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Study Processes and Learning Outcomes

by

John Biggs

Faculty of Education
University of Newcastle

Abstract

This paper is concerned with the relationship between students' study processes and the structural complexity of their responses to finite displays of information. Study processes are conceived in terms of three independent dimensions -- instrumental, internalizing and achieving -- each of which has a cognitive (strategic) and an affective (motivational) component; these are assessed by the Study Process Questionnaire (SPQ). Response quality is expressed in terms of the complexity of the structure of the observed learning outcome by applying the SOLO Taxonomy described below. A preliminary study involving 60 undergraduates' responses to education research abstracts is described, in which SOLO levels and short and long term retention of factual material are related to their study processes.

Introduction

The evaluation of student learning represents one of the major responsibilities of the teacher at all educational levels, yet both the technology and actuality of evaluation have been distorted or one-sided. As Marton (1976) points out, there has been an overwhelming preoccupation with the quantitative aspects of student learning (the number of correct responses, the listing of relevant points, norm-referencing, etc) and a neglect of the qualitative aspects of learning (whether the points made inter-relate, originality, critical analysis from more

general principles, etc.). The Bloom Taxonomy is probably the best-known systematic attempt to provide a structure for assessing levels of learning quality but this remains at best an a priori model that does not necessarily reflect the psychogenesis of good learning. For the most part, the assessment of quality has been highly subjective. Evaluations are usually derived and applied according to a purely private calculus, the workings of which might be clear to the individual, but sometimes difficult to communicate, particularly to the student concerned, and expressed in loosely structured comments.

Marton (op.cit.; Marton & Saljo, 1976) distinguishes qualitative levels of learning in terms of what the student himself construes of the structure of the material to be learned, so that the levels are unique to each learning event. He further proposes that the simplicity or complexity of the student's constructions depend critically upon how the student processes the material during learning: "deep" processing, involving a search for meaning, will result in more complex and higher quality learning than surface level processing.

Marton's approach has its roots in existential psychology and focusses upon the here-and-now of the particular learning situation. Other workers adopt a more nomothetic stance towards students' study processes, and would prefer a categorisation of learning that could be generalised across subject areas. The present paper discusses the writer's work on the two issues of study processes and learning quality and presents some initial data on their interaction.

Students' study processes

It is assumed that, particularly at tertiary level, students exhibit fairly stable attitudes towards studying, motives for learning and strategies of going about learning; these motives and strategies are formed as a result of various factors such as personological characteristics and previous experiences as well as present situational demands (Biggs, 1978). This assumption underlies the use of self-report questionnaires for assessing study processes, including the writer's own Study Process Questionnaire (SPQ) (Biggs, op.cit).

One difficulty with many of these questionnaires, including the earlier versions of the SPQ, is that the scales incorporated therein lack a theoretical rationale. Different instruments include different scales according to the predilections or particular practical purposes of the authors. The version of the SPQ used in Biggs (1976), for instance, contained ten conceptually distinct scales each of which had proved useful one way or another in the past. Both theoretically and practically, however, ten dimensions are simply too many to handle if one is to generalise usefully across different situations.

A factor analysis of these ten scales yielded a second-order factor structure that was stable across three quite diverse populations (Biggs, op.cit.). Item correlations with the three second-order factors revealed an interesting pattern: in each case, a group of items described a general strategy of going about learning and studying, and another group described the motives and feelings a student might have about study. Further, the motives and strategies were psychologically complementary, in ways similar to those noted, but with quite different methodologies, by Entwistle and Wilson (1977), Svensson (1976) and others. The three dimensions and their affective and cognitive components are:

1. Instrumental. The motivational component is represented by fear of failure (particularly test anxiety) and by pragmatism (study seen as means to an end such as a paper qualification, job security). The cognitive strategy is to limit the range of learning to prescribed content (syllabus bound) and rote learn within those boundaries

(cf. Marton's (1976) description of surface level processing).

2. Internalizing. The motivational component here is intrinsic interest in academic study with the goal of self-actualization through study; with a cognitive strategy of reading widely beyond the syllabus, inter-relating material in ways significant to the individual and understanding in depth (deep level processing).

3. Achieving. The motivational component is need-achievement, with particular reference to competition; with a corresponding strategy of high organization, scheduling of work and a cool, systematic approach to study.

While it would be rash to claim that these three dimensions map the entire domain of study processes, the three motivational components include those most often considered to be most relevant to academic study: extrinsic, intrinsic and need-achievement. Another interesting correspondence is with the model of Das, Kirby & Jarman (1976), who propose three dimensions of information processing on the basis of Luria's model of cerebral functioning, viz. successive processing, simultaneous processing and planning. It is tempting to argue that these latter dimensions form the genotypes of those phenotypically revealed in studying as instrumental, internalizing and achieving, respectively.

Accordingly, then, the current version of the SPQ comprises these three dimensions, with seven items defining each cognitive and affective component. This structure of the SPQ represents a considerable saving in items (42 instead of 72), and individual scores may be contained both on the three main instrumental, internalizing and achieving scales, and if required, on each of the six motivational and strategic components. Thus, while the SPQ dimensions may not exhaustively map the study process domain, they do seem to offer a parsimonious and theoretically coherent model for conceptualizing the more important ways in which students may feel about, and behave towards, their study. Further, since the model consists of three orthogonal dimensions, it allows for the fact that students may, depending on their score profile, have mixed motives and multiple strategies: some students may, for instance, be motivated intrinsically, as well as by the ego-enhancement of high grades.

The SOLO Taxonomy

We now turn to the problem of evaluating the quality of learning. This work arose in the quite different context of applying Piagetian psychology to the classroom (Collis & Biggs, 1976). Following the work of Peel and his students (Peel, 1971), we were initially interested in gathering examples of pre-operational, concrete and formal thinking in different school subjects, with the main purpose of providing teachers with examples of such thought in their different subject areas.

It rapidly became apparent, however, that we were not observing developmental so much as learning phenomena. For example the décalages observed both within and between subject areas were too gross to be acceptable within the framework of traditional Piagetian theory. Response levels were clearly dependent inter alia upon prior specific learnings. Further, it did not make sense to observe presumably "formal operational" tertiary students responding at the structural level of a ten-year-old within their own subject areas! What we were observing was the structure of a particular learned response, that was isomorphic to but not identical with the more general structures described by Piaget.

Accordingly, we relabelled the levels with a more descriptive terminology in order to distinguish our levels from Piagetian stages: levels apply to the classification of observed responses, while stages are characteristic of the individual for a given period of time. At

best, then, stages may only put an upper limit to a response level. Thus, a ten year old might not be able to construct an extended abstract response, but an intelligent adult may well, and frequently does, construct responses said to be typical of a ten-year-old.

The SOLO Taxonomy, so-called because it refers to the structure of the observed learning outcome, consists of five levels of response and is most easily applied to learning the meaning of a finite display of information and making judgments about that information (a piece of prose, a map, a moral dilemma, a poem, a mathematical problem, etc) (see Biggs, 1978, and Collis and Biggs, in preparation, for a fuller description). The five levels are:

1. Pre-structural. The response has no logical relationship to the display, being based on inability to comprehend, tautology or idiosyncratic relevance.

2. Uni-structural. The response contains one relevant item from the display, but misses others that might modify or contradict the response. There is a rapid closure that oversimplifies the issue.

3. Multi-structural. The response contains several relevant items, but only those that are consistent with the chosen conclusion are stated. Closure is selective and premature.

4. Relational. Most or all of the relevant data are used, and conflicts resolved by the use of a relating concept that applies to the given context of the display, which leads to a firm conclusion.

5. Extended abstract. The context is seen only as one instance of a general case. Questioning of basic assumptions, counter examples and new data are often given that did not form part of the original display. Consequently a firm closure is often seen to be inappropriate.

In addition, transitional responses may be found in which elements of the next level may appear, for instance a 2A response (transitional between uni- and multi-structural) would contain two contradictory items with a consequent weak or confused conclusion.

These five levels seem to form a hierarchy of learning that correspondes to the developmental hierarchy described by Piaget, but is logically distinct from the latter. We are concerned here only with describing the structural complexity of a particular response to a learning situation.

The SOLO Taxonomy is functionally closer to the Bloom Taxonomy, and especially to Marton's categorisations of particular learnings (see particularly those outlined in Marton & Saljö, 1976) than to developmental states; and indeed it was through discussions with Marton and his colleagues that led the writer to make this minor paradigm shift away from the Piagetian framework. On the other hand, the SOLO levels have a wider generality than Marton's task-specific classifications.

The SOLO Taxonomy has been applied to several school subject areas, including mathematics, English, history, geography, reading skills and modern languages, and at the tertiary level to literature and educational psychology. The last area is that used in the following study, and to illustrate the Taxonomy some (edited) examples will be discussed below.

In one task, an abstract of an experiment on the induction of Nazism in a high school classroom was given to a class of undergraduate Education students. The abstract described how the teacher, Mr Jones, applied procedures over a five day period that produced high conformity to arbitrary regulations, with spontaneous reporting of non-conforming students, chanting of slogans, mass rallies, and the emergence of the "Third Wave Movement". At this point the experiment was terminated and the "problem" of the emergence of Nazism in Germany was discussed. The question asked the present subjects was: "Explain how this experiment throws light on the phenomenon of Nazi Germany".

In the group tested, there were no responses below level 3 (multi-structural). The examples given below for levels 1 and 2 were obtained for illustrative purposes from a few less sophisticated subjects:

Level 1 (Pre-structural)

> "It doesn't to me. I don't see what Mr Jones and Hitler have in common."
>
> "I don't think it does. It's not as if Mr Jones picked on Jews particularly."

The first response is a simple denial; the second is based on an irrelevancy ("picking on", let alone anyone in particular, was not the point).

Level 2 (Uni-structural)

> "It shows how Mr Jones was able to get his students to be extra-obedient in just the same way as Hitler did to the German people."

In this response, the one concept of obedience is taken as the link between the two situations. While this is true, many other points are missed.

Level 3 (Multi-structural)

> "This experiment shows the way that the citizens of Germany could be manipulated by one leader. It shows the way that it began by firstly starting out in a small way and led to one of the most powerful movements ever experienced in the world. It also indicates the blindness of the citizens of Germany - not knowing what they were heading into. It also demonstrates the powerful effects that slogans and signals had upon the citizens of Germany."

This response is basically a catalogue of conclusions "it shows ... it also ... it also" that aren't really tied together. Another, more lengthy, type of level 3 response was the medley: the student simply played back appropriate selections from the original. The latter kind of response shows an ability to understand what is relevant or not, but does not demonstrate an ability to integrate or reformulate the points made, or conceive them as part of a larger structure.

Level 4 (Relational)

> "After the Nazis were defeated, most Germans claimed ... they knew nothing ...
>
> This experiment showed that in a sense the people really didn't know what was happening. The Nazi leaders ... told them they were the best people in the world ... that they must all work together to make Germany the world leader. Mass rallies ... people were encouraged to report their friends.
>
> The experiment helps people to see how easily a group of people can be made to believe in and do things ... Jones had the children saluting ... or were reported ... also for noncompliance ... The tactics Jones used were the same as the Nazi leaders..."

This response takes an integrating concept "how people can claim they didn't know what was happening" to explain Nazi Germany, and listing the mechanisms by which this was achieved, first in Germany, and second by Jones in the experiment. Unlike many 3 responses, discussion here is devoted more to Germany, and the mechanisms applying there, whereas 3 responses often concentrate more on the experiment. When the experiment is discussed in a 4 response it is to relate a particular point to the situation in Germany. Thus the relational response is conceptually integrated within its given context; it does not, however, range beyond the given context, e.g. querying the basic premises of the experiment.

Level 5 (Extended abstract)

> "It shows how people can be manipulated, especially in groups, to conform to an association ... and as the people become more involved in this movement they believe in its ideals more and more. Even at school level this process grew rapidly.
>
> The experiment displays the frightening ease at which people can conform, even to such an aggressive movement and shows that its a phenomenon which could occur with race or culture, and not one which is perhaps peculiar to the Germans at that period.
>
> It makes one wonder whether the people involved and subsequently punished for their actions should have been so treated. Would not you or I have done the same thing? Were they just doing their job?"

This extended abstract response implies the detail but is not preoccupied by it. The general point is made: we are not talking about a classroom simulation of Germany but about a probably universal characteristic of mankind. If so, several questions follow, relating to our own probable behaviour and to the justice of punishing war criminals. None of these

issues are given in the original display and arise because the respondent has construed the passage in terms of abstract principles such as responsibility. Essentially, then, the relational response sticks close to its data and context; the extended abstract response rises above contextual integrating concepts and embraces principle.

Study processes and learning quality

It is interesting to consider what place SOLO levels have in the ecology of higher education. An initial reaction might be that extended abstract responses -- as the isomorph of formal operational thought -- would be the ideal, if not the norm. A moment's thought will show however that this is not so. Questions that ask "What are the main features of ...", "List ...", address multi-structural responding (the isomorph of middle concrete operations). Indeed, if a student speculated from first principles, adduced counter-evidence, or gave qualified answers he may be judged as irrelevant at best, and incorrect at worst. This is not to say that it is a bad thing to require multi-structural responding in certain contexts in higher education, but simply that teacher, and student, need to be aware of what the requirements are.

"Compare and contrast" questions optimally require a relational response, although even here a simple listing of points could be enough to get by. Often a teacher might intend to address extended abstract levels in a setting of a question, but in the marking of papers, particularly if there are a large number of papers to be marked in a short period of time, he can too easily adopt a multi-structural marking strategy: a mark each time a relevant point is mentioned, plus a small loading for "quality" at the end. This effect is of course exacerbated when several tutors, each supplied with a "model answer" sheet, are called upon to mark assignments in large undergraduate classes.

Our concern here, however, is with the relationship between SOLO levels and student's learning processes rather than with teaching processes, important though this latter question may be. How might the three dimensions, instrumental, internalizing and achieving, relate to SOLO levels?

In the instrumental process dimension, the target for learning is deliberately restricted to the given context, which would seem to preclude a set conducive to extended abstract responding. Further, the strategy of rote learning details would place data in serial order, with a listing type of output. Hence it would be expected that the more students use an instrumental strategy, the more likely they will produce SOLO level 3 (multi-structural) rather than level 4 or 5 responses, but at the same time, the more likely they will be able to remember facts and details.

Internalizing strategies, on the other hand, would be expected to produce level 4 or 5 SOLOs. These strategies indicate wide reading, plus the attempt at integration. Thus, if this strategy works, it would produce at least relational and at best extended abstract responding. It is also more likely that wide reading would encourage the student to pursue relevant examples but not ones given in the particular display, and this departure from the given is characteristic of the extended abstract response.

The achieving dimension is not so clearly relevant to qualitative outcomes in any direct sense. Perhaps there is a more specific relationship here that is context-dependent, based on how the student sees what is required of him. In other words, if he perceives the best strategy for gaining maximal marks is to produce high level SOLOs, he will do that, but if he sees it as more appropriate that he produce unrelated lists of facts, he will act accordingly.

These predictions, with the exception of the last, are similar to those made by Marton and his co-workers. The major difference lies in

assumption made here that study processes are stable, and will be reliably employed in a given study situation. Scores along these SPQ dimensions might be regarded as tendencies, which are more likely to be actualized as the situation specifically demands. Thus, one might more confidently assume that the person scoring high on instrumental will adopt instrumental strategies when he is specifically instructed to rote learn facts and details; similarly, the person high on internalizing to score high when instructed to learn meaningfully; while the high achiever would be expected to respond with either, as required.

The remainder of this paper discusses a preliminary study which investigated these relationships.

Method

The new version of the SPQ was administered to a class of 60 undergraduate Education students, together with a booklet containing the tasks. The first was a 750 word abstract, taken from Psychology Today, (July, 1976, p.14.) of an experiment entitled "The Third Wave: Nazism in a High School"; and the second a 600 word abstract, likewise from Psychology Today, (May, 1976, p.36), entitled "Day Care is as good as Home Care". Half the group were instructed to read the first abstract by concentrating "on the purpose of the experiment, and the evidence used to draw the conclusion" and the second abstract by concentrating "on the facts and details of the experiment." These instructions were reversed for the second half of the group. Thus, each student was instructed to read one abstract meaningfully and the other for detail; while each abstract had been read for both meaning and detail.

Following each abstract, an instruction was given to elicit a response for SOLO classification, and students had a page in which to construct their response. No expectations of length were given. The instructions were: "Explain how this experiment throws light on the phenomenon of Nazi German" and "Examine the case that children in day-care do not differ from home-raised children".

Finally, following the SOLO response, a list of highly factual questions were asked about each experiment -- e.g. the name of the experimenter, numbers of subjects, exact descriptions of procedures used, etc. -- and these were scored stringently (approximations and paraphrases were not acceptable). The time each student took to complete the tasks was noted. The factual questions were presented again a week later in order to obtain some data on immediate versus long term retention of detail.

For each task, then, the following data were available: Condition for learning (meaningful/factual), students' scores on three SPQ dimensions (and six component scores), SOLO level, SOLO length (level and length of SOLO might be taken as indices of coding "depth" and "spread" respectively (cf. Craik & Tulving, 1975)), number of factual details recalled (immediate and delayed). In light of the preceding discussion, SOLO level was taken as the index of quality of learning, recall of detail that of quantity of learning. These variables were intercorrelated; and conditions (meaningful/factual) and SPQ dimensions (split at the median) were defined as independent, and the remainder as dependent variables, in a series of analyses of variance. With the factual items, Occasions (immediate/delayed) formed an extra independent variable in a repeated measures design.

Results

(a) Relationship between SPQ dimensions

For information, intercorrelations between SPQ dimensions are given in Table 1.

Table 1 goes here

The instrumental dimension relates to achieving (r = .30), but this is seen to be due to the affective component only (r = .37); the strategies are uncorrelated. On the other hand, the relationship between internalizing and achieving (r = .40) is seen to be entirely due to commonality of strategy (r = .47), the motives being uncorrelated.

(b) Learning quality

Table 2 gives the results for learning quality.

Table 3 goes here

The main index of learning quality was SOLO level, but SOLO length was also included. Length is a possible index of the degree of elaborateness with which the display data have been coded: length correlates with time taken (r = .40 to .48, $P < .01$) and with SOLO level in one task only (r = .41, $P < .01$, for Day Care; r = .12, n.s., for Third Wave).

SOLO level in the Third Wave was positively related to internalizing (but P only <.10); negatively to instrumental, but only under factual conditions ($P < .05$); and negatively to achieving ($P < .05$). In Day Care SOLO level was related to meaningful conditions ($P < .05$) only.

SOLO length was positively related to factual conditions in Third Wave ($P < .05$), but to meaningful conditions in Day Care ($P < .01$). The instrumental dimension was negatively related to length under the factual condition on Third Wave ($P < .01$), but possibly positively related on Day Care ($P < .10$).

(c) Learning quantity

Table 3 gives the results for learning quantity.

Table 3 goes here

The immediate or delayed recall of factual detail of Third Wave was not related to anything except the period of delay itself. With the Day Care task, two interesting interactions were found. High instrumental subjects recalled more facts correctly, both immediate and delayed, but particularly under the factual condition. High achieving was related to better factual recall immediately, but this effect did not last.

Discussion

The general pattern of results obtained was in accord with expectations in one or other of the tasks. It was disappointing however that some effects were not found on each task. Before discussing the findings themselves, then, a brief word on the experiment itself is in order.

Each student had to study the two abstracts, with different conditions for each; and then complete the SPQ. While all completed well within the two-hour class time, it is possible that giving two sets of instructions with identical task requirements would appear contrived. In retrospect, it would probably have been better to have asked students to complete only one task, or two tasks under one condition. It is relevant here to note the flatly contradictory results of the Conditions on SOLO length: the fact condition produced longer Third Wave SOLOs, the meaning condition longer Day Care SOLOs (see Table 2, notes (4) and (9)); and it is noteworthy in this respect that the students who received this sequence took longer than those receiving the other sequence of instructions. In other words, the sequences of instructions may have produced differential effects that could contaminate the present findings. It should also be noted that the SOLO distributions were quite different for Third Wave as for Day Care; but unfortunately, there was no time to trial the tasks or the questions beforehand. Essentially, then, this should be considered as a pilot run.

Given this, we might review the results in so far as they apply to at least one of the tasks, and make the following generalizations:

1. More complex response structures are likely under instructions referring to "purpose of experiment" and "evidence for conclusions" that instructions to search for facts and details (Table 2; notes 7, 8).
2. However, the search for facts and details may lead to higher SOLOs given a low instrumental orientation to study (Table 2; note 2).
3. An achieving orientation to study produces low response complexity (Table 2; note 3) but high immediate but not long term recall of fact and detail (Table 3; note 4).
4. An internalizing orientation may produce greater response complexity, but this was a weak effect (Table 2; note 1).
5. An instrumental orientation, under factual learning conditions, leads to high recall of facts (Table 3; notes 2, 3).

The general direction of these results is mostly in line with that predicted. The instrumental orientation to study works for the retention of fact and detail and against complexity of response. The internalizing orientation relates to high complexity, although this finding was not strong. The achieving orientation on the other hand did not lead to good learning complexity, under conditions encouraging complexity, but was associated with low complexity and high factual recall under all conditions. Since the cognitive strategies of instrumental and achieving are uncorrelated (Table 1), it appears that quantity of learning is bought at the expense of quality by both achieving and instrumental strategies.

These data are encouraging, but clearly much more widespread and ecologically valid work is necessary to substantiate the general model. Meantime, it would seem useful to assume that the study process domain can be mapped in terms of these three dimensions, and that they will interact with the task conditions, and the students' perception of what is required of him, to affect both the quality and the quantity of his learning.

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Table 1

Intercorrelations between Cognitive and Affective components and Total SPQ dimensions

	(a) Affective			(c) Total		
	Inst.	Int.	Ach.	Inst.	Int.	Ach.
Instrumental	1.00	-.05	.37**	1.00		
Internalizing	-.23*	1.00	.06	-.19	1.00	
Achieving	-.03	.47**	1.00	.30*	.40**	1.00

(b) Cognitive

* P <.05; ** P <.01; (N = 56)

Table 2

Determinants of Learning Quality (SOLO)

1. Condition (A) x Instrumental (B) x Internalizing (C)
2. Condition (A) x Achieving (B)

		(a) Third Wave		(b) Day-Care	
		SOLO level	SOLO length	SOLO level	SOLO length
1.	A	ns	<.05 (4)	<.10 (7)	<.01 (9)
	B	ns	ns	ns	<.01 (10)
	C	<.10 (1)	ns	ns	ns
	AB	<.05 (2)	<.01 (5)	ns	ns
	AC	ns	ns	ns	ns
	BC	ns	ns	ns	ns
	ABC	ns	ns	ns	ns
2	A	ns	<.10 (6)	<.05 (8)	<.05 (11)
	B	<.05 (3)	ns	ns	ns
	AB	ns	ns	ns	ns

(N = 43)

Notes

Third Wave

(1) High Internalizing, higher SOLO

(2)

	Hi. Instrum.	Lo Instrum.)	
Mean. Cond.	4.29	4.14)	Fact condition leads to lowest SOLO with high Instrumental but highest with low Instr.
Fact. Cond.	4.08	4.50)	

(3) High Achieving, lower SOLO

(4) Fact Condition, longer SOLOs

(5) Virtually as for (2); longer SOLOs under fact condition with low Instrum.

(6) As for (4)

Day Care

(7) Meaning Condition, higher SOLOs

(8) As for (7), but stronger

(9) Meaning Condition, longer SOLOs

(10) High Instrumental, longer SOLOs

(11) Meaning condition, longer SOLOs

70

Table 3

Determinants of Learning Quality (No. Correct)

1. Internalizing (A) x Instrumental (B) x Conditions (C) x Occasions (D)
2. Achieving (A) x Conditions (B) x Occasions (C)

		(a) Third Wave	(b) Day Care
1.	A	ns	ns
	B	ns	<.05 (2)
	AB	ns	ns
	C	ns	ns
	AC	ns	ns
	BC	ns	<.05 (3)
	ABC	ns	ns
	D	<.01 (1)	<.01 (1)
	AD et seq.	ns	ns
2.	A	ns	ns
	B	ns	ns
	AB	ns	ns
	C	<.01 (1)	<.01 (1)
	AC	ns	<.01 (4)
	BC et seq.	ns	ns

(N = 43)

Notes:

Third Wave
(1) Fewer Correct on second occasion

Day Care
(2), (3)

		Immediate	Delayed
Fact Cond.	Hi. Inst.	10.9	7.7
	Lo. Inst.	6.8	4.8
Mean. Cond.	Hi. Inst.	7.8	5.2
	Lo. Inst.	7.3	4.9

High Instrumental, better recall of facts, both immediately and delayed. Effect much stronger under factual conditions.

(4)

	Immediate	Delayed
Hi. Ach.	9.1	5.3
Lo. Ach.	7.4	5.0

High Achievers recall more facts immediately; effect fades within a week.

INVESTIGATIONS INTO PIAGET'S MODEL OF FORMAL THOUGHT

Trevor G. Bond

Townsville College of Advanced Education

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