Use of cognitive organisers as a self regulated learning strategy

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This research investigates the use of cognitive organisers as a self-regulated learning strategy by gifted and talented science students in a Year 9 class at a metropolitan high school in Perth, Western Australia. The case study research design incorporates three primary methods of data collection including participant observation in classrooms, surveys of student learning approaches and two cycles of in-depth student interviews. Findings indicate the students' use of cognitive organisers to complete an academic task is dependent on the nature of the task and prior exposure to cognitive organisers aligned with the task rather than the students' learning approach. The immediate significance of this research is that it provides a model of factors that facilitate or hinder autonomous student use of cognitive organisers. Recommendations for classroom implementation of cognitive organisers are included.

Introduction

A self-regulated learner is "metacognitively, motivationally and behaviorally active in their own learning process" (Zimmerman, 1989a, p. 4). Self-regulated learning involves the awareness and use of learning strategies, self efficacy of learning and a commitment to academic goals. It has been well established that active engagement in learning results in increases in academic performance (Ablard & Lipschultz, 1998; Pintrich & De Groot, 1990). Moreover, self-regulated learners take greater responsibility for their achievement because they relate proficiency with strategy use that is under their control (Purdie, Hattie, & Douglas, 1996).

Learning strategies provide a systematic plan that assists a student encode information and complete a task (Paris & Byrnes, 1989; Zimmerman & Martinez-Pons, 1992). Fourteen categories of self-regulated learning strategies are proposed by Zimmerman and Martinez-Pons (1988). Some of these categories are cognitive, that is, they include strategies used by students to make cognitive progress. Others categories are metacognitive and include strategies used by students to monitor their progress. Students use different cognitive strategies for different tasks. Examples of cognitive strategies include: rehearsal (reading aloud, highlighting text), elaboration (paraphrasing, summarising, creating analogies, generative note-taking, explaining ideas to someone else, question asking and answering) and organisational strategies (selecting the main idea, outline of material to be learned, concept mapping) (Pintrich & Garcia, 1991).

The main focus of this research is on a specific type of cognitive, self-regulated learning strategy called cognitive organisers (Zimmerman, 1989b; Zimmerman & Martinez-Pons, 1990). Cognitive organisers are visual tools that assist learners to represent facts, ideas, concepts and the connections between them. Examples of cognitive organisers include concept maps, mind maps and graphic organisers (Feden & Vogel, 2003). Cognitive organisers assist in the organisation and transformation of information because they involve students in the representation of concepts and their interconnections, a skill that underpins deep learning. Deep learning is characterised by students making personal meaning of the concepts being presented by creating logical connections between the new knowledge they are learning and what they already know and being able to utilise the new knowledge in fruitful ways (Entwistle, 1988). It follows that teaching methods and assessment practices that promote the use of cognitive organisers facilitate deep learning.

This research is set in the context of a Year 9 (13 and 14 year-old) gifted and talented science program at Metropolitan High School (a pseudonym) in Perth, Western Australia, where the first author/researcher, Kym Tan, is a level three classroom teacher. The teachers of the gifted and talented at Metropolitan High School became interested in the use of cognitive organisers for self-regulated learning because of a desire to link theory with best practice and assist their students realise their potential in accordance with Gagne's developmental model of giftedness and talent (Gagne, 2006). Self-regulated learners relate proficiency with personal strategy use and thus take greater responsibility for their achievement (Purdie et al., 1996). Teachers who purposefully utilise assessment types that promote the use of self regulative learning strategies aligned to deep learning assist their students to achieve their potential.

The teachers of the gifted and talented program at Metropolitan High School were introduced to a wide range of cognitive organisers during whole school professional development prior to 2007. The problem that initiated this research is that the teachers felt that even though they modeled and demonstrated the use of cognitive organisers in the classroom, the students did not appear to use the cognitive organisers in appropriate or autonomous ways that would facilitate the deep learning that was the goal of the gifted and talented program. The teachers suspected that the compulsory, common assessment tasks used across the whole cohort of Year 9 students were not conducive to the use of cognitive organisers. They felt that the common assessment tasks were encouraging students to memorise isolated pieces of information in a superficial manner, simply so they could pass the test. The notion of constructive alignment is one way of explaining what the teachers were observing. In constructive alignment, all critical components of a teaching context should be integrated towards deep learning (Biggs, 2003). Teaching methods and assessment practices are two such critical components. When assessment, rather than the curriculum, determines what and how students learn, 'backwash' is said to occur (Biggs, 2003). It appeared to the teachers at Metropolitan High School that their assessment and reporting processes resulted in just such a backwash effect and constrained their vision of educational best practice for these gifted and talented students.

Purpose and research questions

As a consequence of the problem identified by the teachers at Metropolitan High School, the broad purpose of this research was to investigate the use of cognitive organisers by the Year 9 gifted and talented science students. This broad purpose was focussed through four research questions that specifically examined the teacher's and students' use of cognitive organisers in the classroom and factors that might impact on students' use of cognitive organisers, specifically, the students' learning approach and the nature of different assessment tasks.

1. How were cognitive organisers used in the Year 9 gifted and talented science classroom?
2. How did Year 9 gifted and talented science students with different learning approaches use cognitive organisers?
3. How did the nature of an assessment task influence Year 9 gifted and talented science students' use of cognitive organisers?
4. What other factors facilitated or hindered the use of cognitive organisers by Year 9 gifted and talented science students?

In order to develop a conceptual framework suitable for the purpose of the research, literature with regard to goal theory and learning approaches, as well as literature on the notion of a hierarchical taxonomy of learning was reviewed and synthesised.

According to goal theory, goals are reasons for trying to succeed at a learning task (Ames, 1992; Maehr & McInerney, 2004; Patrick, Gentry, & Owen, 2006). A learning approach describes a qualitative aspect of learning (Ramsden, 2003). It is an interaction between environmental and intrapersonal factors. The approach to learning concept was first introduced in 1975 by Marton in relation to student reading of academic articles. The concept was used to illustrate a student's immediate engagement with the task at hand (Ramsden, 2003). Surface learning was described as sequential or atomistic when the student did not reorganise or reinterpret the text, but was simply concerned with verbatim recall of text or the ideas presented in it. With a deep approach a student read with the intension of extracting personal meaning, adopting a holistic approach that resulted in the making of connections between new knowledge and prior schema (Entwistle, 1988). Whilst acknowledging the surface/deep dichotomy in approaches to learning, and consensus amongst researchers about their characteristics (Ames & Archer, 1988; Dweck, 1985; Entwistle, 1988; Marton, 1988), Biggs (1987) postulated a third 'achieving' approach to learning. Surface and deep approaches describe ways in which students engage with the content of tasks. The achieving approach, in contrast, is not concerned with how the task content is engaged, but focuses on degree of effort (Prosser & Trigwell, 1999), self-organisation and the management of time and resources (Richardson, 2000).

Each of the three approaches to learning: deep, achieving and surface, requires a motive and aligned strategy use (Biggs, 1987). A student with an achieving approach focuses on marks, aims to pass, only learns what he or she perceives as necessary, does not link information to prior understanding and retains little. Biggs considers a surface approach a

learning pathology as a student with such an approach sees knowledge as acquisition of facts, relies on rote learning and does not link information to prior understanding. In order to demonstrate understanding and achieve high levels on the Outcomes and Standards Framework of Western Australia (Department of Education and Training, 2005), a student requires a deep approach to learning. With a deep approach, the student searches for meaning beyond the task at hand, relates information to their prior conceptual framework and personalises learning tasks. Deep and achieving approaches are orthogonal (independent dimensions, not related to one another) so individuals may exhibit characteristics of both. The composite of deep-achieving is a characteristic of many high achievers (Biggs, 1988; Midgley, Kaplan, & Middleton, 2001; Pintrich & Garcia, 1991).

Students' approach to learning can be measured using a survey called the Learning Process Questionnaire (LPQ) (Biggs, 1987). The original form of the LPQ is a 36 item self report questionnaire that provides information on three basic motives for learning and three learning strategies that together form the three approaches to learning: surface approach, achieving approach and deep approach. There are six subscales on the LPQ: surface motive (SM), deep motive (DM), achieving motive (AM), surface strategy (SS), deep strategy (DS) and achieving strategy (AS). For the LPQ, comparative data is available by age and sex to allow a student's preference to a particular learning approach to be determined.

A revised version of the LPQ, Revised Learning Process Questionnaire Two Factor (R-LPQ-2F) was developed by Kember, Biggs and Leung (2004) that took into consideration more recent advances in understanding in approaches to learning. The R-LPQ-2F is a two factor version, with deep and surface approach scales, suitable for use in schools because of its brevity. Like the original LPQ, the R-LPQ-2F is hierarchical in structure and each approach to learning has motive and strategy elements. The R-LPQ-2F has 22 items distributed evenly between the main scales. Using sophisticated statistical techniques, Kember et al. (2004) demonstrated that each subscale of the motive and strategy elements of the original LPQ was multidimensional rather than unidimensional. Unlike the original LPQ, no norms are available for the R-LPQ-2F as a basis for categorising a student's learning approach.

Research by Van Rossum and Schenk (1984) (as cited in Ramsden, 2003) indicated a relationship between students' approaches to learning and their outcomes as measured by an hierarchical taxonomy of learning called the Structure of Observed Learning Outcomes (SOLO) taxonomy. The SOLO taxonomy (Collis & Biggs, 1979) is a hierarchy based on a study of outcomes in a variety of academic areas. It provides a systematic way to describe the stage at which a learner is operating when mastering academic tasks. Five stages can be identified: pre-structural, uni-structural, multi-structural, relational and extended abstract (Biggs & Moore, 1993; Hattie & Purdie, 1998; Ramsden, 2003). Students with a surface approach to learning, as measured by the Learning Process Questionnaire, were not able to give answers beyond the multi-structural level on the SOLO taxonomy, whilst deep learners were able to achieve a relational or extended abstract outcome. The relevance of the SOLO taxonomy to this research is that it informed the development of the science

progress maps of the Western Australian Outcomes and Standards Framework (Hackling, 2003), the curriculum in the state of Western Australia where the research was conducted. The science progress maps (Department of Education and Training, 2005) describe eight levels of achievement of increasing conceptual difficulty that students can attain for each of four conceptual outcomes (Life and Living, Energy and Change, Earth and Beyond and Natural and Processed Materials) and one process outcome (Investigating). The progress maps are used by teachers for planning as well as for assessment and reporting.

Method

Research design

The research design was a case study of 29 Year 9 (13 and 14 year-old) students in a gifted and talented science program at Metropolitan High School, in Perth, Western Australia. The case study spanned one school term (10 weeks) when the students were studying energy and electricity. A simple input/output evaluation does not provide information on how or why educational programs or strategies work and cannot pinpoint the essential elements of success (Black, Harrison, Lee, Marshall, & Wiliam, 2002). Accordingly, it was decided that the research design for this research should be a case study so that the complexities related to the students' use of cognitive organisers could be explored in appropriate detail. Moreover, case study is a complex research strategy appropriate for research conducted in real classroom contexts over which the researcher has no control (Yin, 2003).

Participants

Metropolitan High School is a government-funded high school in a high socio-economic suburb and catchment area. The school offers a range of programs for students from Year 8 to Year 12 of a broad spectrum of levels of achievement. Students are selected to participate in the gifted and talented program based on an independent test conducted by the Australian College of Educational Research when they are in their final year of primary school, Year 7. Fully informed, parental and student consent was obtained prior to data collection for this current research.

The first author/researcher was a teacher in the gifted and talented program at Metropolitan High School. To avoid bias she chose not to teach the class under investigation during the period of data collection. The gifted and talented science class that was the focus of the research had been taught by an experienced teacher of the gifted since entering Metropolitan High School in Year 8 and had been exposed to a range of cognitive organisers during science. The first author/researcher and the classroom teacher worked closely on the gifted and talented science curriculum and shared a similar teaching philosophy.

All teachers at Metropolitan High School, including the classroom teacher, participated in several professional development days on the use of cognitive organisers in 2004, three years prior to the implementation of this research. One of the professional development

days was conducted by the first author/researcher. The classroom teacher also is a strong advocate of self-regulated learning and the use of cognitive organisers and provided some of the background materials on which the professional development was based. The classroom teacher and the first author/researcher work as critical friends, regularly discussing curriculum planning and developing resources for specific lessons. This close working relationship developed over a period of seven years.

Examples of organisers modelled in the professional development sessions included: strengths, weaknesses, opportunities, threats (SWOT); pros, cons, questions (PCQ); plus, minus, interesting (PMI); the balance, T charts and fishbone diagrams (Bellanca, 1992; Bennett & Rolheiser, 2006; Frangenheim, 2002). SWOT analysis is used to analyse a proposal or practice. It provides a structure to allow the strengths, weaknesses, opportunities and threats associated with a practice to be considered for an extended period of time. PCQ and PMI are similar strategies used by students to analyse a situation before deciding if they support it. The benefits and disadvantages are listed first; then questions (in PCQ) or interesting points (in PMI) are displayed. The balance is used to analyse whether evidence is weighted towards or against a proposal. A T chart is applied in a learning situation where students are asked to focus on opposing characteristics of a concept. A fishbone provides an issue that is the focus of thinking, then students recall and organise ideas according to some kind of classification.

Data collection and analysis

Data to address the research questions were collected through three main strategies: 1. Participant observation of classroom activities and collection of artefacts; 2. Survey of students' learning approaches using the Learning Process Questionnaire (LPQ); and, 3. Interviews (two) focused on students' use of cognitive organisers when preparing for different assessment tasks. Figure 1 shows a timeline of data collection activities undertaken and a detailed description of each follows.

Participant observation and artefact collection
In order to immerse herself and acquire data about the processes that had an impact on the students' self-regulated learning strategies, the researcher observed the teacher and students in the Year 9 gifted and talented science classroom over the period of school term (Term 1, 2007). A total of 14 classes were observed with each lesson an hour in length. During each period of observation, the researcher sat at the back of the class in an unobtrusive position for the start of the lesson. When classroom activities commenced, the researcher moved around the room, assisting and talking with the students and teacher as appropriate. The researcher assumed the role of a knowledgeable teacher's aide. The science content of the lessons was familiar to the researcher as she is an experienced science teacher. Since the researcher took part in the classroom activities, the style of observation can be described as 'observer as participant' (Cohen, Manion, & Morrison, 2000). The researcher's purpose as an observer was known to the group and these observations took precedence over participation in the activities of the group (Merriam, 1998).

Term One 2007	Participant observation and collection of artefacts	Survey of students' learning approaches	Interview A: after common assessment task	Interview B: hypothetical assessment task
February		X		
March				
April				

Figure 1: A timeline of data collection activities

During each lesson, data were recorded as field notes, the focus of which were the use of cognitive organisers and self-regulated learning strategies. The researcher's field notes documented each organiser as it was used by the classroom teacher and/or the students and the context of the allied learning situation. Autonomous (unprompted) student use of cognitive organisers during classroom situations also was noted when observed. Samples of student work, artefacts, that were related to the research questions were collected, photocopied and returned to the student in the next lesson. Classroom events, and personal reactions to these, were noted separately so that distinctions could be made between observations and inference (Bouma & Ling, 2004). Notes were made as soon after observations as was feasible. A sample of the participant observation field notes can be seen in Table 1.

Survey of students' learning approaches
Students' learning approaches were determined using the Learning Process Questionnaire (LPQ) specifically to provide meaningful data to answer Research Question 2. For the original LPQ, comparative data is available by age and sex to allow a student's preference to a particular learning approach to be categorised. With the R-LPQ-2F no such comparative data is available (D. Kember, personal communication, February 2, 2007). More detailed information is provided by the R-LPQ-2F than the LPQ for the surface and deep approaches as a result of classification of the subscales; however, it provides no information on the achieving approach. As a consequence, the researcher constructed a composite survey, the combined Learning Process Questionnaire (cLPQ) which combined the R-LPQ-2F with the achieving approach scale of the original LPQ. Specifically, the researcher combined the achieving motive (AM) and achieving strategy (AS) subscales from the original LPQ (Biggs, 1987) with the surface motive (SM), surface strategy (SS), deep motive (DM) and deep strategy (DS) subscales from the R-LPQ-2F (Kember et al., 2004). As a result, the cLPQ had six subscales. Respondents rated themselves using a five point Likert scale from 5, 'this item is always or almost always true of me' to 1, 'this item is never or only rarely true of me'. All items were scored in the same direction.

Table 1: Examples of researchers field notes

Date	Observation	Inferences
1/2/07	Mind map/concept map static electricity (7 mins) Words used with links between ideas Pen used- what student definitely knew Pencil used- what student thinks they know but is unsure about ? used on link student is not sure about	Cognitive Organiser I call this a concept map Students reviewing and making connections between prior knowledge
9/2/07	Homework sheets distributed: 1. Hairy Sheet: "Use to explain and summarise what you know" 2. A Thinking-centred Self Assessment Tool: "Complete this once you have filled in the 'hairy sheet'"	Cognitive organiser (Spider Diagram)used by students to reorganise their knowledge about the concepts of current voltage etc A metacognitive organiser used by students to judge the efficacy of the 'hairy sheet' in their learning process
23/2/07	Teacher used example of what to have for lunch to scaffold a Fishbone Facts about sushi and chicken avocado sandwich Decision about which one to have for lunch Notes on whiteboard: Main stem information Side branches further information Fishtail points to direction of choice made Teacher directed question "Which is the most appropriate circuit type in a house?"	Since this was the first time that students had used this organiser teacher scaffolded its use using a question that the students could relate to easily. Teacher review of how to set up a fishbone Student transfer of use of organiser to a science context

The cLPQ (Biggs, 1987; Kember et al., 2004) was implemented in the fourth week of the school term to determine the learning preferences (deep, achieving, deep/achieving or surface learning approach) of the 29, Year 9 gifted and talented students participating in this research. The results from the survey were used in a process of purposeful criterion sampling (Patton, 2002; Stake, 2000) to select students with distinctive learning approaches for in-depth interviews described in the next section. The researcher ranked the students from the gifted and talented science class on the basis of their total scores for each of the three learning approach dimensions: deep approach (DA), achieving approach (AA) and surface approach (SA). The four top ranked students for each dimension and the four students with the highest composite total for deep and achieving approaches

(DAA) were determined. From this group, thirteen students were selected for in-depth interviews, of these, three students declined to be interviewed. The breakdown of the learning approaches of the final 10 interviewees is shown in Table 2. The number of students interviewed represented 34% of the total number of gifted and talented science students participating in the research.

Table 2: Breakdown of learning approach of interviewees

Learning Approach	Surface (SA)	Achieving (AA)	Deep (DA)	Deep achieving (DAA)
Number of students	3	3	2	2

Student interviews
The ten gifted and talented students with clearly identified learning approaches (Table 2) were interviewed on a one-on-one basis on two separate occasions (see Figure 1 for the timeline). Interview A focused on the students' preparation and use of cognitive organisers for a recently completed, compulsory assessment task that was administered to all Metropolitan High School Year 9 students including the gifted and talented students. Interview B comprised a hypothetical assessment task that was designed to be quite different from the common assessment task in that it was open-ended and authentic.

Pilot interviews were conducted with two of the ten students prior to both Interview A and Interview B to ensure confidence in the interview process. As an experienced teacher and year coordinator, the researcher had experience in questioning and interviewing techniques, thus little modification of the interview protocol was deemed necessary and it was decided that the data from the two pilot interviews would be included in the data analysis. All interviews were tape-recorded and subsequently transcribed. Data were reviewed and analysed to find common themes to describe and explain the use of cognitive organisers as a self-regulated learning strategy under various task conditions. Data analysis involved examination of themes from the multiple data sources in relation to the learning approaches of the students interviewed (deep, achieving, deep/achieving or surface approaches).

Interview A: All students in the Year 9 cohort at Metropolitan High School completed the 30-minute common assessment task under test conditions in Week 6 of the school term. The common assessment task was an in-class test based on the first five weeks of the gifted and talented science program on energy and electricity. The test consisted of nine short answer questions that were marked out of a total of 28. Interview A commenced as soon as was feasible after the common assessment task in order to assist accurate student recall concerning their preparation for the task. To minimise disruption to other classes, interviews were only conducted during science, thus interviews took place over about a week.

Interview A commenced with an open-ended question regarding the student's preparation for the common assessment task. A semi-structured interview protocol was used to

further probe the students' use of cognitive organisers in their preparation (Appendix A). The effectiveness of various cognitive organisers presented in class also was discussed in relation to student preparation for, and successful completion of, the assessment task. Data obtained during classroom observations were used to prompt student recall. The duration of each in-depth interview was approximately 30 minutes.

Interview B: At the beginning of Interview B, each student was presented with, and given time to read, a hypothetical assessment task. The task was designed to be analogous to the open-ended, authentic, assessment tasks commonly used in the gifted and talented program about once per term. Often these tasks involve group work and proceed over a number of weeks. Since the researcher wanted to study the types of cognitive organisers used in the planning and completion of such tasks, it was necessary to produce a hypothetical, authentic task that could be used for the purpose of in-depth interview (Interview B). The task developed had to stand alone and enable students to discuss organisers that they might use in relation to the task. The task required the students to develop an action plan to discuss with their parents and convince them about switching to green energy use in their home. The full task can be seen in Appendix B.

During Interview B, students were encouraged to 'think aloud' (Anders, Ericsson & Simon, 1993) and outline the planning processes they would adopt to accomplish the task. Part of the task requirement was for the student to produce something written to take to the target audience, the students' parents, for the purpose of discussion. As the interview proceeded the students were asked to draft the written work so the researcher could observe whether it was modelled on any cognitive organiser known to the researcher. In preparation for the interview, the researcher had preselected several common cognitive organisers aligned to the organisation and transformation of information processes required for the successful completion of the task. The students were then shown a range of cognitive organisers and asked if they recognised any of them. Copies of a SWOT analysis, balance, PCQ and fishbone were tabled and the students were encouraged to discuss their familiarity with each strategy and how effective each might be in planning for the hypothetical task. Although the researcher had not seen all of these organisers used in science lessons during the period of participant observation, the chosen organisers had been modelled to Metropolitan High School staff at professional development and discussions with the class teacher confirmed that the students had been exposed to them during science at some time during the current or previous year.

Research rigour and limitations of the method

The method for this research was specifically designed to provide data that would address the research questions. The main approach to ensure the rigour of the research was a process of triangulation (Merriam, 1998; Patton, 2002). As outlined above, a number sources of data, including the students and classroom observations, and a number of methods of data collection, including field notes, artefact collection, questionnaire and audio tape recording were employed. This resulted in a robust and extensive set of data from multiple sources and collected with multiple methods that could be triangulated to ensure the findings were convergent. Both quantitative and qualitative findings are

presented in detail in the results section to enable the reader to come to their own conclusions and to enhance the transferability of the findings (Merriam, 1998).

As with all research, however, there are a number of limitations that should be considered before the results are presented. For example, the participant observation occurred in a limited number of lessons over only one school term. Moreover, the researcher is a teacher with limited experience in participant observation techniques. Assumptions were made about which specific organisers the students had been exposed to in the year prior to the research on the basis of conversations with the teacher of the class.

Another limitation of the method is that students were assigned to a particular learning approach on the basis of their scores on the cLPQ. In this research, learning approach was viewed as a predilection to address a range of tasks in a particular way. Research suggests that an approach to learning, as measured by the LPQ, is not necessarily stable. Variability in approaches coexists with consistency and students perceptions depend on their learning situations (Biggs, 2003; Prosser & Trigwell, 1999; Ramsden, 2003; Schmeck, 1988). Such adaptation by students of their learning approach to their perception of what is required is called 'study orchestration' "… students react by tuning their approach to learning to suit the environment to which they were exposed" (Biggs, 2003, p. 25). It is important to keep in mind, therefore, that the LPQ may not be a consistent measure of how students think and behave during every learning task.

A further limitation with regard to the transferability of the results to other contexts and situations (Merriam, 1998) is that only 10 students were interviewed. Statements about the way students with a particular approach complete a task are, therefore, not necessarily generalisable or transferable. Readers should be appropriately circumspect with regard to how the results of this research might be relevant to their own educational contexts.

Results and discussion

Use of cognitive organisers in the Year 9 gifted and talented science classroom

Within the Year 9 gifted and talented science class, the teacher made extensive use of cognitive organisers. The choice of organiser was determined by the teacher on the basis of her pedagogical content knowledge; in other words, she selected from her repertoire of strategies the organiser most suited to the task at hand. During the period of observation, the following organisers were used: concept map, mind map, structured overview, fishbone and a spider diagram which the teacher called the "hairy sheet". The researcher noted the educational purpose for these organisers and these purposes are summarised in Table 3. The organisers were used by all students either in class or for homework.

When the teacher introduced and modelled the organisers for the first time she used familiar, everyday concepts before the students used the organisers to structure material in the context of the lesson. For example, when the fishbone was first introduced, it was modelled around the teacher's dilemma of what to order for lunch: "sushi or a chicken and avocado sandwich?" The students then utilised the fishbone to compare features of

series and parallel circuits and to decide which type of circuit would be most suitable in the home. In this way, the teacher modelled the use of cognitive organisers with the intention that students would eventually learn to use them autonomously as situations presented themselves (Roth, 1999; Vialle, Lysaght, & Verenikina, 2005).

Table 3: Use of cognitive organisers in the G&T science class

Organiser used	Purpose
Concept map	To pre-test students' prior knowledge of electricity
Spider diagram	To summarise ideas concerning current electricity
Fishbone	To compare series and parallel circuits
Structured overview	For note taking during library research on renewable energy sources
T chart	To display the advantages and disadvantages of an energy source

On one occasion the students were asked to think about their use of a cognitive organiser using a metacognitive reflection sheet. This process required students to reflect on the thinking they had to engage in, in order to complete the spider diagram (the classroom teacher called this 'a hairy sheet') and explain what was good about their thinking. After completion of the spider diagram and metacognitive reflection sheet, the researcher retained copies (artefacts) for analysis. The researcher looked for connections between the way in which the spider diagram had been completed and the student's learning approach. The metacognitive reflection sheet provided a window to student understanding of the usefulness of the spider diagram as an organiser.

Concept maps were used as a tool to develop conceptual understanding by the teacher in the Year 9 gifted and talented science classes. For example, as a pre-test on the concept of electricity, the gifted and talented science teacher instructed the students, "to create a concept map and to use a pen to add things that you definitely know and a pencil to add things you think you know". In a subsequent lesson students were encouraged to modify their concept maps in light of the knowledge they had gained.

During the period of participant observation, prior to a section of content that was to be presented in lecture format, the teacher discussed a number of appropriate ways for students to take individualised notes. The students were then required to listen to the lecture and make notes in a way that suited them. Copies of note making sheets were retained by the researcher as artefacts. During the lecture session, eight of the 29 students in the class (28%) used a structured overview, three (10%) used a concept map and two (7%) used a mind map. The majority of students, 16 of the 29 (55%) made notes with no apparent structural organisation (Table 4).

Table 4: Autonomous use of cognitive organisers by students for note taking purposes

Type of structure	Number of students choosing the structure (n=29)
Structured overview	8
Concept map	3
Mind maps	2
Notes with no apparent structure	16

Student use of cognitive organisers for preparation for the common assessment

The interviews revealed that in preparation for the common assessment task the students made use of cognitive organisers for various purposes including revision, review and recall of information as indicated in Table 5. For most of the students (8 of the 10 interviewed), preparation for the common assessment task involved reliance on their textbook and making notes in the form of a structured overview using the chapter headings from their textbook as organising themes. Few students reviewed any organiser constructed prior to the common assessment task. During the interviews, organisers constructed during the term were spontaneously mentioned by students on five occasions. Two students indicated that the fishbone used in class activities assisted their recall during the common assessment task.

Table 5: Student use of cognitive organisers in preparation for a common assessment task

Organiser used	Purpose	Number of students choosing the structure, organised by learning approach of students			
		Surface (SA) (n=3)	Achiev'g (AA) (n=3)	Deep (DA) (n=2)	Deep achiev'g (DAA) (n=2)
Structured overview	Revision notes	2	2	2	2
Concept map	Review of information	0	0	0	1
Spider diagram	Review of information	0	1	0	1
Fishbone	Review of information	0	1	1	0
	To recall information in common assessment task	1	1	0	0

Students whose revision program for the common assessment task involved written notes chose to use structured overviews regardless of their learning approach. Students had completed eight common assessment tasks the previous year, Year 8, and understood that the content to be tested was to be based solely on their textbook. Thus most students relied exclusively on their textbook for information and limited their notes to what they thought would assist them in the forthcoming test. The students' structured overviews were, therefore, almost always based on the content of the science textbook and were

generally organised around chapter headings. Even the students with a deep approach relied on the textbook for the structure of their notes.

> I find that the teachers often base the test on the textbook ... so it helps a lot to research in the textbook. ... I tried to research on the internet once and I just got totally messed up. (Student 7, Deep Approach*)*

Three students made no notes at all. Two of these students (Surface Approach, Achieving Approach), had no organised study timetable, so they did not make notes, but read through the textbook shortly before the common assessment task. Two of the same three students (Achieving Approach, Deep/Achieving Approach) made use of a revision sheet supplied by the teacher to target their revision reading. Only the two Deep Achieving learners read with the intention of adding to their personal constructs. One consciously chose to add information from his revision reading to the mind map in his brain rather than making notes. The other cross referenced information from multiple sources to build:

> … layers of brick wall, not just one small brick. If you put the internet and then the research that we did and then the experiments, it all adds up, it makes a really clear picture. (Student 9, Deep/Achieving Approach)

When revising, few students referred to any of the cognitive organisers they had produced during lessons. Those students who did refer to the organisers had a deep, achieving or deep/achieving approach. No students thought to add to the concept maps they had produced and edited in class time in the light of new knowledge. Lack of understanding, at the point when the concept map was drawn, prompted one student (Deep Approach) to do extra revision, although this student did not think to extend her map as a means of review. Most students were still at the stage where they needed to be cued to use concept maps in situations where they would be an effective learning tool.

> I haven't thought of going back, but if you said you'd better go back to your concept map and have a think about it then I'd probably go back. ... I didn't actually go back, but if it was given to me now, for me to do again, I'd probably be able to write most of the things in pen because of the things I've learnt. (Student 10, Achieving Approach)

Concept maps were shunned by some students as an organiser. Indeed a number of students found them to be confusing rather than assisting them to streamline their thinking processes.

> I find that it is more difficult for my brain to really picture that sort of set out, like a mind storm. I prefer having dot points and going down a list, linear rather than every which way. (Student 8, Deep/Achieving Approach)

Other students felt that you could not put enough detail on a concept map, indicating that these students equated knowledge with the acquisition of copious facts, rather than an holistic understanding of a concept and the interrelationships between facets. However,

those students who used concept maps understood their use to link ideas under a unifying theme.

> If you make a concept map you can't write as much. Under dot points you can write as much as you want. (Student 8, Deep/Achieving Approach)

> I think mind maps are really useful as they help you to organise your ideas. (Student 4, Achieving Approach)

The timeframe to create a concept map also appeared to be an issue.

> When you create a concept map it takes ages, compared to just doing dot points ... because you have to link the stuff together. (Student 6, Deep Approach)

The concept map was also being used in a fashion that was converse to that intended. Concept maps are a means of distilling salient information. One would think that deep learners would recognise the value in this strategy as a means of honing their understanding of a concept. Interestingly both of the students interviewed with a deep/achieving approach thought of concept maps as a tool for creating better linear notes.

> Why make a mind map when you can have a mind map in your head that you can simply turn into dot points? (Student 8, Deep/Achieving Approach)

During the common assessment task, the students were presented with a question concerning series and parallel circuits. Of the students interviewed, two stated that the fishbone assisted their recall of concepts although they had not used the organiser to revise.

> That, [the fishbone], helped me get my ideas in order ... but I didn't study from it. (Student 6, Deep Approach)

In summary, preparation for the common assessment task was limited in most cases to notes in the form of a structured overview based on the content of the textbook, with little or no reference to any cognitive organisers used in prior lessons.

Student preparation for the hypothetical authentic assessment task

The format of the written work produced by the students during Interview B was examined to assess whether it was based on any cognitive organiser known to the researcher. Results are shown in Table 6.

Table 6: Student use of cognitive organisers for a hypothetical authentic assessment task

Written component	Number of students choosing the organiser, organised by learning approach of students			
	Surface (SA) (n=3)	Achieving (AA) (n=3)	Deep (DA) (n=2)	Deep achieving (DAA) (n=2)
Structured overview	1	1	1	1
T Chart	0	1	0	0
PMI	0	1	0	0
Alternative structure	2	1	0	0
None deemed necessary	0	0	0	1

When asked to draft the written component for the hypothetical task, the most common organiser, used by four of the ten students interviewed, was a structured overview (Table 6). These overviews were usually constructed using organising themes from the pamphlets provided as stimulus material for the task. In recognition of the aim of the task, one student (Achieving Approach) chose to use a PMI without prompting and another (Deep Approach) used a T chart of pros and cons (Table 6). Those students (Surface Approach, Achieving Approach) with an alternate structure for their written work based it on a pamphlet, which was the format of the reading material provided for the task (Table 6). Biggs (2003) describes a surface approach as a learning pathology that does not engage a task in the way it should be, students with a surface approach to learning were, therefore, not expected to go beyond what they considered to be the essential elements of the task. In this hypothetical situation, surface learners did not plan to research beyond the material provided to them and duplicated the format of the pamphlet for their written work.

Once the students had completed their written draft, the researcher provided copies of several specific alternative cognitive organisers which the researcher deemed to be aligned with the task and students were asked if they recognised them. Results are shown in Table 7.

Nine of the ten interviewed students recognised the fishbone and recalled it being used in science classes (Table 7). Some students could explain how this organiser could be used for the task presented.

> The fishbone, you could put on one side the bad things about switching to renewable energy and on the other side you could put the good things and show them [the target audience] how the good things outweigh the bad things. (Student 5, Achieving Approach)

Few students, however, deemed this format to be better than either the structured overview or PMI for the task at hand. The problems stated for the fishbone were the

limited amount of space to present information and possible confusion due to the format for the target audience.

> Green house gases and Earth friendly energy is a lot of work, so it's hard to put such a lot in a small space. (Student 9, Deep/Achieving Approach)

Although the students had been exposed to the other organisers in science class, some in the year preceding the research, students were less familiar with them. They did not recall using the SWOT or scale (Table 7). The six students who recalled the PMI or PCQ (Table 7) recognised them from a number of different contexts, not always science. Students were asked to comment on whether the various organisers recognised would have been suitable for the written component or planning of the hypothetical task. Results are shown in Table 8. Although both the fishbone and PMI/PCQ were recognised by students (Table 7), they did not see them as being equally suitable for the task presented. Seven of the ten students thought the PCQ was suitable for the task compared with only four for the fishbone (Table 8). Some students explained they could appreciate how they could develop arguments for a discussion with parents using a PCQ.

Table 7: Recognition of cognitive organisers by Year 9 gifted and talented science students

Cognitive organiser	Numbers of students recognising the organiser, organised by learning approach of students			
	Surface (SA) (n=3)	Achieving (AA) (n=3)	Deep (DA) (n=2)	Deep achieving (DAA) (n=2)
Fishbone	3	2	2	2
Scale	0	0	0	0
SWOT	0	0	0	0
PMI/PCQ	2	2	1	1

The hypothetical task involved persuasive argument and students with a deep or deep/achieving approach had recognised the need to prepare counter arguments, to expected questions from their target audience, before being presented by the researcher with the PCQ (pros: cons: questions organiser) for comment. Most students conceded that using a PCQ (which is closely aligned to a PMI) would have been useful for the task at hand. Once shown the visual prompt, learners of all approaches could see its application (Table 8).

> The PMI ... is structured, so that if they [target audience] come up with the cons, you can counteract with the pros. (Student 1, Surface Approach)

One student (Achieving Approach) drafted her written work along the lines of a PMI without prompting. This student was familiar with the use of PMI as she had been exposed to this strategy from primary school onwards and was therefore able to use it autonomously.

> If I had to take a piece of paper it would probably be like this (PMI) because it's easy to categorise things ... I don't think I have used it this year. ... I used it quite a lot last year and in Year 8. First of all the teacher would tell you to do it. After a while, like last year, I was writing a book review, the teacher wouldn't say to draw this, but it was easier for me to say the good things and bad things when I did it. (Student 8, Achieving Approach)

Table 8: Suitability of specific organisers for the hypothetical task as perceived by gifted and talented science students

Cognitive organiser	Numbers of students assessing the organiser as suitable for the task, organised by learning approach of students			
	Surface (SA) (n=3)	Achieving (AA) (n=3)	Deep (DA) (n=2)	Deep Achieving (DAA) (n=2)
Fishbone	1	2	0	1
PMI/PCQ	2	3	1	1

In summary, the results from Interview B indicated that although the deep learners could articulate the processes required for planning a reasoned argument and they had an organiser available to them in their repertoire suited to the task, they chose not to access it and use it. It appears that these students were not yet sufficiently familiar with specific organisers to be able to use them autonomously in a task situation where they would have facilitated the transformation of information.

Significance of the findings

The significance of this research is that it indicated that the autonomous use of specific cognitive organiser by a student appears to be influenced by a number of factors. The model shown in Figure 2 is based on the findings of this research and attempts to illustrate how each variable may facilitate or hinder the development of autonomy in the use of organisers. The factors appear to operate sequentially.

First, the student needs to be exposed to a particular organiser, for example, a fishbone, which usually occurs during a period of instruction. A student cannot use an organiser that they have no knowledge of and there was no evidence of any student developing their own organiser. Prior exposure to a specific organiser is, therefore, likely to be the first factor to impact on autonomous student use of a specific cognitive organiser and is included at the top of Figure 2.

Organisers vary in complexity. Some, like the structured overview, are merely a way of assisting transformation of data into note form. At their most simplistic, note making categories may be based on the chapter headings in the student's textbook. Such an organiser may be used with ease by a learner at the concrete multi-structural stage on the SOLO taxonomy (Collis & Biggs, 1979). A concept map is more complex, requiring the student to show the relationships between concepts. A student using a concept map would need to be at the concrete relational stage, or higher, if the concept involved a

degree of abstraction. Thus, we suggest that the complexity of the cognitive organiser needs to be matched to the student's stage on the SOLO taxonomy (Collis & Biggs, 1979). However, students tend to rely on organisers that are less cognitively demanding. This provides a possible explanation for the observed widespread use of the structured overview by students of all learning approaches. Thus, we have included students' level of cognitive processing as the second factor leading to autonomous use of cognitive organisers in Figure 2.

Unless a student has the opportunity to use an organiser a number of times, the findings of this research indicate the organiser is unlikely to become embedded in their repertoire of personal strategies. Thus, use of the organiser will be limited to those times when the teacher prompts the student to use it. For example, only after prompting did students acknowledge the value in using various cognitive organisers for the hypothetical task, such as the fishbone and PMI. It appears that the students have not been exposed to a wide range of organisers in their schooling thus far, so only the most common of organisers (such as the structured overview) were used autonomously on a regular basis. Deep learners did not seem to have access to a range of strategies to choose from, so their use of organisers did not vary markedly from surface learners. Whether the organiser is embedded in the student's repertoire of strategies is included in Figure 2 as a third factor leading to autonomous use of specific cognitive organisers.

The classroom teacher observed in this study used her pedagogical content knowledge to match an appropriate strategy to a task. For autonomous use of a cognitive organiser, a student needs to emulate this skill. The results of this study demonstrated that students had difficulty matching an appropriate cognitive organiser with a specific task. When introducing a new organiser, it is possible a teacher can facilitate student understanding of its use by thinking aloud and discussing the merits of the organiser in the specific context. The ability of the student to select an organiser with an appropriate structure for a task is the fourth factor included in Figure 2.

Finally, it became evident in this research that the students needed a motive for using a particular organiser, unless the student sees value in its use, they will not use it. The deep learners in this research added to their conceptual frameworks each time they reviewed their work, but resisted representing their understanding in the form of a concept map for various reasons. They did not recognise the value in making links between concepts. As a consequence, the fifth factor leading to autonomous student use of cognitive organisers included in Figure 5 is that the students' learning approach confers value to the use of the organiser as a learning strategy.

In general one would expect that students with a deep approach would be looking for ways to build their understanding, however, in situations where students experience success with minimal effort, it is unlikely that they will extend themselves. The common assessment task appeared to curtail effective learning patterns rather than promote them. Students of all learning approaches were content to make notes from the textbook, only the deep/achieving learners attempted to extend their understanding to making links between concepts. Students in this gifted and talented science class experienced success in

the topic of energy and electricity because all 29 received an A grade on their report. Until assessment tasks challenge the students they will continue to rely on study strategies that have served them well in the past.

```
┌─────────────────────────┐
│ Prior exposure to       │──────────────────► Yes
│ specific organiser      │                      │
└─────────────────────────┘                      │
              │                                   ▼
             No           ┌─────────────────────────────────────────────┐
                          │ Student's level of cognitive processing     │
                          │            (SOLO taxonomy)                   │
             No  ◄─────────│ is aligned to the level of cognitive         │
                          │ processing required for the use of organiser │
                          └─────────────────────────────────────────────┘
                                                 │
                                                Yes
                                                 │
                                                 ▼
                          ┌─────────────────────────────────────┐
             No  ◄─────────│ Organiser is embedded in student's   │
                          │ repertoire of strategies             │
                          └─────────────────────────────────────┘
                                                 │
                                                Yes
                                                 │
                                                 ▼
                          ┌─────────────────────────────────────┐
             No  ◄─────────│ Structure of organiser is            │
                          │ aligned to task                      │
                          └─────────────────────────────────────┘
                                                 │
                                                Yes
                                                 │
                                                 ▼
                          ┌─────────────────────────────────────────────┐
             No  ◄─────────│ Student's learning approach confers value to  │
                          │ the use of the organiser as a learning strategy│
                          └─────────────────────────────────────────────┘
                                                 │                 ┌──────────────┐
                                                Yes ──────────────►│ Autonomous   │
                                                                   │ strategy use │
                                                                   └──────────────┘
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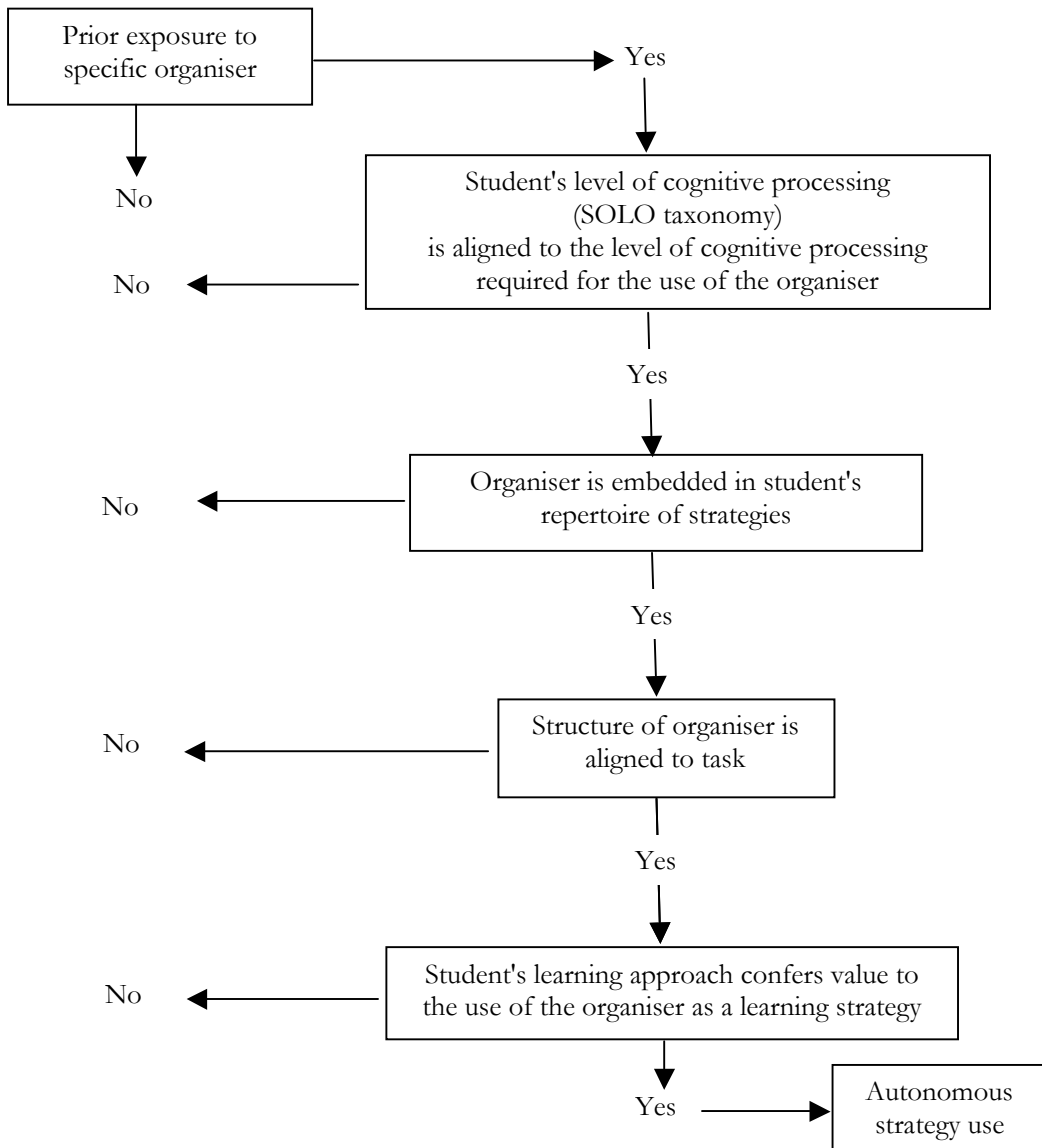
Figure 2: Factors leading to autonomous student use of a specific cognitive organiser

Conclusion

The autonomous use of cognitive organisers by the gifted and talented science students at Metropolitan High School, regardless of learning approach, was minimal. Despite numerous organisers being modelled and used in science classes, the students were not able to translate this to autonomous use of such organisers during class work or in preparation for assessment tasks without prompting. The common assessment task based on specific content did not prompt students to refer to organisers in their preparation. Most students used structured overviews to make notes for the common assessment task and for structuring information for the open-ended, hypothetical task. It would seem that the students were yet to internalise the value of more complex organisers. In particular, the way concept maps were used by students with the most adaptive learning approach, deep/achieving, was contrary to that intended. Thus, it appears that the most important factors affecting the use of an organiser are the student's familiarity with it and its appropriateness to the task.

Classroom implications

The following are recommendations based on the findings of this research for improved autonomous use of cognitive organisers, not only by the Year 9 gifted and talented science students at Metropolitan High School, but by students in general:

- Organisers must be assessed for their cognitive difficulty and introduced sequentially according to the cognitive ability of the students in the class.
- Each organiser needs to be modelled by a teacher or knowledgeable peer and used on a number of occasions to enable students to become familiar with its applications.
- For an organiser to become embedded, it needs to be used frequently over an extended time frame.
- A school-wide focus may be needed to improve student exposure to such strategies.
- Assessment tasks that warrant the use of specific organisers must be included in teaching programs.
- The classroom environment and teaching strategies should encourage a deep/achieving approach to learning as the most adaptive of the learning approaches by promoting connections between the learning context and the students' prior conceptual frameworks.

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Appendix A

Interview A: interview protocol about student preparation for the common assessment task.

1. How did you go about preparing for the common assessment task?

2. Did any of the following strategies help with the common assessment task: fishbone, concept map, Bloom's taxonomy questions, hairy sheet (spider diagram), metacognitive sheet, analogy -role play, revision sheets?

3. Further questions asked to tease out self regulation strategies used based on Zimmerman's classification scheme

Category of SRL strategy	Examples
Self evaluating	Check quality of own work
Organising/transforming	Rearrangement of instructional materials, analogies, cognitive organisers
Goal setting/ planning	Goals, sub-goals, timeline
Seeking information	
Keeping records, monitoring	Note taking, summarising
Environmental structuring	Study area etc
Self-consequating	Self-rewards or punishments
Rehearsing, memorising	
Seeking assistance: peers, teachers, adults	Explaining to someone else, asking questions, answering questions
Reviewing records: notes, tests, textbooks	Highlighting, paraphrasing
Other	Responses about behaviours instigated by others (not SRL) or other (unclear)

Appendix B

Interview B: Hypothetical Task

You have received a flier from school about choosing green energy at home. You want to help the environment, but you are not the one paying the electricity bills!

You are planning to talk to mum and dad at dinner time later in the week about switching to green energy, but you need an action plan. You are also going to take something in writing to the dinner table.

Draft the action plan and the written work that you will use when you discuss the issue with your parents.

Note: with this task a flier and information sheet were provided for student reference purposes.

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