories' ($n = 6$) and 'deciding on a good topic' ($n = 6$). This concern was repeated by several students in the second stage of the task although most students ($n = 69$) highlighted their ease in information and resource gathering.

Most students (*M* = 45) continued to report the most ease with information and resource gathering during the middle stages (3 and 4) of work on the WST. In stage 4, several (*n* = 13) noted ease with for example, ‘simply answering the questions provided on the assignment sheet’. More students reported difficulties during the middle than early stages of work on the WST. Concerns centred on concerns like ‘having too much information to organise’ (*M* = 12), ‘finding certain information’ (*M* = 10), and ‘being bored because this is easy stuff’ (*M* = 4).

Two general difficulties were reported during the final stages (5 and 6) of work on the WST. Some students (*M* = 20) continued to struggle with finding and organising information to fulfil the requirements of the tasks. Some (*M* = 20) cited difficulty in writing, formatting and typing (‘putting things together and expressing myself’) the report. In terms of ease, finishing the research (*M* = 12), organising the writing (*M* = 12), and typing the report (*M* = 29) were reported. For example, a representative response for these students was ‘Now I know what I’m going to say and I can type fast and have done it lots before’.

Ill-structured task. During the first stage on the IST, several students reported confidence in their ability to ‘understand what needs to be done since it is outlined very clearly on the sheet’ (*n* = 8). Some (*n* = 3) of these students had low OAA, which might reflect their under-estimation of the complexity of the IST. During these first two stages, students (*M* = 14) also perceived ease in finding the necessary information. Further, at stage 2, many (*n* = 25) reported difficulty comprehending the scope of the task. The common theme was experiencing challenge in ‘understanding the project because it isn’t clear what exactly we’re supposed to research on’, and, ‘trying to figure out if you should recommend the government focus on prevention or treatment because it is hard to back up your answers’. During the second stage on the IST, this sense of confusion and of feeling overwhelmed continued. Several students (*n* = 34) reported difficulty coping (‘trying to figure out what to do’) with the assignment and admitted struggling to find relevant and specific information (*n* = 30).

In stages 3 and 4 of the IST, many (*M* = 31) reported ease with ‘finding information because there is a lot of books and articles on cancer’. Students encountered several challenges during these middle stages of work on the IST. Most (*M* = 36) continued to report ‘difficulty with finding helpful, relevant, and specific enough information to support what is needed’ to justify adequately arguments for prevention or treatment in the response to cancer. This difficulty was a theme extending through task work. A typical comment is ‘finding facts to back up my opinions on both treatment and prevention is difficult because the books don’t give that information’. Some (*M* = 11) continued to struggle with which position to take on the issue ‘because there is lots of stuff for both sides and it is difficult to choose just one’. Fewer students (*M* = 8) held the view that the issue in the IST was easy. Typical responses from this group were ‘It is pretty much straight out of my head so I don’t need to find out anything else besides what I have in my head’ or ‘It is easy to come to the conclusion because I’ve read all I need that tells me which one of the two choices is better’.

During these later stages (5 and 6) of the IST, students reported ease with writing (*M* = 15) , for example, ‘It is easy because I had all of the notes and facts written and all that was needed was to put it in sentences that made sense’. Some also stated that typing (*M* = 25) was easy for them: ‘There is no thinking involved’. A third of the students (*M* = 29) continued to report struggles with finding information and formulating arguments to resolve successfully the main dilemma in the task (prevention versus treatment of cancer). One such student wrote, it is ‘difficult because you have to support and organise everything you say and you don’t always have enough points but that information was all you could find’. As on the WST, another area of difficulty during these final stages of the IST was writing, organising, formatting and proofreading ($M = 21$). During stage 6 of the IST, several ($n = 8$) students reported challenges in concentrating (‘I’m tired and I just want to get it over with’) and finishing on time ($n = 9$).

Post-task results

Using results from the PTQ, one-sample *t*-tests revealed that significantly more students reported the IST as more difficult (58.3%) than the WST [$t(83) = 6.16$, $p < .001$]. No difference in interest between tasks was observed [$t(83) = .22$, $p = .83$]. In relation to students’ calibration, regression analyses ($p < .05$) revealed that students’ estimated task grade predicted their actual task grade for the WST [$R^2 = .11$, $F(1, 80) = 10.33$, $p = .002$, $\beta = .34$] and IST [$R^2 = .27$, $F(1, 80) = 29.43$, $p < .001$, $\beta = .52$].

Motivation and perceived use of learning strategies

Student’s motivation and perceived use of learning strategies by task were assessed using three separate MANOVA procedures ($p < .05$) (one each for motivation, meta-cognitive and cognitive strategies, and resource management strategies) with task as the fixed factor in each. Motivation did not differ between tasks either collectively [$F(6, 166) = .96$, $p = .45$, $\eta^2 = .03$] or individually by scale. Differences between tasks were evident in cognitive and meta-cognitive strategies [$F(5, 167) = 3.02$, $p = .01$, $\eta^2 = .08$]. *Post-hoc* analysis indicated significantly increased perceptions of the use of critical thinking on the IST compared with the WST [$F(1, 171) = 12.67$, $p = .004$, $\eta^2 = .05$]. Finally, self-reported use of resource management strategies did not collectively differ on the IST and WST [$F(4, 168) = 1.89$, $p = .12$, $\eta^2 = .04$]; however, individually, use of peer learning was statistically higher on the IST [$F(1, 171) = 4.28$, $p = .04$, $\eta^2 = .02$].

Differences by levels of OAA

Differences in students’ motivation, use of learning strategies, and calibration across tasks were assessed. Descriptive statistics for levels of OAA are presented in Table 4. The mean for OAA was 74.43 (SD = 8.81).

Regression analyses revealed that OAA predicted both the WST grade [$R^2 = .25$, $F(1, 87) = 28.34.33$, $p < .001$, $\beta = .50$] and IST grade [$R^2 = .29$, $F(1, 87) = 35.86$, $p < .001$, $\beta = .54$]. Students with higher OAA had significantly higher grades on both tasks. An analysis of variance (ANOVA) ($p < .05$) revealed that, calibration accuracy increased in students with higher levels of OAA on both the WST [$F(2, 79) = 5.14$, $p = .008$, $\eta^2 = .12$] and IST [$F(2, 79) = 3.70$, $p = .03$, $\eta^2 = .09$]. Calibration (bivariate correlations between estimates and actual grades) was .02 (WST) and .24 (IST) for low OAA; .29 (WST) and .32 (IST) for moderate OAA; and .55 (WST) and .71 (IST) for high OAA.

In terms of motivational differences, MANOVA by level of OAA exposed significant differences on the IST but not the WST in motivation between high, moderate, and low OAA students [$F(12, 162) = 2.76$, $p = .002$, $\eta^2 = .17$]. On the IST, SE

Table 4. Descriptive statistics for each task by levels of overall academic achievement (OAA).

	Post-IST *M* and *SD*			Post-WST *M* and *SD*		
Scales	Low	Mod.	High	Low	Mod.	High
IST grade	54.58 (15.46)	64.24 (16.81)	80.81 (16.82)	60.21 (15.09)	69.42 (17.96)	83.07 (18.16)
Intrinsic goal orientation	4.51 (.83)	4.40 (1.16)	4.47 (1.33)	4.39 (.93)	4.67 (1.21)	4.62 (1.40)
Extrinsic goal orientation	5.10 (.97)	4.82 (1.44)	4.95 (1.38)	5.25 (1.32)	5.10 (1.38)	5.00 (1.32)
Task value beliefs	4.96 (.83)	4.98 (.97)	5.12 (1.15)	5.19 (.96)	5.35 (.82)	5.25 (1.30)
Control beliefs for learning	5.12 (1.06)	5.29 (1.00)	5.29 (.86)	5.39 (1.02)	5.41 (1.02)	5.36 (.89)
Perceptions of self-efficacy	4.85 (.94)	5.04 (1.16)	5.38 (.83)	5.26 (.90)	5.44 (.84)	5.28 (1.14)
Test anxiety	3.34 (1.42)	2.70 (1.24)	2.49 (1.24)	2.96 (1.41)	2.54 (1.14)	2.58 (1.32)
Rehearsal	3.33 (.92)	3.41 (1.12)	3.27 (1.22)	3.27 (1.13)	3.63 (1.45)	3.48 (1.24)
Elaboration	3.78 (1.09)	4.17 (.92)	4.37 (1.26)	3.60 (1.02)	3.95 (1.00)	4.21 (1.05)
Organisation	3.28 (1.10)	3.12 (1.14)	3.25 (1.40)	3.07 (1.14)	3.35 (1.27)	3.26 (1.10)
Critical thinking	4.33 (1.10)	4.42 (1.17)	4.65 (1.16)	3.76 (1.17)	3.98 (1.28)	3.99 (1.35)
Meta-cognitive self-regulation	3.61 (.72)	3.77 (.83)	3.83 (1.10)	3.63 (.72)	3.74 (.73)	3.93 (.83)
Time and study environment	3.87 (.75)	4.07 (.97)	4.27 (1.24)	4.26 (.90)	4.24 (.98)	4.41 (1.05)
Effort regulation	4.30 (1.15)	4.87 (1.31)	5.04 (1.23)	4.64 (1.21)	4.85 (1.24)	5.03 (1.22)
Peer learning	3.31 (1.26)	3.82 (1.21)	3.50 (1.20)	2.86 (1.12)	3.47 (1.29)	3.12 (1.22)
Help-seeking	3.93 (1.40)	4.38 (1.24)	3.77 (1.33)	3.89 (1.36)	4.31 (1.22)	3.65 (1.54)

Note: IST, ill-structured task; WST, well-structured Task; standard deviation in parentheses; Low OAA, $n = 24$; Moderate OAA, $n = 38$; High OAA, $n = 27$.

[$t(46) = -2.10$, $p = .04$] and TA [$t(46) = 2.25$, $p = .03$] were statistically more elevated in high OAA compared with low OAA. In relation to perceptions of interest on each task, more low OAA (58.3%) and moderate OAA students (62.2%) than high OAA students (39%) reported higher interest on the WST [$F(2, 81) = 4.31$, $p = .02$, $\eta^2 = .10$] than the IST.

Finally, differences in students' perceived use of learning strategies by level of OAA (high, moderate, and low) were assessed using four MANOVA tests ($p < .05$) with levels of OAA as the fixed factors. The first two assessed the cognitive and meta-cognitive strategies within each task and the other two tested resource management strategies within each task. Differences by level of OAA were only evident in cognitive and meta-cognitive strategies on the WST [$F(10, 158) = 2.05$, $p = .03$, $\eta^2 = .12$]. *Post-hoc* analysis revealed that, individually, only effort regulation on the IST [$t(42) = -2.21$, $p = .03$] and elaboration on the WST [$t(47) = 2.04$, $p = .05$] differed between high and low OAA. More low OAA (58.3%) and moderate OAA students (70.3%) than high OAA students (39%) reported the IST as more difficult than the WST [$F(2, 81) = 2.93$, $p = .05$, $\eta^2 = .07$]. Thus, most (61%) of the high OAA students reported more difficulty with the WST and the majority (61%) expressed greater interest on the IST, while qualitative results revealed that most OAA students (75%) expressed boredom during the latter stages of work on the WST.

Discussion

To recapitulate, the main aim of this study was to apply social cognitive theory through the use of an authentic classroom setting to explore quantitatively and qualitatively how students' motivation, reported use of learning strategies, achievement, calibration, and task perceptions would vary during and after work on a WST and an IST. Psychometric analysis of the quantitative portion of the STPQ revealed satisfactory structure and fit indices for task value and task management factors that were used repeatedly to assess how students coped with each task. Secondly, we hypothesised that most students – particularly lower academic achievers – would perform worse, be less motivated, calibrate their performance less accurately, and regulate their learning less strategically on an IST than on a WST. The results generally supported these hypotheses. At practically each stage of task work, students' reported value for and management of tasks were significantly higher during the WST than during the IST. Further, students reported using cognitive and meta-cognitive strategies – particularly critical thinking and peer learning – significantly more on the IST than the WST. Compared with high academic achievers, low achieving students calibrated their achievement less accurately on each task and experienced lower grades, interest, ease, and management capability on the IST than the WST. Meanwhile, students with an elevated academic average reported statistically higher levels of self-efficacy, effort regulation, and boredom; and, lower anxiety and elaboration on the IST than the WST.

Whereas students' post-task motivation indices did not differ between tasks, achievement motivation is also manifested in, for example, students' behaviours related to task choices and their engagement with and persistence on a task (Pintrich et al., 1993). Kanfer (1990) states: 'self-regulation is the proximate motivational processes by which persons influence the direction, amount, and form of committed effort during task engagement' (p. 222). In this study, students reported more interest on the WST than the IST, whereas they noted that the IST was more challenging than the WST. First, students reported more task value for the WST than the IST during task work and also rated the WST as more interesting than the IST after the completion of both tasks. In other words, student reactions towards each task are likely influenced by whether they perceive that what is being learned or gained from tasks is valuable. Since students reported more task value on the WST, and since task value has been linked to achievement factors like activity choice, attention, depth of cognitive processing, and performance (Pintrich & Schunk, 1996), it might have contributed to higher student self-efficacy, motivation and performance on the WST than on the IST. Second, grades were significantly higher on the WST than on the IST. Third, students reported more difficulty with managing the IST than the WST at each stage of task work except for early in the task when many students were likely still trying to comprehend the requirements of the task. Finally, analysis of the qualitative data revealed that more students experienced a sense of being overwhelmed when managing the more challenging features of the IST than the WST, like understanding the requirements, deciding on how to resolve the main issue (prevention and/or treatment of cancer), and accessing useful and pertinent information to reinforce those claims. Meanwhile, although the most common concern of students on the WST was attaining, organising, and expressing the information needed to provide the more explicitly requested content for task completion; this, interestingly, was also the most frequently reported ease with the WST.

We suspect that these results are partially reflective of students' diverse characteristics for self-regulating learning and how the structure of the WST and IST might uniquely influence such regulation. Models of self-regulated learning assume that, rather than being programmed by tasks, learners approach, modify, and respond to them in various ways (Butler & Winne, 1995). These approaches predict how deeply students' study and can influence whether they will engage in the task primarily to attain a good grade rather than to learn and understand the content (Winne & Hadwin, 1998). Students also come with beliefs and a history of learning experiences that influence their choices regarding self-regulated learning. For example, depending on the motivational or cognitive status of the learner, a task's design can impact students' interactions with it. A study by Cope and Simmons (1994) found that restriction of feedback from a computer appeared to result in more sophisticated levels of processing, discussion, cognitive effort, and stimulated students to search for higher level responses requiring the use of alternative problem-solving strategies.

The structure of a task may differentially influence high and low academic achievers. Students' perceptions of the value and difficulty of each task in this study and, how they managed those tasks, varied by their level of prior academic performance. High academic achievers reported the WST as more complex compared with low achievers who rated the IST as most challenging. High academic achievers were also more interested, self-efficacious and less anxious on the IST, comprised most of the students reporting boredom on the WST, elaborated more on the WST, and regulated their effort more on the IST. Lower academic achieving students may have experienced more difficulty and less task value with the IST than the WST because the IST lacked explicit sub-goals on which they could 'scaffold' their knowledge and progress. Students seem to manage better when sub-goals are clearly labelled for them such as on the WST, rather than when they are forced to set their own sub-goals like on the IST (Catrambone, 1995). If students are weak at setting their own goals and sub-goals, they often do little advanced planning, fail to use other important strategies and deal with the task superficially (Morgan, 1985). Even if students are aware of learning strategies they may not apply them optimally when faced with challenging tasks (Winne & Marx, 1982). In contrast, superior problem-solvers look beyond the superficial demands of a task to comprehend more important features of a task, categorise the requirements of the task into relevant sub-tasks and apply actions that are necessary to solve the problem (Catrambone, 1995). Higher achieving students may prefer the autonomy, deeper cognitive processing, and more challenging deductive requirements of the IST that enhance their sense of self-determination for pursuing success on the task relative to the more inflexible operations required to succeed on the WST (Doyle, 1983).

Overall, students more highly valued the WST and used several cognitive and meta-cognitive learning strategies like critical thinking and peer learning more on the IST. Complex problems can prompt students to construct knowledge by using and improving competent forms of self-regulated learning (e.g., plan, implement tactics, monitor conditions and progress), draw information from multiple sources, and interact with peers to succeed (Blumenfeld et al., 1991). Working interdependently with peers can facilitate conceptual growth if peer groups pursue mutually beneficial goals, foster constructive cooperative interactions, and ease individual anxieties, cognitive overload, and share resources (Cohen, 1994). For example, peers can provide valuable alternatives, feedback and information and can ask for explanations that stimulate comprehension. Tasks need to have appropriate structure for the developmental level of students so that working with others is necessary or students will resort to working individually. Alternatively, tasks that prompt students to depend too much on others can also compromise motivation and the use of learning strategies like peer learning and instrumental help-seeking (Blumenfeld et al., 1991).

In this study, motivation collectively predicted performance on the IST but not the WST, whereas use of learning strategies was not a predictor of achievement on either task. Perhaps successfully completing a less-structured task is more contingent on motivation than performing a more structured task. Tasks that are too highly structured (e.g., little ambiguity, relevance, or cognitive complexity) may undermine certain students' motivation and strategic learning because they fail to challenge them adequately to analyse underlying relationships, build hypotheses, or solve problems (Cope & Simmons, 1994). This may help to explain why students' motivation – specifically their IGO, task value, and self-efficacy in this study – was more related to solving an ambiguous and unfamiliar task in comparison to one more clearly formulated and presented. Learners with high, yet realistic, self-efficacy performing tasks that they value tend to be more invigorated by challenging tasks so they aim higher, are more committed to and persist longer to meet aims, anticipate more positive outcomes, and sense more control over their learning (Bandura, 1993). Winne (1996) explains that this may be due to 'efficacy expectations having roots in the descriptions that meta-cognitive monitoring creates about the complexity, speed, and reliability of retrieval operations' during self-regulated learning (p. 346). In other words, students who can effectively cope with a task tend to me more interested in, and self-efficacious about, succeeding and learning on it.

We found that, in lower academic achievers, a lower IGO predicted IST performance. This was somewhat surprising since we hypothesised that performing a task primarily for intrinsic rewards, such as to satisfy a curiosity or master a challenge, would provide students with a more suitable foundation for courageously and enthusiastically performing a more deductive (e.g., ambiguous issue) IST than a more inductive (e.g., reporting) WST. We conjecture, therefore, that some aspect of the IST (e.g., topic, relevance, challenge, or progression) induced intrinsically-motivated students who tend to achieve lower academically to perform lower on the task. This might also be reflected in the finding that lower academic achievers also reported less interest for the IST than the WST. However, since neither IGO nor EGO differed between tasks or across levels of OAA, we also attribute this predictive association to the likely influence of other factors. For example, Ames (1992) reports that in addition to the design of the task, classroom practices such as assessment methods, use of rewards, and styles of authority can each influence goal orientation. We welcome more research into the mediating role of IGO on achievement using differently structured tasks.

Calibration accuracy may be related to self regulated learning during task work. In this study, students moderately calibrated their performance on each task although their calibration on the IST was higher than on the WST. In a more fine-grained analysis, lower academic achievers had statistically lower calibration accuracy of their task grades on both tasks compared with higher overall achievers who statistically estimated their achievement on both tasks. For example, academic ability can lead to more accurate calibration when a task has certain well-structured features like more identifiable answers, when students use favourable strategies to learn the material, and when the tasks are challenging, attainable, and foster learning (Schraw, Potenza, & Nebelsick-Gullet, 1993). Our discovery that calibration was higher for the IST than the WST may reflect Winne and Jamieson-Noel's (2002) hypothesis that during task work 'the degree to which a student's cognitive representations about achievement and study tactics is error-full should theoretically be inversely proportional to the productivity or effectiveness of self-regulated learning' (p. 553). In other words, higher achieving students may be more cognitively engaged on tasks – particularly the IST – which may enable them to calibrate more accurately their achievement on tasks, especially during work on less-structured tasks like the IST that require them to apply more study tactics. More research is needed into how the varying designs of learning tasks and optimal calibration and self-regulated learning relate.

There are many environmental factors (e.g., contextual cues, attributions, prior content or strategic knowledge, affective states and instructional characteristics like autonomy, expectations, prior positive and negative experiences) that trigger mental representations and the self-regulatory choices of students as they work on tasks. We recognise the limitations in fully accounting for these multiple environmental and self-regulatory influences from the measures and setting used in this study. For example, due to our within-subjects study design it was impossible to disentangle the effects of task structure from task content, yet we concur with Blumenfeld et al. (1987) that 'classroom tasks can also be characterised according to their form irrespective of their content' (p. 139). Further, some scales of the MSLQ (e.g., self-efficacy) may be less valid in fine-grained task settings compared with course environments. We admit therefore, that our results are transferable to settings with similar tasks and welcome research investigating these constructs with other tasks.

Despite these inherent limitations, this study contributes important new insight into how students' vary in their motivation, use of learning strategies, calibration and achievement on two differently structured tasks in an authentic learning setting. OAA predicted performance on both the IST and WST. The link between performance on each task and broader academic capability likely reflects the existence of, and need for, both ill- and well-structured learning tasks in schools. Past research indicates that learning tasks should involve students in designing and interpreting experiments from a wide variety of higher cognitive questions in well- and ill-structured domains (Spiro et al., 1988). Several scholars have called for an increase of IST in schools since such tasks appear to demand more productive self-regulatory strategies that could transfer more effectively to other domains, learning tasks, and problem-solving activities outside of school (Blumenfeld et al., 1991; Simon, 1973). We concur with Winne and Hadwin (1998) that 'when students are forced to work hard on difficult problems they abstract a general perception that effort is an inherent part of tasks which becomes a standard they use to meta-cognitively monitor the work to be done' (p. 298).

Blumenfeld et al. (1991) report that, in addition to WSTs, which are assigned more often in schools, students can benefit from less-structured tasks that are specific, achievable, and activate various forms of knowledge, and that involve an authentic topic which students perceive as interesting. Less-structured tasks can also prompt students to analyse underlying relationships, build hypotheses, use multiple sources of information, set and assess goals and sub-goals, and collaborate with peers. To facilitate students' success on less-structured tasks, educators need to help them to perceive and comprehend clearly the nature of the task and how they can more effectively regulate their learning and improve their calibration and performance on it.

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