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Preparing for Examinations: The interplay of memorising and understanding, and the development of knowledge objects

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ABSTRACT *Two groups of students (N = 28) were interviewed about their experiences of preparing for, and taking, final university examinations. The analysis examined the processes of learning used during revision, and, in particular, the ways in which understanding and memorising were described. A sequence of categories was identified through which to present a typical sequence of study activities in preparing for final examinations. One recurring aspect of the revision process involved the creation of "knowledge objects"—tightly structured, quasi-visual forms of understanding. The analysis showed that the distinction between "understanding" and "memorising" is not easy to delineate, with "committing to memory" and "rote learning of details" both contributing to the production of a knowledge object. The findings warn against too ready a linkage of intention to any specific process in student learning: a deep intention can involve rote memorisation, while a surface approach at university level will include understanding, even if it is reproduced from lecture notes. They also draw attention to the complexity of the interplay between different learning processes and so complement psychometric studies of memorisation and understanding.*

Introduction

In previous research on student learning, the distinction between deep and surface approaches to learning has pointed up contrasting intentions and processes (Marton & Säljö, 1976). The deep approach involves the intention to reach a thorough understanding for oneself, while the surface approach suggests an intention to reproduce the material to be learned. To reach their own understanding, students tend to make connections with previous knowledge and examine evidence, while relying on reproducing invites routine memorisation. The identification of a strategic approach to studying (Entwistle & Ramsden, 1983) subsequently drew attention to the strong influence of assessment on how students learn.

The existence of two contrasting ways of learning was by no means surprising. Ausubel, for instance, had already made a clear distinction between meaningful learning developed through making connections with previous knowledge, and rote learning involving "mechanical" repetition and over-learning (Ausubel, Novak, &

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Hanesian, 1978). These fundamental psychological processes are used by everyone, but not always in the most effective way. The research stemming from the work of Marton and his colleagues stressed the educational significance of this distinction within higher education, but subsequent research has sometimes placed implicit value judgements on understanding and memorising. Is memorising always an inferior process? Can memorisation play a part in developing understanding?

These questions created a particular problem in relation to the learning reported by Asian students who appeared to be over-reliant on memorisation, and so might have been expected to do badly. Their strong academic performance in Western universities belied that expectation, leading to a series of investigations into the "paradox of the Asian learner" (e.g. Kember & Gow, 1991; Biggs, 1996). This research found that many Chinese students combine memorisation with attempts to understand in ways which seemed to contradict earlier findings on student learning among Western students (Kember, 1996). This combination is seen by Chinese students as normal because "having an understanding of something implies memory, just as (meaningful) memory implies understanding" (Marton, Watkins, & Tang, 1997, p. 32). These students tend to see memorisation and understanding taking place in conjunction with understanding, making it possible to memorise with much less effort (Marton, Dall'Alba, & Tse, 1996). This combination has been labelled "deep memorising" by Tang (1991), while Marton and his colleagues have described it as "memorisation with understanding" (1996, p. 75; 1997, p. 36).

Recent inventory studies have sought to measure different kinds of memorisation. Au and Entwistle (2001) used scales describing "rote memorisation", "memorisation with understanding", and "understanding without memorisation", while Meyer (2000) found psychometrically distinguishable scales labelled "memorising as rehearsal", "memorising before understanding", and "memorising after understanding". In both studies, rote learning was distinct from the forms of memorisation associated with understanding. Au and Entwistle (2001) identified three factors in their study, one linking understanding with or without memorisation to the deep approach, and the other two representing active and passive forms of rote memorisation. The deep approach correlated negatively with rote memorisation, as would be expected, but not strongly.

The use of inventories to capture distinctions in learning processes has clarified the general relationships between understanding and different kinds of memorisation, but the very generality of their findings can also be misleading. Psychometrically distinct scales help to map the domain, but can also create impressions of uniformity, thus disguising important variability in the ways individual students go about their work (McCune, 2001; Entwistle, McCune, & Walker, 2001). In interviews, there are other confusions created by the use of language. Students can mean rather different things when using terms such as "learning", "memorising" and "understanding" to describe how they tackle academic tasks (Entwistle & Entwistle, 1991).

This study uses two series of interviews carried out previously, reanalysing the transcripts to look specifically at the interplay between different learning processes in the development of understanding. The interviews relate solely to one context—

preparing for final degree examinations. This limits the generality of the findings, but does illustrate clearly how that context affected the learning processes adopted.

Method

Aim

The current analysis was designed to explore the different learning processes students described in preparing for, and taking, their final examinations, and to consider the interplay between memorising and understanding which may take place. It also focused on how memory is used in both revision and examinations, and on the context within which these activities took place.

Sample

In the first investigation, two pilot interviews and eleven full interviews were carried out with final-year university students shortly after they had completed five final examinations, typically answering three essay questions in three hours. This group consisted mainly of psychology students, but also included two medics, two zoologists and a biochemist. This first series of interviews was essentially an exploratory study of how students went about their revision and, in particular, how they developed and experienced their understanding as they prepared for finals (summarised in Entwistle & Entwistle, 1997). A second sample of fifteen students, all taking social and economic history, was interviewed both during the course and immediately after finals. In these interviews, the main focus was on how essays were researched and written, both for course work and examinations (Entwistle, 1995).

Data Collection

In both studies, interviews generally lasted about an hour and covered predetermined areas of interest, using a conversational style to allow free exploration of the issues. In line with phenomenographic interviewing, students were asked to reflect on their experiences and were asked to explain, in as much depth as they could manage, what processes of learning were involved. Students were encouraged to reflect on a particular activity and how it was experienced at the time, in order to reach what Marton has called "meta-awareness".

> Sometimes such reflection occurs spontaneously, and sometimes the interviewer and the interviewee have to work together to reach the required state … The researcher is mindful of working toward an articulation of the interviewee's reflections on experience which is as complete as possible, … bringing the interviewee repeatedly back to the focus for reflection, (through alternative questions or) … offering interpretations of … things the interviewee has said earlier in the interview. (Marton & Booth, 1997, p. 130)

Data Analysis

In both sets of interviews, students were asked about the learning and study processes they had used in preparing for, and taking, examinations. The time interval between the two sets of interviews meant that it was possible in the later interviews to anticipate, and check and explore more thoroughly, certain aspects of students' experiences. Previously published analyses had used only the first data set to examine, firstly, differing forms and levels of understanding (Entwistle & Entwistle, 1991) and, secondly, the experience of "knowledge objects" (Entwistle & Marton, 1994). The current analysis looked specifically at students' learning and study processes to consider the interplay between memorising and understanding, both in general and more specifically in the formation and subsequent use of knowledge objects.

The earlier work had already described, in a general way, how students prepared for Finals, thus establishing a preliminary framework for the current analysis. Initially, transcripts were scanned to identify occasions when students mentioned the learning processes they had adopted in revision. The extracts were then examined, both individually and collectively, to identify how students described using "understanding" and "memorising", and how these processes fitted into their overall revision strategy.

Interpretation and reporting of interviews depend on producing an appropriate analytic framework within which to locate comments. In phenomenography, the interpretative framework focuses on conceptions of phenomena, and often results in a hierarchy of categories that allow the researcher to explore and display the differences between individuals and the logical relationships between the categories of description emerging from the analysis (Marton & Booth, 1997). In this study, the focus was not on the students' conceptions of revision for examinations, but rather on their experiences of, and reflections on, the study activities, strategies and learning processes they had adopted. A framework for this investigation required sufficient generality to cover a majority of the students' reflections on their study activities and their reasons for adopting them. Rather than seeking to distinguish *differences*, it was decided to describe a *general* revision process, using an ordered set of categories to display the steps typically used within the revision process.

This analytic approach inevitably implies that there is a similar pattern of revision practices among all students. Although there were common elements, students did not necessarily mention, or carry out, every stage within the flow diagram. Other variations were also noted between individuals, although these could not be investigated systematically within a small sample. Nevertheless, the extracts used to exemplify the meaning of each category also illustrate some of these individual differences.

Findings

Although all the students indicated they had focused on understanding, the extent to which they had developed an individual form of it differed markedly (Entwistle &

Entwistle, 1991; 1997). Some were seeking their own, somewhat individualistic, understanding of the discipline as a whole, while others concentrated on being able to present an understanding which would be immediately recognised and accepted by the examiner (usually the lecturer who had taught that part of the course). All the students were strategic in their revision, but to differing extents. Their descriptions produced recognisable patterns in using the various learning processes although, as already mentioned, idiosyncratic elements still remained.

Figure 1 presents the series of categories used to describe aspects of the process of revising and taking examinations, and ordered so as to present a typical sequence

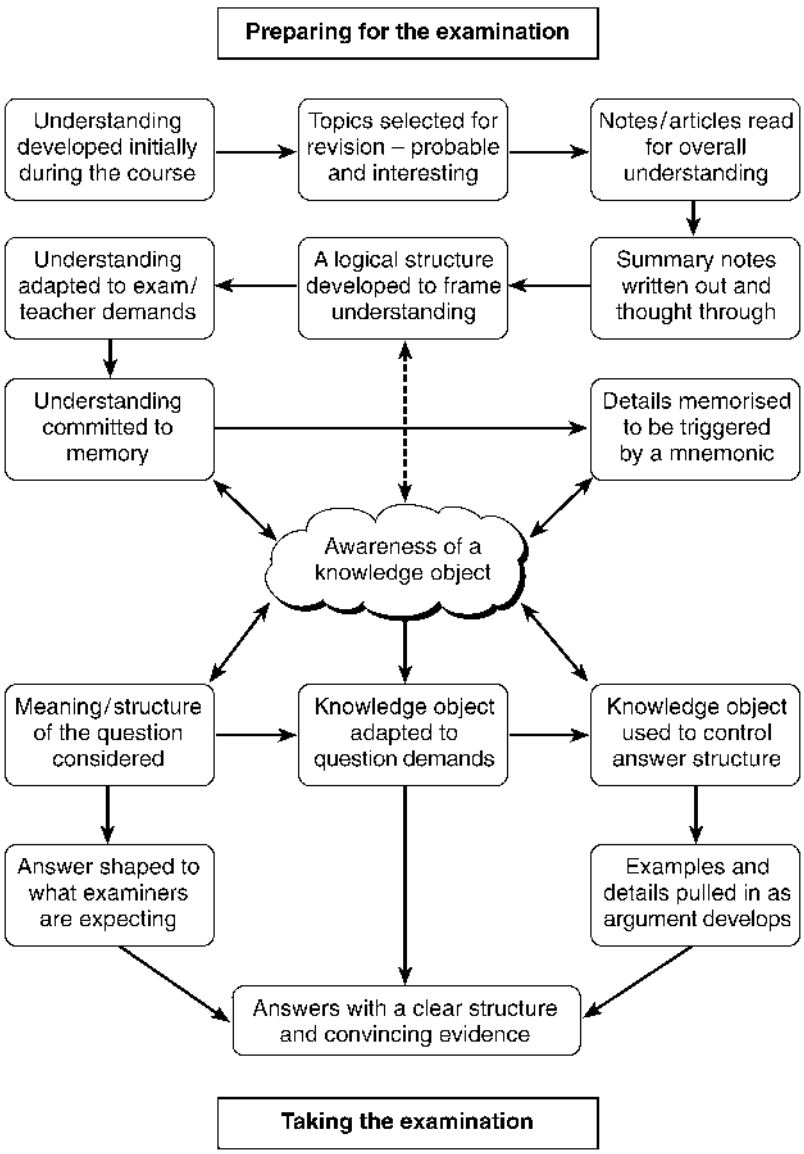

FIG. 1. Ordered set of categories used to describe revising and taking exams.

of activities. The top half of the diagram covers elements identified within the revision process. For the purposes of this paper, the focus is mainly on revision and how memorising and understanding were used within it. To complete the picture, the bottom half of the diagram indicates some of the ways in which students used their memory of the revised topics during the examination, although these categories are less fully illustrated through extracts.

The categories will be presented within the sequence indicated within Figure 1, with extracts used to create a fuller impression of the meaning of each category. However, as several of the extracts cover more than one of the steps in revision, the meanings of the earlier categories of description will become clearer as subsequent comments from students are introduced. Student code numbers with an "S" prefix come from the initial sample of psychologists and other students, while those starting with "H" were all taking economic and social history.

Aspects of the Revision Process

Preparation for examinations cannot be seen wholly in isolation from more general aspects of studying. What students do when they begin their final preparation for examinations depends on what they have done previously. Hence, the analysis of revision begins with students' comments on the understanding they achieved during the course itself, from lectures and other learning experiences. The sequence of activities suggested in Figure 1 indicates steps within a revision strategy mentioned by some, but not all, students. It was very common for a majority of these steps to be followed—preparatory review of all notes, producing summary notes, checking understanding of those notes, and memorising both the structure of their understanding and the details to support it. A quite different system was, however, used by a minority of students who had prepared for the examination by using published review articles rather than previous notes.

Earlier analyses had shown that some students, particularly those adopting an active, deep approach to learning, reported a distinct form and structure in their understandings, which were seen almost as independent entities, controlling their thinking paths (Entwistle & Marton, 1994; Entwistle, 1995; 1998). The term *knowledge object* was used to describe the essence of these experiences. It involved awareness of a tightly integrated body of knowledge, the visualisation of its structure in a "quasi-sensory" way, awareness of unfocused aspects of knowledge that could be brought to mind as required and recognition of its use in controlling explanations (Entwistle, 1995). Several of the steps in the revision process contributed to the formation of knowledge objects, as will be become evident in outlining the various stages in sequence.

Understanding Developed Initially during the Course

Several students indicated that they were able to understand the material presented in the lectures immediately, without having to "learn" it. The knowledge was being directly absorbed from the lecturer's presentation—at least if the lecturer was

explaining the material well and the student had a good grasp of the topic. The term "understanding" was being used here to imply "comprehension" or getting a sense of the overall meaning, but students recognised that this level of understanding was still rather superficial and would subsequently need to be broadened and deepened.

S8: Lecturing to a whole 200 people might not be effective for some, but I've always found it a good way of learning, and also learning for understanding (a topic) at the time, (and then) to go away and try and learn it.

I: What form of learning is it, then, in the lecture?

S8: I don't know. I mean, something goes in, because when I read all my lecture notes I remember things … I remember the themes. I mean, I certainly don't remember concrete examples of experiments or studies but, when I have gone over notes, I can remember the sort of gist that he's trying to get across; … the general feel of the lecturer, his sort of point of view and what he was trying to get across on various issues …

……

S10: The theories have been absorbed very quickly … because, I suppose, the theory is much more related to your basic understanding—if you understood it at the time, the theory tends to click. I mean if you understand why "Optimal Foraging" works, and what the idea is behind it, you'll understand it, and you can't not understand it—you can't "de-understand" it!

Other students commented that "understanding" was not a once and for all state or experience. Understanding depended on prior knowledge and developed as new knowledge was added, so understanding had to be judged in relation to the stage of development currently reached.

I: How do you know that you understand something?

S1: Well, with past experience you can relate it to something … But sometimes, when it's all clicked into place, later on you discover that it's not necessarily clicked into the right places, so you could have a feeling that you understand, but I mean your understanding is inevitably—even if it's right at the time—incomplete.

I: And how do you know when you don't understand?

S1: Because it just doesn't connect, because you can't make logical connections between the bits … Well I don't suppose that you actually know you don't understand, you just don't feel at ease with whatever it is you are meant to be doing, you're confused … (When you understand) you do definitely get a feeling that the penny's dropped, it just all clicks into place and you just see … If you don't understand, it's just everything floating about and you can't quite get everything into place, like jigsaw pieces, you know, suddenly connect and you can see the whole picture.

Topics Selected for Revision

None of the students tried to revise everything, although there were very different strategies in terms of what proportion of the course was covered. Past papers were used as a guide, and a set of topics chosen which would form the main focus of revision.

I: So you would start by looking at past papers to see the sort of questions which might come up?

H5: Yes, and also to get a feel of what the question type will be, and following that looking at the lecture notes and, more importantly, the reading lists and then picking the relevant readings and noting those.

.....

I: You say that you looked over past papers. Did you attempt to spot questions?

H14: Not so much questions, but certainly themes. Our tutor kept telling us that she wanted to see that we had knowledge from the whole year. And that's why I did spend quite a lot of time going through the papers, but I did want to pick on four specific themes because I felt it was just ludicrous to try to know everything in detail.

.....

H6: I know some people who made the mistake of learning whole courses … They may have a far better question choice, but they don't get any marks for essays they didn't write. I felt I had to approach the exams very much on that basis. Because of the short time, I knew I had to manage my time extremely well.

Notes and Articles Read for Overall Understanding

The first step in the revision process proper generally involved reading through all the notes on the selected topics—handouts and notes from both lectures and additional reading. The aim was "to understand" the topics, but an important distinction was made between an understanding for oneself and an understanding which would be strong and memorable enough to meet the requirements of the examination. The latter involved a condensed, readily accessible form of understanding that could be more easily committed to memory.

I: It sounds as if you're distinguishing between understanding for yourself and understanding in order to write an exam answer. Are these two different things?

S8: Well, yes. After I've been reading all the books for three or four weeks, I understand things perfectly well … I would be able to have a normal conversation about all sorts of issues, but I couldn't have written an exam essay on it. Whereas, after I had been at home, after I had actually gone over things, actually memorised it, written it down, then I could write an essay on it … The problem is … I feel I

understand so much more than I can put down in exams. So I find there is always at the back of my mind, that … I've got to learn this for exams.

……

S11: I understand virtually everything that we go through in the class—it all makes sense and I can follow it step by step. So it's not the understanding (that's the problem), it's the actual learning and remembering.

Summary Notes Written out and Thought through

After having done a preliminary reading of the notes on the topics chosen, many students produced condensed summary notes, perhaps with several iterations, which were then used to check their understanding. Writing these notes was not necessarily just a mechanical process; it could provoke consideration of logical connections within the material being summarised, and thus involved relational knowledge. This activity seemed to develop personal meaning for the student by drawing attention to new ways of structuring their understanding.

I: From what you've said, you had notes on seminars, notes on prior reading and notes on last minute reading—focused reading—and then you made condensed notes—what would the final condensed notes be made up of?

H1: I would read through the topic—I would have quite a thick wad of notes by this time for each topic—and I would make myself write it all out again without the notes to try and fix it in my memory. I would just put down on a piece of paper, either five or six points of the main things for each topic. They would be very broad points which would trigger my memory once I got into the exam—just key words almost, sometimes they would be almost sentences.

……

S13: When it came to (revising for) Finals I read most things—to get a sort of general view of what was happening. This was what I did for things like Animal Kingdom … I read through all the groups and pinpointing gradual changes or differences between the groups, like respiration or skeleton—and how this changed (by evolution) through the groups. And then I wrote down what happened in these groups and examples from each, … (using) a set of condensed notes, which I then transferred onto a small card index.

I: Did you then learn the examples on these cards?

S13: Very little learning goes on—I just knew most of it already. But it helped me to get an overview of the (zoological) groups by looking at common features across them … By doing this, it made you understand it as the subject is, being tied together.

A Logical Structure Developed to Frame Understanding

The process of condensing notes, as we have seen, often helped to clarify topics and begin the process of organising them in more personally meaningful ways. Sometimes, the structure was provided in the lecture notes or obtained from a review article, but often a new one was formed in the process of revision and reflected the student's own emerging view of the topic. The emphasis on structuring their own understanding represented, for some students, a first step towards the creation of what has been described as a "knowledge object"—the construction and awareness of a tightly integrated body of knowledge.

I: You were saying that if something's not in a certain position on your (revision) card you're unhappy about it.

H14: Yes, it goes back to this idea of knowing where it is on the card … For example, I've got here the politics of why these organisations were set up, then I've got general points about three organisations. And then I've got a couple of things that they did, and at the end I've got links to the broader Scottish economy. At the very end, I've got something on important dates to try and link it in with other people … So, when I'm revising, I'm not just looking at, say, the Board of Trustees, I'm thinking about it in conjunction with (other things), why did it start up, who was involved, and all the rest of it.

……

I: So a (review) article like that organises it for you?

S2: Yes. Once I have got to grips with what it's actually saying, I find out who said it, what the evidence is, and then look at it. That's my simple picture and the implications of it as well.

……

H1: I always tried to structure my revision so that I could understand what was going on and I could see how everything fitted in. So, although I had this structure when I went into the exam, I still wanted it to be flexible so that I wouldn't be worried by the (particular) question … I wouldn't be stuck if I couldn't remember what came next in my plan, because I would still be able to understand how everything fitted in and be able to draw from information that I remembered.

……

I: How did you go about understanding things?

S9: Well (it's) just being able to maybe have a skeleton where I could hang experiments on to prove points this way or that way, or apply it to real life circumstances … and try and work out some sort of link … (It became) a kind of master plan for understanding things.

I: How do you construct the skeleton and where does it come from?

S9: Try and get into the jargon of it first, you know, make sure you know your way around so you're not frightened off by the words.

I: But how does that create a skeleton?

S9: The words themselves must have some kind of scheme to them, some sort of way that they link. Let me think of an example in schizophrenia—talking about the Dolphomine hypothesis, which is basically just a biochemical theory of how it might work. The first thing I would do would be to find out in one sentence what it is, and that would be maybe the first skeleton. Then start to build up; what are the different parts of the theory, what assumptions does it make … You start finding out what the core of it is, and then gradually work outwards …

I: Is it a visual structure you create?

S9: It's sort of visual, but it's not really. I find it hard to describe how I would remember it.

Understanding Adapted to Perceived Examination and Teacher Demands

The more strategic students were very conscious of what lecturers were looking for and tailored their revision to what they believed particular staff expected to see in the examinations.

H12: The lecturers put a lot of emphasis on knowing the writers' names, you really need to know the literature quite well. So, I would visualise somebody's name and what the article was about just very briefly, and when I remember that—that's from my last minute notes—a lot of it comes back from what you've read. Just a couple of things to jog your memory. So I try and visualise that.

I: Are things a lot better for having found that mental "coat hook", so to speak?

H12: Yes, I think so. Also, it took me a while to actually realise that is what they're looking for—evidence that you've done the reading. You can write for ages, and you might know it all, but it's better if you say where you got it from. So, it's quite useful to do it that way, I think.

……

I: How did you revise for that?

H15: It was basically trying to home in on the basic concepts and theories, as we knew that the lecturer particularly liked concepts, theories and arguments.

……

S9: And (in the revision) one thing was … to do a kind of profile in my head of each lecturer and what their hobby-horses are.

Understanding Committed to Memory

The distinction between understanding for oneself and being able to convey that understanding within the constraints of a three-hour exam led students to produce

condensed notes within a clear structure, and then commit their understanding to memory through re-writing the notes or repeating explanations out loud. Some students saw that as no more than a process of repetitive memorisation, but for others it was a necessary part of strengthening and confirming their understanding. Committing to memory is also an important step towards producing a knowledge object, one which often leads to the experience of "visualising the structure in a quasi-sensory way".

S8: (I'm) actually thinking about it as I'm writing it down (in my summary notes) … Then, what I'd do, I'd get up from my desk and start lecturing, … walking around, pacing up and down, … and (explaining)—that means that I understood it … But … that understanding wouldn't help me in the exam, because you're under pressure, you've got to remember things quickly, and get the facts down. (So, I used) rote memorising, as a memorising tool, so that … I could have all the points there in the exam.

……

S10: Because I had to tackle so much, over such a short period, I designed a sort of check-list system … It's systematic, but it's based on this hierarchical method, going from many to a few … Basically what I used to do is come to the top of a page and it would say, (for example) Carbon Cycle, and I used to write about (that), and it was obvious I knew what they were talking about. (Other times there were) a few points I'd missed out, or I didn't have a clue. Then, I would just have to write it out again and try and remember it. It's this sort of process of testing myself … Basically it went from going through the whole lot and making notes, then I'd go back to the next stage—this was (producing) condensed notes—and again I would ask myself if I remembered it, and if I could then talk about (it), then that went off the list.

……

H1: I like to do (my revision) more by a process of understanding and seeing how things fit together. Because, if I can't, then I find it very difficult to get to grips with the topic. It would be a matter of reading through the notes that I had made and seeing how everything fitted together, both in chronological terms and facts and changes. And then I would just make myself write out a pattern, just try to remember figures and names and dates and then I would look through my notes and almost mark it, and in doing so I would remember the things that I hadn't put in.

I: There seem to be almost two processes going on—one is getting yourself a clear structure you can remember quite easily, and the other the supportive details which get connected to this. How did you remember these details?

H1: I think it just purely came down to memory. I would have to

remember that for each point there is a lot of associated points. But I didn't want to keep it too complicated, I wanted to reduce it down to its basic structure, then expand on that … It was in so much detail that you began to lose the overall structure of what was going on. Some people can remember detail quite clearly, but I really need to see how it all fits in.

Details Memorised, to be Triggered by a Mnemonic

The previous extract distinguished between the use of summary notes to commit understandings to memory and a rather different form of learning that dealt with details—a distinction that was found in several other transcripts. Students could often visualise the structure of the summary notes, but then had to use a rather different process to memorise the details and subsequently bring them to mind. By establishing links between details and structure, another defining feature of a knowledge object is being created—"awareness of unfocused aspects of knowledge".

I: So what was on this set of cards—were they things that would be learnt?

S13: I wrote the names and dates of relevant papers and a brief description of what they'd done … They'd trigger off the experiments, and these were the things that I often had to learn—names and, more importantly, dates.

……

I: Do you try to learn specific names and dates?

S2: Yes, towards the end I do, but not when I'm learning the actual matter itself.

……

S6: (My revision notes) were just little charts that linked everything up together (with) a little diagram in the centre and sort of spokes coming out … I (used them for sorting) an argument out in my head, sorting out where everything was pigeon holed … It was a mind map.

I: How were you using this in relation to revision? To construct an argument?

S6: Also to remember specific names.

I: Right, this mind map has labels on it? What are those labels?

S6: Well it has branches coming out of the centre and I suppose they are the (main) argument, and then on the branches coming out from each main branch there would be subsidiary arguments …which is right and which is wrong, according to experiment … that kind of thing.

I: Where do the facts come? At the tail end of these arms?

S6: Yes, Yes … I suppose the fact is in the argument that comes off the branch that comes off the main branch to which the name is then pinned at the end. So what the name triggers, is the whole branch going backwards.

Awareness of a Knowledge Object

The "quasi-sensory" experience associated with the establishment of a knowledge object was partly a sense of wholeness, but also an ability to manipulate the understanding through visualising its "shape" and structure. Responses mentioning visualisation and its use in thinking are thus central to the identification of knowledge objects within students' comments. In considering the rather different forms of representation illustrated below, it may be helpful to distinguish between a remembered image or diagram provided by someone else, and a knowledge object which is constructed in the process of developing a personal understanding. During revision, students were describing remembered images on some occasions, and on others, describing how they had used such images in the process of developing their own understanding.

S12: I can see that (part of my revision notes) virtually as a picture, and I can review it and bring in more facts about each part … Looking at a particular part of the diagram sort of triggers off other thoughts. I find schematics, in flow-diagrams and the like, very useful because a schematic acts a bit like a syllabus; it tells you what you should know, without actually telling you what it is … The basic diagram is on paper, but details about the diagram are added on later by myself in my head … The facts are stored separately, and the schematic is like an index, I suppose …

……

S10: (What I visualise), it's the general shape, and once I get that general shape on paper the rest will follow. (Draws) At the moment I'm visualising an (animal's) head there, and that's basically what I see. I know there are muscles in various places, but I'm not going into that sort of detail when I first think of it. I just have the rough shape … I've learned two-dimensional on that plane, and two-dimensional on that plane, and then I've seen a real skull; so basically I've got these two which are put together alongside the object memory, and so this allows me to rotate it in my mind … You don't actually have a picture of either a (diagrammatic), non-realistic skull, or a real skull, you just know where everything is.

……

H10: I would sometimes take myself through a topic, say when I was in bed at night before I fell asleep.

I: When you were doing that, would you be visualising it?

H10: For some courses, it would definitely be a visualisation. For something where you can picture things, like the tobacco trade, and it's development in Glasgow or piracy and privateering, I would visualise both the notes and perhaps even the situation at the time. I did an essay on the development of industry in the west coast around Glasgow and I would picture a map of the area really, and go through

each of the regions and I could picture the Forth and Clyde Canal and that can lead on to (a whole essay structure).

Sitting the Examination

Memory and understanding still played an important part in the examination itself, although the interviews did not examine these aspects as fully as in the exploration of revision strategies. The extracts that can be provided here are thus much briefer and, for the purposes of this paper, they focus on the ways in which students made use of knowledge objects produced during revision to cope with the demands of the examination.

Considering the Meaning and Implied Answer Structure of the Question

Most students realised the importance of thinking carefully about the specific question set, recognising that they had to determine what lay behind the form of words it contained. They might see an implied answer structure in the way the question had been formulated, and gratefully accept it. If not, they had to consider how best to adapt their knowledge to what was being asked. Students differed markedly in their ability to handle these demands, with some only writing about the topic in general terms, because they were unable or unwilling to reorganise their understanding.

H1: I was asking myself what the question was looking for, and I decided that it would help if I could remember the actual wording. I decided it was asking me what the limitations were in investigating theories of distribution of wealth and income and why, if I was to look at a survey, what the points were I should remember. I shouldn't take it at face value, but I should be able to understand that there are several limitations.

……

H4: I suppose often it's the word like "assess" or "discuss" or "to what extent" influences the balance (of the essay) I think. It may be the same basic information that you have that you could use for several questions, but there's this sort of trigger of phrases in the question which show how much should be balanced towards certain aspects … (I use) the introduction (as) a way of making sure that the person reading it and marking it, knows right from the beginning that I wasn't just going to go into masses of detail about the experiments and not address the question.

Adapting a Knowledge Object to the Question Demands

Students who had developed well-structured understandings of topics, sought to adapt their underlying knowledge objects to the perceived demands of the question.

H1: I had tried to structure my revision … to be flexible, so that I could approach the question (itself) … I think you're almost developing what you know and are playing it in a slightly different way. I think that's what they're looking for; that's why the question always has a slightly different twist. It's just really a matter of trying to recall something you've learned and understanding how it fits in.

……

I: It sounds as though you might have prepared part of the structure for that question beforehand. Did you have to adapt it very much to the question?

H6: This one was very good in that it did seem to be a bit of a gift. This is maybe more the exception than the rule, with other questions it's different. I didn't do model answers … You tend to be adapting what you know; certainly not just big paragraphs going straight down. I've never learned anything in that way; I think it's detrimental to learn like that.

Using a Knowledge Object to Control the Answer Structure and Pull in Supportive Details

The adapted knowledge object generally provided a ready-made structure to control the logical flow of the answer and triggered supportive details as the explanation or argument developed.

H4: (The logical structure I've worked out) does control (my answer) very much because that is all really fixed in my mind … I've never really … totally changed my mind half way through the essay. So the shape is obviously really clear in my mind before I start. I might remember some more information, but I don't really change (the structure).

……

S1: (As I wrote), it was almost as though I could see it all fitting into an overall picture. I think you're almost developing what you know, and are playing it in a slightly different way (to fit the question set).

……

S10: Following that logic through, it pulls in pictures and facts as it needs them … Each time I describe (a particular topic), it's likely to be different … Well, you start with evolution, say, … and suddenly you know where you're going next. Then, you might have a choice … to go in that direction or that direction … and follow it through various options it's offering … Hopefully, you'll make the right choice, and so this goes to this, goes to this—and you've explained it to the level you've got to. Then, it says "Okay, you can go on to talk about further criticisms in the time you've got left".

Shaping the Answer to the Examiners' Expectations and Monitoring its Adequacy

The more strategic students were very aware of what they believed the examiners were expecting, and wrote their answers to achieve the desired impact.

> S12: In an exam, you have to have background knowledge of the subject, and an ability to interpret the information in your own way … You don't sit down and think "How much can I remember about this particular subject"; you try and explain your ideas, using examples which come to mind … You can't use all the information for a particular line of argument, and you don't need to; you only need to use what you think is going to convince the examiner.
>
> ……
>
> S3: The more I have done exams, the more I'd liken them to a performance—like being on a stage; … having not so much to present the fact that you know a vast amount, but having to perform well with what you do know … Sort of, playing to the gallery … I was very conscious of being outside what I was writing.
>
> ……
>
> H6: I think you're very much marked on how different you are to somebody else, … so you're trying to make them think this is something different or special. Something to make them think, "That's just taken him that little bit further and has given him that little bit extra, so it gets the extra three marks".
>
> I: That's very strategically thought out.
>
> H6: I think you have to. I felt I had to approach these exams logically and strategically.

Bringing together the implications of comments made about the whole process of taking examinations suggests that several forms of awareness can be used in monitoring the effectiveness of an emerging answer (see Figure 1). Students have to keep in mind the form of the question, the structure of their adapted knowledge object, and the expectations of their audience of examiners. They also have to monitor the adequacy of their emerging answer in relation to the perceived requirements of the question. All these forms of awareness make substantial demands on students' concentration and stamina, adding to those imposed by the question itself in testing their knowledge and understanding of the topic.

Discussion

This new analysis was designed to explore the learning processes used by students in preparation for final examinations, within the general framework of their revision strategies. A sequence of activities was identified and used as an analytic framework through which to summarise the main characteristics of students' revision strategies and learning processes. The sample was not large enough to allow any detailed examination of different individual patterns in the learning processes, but the

extracts do suggest some of these variations. The students' comments made clear how memorising and understanding had been used at different stages of their revision, and also indicated how the meaning of these terms changed when used in different situations.

Memorising and Understanding during Revision

Earlier and ongoing research has developed inventory scales that distinguish between the different forms of memorisation and understanding used by students, and has identified some of the cultural differences underlying that usage. The simple dichotomy between memorisation and understanding is potentially misleading. Meyer (2000; 2001) has shown that there are clear variations in how students respond to inventory items, allowing distinctions to be made between rote memorisation and memorisation related to understanding, and also between memorisation taking place before or after understanding. The current analysis provides a different perspective on this phenomenon, based on a qualitative analysis of sequence and purpose, and consideration of how understanding changes during the process of revision.

Students talked about being able to understand immediately the topics introduced in lectures or books. This implies a learning process in which knowledge is "absorbed" directly as it is presented, equivalent to what Ausubel described as "meaningful reception learning" (Ausubel, Novak, & Hanesian, 1978). Such learning depends on sound prior knowledge and engagement with the task, but is probably the most frequent learning process used in traditional forms of education. In terms of preparation for Finals, however, students saw this form of understanding as inadequate in two ways. The lectures had provided no more than an outline understanding that needed to be filled out by further reading. This led to a deeper level of understanding, yet was still not generally considered adequate as preparation for the examination. Students felt that their understanding had to be more consciously structured to make it immediately accessible during the examination. For that reason, they wrote topic summaries and often created patterned notes as mnemonics that could be readily visualised.

The distinction suggested by the current analysis is between "memorisation"—implying a process of repetitive overlearning—and "committing to memory". Memorisation is a largely mechanical, unreflective process of *forcing* knowledge into memory by conscious effort (Au & Entwistle, 2001). "Committing to memory" is more like "meaningful reception learning" repeated several times, with understanding being sequentially deepened and regularly checked. This process appears to be somewhat similar to the "deep memorising" of Asian students, but still with important cultural differences. Even memorisation retained a meaningful focus when revising for Finals, as the details were being incorporated within a framework of understanding.

The analysis serves to warn against any rigid linkage of intention to a specific approach to learning. A deep intention can involve memorisation, particularly of specific details or technical terminology, while a surface approach at university level

will include at least a modicum of understanding, even if it is at second-hand, reproduced from lecture notes. A deep approach leads to understanding of a quite different quality to descriptive reproduction, carrying with it personal meaning for the individual student.

Knowledge Objects and Learning Processes

The first series of interviews had already provided the initial description of "knowledge objects" and so the second set allowed more focused questioning of the students. As a result, the new analysis has been able to clarify the ways in which students develop knowledge objects. Each of the steps in the revision process for strengthening understanding and making it more memorable can now be seen as contributing sequentially to the defining features of a knowledge object. "Awareness of a tightly integrated body of knowledge" was heightened by looking for meaningful relationships in writing the summary notes. "Visualising the structure in a quasi-sensory way" was a by-product of notes designed as a mnemonic to represent personal meaning and a logical structure for the topic. "Awareness of unfocused aspects of knowledge" came from the memorisation of details within the mnemonic structure. The way knowledge objects were used during the examinations involved controlling explanations, and also pulling in examples and details to support emerging explanations.

Knowledge objects proved a valuable concept in making sense of students' experiences of revision. Their use within examinations generally related to the mnemonic through which they were brought to mind, but some students only visualised their notes during the examinations as a last resort. In those circumstances, understanding was tapped directly, with visualisation being "available", but not often used—as we can see by extending a previous extract used to describe an awareness of a knowledge object. The student had described how she visualised an animal's head (see S10, p. 32 above). Further probing by the interviewer led to extended reflection on the experience of visualisation and memory, from which came the notion of a "central memory" that could be accessed directly and used, when required, to create a conscious visual image.

> I: Is it just the general shape of the head you are visualising?
> S10: It's the general shape, and once I get that general shape on paper, the rest will follow …
> I: The trigger is that shape, and that shape produces a name?
> S10: Well basically I remember, I see the picture, and if I were to probe deeply I could probably see the names of the bones in the notes I've stored in my brain … When I'm in an exam situation this visual memory is not so obvious, because (the process) is much faster … I don't know if the visual memory is by-passed … (Perhaps) you have a general memory (that) can either be expressed visually, mechanically or orally, but in extreme stress situations it just comes straight out.

I: The stress is speeding things up, short-circuiting some of the processes?

S10: Yes, it's almost like you don't need to see it consciously … I don't perceive it in any particular way, I just know it … And that may show it's not actually a visual memory as such, but a visual expression of central memory. So you may remember this graph in many ways. You may remember it from having drawn it or from having just thought about it, but to actually reproduce it on paper, you may or may not have to go through the visual process of remembering what it looked like on the page. It may be there automatically, from having drawn it, but you don't know. You may say you've got a visual memory of it if you have to search for it, but otherwise it just appears, and therefore it's just a memory that may or may not be expressed visually.

Several years' later this same student, who had subsequently come across the notion of a knowledge object, was able to recreate the knowledge object developed to represent her understanding of two component explanations of bird migration (Entwistle, 1998). This memory was triggered by two images—a bird in a cage (representing long distance navigation using polarised light and investigated experimentally) and a birds' eye view of countryside (representing local navigation through previously visited territory). Questioning the meaning of the two images enabled the student to recreate the structure of her understanding—her knowledge object. Perhaps there is a reciprocal relationship between images and knowledge objects: images can be used in forming a knowledge object, and they also reside in memory, acting as triggers for the reconstruction of a knowledge object. The underlying understanding apparently exists independent of any visual representation, but visualisation may help in explaining that understanding to others.

Knowledge Objects and Objects of Study

Since the earlier analysis which reported the idea of a knowledge object, a somewhat similar idea has been introduced which examines the focus of students' attention as they learn. Marton and Booth (1997) described the construction of an "object of learning", while Patrick (1998) defined an "object of study" (from the teacher's perspective) in the following terms.

> This study … makes visible what is actually taught. I mean by this not what is proposed to be taught—the topics or objectives specified in the curriculum—but the way the subject is presented to students, and the tasks they are asked to address … Where they intersect within the discipline they are studying … , is what I call the "object of studying". (Patrick, 1997, p. 2)

Essentially, both Marton and Patrick are drawing attention to the context within which learning takes place. The processes of teaching and learning within a par-

ticular social situation provide a set of experiences which create an object for students to learn. How that object is perceived depends on the student's own previous educational and personal history, and also on the way the subject is taught. Patrick gives vivid examples of the contrasting ways in which secondary teachers interpret their subject, reflecting their own distinctive ways of conceiving it. Other work has suggested that students are presented with a "target understanding" constructed by the teacher, and the level of the student's own "personal understanding" is judged in terms of the match with the target set (Entwistle & Smith, 2002). In higher education, it is generally less clear than at school what is expected by staff, and so students are forced to interpret the target understanding largely for themselves. This can be seen as creating individual contextualisations of their studies (Scheja, 2002), which lead to different coping ploys in dealing with any difficulties produced by the teaching and assessment requirements.

Marton sees the *object of learning* as being a complex of individual ways of viewing a phenomenon, towards which students progress as their understanding increases—it is not "in the head" (Marton & Booth, 1997, p. 163), but within the relationship between the individual and the phenomenon. In describing the *object of study,* Patrick (1998) puts the emphasis on the effect of the teacher's perspective on the subject. *Knowledge objects*, as they appear in the current analyses, are clearly influenced by the perceived requirements of both the lecturer and the examination, but they are experienced as being "within the head". The differences, then, between an object of learning, an object of study, and a knowledge object, lie in the focus of attention of the researcher. They depend on whether what is being described is the individual experience of understanding, the set of those experiences examined collectively, or the teaching and assessment context set up by the teacher to develop a particular kind of understanding. In reality, these are facets of shared experiences highlighted by contrasting research goals, and by collecting and analysing data in rather different ways.

Conclusion

The current analysis of these two sets of data has illustrated the value of using an ordered sequence of categories as an analytic framework, where the purpose of the research is to examine an extended study activity. The analysis has confirmed the value of distinguishing different forms of memorising and understanding. It has also produced further insights into the formation of "knowledge objects" in the process of revision and into their use under examination conditions. While examinations have been increasingly castigated for encouraging memorisation and reproduction, our analysis has shown that the process of revision for essay examinations can involve deep reflection on topics and an active search for understanding, at least where conceptual understanding is being expected.

The current study is restricted by its specific context—preparation for final examinations. It does, however, illustrate a pattern of interplay between memorisation and understanding that would almost certainly be found in other situations, although used in rather different ways. Further fine-grained analyses of study

activities would be valuable to see how the contrasting learning processes are used in other contexts.

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