THE RELATION BETWEEN CRITICAL THINKING ABILITIES AND STUDENT STUDY STRATEGIES

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Introduction

Recent debate stimulated by competency standards and the Finn / Mayer key competencies has directed attention to the series of higher order competencies that are claimed to be the hallmark of a university education. Critical thinking is a central example of these higher order competencies. If the Finn/Mayer Reports are implemented, critical thinking will be but one of a series of such competencies that Australian education at all levels will attempt to address more systematically. So far there appears to have been little research on the critical thinking capacities of Australian higher education students. This paper continues an initial exploratory study in this field. Following earlier investigations of the critical thinking capacities of vocational teachers using the Cornell Critical Thinking Test Level X (Kaye and Hager, 1991; Hager and Kaye, 1991), the authors hypothesised that there should be significant connections between a student's critical thinking capacities and their study processes. This paper reports on and discusses a test of the hypothesis. The view that there should be significant connections between students' critical thinking capacities and their study processes has prima facie plausibility because many of the common components postulated of critical thinking are clearly conducive to effective study processes as they are typically conceived.

NATURE OF CRITICAL THINKING

There has been much debate on the question 'what is critical thinking?' (Kennedy et al., 1991, pp. 13-14, 26) While there are still disagreements about matters of detail, considerable agreement has been achieved that critical thinking is a combination of abilities and dispositions. The most influential characterisation of critical thinking is due to Ennis (1987). According to Ennis, good thinking is critical thinking which he defines as follows:

> CRITICAL THINKING is reasonable reflective thinking that is focussed on deciding what to believe or do.

As Ennis elaborates it, critical thinking includes both dispositions and abilities. He lists 14 dispositions (e.g. seek reasons, use and mention credible sources, look for alternatives) and 12 abilities (e.g. focussing on a question, making and judging observations, identifying assumptions). (the latest so far unpublished account includes 12 dispositions and 16 abilities, see Ennis, 1991). According to Ennis, to think critically in some discipline or subject is to display these

dispositions and abilities within that discipline or subject, i.e. the dispositions and abilities are relatively general.

ASSESSING CRITICAL THINKING

Currently, the Cornell Critical Thinking Tests, Levels X and Z (Ennis, Millman, and Tomko, 1985) are the most commonly used instruments to assess critical thinking capacities. The Level X Test is aimed principally at senior high school and early year undergraduates, while the Level Z Test is aimed principally at graduates and post-graduates. Broadly speaking, both tests require respondents to decide whether there is sufficient evidence or reason to draw certain inferences or conclusions. The Level X test was chosen for this study because the subjects were first year undergraduates Critical Thinking Test, Level X, begins with a fictitious situation description followed by a series of alternative inferences and conclusions from which respondents must choose.

ASSESSING STUDY PROCESSES

Our data on the effectiveness of subjects' study processes was obtained from the General Study Processes Survey, a 21 item Likert scale questionnaire derived from Biggs' Study Processes Questionnaire (Biggs, 1987). The General Study Processes Survey provides indicators on three dimensions of student study strategies as follows:

1. Surface study strategy
2. Deep study strategy
3. Achieving study strategy

The General Study Processes Survey includes seven items on each of these dimensions. The surface study strategy questions mainly investigate students' strategies in attempting to learn new material. The deep study strategy questions mainly investigate students' strategies in attempting to relate new material to previously learnt material in a new way. Finally, the achieving study strategy questions mainly investigate students' strategies for organising their studies in an efficient way so as to maximise their assessment grades. As Hegarty-Hazel and Prosser (1991, pp. 305-6) point out,

> ".....it is the achieving study strategy that is traditionally the focus of study skills courses in higher education, and is the one traditionally encouraged in teaching in higher education. A 'good' student is often described in terms of this study strategy."

Examples of items from each of the three dimensions of student study strategies are shown in Table 1.

TABLE 1

Examples of Items from the General Study Processes Survey

Surface Study Strategy

1. I only study seriously what is given out in class or on course outlines because I think browsing around is a waste of time.
4. I learn some things by rote, going over and over them until I know them by heart.
7. I tend to prefer subjects with a lot of factual content rather than theoretical kinds of subjects.

Deep Study Strategy

2. While I am studying, I often think of real life situations to which the material that I am learning would be useful.
5. In reading new material I often find I am continually reminded of material I already know and see the latter in a new light.
8. I find that I have to do enough work on a topic so that I can form my own point of view before I am satisfied.

Achieving Study Strategy

3. I summarise suggested readings and include these as part of my notes on a topic.
6. I try to work consistently throughout the semester and review regularly when the exams are close.
9. I try to do all of my assignments as soon as possible after they are given out.

METHOD

The Cornell Critical Thinking Tests, Level X was taken by the 54 first year engineering students who comprised the subjects for this study a month after commencing their university studies. The test was administered according to the instructions in the Test Manual (Ennis, Millman and Tomko, 1985). Subjects had fifty minutes to complete the test. The scoring system (half number right minus number wrong) was designed to discourage guessing. The subjects were informed of this prior to taking the test. The General Study Processes Survey derived from Biggs was not subject to a time limit, but all subjects were finished within a quarter of an hour. The subjects were instructed to "circle the number that best fits your immediate reaction. Do not spend a long time on each item: your first reaction is probably the best one. Please answer all 21 items. Do not worry about projecting a good image." In both cases the subjects supplied their student number to enable scores to be correlated. Also in both cases the subjects were assured that their results were confidential and would not be individually identified, but only used for computing group results. The General Study Processes Survey was completed by the subjects approximately six weeks after taking the Cornell Critical Thinking Test Level X. This ensured that the subjects had had sufficient time to settle into a study pattern at university. It also meant that any influence from having taking the Critical Thinking Test on the completion of the General Study Processes Survey would be minimal.

RESULTS AND DISCUSSION

For each student there were eight measures; five of these were scores obtained from the Cornell Critical Thinking Test Level X and the other three measures were obtained from the student's responses to the items in the Study Processes Questionnaire. The five scores on the Critical Thinking Test corresponded to each of the four subsections and an overall test score. The four subsections were induction (I, items 3 - 25), credibility (C, items 27 - 50), deduction (D, items 52 - 65) and assumption identification (A, items 67 - 76). The three measures obtained from the Study Processes Questionnaire corresponded to the three dimensions of study strategies; namely the surface (SS), deep (DS) and achieving (AS) dimensions

Table 2 reports the mean values and the standard deviations of

the five sets of scores obtained from the test of critical thinking. The mean scores on the whole test (CRT) was noticeably higher than the mean values obtained in a previous studies of the critical thinking abilities of samples of university graduates and undergraduates (Kaye and Hager, 1991; Hager and Kaye, 1991). The higher mean score for this sample of undergraduates was mainly due to the higher mean scores on the subsections of the test referred to as Induction (I) and Credibility (C).

TABLE 2

Mean Scores on the Cornell Critical Thinking Test

Test Items	Mean Score	Standard Deviation
CRT (whole test)	37.4	12.52
I (induction)	16.5	2.93
C (credibility)	15.3	3.69
D (deduction)	10.8	3.34
A (assumption) (identification)	5.3	2.80

Table 3 reports the correlation coefficients between the different combinations of the three dimensions of study strategies and Table 4 gives all the inter-correlations between each of these dimensions and each of the five scores from the test of critical thinking.

TABLE 3

Correlation Coefficients between Dimensions of Study Strategies

	This Study N = 54	Hegarty-Hazel and Prosser (1991) N = 72	Trigwell and Sleet (1990) N = 19

S S versus AS	- 0.14	0.19	0. 08
SS versus DS	- 0.15	-0.09	-0.36
AS versus DS	0.29	0. 31	0.39

As Table 3 shows the pattern of correlation coefficients between the different dimensions of study strategies found in this study was similar to the patterns reported in earlier studies involving university undergraduates by Hegarty-Hazel and Prosser (1991) and Trigwell and Sleet (1990). The correlation coefficients between the SS and AS dimensions and between the SS and DS dimensions were small and/or negative and the largest correlation coefficient was between the AS and DS dimensions.

TABLE 4
Correlations between Study Strategies and Critical Thinking Scores

Critical Thinking Score	Study Strategy		
	SS	AS	
DSCRT-	0.05	-0.52(1)	-0.07
I-	0.06	-0.23	-0.10
C-	0.13	-0.45 (1)	-0.10
D	0.04	-0.30 (2)	-0.02
A	0.03	-0.48(1)	0.00

Notes : (1) $p < 0.001$
(2) $p < 0.05$

The achieving dimension (AS) was the only study strategy which correlated significantly with scores on the test of critical thinking (see Table 4). There was a statistically significant negative correlation between the scores on the whole test (CRT) and this study strategy. As reported earlier in this paper, Hegarty-Hazel and Prosser (1991) stated that the achieving study strategy is traditionally the focus of study skills courses in higher education. We have found in this research that students who indicate that they have a strong propensity to adopt study processes which focus on achievement are less likely to score highly on a test of critical thinking. Does this finding imply that encouraging students to adopt an achieving study strategy is likely to hinder rather than promote their development of critical thinking abilities? It seems to us that the question should be investigated by further research.

In order to obtain more information about any relationship between study strategies and critical thinking ability the study strategies of the ten highest achieving students on the CRT were compared closely with the study strategies of the ten lowest achievers on the CRT. The mean scores + standard deviations on the CRT for the ten highest and the ten lowest achievers were 54.5 + 2.10 and 18.6 + 5.34 respectively. The main or preferred study processes adopted by students in these two groups were

ascertained as follows. Students were considered to indicate a strong preference for and item in the Study Processes Questionnaire if they circled 4 or 5 for this item. For each item in the Questionnaire, the number of students who indicated such a strong preference was determined. These frequencies are shown in Table 5 for the two groups of students.

TABLE 5
Study Strategies of the Highest and Lowest Achievers on the CRT

Item	Frequency for Highest Achievers (N=10)		Frequency for Lowest Achievers (N=10)							
1	4	5	9	2	6	3	4	7	5	2	8	4
8	9	2	4	10	3	4	11	4	6	12	3	3
13	9	9	14	3	1	15	1	4	16	4	5	17
2	0	18	2	0	19	3	4	20	8	7	21	6
8												

Note: In Table 5 frequency refers to the number of Students in the group of ten highest (or ten lowest) achievers on the CRT who rated the item as highly as 4 or 5 in the Study Processes Questionnaire.,

Perusal of Table 5 reveals that the major difference in study strategies between the highest and lowest achievers is with the process or strategy implied by item 5. This item is;

"In reading new material I often find I am continually reminded of material I already know and see that latter in a new light."

It is very interesting to compare the students' responses to item 20 with their responses to item 5. Item 20 is,

"I try to relate new material, as I am reading it, to what I already know on that topic."

As Table 5 shows a very high proportion of students in both the highest and lowest achieving groups indicate that they try to relate new material to previous knowledge of the topic (item 20) but, judging from their responses to item 5, students who are not successful critical thinkers are usually students who are not able to relate new information clearly to previous knowledge. Apparently students who are successful critical thinkers are aware that they are able to relate new material to previously learnt material and in doing so they are aware that their understanding of the previous knowledge is enriched. This finding suggests that there is a link between meaningful learning and critical thinking. It seems that students who are capable of learning meaningfully are more likely to be successful critical thinkers. Our research indicates that students who through "reflective thinking" are able to decide correctly "what to believe or do" are most likely to be those students who can link new information to existing mental structures. We suspect that this ability to co-ordinate meaningfully new information with

other items of information is related to a person's inherent working memory capacity. There is likely to be a significant positive correlation between working memory capacity and critical thinking ability.

The responses of students in the lowest achieving group to items 3 and 8 are different enough to the responses to those items of the highest achieving students to call for comment (see Table 5). Items 3 and 8 are;

"I summarise suggested readings and include these as part of my notes on a topic" (item 3).

"I find that I have to do enough work on a topic so that I can form my own point of view before I am satisfied" (item 8)

The more positive responses to items 3 and 8 by the lowest achieving group are difficult to rationalise. Perhaps students in this group lack confidence in their initial understanding of a topic and therefore feel a greater need (or at least indicate in the Study Processes Questionnaire that they do) to spend more time thinking about the topic or to seek the views of others in order to develop a deep understanding of it. On the other hand students who have good critical thinking skills may have a greater confidence in their ability to judge whether or not they have the correct understanding of a topic and therefore feel less need to "work on a topic" before they are "satisfied". A high degree of self-confidence and an ability to monitor one's own

thinking are probably attributes of many successful critical thinkers. Ennis (1991) has claimed that an ability to monitor one's own thinking is an "auxiliary criticial thinking ability"

Finally we would like to point out the very positive response to item 13 shown in Table 5, of students from both the lowest and highest achieving groups.

This item is;

"I learn best from lecturers who work from carefully prepared notes and outline major points neatly on the board".

This response is consistent with research evidence about students' evaluation of lecturers; that is lecturers who are well-organised are usually highly rated by all students.

Conclusion

There are two findings from this exploratory study of the relationship between students' study processes and their critical thinking abilities which we would like to emphasise. First, the negative correlation between the achieving study strategy and critical thinking ability needs to be investigated further to see whether or not such study processes hinder rather than promote the development of critical thinking abilities. Secondly, the finding that good critical thinkers are more likely to be students who can successfully relate new material to previous knowledge of a topic has implications for teaching critical thinking. It may be helpful in designing a course aimed at

promoting the development of critical thinking abilities to explain to students techniques or strategies which are likely to promote meaningful learning and to explain ways in which students can make most efficient use of their working memories.

References

Biggs J. B. (1987) Student Approaches to Learning and Studying. Melbourne: Australian Council for Educational Research.

Ennis, R.H. (1962) "A Concept of Critical Thinking", Harvard Educational Review, 32, 81-111.

Ennis, R.H. (1987) "A Taxonomy of Critical Thinking Dispositions and Abilities" in Baron, J. and Sternberg, R.(Eds.) Teaching thinking skills: theory and practice. New York: Freeman.

Ennis, R.H. (1989) "Critical Thinking and Subject Specificity: Clarification and Needed Research", Educational Researcher,18(3), 4-10.

Ennis, R.H. (1991) "Critical Thinking: A Streamlined Conception", typed manuscript.

Ennis, R.H., Millman, J. and Tomko, T.N. (1985) Cornell critical thinking tests level X and level Z. Pacific Grove, Ca.: Midwest Publications.

Hager, P. (1991) "The Critical Thinking Debate - Editorial Introduction", Educational Philosophy and Theory, Vol. 23, No. 1, pp. 1-6.

Hager, P. and Kaye, M. (1991) "Critical Thinking Ability and Teacher Effectiveness", Higher Education Research and Development, Vol. 10, No. 2, pp. 177-186.

Hegarty-Hazel, E. and Prosser, M. (1991) "Relationship Between Students' Conceptual Knowledge and Study Strategies-Part 1: Student Learning in Physics", International Journal of Science Education, Vol. 13, No. 3, pp. 303-312.

Kaye, M. and Hager, P. (1991) "A Study of the Critical Thinking Skills of Vocational Teachers", Australian Journal of TAFE Research and Development, Vol. 6, No. 2, , pp. 19-29.

Kaye, M. and Hager, P. (1992) "Critical Thinking in Adult Vocational Education: A Human Communication Perspective" in Ticehurst G.W. (Ed.) Communication Australia: A Search for Meaning in Changing Times. Sydney: Griffin Publications.

Kennedy, M., Fisher, M.B. and Ennis, R.H. (1991) "Critical Thinking: Literature Review and Needed Research" in Idol, L. and Jones, B.F. Educational Values and Cognitive Instruction: Implications for Reform. Hillsdale, N.J.: Lawrence Erlbaum.

Trigwell, K. and Sleet, R. (1990) "Improving the Relationship Between Assessment Results and Student Understanding", Assessment and Evaluation in Higher Education, Vol. 15, No. 3, pp. 190-197.

x·y{>í|vÉ·Ñ·W (or 'short term') has been shown to be a crucial factor in the solution of complicated problems (see, e.g.,

Johnstone and El-Banna, 1989; Niaz, 1987; Sleet, 1991).
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M. () "Relation Between M-Space of Students and M-Demand of Different Items of General Chemistry and Its Interpretation Based Upon the Neo-Piagetian Theory of Pascual-Leone", Journal of Chemical Education, Vol. 64, No. 6, pp. 502-505.
R. () "Teaching Chemical Problem Solving", Royal Australian Chemical Institute Chemistry Resource Book, Vol. 10.

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It is considered that most people have an upper limit of about 61 pieces of information which they can manipulate simultaneously in working memory (Johnstone and Letton, 1989).

LettonK. M "Why Do Practical Work? A Researcher's Point of View", Kemia-Kemi, Vol. 16, pp. 146-148.
This research has shown that generally the greater the inherent working memory capacity of the problem solver, the greater the chance of solving closed problems with a large number of steps. The pieces of information that are manipulated in working memory can come from long term memory and external sources such as textbooks, test instructions, etc. R Support for this

hypothesis comes from the ative resultsof on Items 5 and 20 as discussed in the previous paragraph.
In addition, it is interesting that, as noted earlier, not only did this sample of undergraduates obtained markedly higher mean scores on the Cornell Critical Thinking Test Level X than previous groups tested by Kaye and Hager, the increased scores were mainly in the two subsections of the test that rely significantly on memory. hat is, t These two subsections of the test progressively build up the data on the fictitious situation that the subject will need to consider in deciding whether, for a particular item, Hence, as subjects move through these subsections, more and more data accumulates that may be relevant to answering the remaining items. For this reason, in these two subsections of the test, subjects are instructed not to go back

to a problem once they have passed it. Otherwise they will be employing later information when making earlier inferences. In contrast, the Deduction (D) and Assumption Identification (A) subsections of the test consist of items that are self-contained, i.e. no information from earlier items is needed. Subjects are told that it is permissible to go back and check over their answers in these subsections. It seems reasonable, therefore, to infer that the present sample of undergraduates may have superior working memory capacities compared to the previous groups tested by Kaye and Hager. Overall, our belief that significant suggests further research possibilities.ching Chemical Problem Solving" in Fogliani, C. (Ed.), Vol. 10, pp. 22-33.s's, identifying assumptions).

Hager, P. and Kaye, M. (1992inducation: A Process Oriented Research Agenda, The eacher Education (in press).

It is perhaps also important to consider why no significant correlation between surface study strategies and critical thinking ability and between deep study strategies and critical thinking ability was found in the present study. One would expect, for example, that the successful use of a deep study strategy would to some extent go hand in hand with the ability to think inductively. This expectation is based on the assumption that relating new material to previously learned material is effectively a cognitive process involving the generation of general conclusions stemming from particular new bits of information.

Naturally, it is possible that such an assumption is unwarranted since the deep study strategy may represent what is essentially a procedure for the classification of experience and information and for the facilitation of delayed recall. In other words, one could speculate that it is possible to use a deep study strategy as an aide-memoire or prompt when recalling information for other instructional purposes e.g. examinations. Alternatively, a deep study strategy may involve divergent rather than convergent thinking characteristics since unfamiliar material is related to previously known information in new and presumably inventive ways.

The lack of any significant correlation between the surface study strategy and critical thinking ability is perhaps easier to accept. Since the surface study strategy is primarily concerned with how students address new and unfamiliar material, it is quite likely that in many cases any critical or analytical thinking about the newly experienced material may follow a phase of simple memorisation purely for storage purposes. Thus, surface study strategies may primarily serve the purpose of enabling students to retain information before it is interpreted and analysed.

Another likely reason to account for the lack of correlation between deep and surface study strategies and critical thinking ability may be that the students investigated in this study had

not as yet fully established their study strategies. These students were in their first year of university, and as such were only beginning to come to terms with learning in higher education contexts. Quite possibly, had the present study used senior undergraduate university students, any potential relationship between study strategies and critical thinking ability could be more definitely either discounted or supported.

Whilst previous studies by Kaye and Hager (1991) and Hager and Kaye (1991) have attempted to justify the use of the Cornell X version in preference to the Z form of the test, there is still the possibility that the X level test may be inappropriate for late adolescent students with latent critical thinking ability.

One implication to emerge from this and previous Australian studies on the critical thinking effectiveness of university students is that alternative ways of assessing critical thinking ability should be explored and developed. This point formed part of a process-oriented research agenda for critical thinking, developed by Hager and Kaye (1992).

Again, the point may be made that the apparent failure of this study to establish any high positive correlation between student study strategies and students' critical thinking abilities could be because the course in which these students are enrolled does not necessarily require them to be critical thinkers in order to achieve well or obtain high grades One useful exercise to follow on from this study might be to undertake a content analysis of university undergraduate science subjects in order to determine the kinds of analytical and critical thinking processes students need to experience in order to gain mastery over essential concepts and their application.

According to Trigwell and Sleet (1990, p. 191) a

> "....involves an intention to complete task requirements. Students focus on the 'signs' and on discrete elements, memorise information and procedures for assessments, unreflectively associate concepts and facts, fail to distinguish principles from evidence and new information from old, treat the task as an external imposition and adopt an external emphasis."

Again, according to Trigwell and Sleet (1990, p. 191), in adopting adeep

> "....students have an intention to understand. They focus on what is signified, relate and distinguish new ideas and previous knowledge, relate concepts to everyday experience, relate and distinguish evidence and argument, organise and structure content and adopt an internal emphasis."

RESULTS AND

to Table 4

was found in the present study. e ability to think inductively. This expectation is based on facilitation of delayed recall. , , ,, dCritical Thinking Test in the form or mature age abilitiesould be explored and developed. h positive correlation between enrolled does not necessarily .