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Student Prior Learning Experience – Its Significance to Course Perception, Approaches to Learning and Learning Outcome (A Case Study in Canada)

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Findings from traditional studies in student learning indicate that a student's perceptions of the learning environment, learning approach, and learning outcomes are interrelated. This case study suggests further that the prior learning experience of the student could lead to variation in the perception variable. A student with surface learning experience would only focus on the surface element of the course and adopt a surface approach to study. By using two interview tasks, this study also suggests that a student who adopts a surface approach to learning, depending on the level of the task, could also attain a deep level of understanding. In this case study, the student generated a canonical conceptualization of meiosis but failed to apply that concept to a complicated task. All these two findings have significance for educational researchers and practitioners in course design.

Key words : prior knowledge; learning process; learning outcome

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Introduction

Conventional wisdom would hold that students in higher education should be expected to learn complex scientific concepts and develop independence of judgement in their coursework. Entwistle (1984) found that while most tertiary teachers (educators) believed that the university experience, and their own teaching subject in particular, should affect their students' learning and thinking qualitatively, they found year after year that this was not the case for many students. According to the teachers, the problem was seen to reside in the students. Students, on the other hand, see the problem as residing in the teaching they experience.

The focus of the study is on a third year genetics course at a Canadian University that is pre-requisite for all biology students. Typical of genetics courses at other universities, this course assesses student understanding of concepts chiefly by problem-solving. Both teachers and students alike acknowledge that genetics and genetics problem-solving are extremely difficult to learn and to teach (Smith, 1988). Similarly, owing to its emphasis on problem-solving, this course has the reputation of being extremely difficult. Recent results of pilot interviews of students revealed that students who enrolled in this course had serious concerns about their likelihood of success. This stemmed from the fact that a significant number of students who performed well previously in other science courses had minimal success in their genetics course. The present study is an attempt to investigate the effect of the students' perceptions of the genetics curriculum and the assessment tasks on the way they typically approach their learning in genetics. It is first necessary to define research traditions in the learning literature and "approach to learning" as used here.

Some Common Approaches to Learning

During the past decade, several studies of student learning in higher education identified students' approaches to complicated problem solving tasks in different subject disciplines (Marton & Saljo, 1976; Svensson, 1977;

Ramsden, Whelan & Cooper, 1989). The two earlier classical studies of Marton and Saljo, and Svensson were related to the reading of academic texts. Marton and Saljo (1976) asked students to read a text and to answer a series of questions. They reported that some students viewed learning as one that required them to "understand" and "extract" meanings from the article. "Understanding" was essentially the characteristic of this group of students who demonstrated what was termed the "deep" approach. Conversely, the other group of students using what was called the "surface" approach only intended to reproduce materials being studied with no intention of understanding the article. Alternatively, some of them failed to recognize the words and phrases in the article and used their own predetermined way to interpret the information. They misunderstood the article and their way in approaching the task was defined as "surface".

Svensson (1977) also asked students to read an academic text. He shifted the focus and tried to identify the "integration" component of the "deep" approach. "Integration", according to Svensson, was the ability to use all the information in the task. Students using the "surface" approach did not appear to pay attention to the entire task. In other words, they focused on parts of the text rather than the entire article. They memorized information of individual parts and indicated a lack of understanding of the message conveyed by the article as a whole.

In a recent study in the area of diagnostic problem solving, Ramsden, Whelan and Cooper (1989) described the metacognitive behaviour of "checking and monitoring responses" that characterized the "deep" approach. Their study was designed to probe fourth-year medical students' approaches in addressing a data base which contained significant facts about a patient. In other words, the patient's case was presented in the form of a problem to the student who was interviewed. Non-directive questions were designed to collect students' interpretation of the cases, in particular, a diagnosis or set of diagnoses and the students' reasons for their interpretation.

In summary, a "deep" approach might be described in terms of a search for "understanding" by employing strategies which attempt to "integrate" features of the task and by "checking and monitoring their own responses". Students using the "deep" approach tend to extract meaning from the task by considering and understanding all the information. More importantly, they constantly "check or monitor" their interpretations. "Checking or monitoring" one's responses is considered to be the pivotal characteristic of metacognitive behaviours. Students, using the "surface approach", however, address the task without the intention of understanding it. Thus they ignore most or part of the information of the task and make their own interpretations. They never check or monitor their interpretations.

The concept of approaches of learning will be used as the framework to guide the exploration of the student's process (approaches of assessment preparation) and product of learning (meiosis conceptualization and approaches to the second interview task).

The 3P Model

How students conceptualize learning before it takes place; how learning is being actually achieved; and how well learning has been achieved constitute a complicated relationship. It is anticipated that the relationships between these aspects will be more than just linear. Apart from the approaches of learning delineated above, the 3P model will be employed as the framework for showing the relationship between the different aspects of students' learning, as extracted from the interview transcript.

The model, first outlined by Dunkin and Biddle (1974) in the context of classroom interaction, is represented in the present version as an integrated system, comprising three main components: **presage, process, and product** (hence the **3P** model). The 3 P model as developed by Biggs (1993) is an adaptation of a linear model proposed by Dunkin and Biddle (1974). This model enables teachers to be action researchers and to monitor and modify their teaching for student-centred learning. Various contributors (Dart and Boulton-Lewis, 1998) based their work on the 3P model which John Biggs had elaborated and modified over the past 20 years.

Presage factors exist prior to learning, and are of two kinds: those pertaining to the student, and those to the teaching context. Students bring to the classroom relatively stable, learning-related characteristics: abilities, expectations and motivations for learning, conceptions of what learning is, prior knowledge, and so on.

The teaching context contains the structure set by the teacher and the institution. On the teacher's side, there are such things as the teacher's personality, their own beliefs and conceptions of teaching, and the like; and on the institutional side, the course structure, curriculum content, and methods of teaching and assessment. This context also generates a "climate" for learning, which, whether "cold" or "warm", teacher-centred or student-centred, has important motivational consequences.

The students are immersed in this teaching context, and interpret it in the light of their own preconceptions (prior knowledge, abilities) and motivations. This interpretation, and the decision for action based on it, comprise a metacognitive activity called "metalearning" (Biggs & Moore, 1993), by means of which students derive their approaches to learning, which in turn determine the outcome of learning.

Phenomenography: An Analytical Tool Used in the Study

Phenomenography is a study of how people experience and make sense of their encounters with the world. It is a research approach that provides a way to identify, systematize, and describe the qualitatively different ways in which individuals experience phenomena (Lybeck, Marton, Stromdahl & Tullberg, 1988; Marton, 1981, 1988, 1989, 1996; Marton & Booth, 1997).

The decision to use this analytic framework was based upon several considerations. First, in analyzing the interview data the framework was very effective in generating descriptions of student understanding that were useful in helping us to plan subsequent instructional activities. Second, this framework had been used successfully in other studies in science education which includes students' conceptions of matter (Renstrom, 1987, 1988); the "mole concept" (Lybeck, et al., 1988);. factors affecting acceleration and velocity (Johansson, Marton, & Svensson, 1985); relative speed (Walsh et al., 1993); sound (Linder & Erickson, 1989) and solubility (Ebenezer & Erickson, 1996). Third, apart from conception research, the second form of phenomenographic study investigated people's approaches during their engagement with particular academic questions (Marton & Saljo, 1976; Svensson, 1977; Ramsden, Whelan & Cooper, 1989). Results of these studies generated the "deep" and "surface" dichotomy used to describe the various approaches to problem solving.

In order to fully explore the student's process (assessment preparation strategies) and product of learning (conceptualization of meiosis and problem-approaching strategy), both forms of phenomenographic studies were incorporated in the present study.

The Study

This paper was based on an interview transcript of a female undergraduate student in the genetics course. This qualitative interview was to assess the subjects' perspectives and understanding of the genetics phenomena being investigated. It provided a framework in which she could express her own understanding of learning genetics. The aims of the interview were to (1) examine and describe the way that the student perceived the learning of the genetics course in relation to her prior experience, (2) examine and describe the study strategy that the student said she adopted in preparing for the test, and (3) examine the student's conceptualization of meiosis and ways in approaching an exemplary genetics problem during the interview.

Interview Results

This case study is based upon the learning experiences of A, a third year science student, who was enrolled in a genetics course. The interview was done after the course was finished and the final examination was done. The subject talked about her background and her plan after graduation:

> "I am doing a general biology or general science degree, but I have a concentration in Ecology, but I am also doing extra courses that are outside of my discipline.

I am doing some Forestry courses, Soil Science, that sort of thing."

"I would like to be employed by the Ministry of the Environment, if possible."

We can see that the student is not a genetics major and her career choice is definitely not directly related to the concepts and skills of genetics as a subject. This orientation is related to her view on the course of genetics later on in the interview.

Presage Learning Factors

(1) Student perception of the course and her prior ability / experience

When the subject was asked about her perception of the difficulty of the course she commented directly on her computational ability. She discussed this issue in terms of courses she found difficult.

> "Math courses, I found Genetics exceptionally difficult, very frustrating."
>
> "Maybe my computational skills are..."
>
> "I have always had problems with it, especially Physics."

The weak computational skills of this learner definitely affect her perception of the course. Genetics, similar to Mathematics and Physics, has to do with problem solving and computation. Therefore, she found the Genetics course difficult.

Besides, the perception of the level of difficulty of genetics is also somehow related to her previous learning experience in her college study.

> "I was at Okanagan College, and I found that the way that they were testing there was more of a regurgitation of stuff that was directly taught to you. Coming here (to university) it is a bit different where you are using stuff that was taught to you, but you were tested in a way that makes you utilize everything that you have learned in order to solve a problem. I am used to that method."

The interview excerpt above further clarifies the reason why the learner found genetics difficult. She attributes this difficulty not only to her computational ability, but also to her previous learning experience. This is in the form of testing that requires only rote-memorization, regurgitation of stuff, without understanding, as is opposed to "deep memorization" which requires understanding before memorization.

The above conjecture is also related to the subject nature of genetics. Some years ago, the author was enrolled in two units of genetics course in his undergraduate degree program. What the author perceived is similar to the interviewee: genetics is a subject that requires understanding and integration of concepts. This mode of learning is completely different from other biology courses such as morphology which requires memorization. It is similar to biochemistry and molecular biology, which require reasoning and problem solving.

Another related reason is speculative and based upon comments from the Genetics course from tutorial leaders. It was brought out by some tutorial leaders that many biology students do not have a good background in Mathematics and this might account for the difficulties many students experience in studying subjects such as genetics. One tutorial leader in the group even commented that he had taught Genetics to an engineering student who could understand the subject well. Hence it might be appropriate to investigate the role of mathematical understanding in learning the subject matter of genetics. This would provide information into the design of the course and whether the students might be provided with some work in Mathematics to assist them in understanding some concepts of the course.

Process of Learning

(2) Assessment Preparation Strategies

Different perceptions of task demands may affect the students' approaches to studying. In this section, the subject was asked to describe in detail how she went about preparing for the assessments. The information in the interview transcript was analyzed to discern the pattern of assessment preparation strategies adopted.

> "It was memorization for lower level courses, even some of the upper level courses like Ecology and Statistics, and I found Statistics to be somewhat like genetics."

> "I'd read through the text first, highlight things that we learned in lecture, then I'd read through it again, and then I'd go to the questions. While I'm doing the questions I'd go back to the text and if I needed help to answer the questions... You stated that it's learning the principles that are more important than actually just doing the questions; that's the toughest part, to be able to understand all the principles."

Highlighting points while studying the notes and books for the test is a common strategy. In itself, this strategy is just a mechanical activity used to identify or locate some of the points. What is more important is how that highlighted information will be further processed. If the student tries to rote learn these points, then highlighting will be associated with a surface strategy. If this highlighting serves as a means of identification of ideas that require further thinking and relating to other information by understanding, then it becomes part of a deep strategy. In this case, the reason for highlighting was for easy location of the points and for easy application of the points to the question. However, the student mentioned that understanding the principles was a difficult task for her. It was then clear that the only strategy she employed here was the mechanical, transmission of points from the text to the question. From time to time, she needed to go back to the text for help when solving the problem. This showed that she highlighted discrete points in the text and tried to rote learn them without integration. Rote learning is a short term process, that was why she often went back to the text when she was doing the questions. She definitely employed the surface strategy in studying.

Product of Learning

(3) Conceptualization of Meiosis and Problem-Approaching Strategy

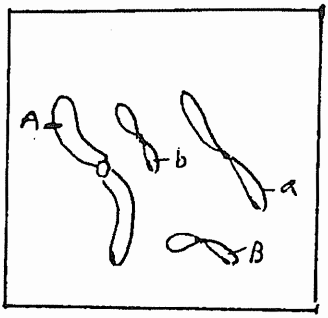
In this session of the interview, the student was asked to verbalize her thought and feelings as she was reading and going through two interview tasks. The meiosis task served as the first interview task. It provided the following information: a diploid cell with two pairs of homologous chromosomes; and each pair of homologous chromosomes carries a different kind of gene, designated as A, a and B, b respectively. Students were expected to describe the products of meiosis when asked to consider cell division in this generalized parent cell. This interview task enabled the researcher to explore the student's conceptualization of meiosis.

The second interview task provided specific information about a particular organism. This problem, like the meiosis task, also involved the concept of meiosis. However, this question "embedded" the meiotic concepts in the problem context. This question required an understanding of the life cycle of haploid organisms, appreciation of haploidy itself and the language in the data set as well as a knowledge of meiosis.

First Interview Task: The "Meiosis" Task

In this phase, the "Meiosis" task was provided:

> Starting with the cell shown below containing 4 chromosomes(that is a set of two pairs). DRAW A SET OF DIAGRAMS and EXPLAIN to a first year student who is confused, what happens when meiosis occurs. Label your Diagrams, the chromosomes, and the genes, and discuss your diagrams and labeled parts during your meiosis explanation, so that the "confused" student can keep track of what is taking place. Your FINAL DIAGRAM should clearly show the end result of the events as clear as possible.

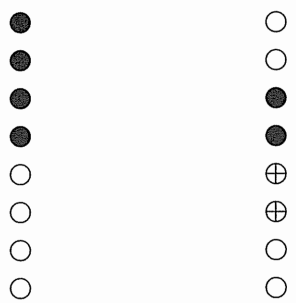


Interview Task Two: The Ascobolus Problem

In the fungus Ascobolus (similar to Neurospora), ascospores are normally black, the mutation (f) producing fawn ascospores is in a gene just to the right of the centromere on chromosome six, whereas the mutation (b) producing beige ascospores is in a gene just to the left of the same centromere. In a cross of fawn by beige parents (+fxb+) most octads show four fawn and four beige ascospores, but three rare exceptional octads were found as shown below. In the sketch, black is wild type phenotype, a vertical line is fawn, a horizontal line beige, and an empty circle represents an aborted (dead) ascospore.

i) Provide reasonable explanations for these two exceptional octad cases.

ii) Diagram the meiosis that gave rise to both octad cases.

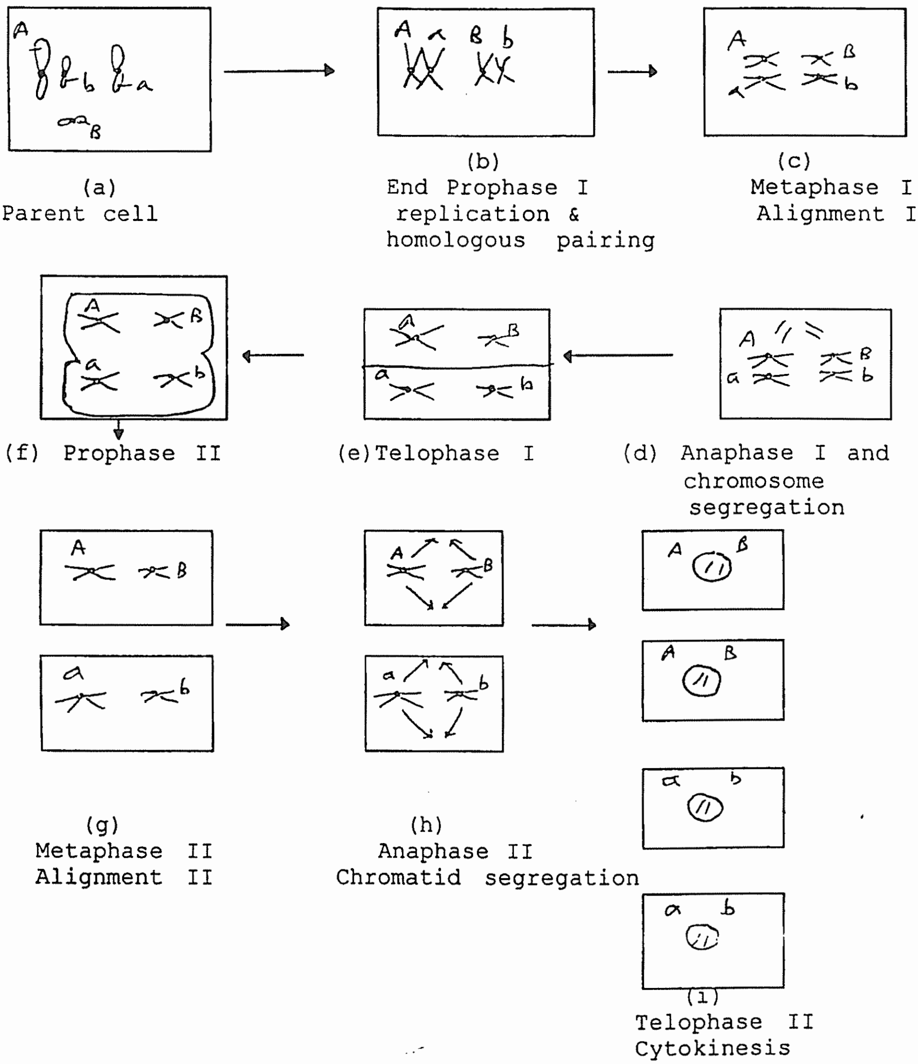


Octad Case 1 Octad Case 2

Canonical Conceptualization of Meiosis (Interview Task 1)

Sharilyn's example showed the most complete meiosis model for the "canonical" conceptualization. The two events of segregation (namely chromosome segregation and chromatid segregation) are represented by a series of diagrams to show the formation of spindle fibres, moving of chromosomes and sister chromatids to opposite poles, formation of cell membrane and nuclear membranes. Chromosome segregation is represented by three diagrams in Figure 1 (d), (e) and (f). For chromatid segregation, it is represented clearly by two diagrams in Figure 1 (h) and (i). Replication and homologous pairing were included in one step (Figure 1b), showing that this student realized that doubling of chromosomal materials should have occurred before meiosis (premeiotic syntheses of DNA materials).

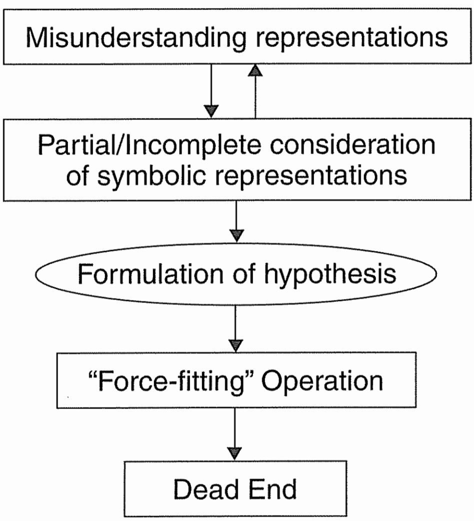
Figure 1 Sharilyn's Illustration Showing a "Canonical" Conceptualization of Meiosis



Problem-solving Strategy (Interview Task 2)

Sharilyn's problem-solving strategy could be described as the "partial recognition and forced fit"approach. One major characteristic of the 'partial recognition and forced fit' approach is the misrepresentation of the data in the problem by the students. Students using this approach had limited knowledge of the biology of the haploid organism Ascobolus and could not relate the data to a reasonable hypothesis. These students misrepresented the meaning of the gene symbols in the problem. Although these students formulated hypotheses, these hypotheses were never checked or monitored. They used only a "force-fitting"operation to fit their hypotheses into the results of the problem. The sequence of events explicated by this approach is summarized by the following flow chart (See Figure 2)

Figure 2 Flow Chart Summarizing the "Partial Recognition and Forced Fit" Approach



Conclusions and Implications

The balance between the design of a learning environment, students' perceptions of that environment, and their approach to learning is a very delicate one. In this case study of the relations of these three variables in a university genetics course, we observed a breakdown of the association between course design and perception. An analysis of the course content and presentation methods suggested that the course would be likely to encourage a deep approach to learning. However, interview of the student suggested that she adopted a surface approach, her learning outcome showed that she knew the meiosis theory but was unable to apply that concept to a complicated genetics problem.

The results above draw our attention to the fact that a student's prior experience of learning does have considerable influence on his / her perception of the learning environment, and subsequently the approaches he / she adopted in learning. Findings of the present study suggested that a student whose prior experience of the topic being taught had been of limiting conceptions of learning and surface approaches to study found herself in a Genetics course which was designed to afford a deep approach to study. Given the prior experience, the student adopted a surface approach in assessment preparation, and focussed on those aspects of the course which did not afford a deep approach, as was revealed in the learning outcome. The learning outcome, which consisted of the meiosis conceptualization and the problem-solving strategy, reflected that the student could successfully describe the concept of meiosis, but was not able to apply the same concept to a complex genetics problem.

A surface approach to studying could result in different levels of learning outcomes, depending on the complexity of the task. The decision to employ two types of assessment tasks in this study helped researchers spell out this scenario. Taking a surface approach, the student in this study was still able to elicit the canonical conceptualization in the simple meiosis task (first interview task). This canonical conceptualization vanished in the complicated genetics problem (second interview task) when she adopted the "partial recognition and forced fit" approach.

Based on the above findings, how could teachers design courses so as to accommodate the different prior experiences of students? The present study indicated that prior experience did have a strong impact on a student's perception of the course. Students with limited, surface learning experience will focus on the surface components of the course, whereas students with espoused, deep learning experience will focus on the deep component of the course. Though this genetics course emphasized problem solving, it also tested students' understanding of certain theoretical constructs. In this way, the course accommodated a broader spectrum of students with different background and prior experience. Even so, the most critical issue in the curriculum design lies not only in the accommodation procedures, but also in its capability to enable students to transfer theories to problems. The student in this case study was incapable of transferring her knowledge of meiosis to a problem. Two issues need further research. First, it would be interesting to replicate this study with some other students with a prior deep learning experience, and to find out whether a different result emerges. Second, under this course design that catered to both theoretical and applied knowledge, what sort of teaching methods could promote transference of knowledge? This would be a definite worthwhile area to explore.

References

Biggs, J.B., & Moore, P. (1993). *Process of learning* (3rd ed.). Australia: Prentice Hall.

Dart, B., & Boulton-Lewis, G. (1998). *Teaching and learning in higher education.* The Australian Council for Educational Research.

Dunkin, M.J., & Biddle, B.J. (1974). *The study of learning.* New York: Holt, Rinehart & Winston.

Ebenzer, J.V., & Erickson, G. (1996). Chemistry students' conceptions of solubility: A phenomenography. *Science Education, 80* (2), 181-201.

Entwistle, N.J. (1984). Contrasting perspectives on learning. In F. Marton, D.

Hounsell & N. Entwistle (Eds.), *The experience of learning* (pp. 1-18). Scot tish Academic Press.

Johansson, B., Marton, F., & Svensson, L. (1985). An approach to describing learning as change between qualitatively different conceptions. In L.H.T. West & A. L. Pines (Eds.), *Cognitive structure and conceptual change.* Orlando : Academic Press.

Linder, C., & Erickson,G. (1989). A study of tertiary physics students' conceptualization of sound. *International Journal of Science Education, 11*, 491-501.

Lybeck, L., Marton, F., Stromdahl, H., & Tullberg, A. (1988). The phenomenography of the 'mole concept' in chemistry. In P. Ramsden (Ed.), *Improving learning: New Perspectives.* London: Kogan Page.

Marton, F. (1981). Phenomenography – describing conception of the world around us. *Instructional Science, 10*, 177-200.

Marton, F. (1988). The phenomenography of the 'mole concept' in chemistry. In P. Ramsden (Ed.), *Improving learning : new perspectives.* London: Kogan Page.

Marton, F. (1989). Towards a pedagogy of content. *Educational Psychologist, 24*, 1-23.

Marton, F. (1996). Cognosco ergo sum – Reflections on refections. In G.M. Dall' Alba & B. Hasselgren (Eds.), *Reflections on phenomenography. Toward a methodology?* (G_teborg Studies in Educational Science 109). G_teborg: Acta Universitatis of Gothoburgensis.

Marton, F., & Booth, S. (1997). *Learning and awareness.* Mahwah N.J.: Lawrence Erlbaum Associates.

Marton, F., & Saljo, R. (1976). On qualitative differences in learning: I – outcome and process. *British Journal of Educational Psychology, 46*, 4-11.

Ramsden, P., Whelan, G., & Cooper, D. (1989). Some phenomena of medical students' diagnostic problem solving. *Medical Education, 23*, 108-117.

Renstrom, L. (1987). Pupils' conception of matter: A phenomenographic approach. In J. Novak (Ed.), *Proceedings of the Second International Seminar on Misconceptions and Educational Strategies in Science and Mathematics*, Cornell University, June, 1987, III.

Renstrom, L. (1988). *Conceptions of matter: A phenomenographic approach.* Published Ph.D. dissertation. Sweden: Gothenburg University Press.

Smith, M.U. (1988). Successful and unsuccessful problem solving in classical genetics pedigrees. *Journal of Research in Science Teaching, 25* (6), 411-433.

Svensson, L. (1977). On qualitative differences in learning: III study skills and Learning. *British Journal of Educational Psychology, 47*, 233-243.

Walsh, E., Dall'Alba, G., Bowden, J., Martin, E., Marton, F., Masters, G., Ramsden, P., & Stephanou, A. (1993). Physics students' understanding of relative speed: a phenomenographic study. *Journal of Research in Science Teaching, 30*, 1133-1148.