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THE ORGANIZING EFFECT OF A SIMULATION GAME EXPERIENCED IN ADVANCE OF RECEPTION LEARNING OF ECONOMICS

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A research report submitted to the Faculty of Education, University of the Witwatersrand, in part fulfilment of the requirements for the degree of Master of Education.

Johannesburg, July 1983.

ABSTRACT

AN EVALUATION OF THE ORGANIZING EFFECT OF A SIMULATION GAME EXPERIENCED IN ADVANCE OF RECEPTION LEARNING OF ECONOMICS IN A CLASSROOM SITUATION

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This report examines the effectiveness of an advance organizer, experienced as an element of a simulation game, on subsequent reception learning of economic concepts, in the milieu of the expository classroom situation.

In the research, an adaptation of the simulation game: TREBEDIES ISLAND: The Economics of Monopoly Management (Simile II 1977), is used for meaningful discovery learning of the concept 'price elasticity of demand', in order to organize in advance the reception learning that follows. The hypothesis tested is that the organizer concept has the effect of improved reception learning of subsequent subsumptive concepts (i.e. by sequential transfer).

The research is augmented by an illuminative evaluation of the learning program[illegible] the milieu that it created.

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TABLE OF CONTENTS

ABSTRACT i

ACKNOWLEDGEMENTS ii

page

Chapter

1 THE PROBLEM AND ITS SETTING 1

1.1 The Problem 1

1.2 The Setting 1

1.3 Supplementary Questions 1

1.4 The Hypothesis and the Null Hypothesis ... 3

1.5 Delimitations 4

1.6 Definitions of Terms 8

1.7 The Assumptions 13

Chapter

2 REVIEW OF RELATED LITERATURE 22

2.1 Teaching for Reception Learning ... 22

2.2 Discovery Learning 24

2.3 The Use of Games and Simulations for Training and Education 28

2.4 The Use of Games in the Classroom ... 32

2.5 Simulation Games used as Advance Organizers 34

2.6 Assessment of Effects of Advance Organizers (other than in simulation games) on learning and retention 35

2.7 Simulation in the Teaching of Economics 40

2.8 The Use of Concrete Models in Teaching 42

2.9 Cognitive Structure 44

Chapter		page
2.10	Recall by Transfer of Verbal Information	46
2.11	Transfer of Learning and Ausubel's Theory of Cognitive Structure	50
2.12	Historical Background to Transfer Theory ...	51
2.13	Vertical Transfer	54
2.14	Lateral Transfer	55
2.15	Sequential Transfer	56
2.16	Bloom's Taxonomy and Ausubel's Hierarchy of Behavioural Outcomes	59
2.17	Recommendations for Research Design ...	63

Chapter		
3	THE RESEARCH DESIGN	64
3.1	Methodology	64
3.2	The Pretest and the Posttest	69
3.3	Control of the Variables	72
3.4	Treatment of the research Data	76
3.5	Schedule of the Research and Learning Programme	84

Chapter		
4	THE RESULTS OF THE RESEARCH	85
4.1	The Allocation of Matched Pairs ...	85
4.2	The Transfer Retention Test (TRT) Results	86
4.3	The Test of the Hypothesis	88

Chapter page

5 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS 89

5.1 Summary of the Research 89

5.2 Research Conclusions 91

5.3 Recommendations 92

Chapter

6 EVALUATION 96

6.1 Selection of an Evaluation Strategy ... 96

6.2 The Evaluation Procedure 98

6.3 The Evaluation Report 100

LIST OF REFERENCES 115

APPENDICES 119

Appendix A: Pre/Post Test.

Appendix B: Student Variables for Matching of Pairs.

Appendix C: Allocation of Matched Pairs to Experimental and Control Groups.

Appendix D: Simulation Game: Allocation of Students to Experimental and Control Groups, and to Simulated 'Firms' for Competitive Bidding.

Appendix E: Results of the Transfer Retention Test (TRT) and Pre/Post Score Gains.

Appendix F: Schedule of the Research and Learning Programme.

Appendix G: Lecture notes: Monopoly Market Supply and Consumer Expenditure.

APPENDICES - continued

Appendix H: Lecture notes: Market Demand Schedules and Curves.

Appendix I: Experimental Group Organizer Material.

Appendix J: Isolation of the Advance Organizer.

Appendix K: Control Group Simulation Material.

Appendix L: Simulation Material Common to the Experimental and the Control Subjects.

Appendix M: Simulation Script.

Appendix N: Instructions for the Business Representative.

Appendix O: Instructions for the Homeowners' Association Representative.

Appendix P: Instructions for the Investors' Representative.

Appendix Q: Evaluation Questionnaire.

Appendix R: Transfer Retention Test (TRT).

Appendix S: Lecture Notes: Price Elasticity of Demand.

Appendix T: Evaluation Questionnaire.

Appendix U: Transcription from Sound Tape of Personal Interviews and a Class Discussion.

Appendix V: Instances when students' absences from the learning programme were noted.

Appendix W: Dialogue between the Evaluator and Experimental Group Subject 38.

Appendix X: Transfer Retention Test Script of Student E30EF18.

LIST OF FIGURES AND TABLES vii

LIST OF FIGURES

Figure:		page
1	Sequence of the research procedure ...	6
2	An act of learning	16
3	Ausubel's learning- retention-practice-transfer-retention-madel	18
4	Comparison of the Taxonomies of Bloom and Ausubel	60
5	Sequence of the research procedure ...	64
6	Paradigm for the pre/post test control group design	66
7	Paradigm for the research design ...	67
8	Fisher's contingency table	84

LIST OF TABLES

Figure:		page
I	Wilcoxon Matched-Pairs Signed-Ranks Test, illustrated using hypothetical test scores	79
II	Ranking of gains on pretest scores to calculate the Mann-Whitney U statistic ...	82
III	Contingency table of the second transfer retention test scores	87
IV	Wilcoxon Matched-Pairs Signed-Ranks Test of the research data scheduled in appendix D ...	88

1 THE PROBLEM AND ITS SETTING

1.1 The problem

Can an advance organizer, experienced as an element of a simulation game, effectively improve subsequent reception learning and retention? In other words, if expository classroom teaching of an economic concept is preceded by the kind of advance organizer referred to above, would retentive learning be enhanced?

1.2 The setting

Expository classroom teaching is a common educational practice. This problem is therefore of interest to teachers at all levels from primary schools up to tertiary institutions. This research examines the problem in a Higher Diploma in Education class of first year Business Economics students at the University of the Witwatersrand, Johannesburg.

1.3 Supplementary questions

1.3.1 How to construct the simulation game in order to enable the organizing phenomenon to operate.

1.3.2 What is the nature of the organizer in relation to the alternatives of discovery learning and reception learning?

1.3.3 How do theories of <u>transfer</u> relate to Ausubel's concept of an <u>organizer</u>?

1.3.4 Would criterion-referenced achievement testing be adequate to validly assess the effectiveness of learning and retention in the experimental design?

1.3.5 What insights about the effectiveness of an advance organizer as an element of a discovery learning experience on subsequent reception learning would be revealed by means of illuminative evaluation?

1.4.1 The hypothesis

Participation by students in a simulation game is effective in causing improved achievement scores in a test of retention of reception learning material, where the reception learning is preceded by the enactive use of organized learning material in the simulation which cognitively subsumes the concepts in the reception learning material.

1.4.2 The null hypothesis

The achievement scores in a test of retention of reception learning material by students whose participation in a simulation game has been preceded by the enactive use of organized learning material in the simulation which cognitively subsumes the concepts in the reception learning material, will not differ significantly from those of students who were not exposed to this treatment.

1.5 Delimitations

The research was centred specifically around Ausubel's theory of advance organizers. Related theories on learning, perception, concept attainment and cognitive development of Piaget, Gagné and Bruner are also of interest. The "intra-material" organizing capacity of the simulation was not investigated, nor its capacity for the learning of problem-solving skills. By placing the organizer in an "intermaterial" design, i.e. between a simulation and expository material, its effect on a subsequent stage of learning was examined experimentally. The research was accompanied by an illuminative evaluation of the learning experience.

As this research constitutes part of an M Ed by coursework degree, time was a constraining factor which necessitated that the field of study be limited. It was easier for the researcher to have access to classes of teachers-in-training than secondary school classes as originally intended. A first-year class of Business Economics (Education) students was therefore the subject of the research. No claim to generalized validity of the results of the research, beyond the class of students involved, is made.

Ausubel (1969) recognizes a need to develop theories of instruction which take as their central concern meaningful school learning. He recognizes that there is probably a place for discovery learning procedures in schools, but points out that although such procedures may be meaningful, they are time consuming and therefore not as efficient as expository-reception learning methods.

Ausubel's theory of subsumptive structuring of learning material enables students to learn meaningfully, as against the rote learning that so often characterizes school learning. Subsumptive learning processes operate at a level of comprehension, above rote learning but do not necessarily involve the higher levels of problem solving and creative behaviour.

The dependent variable in this research was delimited to what Ausubel (see 1.6.7 and 1.6.9) defines as reception learning and retention. The independent variable was the subsumptive capacity of what Ausubel (see 1.6.1 and 1.6.2 below) defines as the organizer. Ausubel and Robinson (1969 p 43) postulate two dimensions 'representing fundamental distinctions between types of learning processes'. The first distinction concerns the means 'by which the knowledge to be learned is made available to the conscious mind of the learner' - that is, the reception learning / discovery learning dimension. The second distinction deals with alternative ways in which 'the learner may incorporate such knowledge into his existing structure of ideas' - that is, the meaningful learning / rote learning dimension. Ausubel and Robinson (ibid.) assume that these two dimensions are relatively independent, that is they are not discrete distinctions, but continua. They distinguish four basic kinds of learning which may occur in schools: (1) meaningful-reception; (2) rote-reception; (3) meaningful-discovery; and (4) rote-discovery. Definitions of meaningful and rote learning and reception and discovery learning appear in section 1.6. It is the first of these kinds of learning, namely meaningful-reception that is assumed, in this research, to give rise to the dependent variable of more effective learning and retention, in the usual expository situation of the classroom.

The independent variable, namely the organizer, which precedes the reception learning material, is designed to be an essential part of a guided discovery learning experience - preferably an experience that tends more towards meaningful-discovery rather than rote-discovery learning.

The research design follows the sequence A to F indicated in figure 1 below:

A	B	C	D	E	F
PRE TEST ALL	MATCHED GROUPS	INDEPENDENT EXPERIMENTAL VARIABLE	TRANSFER RETENTION TEST	DEPENDENT VARIABLE	POST TEST ALL

Figure 1: Sequence of the research procedure.

The pretest sets a benchmark against which the post test of reception learning and retention can be compared. The pretest data also measure one of the variables to be equalised between the control group and the experimental group, by means of matched pair selection.

The independent variable is the intervention of discovery learning of the organizer, as an essential part of the simulation, by the experimental group only. In all other respects, the control group and the experimental group together participate equally in the simulation game.

The transfer retention test, as defined by Ausubel and Robinson (1969 p 609), "measures whether a given segment of knowledge is sufficiently stable, clear and well-organized to serve as a basis for new sequentially related learning tasks and problem solving".

The dependent variable is the expository material for reception learning by the combined control and experimental groups. Reception learning corresponds roughly with "comprehension" in the Bloom (1956) taxonomy. In Ausubel's taxonomy, it involves meaningful (not rote) learning by reception (not discovery) of concepts and generalizations, but does not require problem solving (analysis) or creative behaviour (synthesis).

The post test measures whether the organizer is effective in causing improved achievement scores for the experimental group of retention of the reception material, as compared with the control group.

1.6 Definitions of Terms

1.6.1 advance organizer

Defined by Ausubel and Robinson (1969 p 606) as: 'organizer: introductory material presented in advance of and at a higher level of generality, inclusiveness, and abstraction than the learning task itself; designed to promote subsumptive learning by providing ideational scaffolding or anchorage for the learning task and / or by increasing the discriminability between the new ideas to be learned and related ideas in cognitive structure'. For example, the advance organizer used in this research is shown in appendix J.

1.6.2 subsumptive learning

Ausubel (1963 p 83) says two important antecedent variables in meaningful learning and retention are: 1 'whether or not a relevant subsumer at an appropriate level of abstraction; generality; and inclusiveness is available in cognitive structure'; and 2 'the stability and clarity of this subsumer'. Snelbecker (1974 p 427) says that the principle of subsumption is a key explanation in Ausubel's theory as to how one increases and reorganizes one's fund of knowledge. 'New ideas and information are grasped and retained by the learner 'only to the extent that more inclusive and appropriately relevant concepts

are

already available in cognitive structure to serve a subsuming role or to provide ideational anchorage" (Ausubel 1967 p222)'.

1.6.3 derivative subsumption

Ausubel and Robinson (1969 p605) say that in derivative subsumption: 'the new ideas in the learning task are supportive or illustrative of an existing relevant idea in cognitive structure'. (Similar to 'assimilation')

1.6.4 correlative subsumption

Ausubel and Robinson (1969 p604) distinguish correlative subsumption from derivative subsumption. In correlative subsumption: 'the new ideas in the learning task are extensions, elaborations, modifications, or qualifications of an existing relevant idea in cognitive structure'.

1.6.5 discriminability

Ausubel (1963 pp 108-9) says that advance organizers ordinarily have two distinct functions corresponding to different aspects of the unfamiliarity of meaningful learning material. In the first instance, 'the new material is almost completely unfamiliar in the sense that cognitive structure is barren of even generally related concepts.

Under these circumstances the purpose of the organizer is simply to provide ideational anchorage or scaffolding'. The discriminability of learning, in the other more typical instance, applies where 'the new learning material (for example, Buddhist doctrines) is a variant of related, previously learned concepts (Christian doctrines) already established in cognitive structure'.

1.6.6 meaningful learning

Meaningful learning presupposes that the learner has a meaningful learning set, that is a disposition to relate a learning task nonarbitarily and substantively to his existing cognitive structure, thereby making the learning of a potentially meaningful task possible. (Ausubel and Robinson 1969 p606). (See below 1.6.11 meaning)

1.6.7 reception learning

Reception learning may be by rote or it may be meaningful to the learner. Ausubel and Robinson (1969 p607) define reception learning as: 'that kind of learning in which the entire content of what is to be learned is presented to the learner in more or less final form'.

1.6.8 discovery learning

Ausubel and Robinson (1969 p605) point out that reception

learning can be distinguished from 'discovery learning: that kind of learning in which the principal content of what is to be learned is not given, but must be discovered by the learner before he can incorporate it into his cognitive structure'.

1.6.9 retention

Ausubel and Robinson (1969 p603) use the term anchoring ideas. This helps to define retentive learning. They define an anchoring idea as: 'an established relevant idea in cognitive structure to which new ideas are related and in relation to which their meanings are stored in the course of meaningful learning and retention'.

1.6.10 rote learning

Stones (1966 p149) defines rote learning in terms of Ausubel's theory, as learning that is not meaningful. That is, new learning that takes place but cannot be fitted into the hierarchy of concepts because it is not related to existing cognitive structure. 'Consequently, it remains an isolated response. Because of this the new learning lacks meaning. It also tends to be specific and does not transfer to new situations.' Since it is not anchored to existing knowledge structures, it is likely to be forgotten easily. Hence rote learning tends to be more difficult than meaningful learning; and therefore less effective.

1.6.11 meaning

Ausubel and Robinson (1969 p54) say:

Meaning itself is the product of a meaningful learning process. It is the differentiated cognitive content, or content of awareness, which emerges when potentially meaningful material is incorporated into cognitive structure in a nonarbitary and substantive fashion. It can also be said that meaning is an idiosyncratic phenomenon in that it is a particular content of awareness evoked in a particular learner who has a unique cognitive structure. Consequently the meaning elicited by any particular symbol or group of symbols will depend upon the ideas that exist in a particular learner's mind.

1.6.12 simulation game

Ellington and others (1981 p 17) define a simulation game as 'an exercise that possesses the essential characteristics of both games (competition and rules) and simulations (ongoing representation of real-life)'.

1.6.13 case study

Ellington and others (1981 p 17) define a case study as 'an in-depth examination of a real-life or simulated situation carried out in order to illustrate special and/or general characteristics'.

1.7 The assumptions

It is assumed by Gagné (1975 p 28) that an act of learning occurs through a sequence of phases. These are set out diagramatically in figure 2 below. The first is motivation; although, Ausubel (1969 pp 283-4 and pp 412-417) holds that learning is possible without extrinsic motivation. Motivation is caused by particular expectations. Participation in games appropriate to the abilities of those involved has a strong tendency to motivate the behaviour of the participants in certain ways. Based on this assumption, the researcher has used a simulation game to facilitate the organization of the students' existing cognitive structures, before new reception learning material is presented. The game, through the situation it simulates, was designed to facilitate selectively guided attention. Attention, and selective perception, occurs in the second phase of the act of learning. The third phase, acquisition, depends on the learner's coding of the information for 'storage entry'. A memory storage process in the fourth phase is necessary for retention to occur. Gagné (1965 p 74) says that: 'Having been acquired, the new capability must be "stored", if it is to qualify as something that has truly been learned. The change that has been brought about by the event of acquisition now becomes retained, over a period that might be a few minutes or a lifetime'. He says there is evidence to suggest that storage may be of two kinds: short-term memory or long-term memory. 'Retention' of reception learning material, in the hypothesis of this research as defined by Ausubel (see paragraph 1.6.3), is that which is retained by process of long-term memory storage. Coding is a critical process preceding memory storage whereby, it is assumed, knowledge is acquired after selective perception. The focus of this research, in

the context of Ausubel's principles of subsumptive learning, seems to centre on the acquisition by coding phase of the learning processes. After the memory storage process for retention, follow processes of retrieval and transfer in Gagné's theory. Gagné (1965 p 76) says that: 'When the individual is called upon to display what he has learned or to put it to use in some way, he must retrieve the entity that has been acquired and stored.' Retrieval, he says, may occur in a disorganized way, as for example, when situations in a novel "remind" the reader of various events learned in different contexts. Based on Ausubel (1968 pp 83-123), Gagné (loc. cit.) says that when deliberate retrieval is undertaken by the individual, it is usually apparent that certain organizing factors are at work: ' - the individual may recall a variety of specific instances falling into a given category, for example, or he may recall several categories that are meaningfully related to each other'. Transfer is the sixth process in the act of learning which according to Gagné gives rise to the phase of generalization. Assumptions about recall by transfer of verbal information; transfer of learning and Ausubel's theory of cognitive structure; transfer theory in general; and the more specific aspects of transfer: vertical, lateral and sequential; are treated respectively in paragraphs 10 to 15 of chapter 2 of this report. The act of learning culminates in the phases of performance and feedback which depend respectively on processes of: responding and reinforcement.

Simulations create situations in which the participants are expected to respond in particular ways. Thus the process of expectancy which is assumed to initiate an act of learning, continues in simulation games to motivate learning in the performance phase too. Simulations, by design, create situations in which performances of responses are expected which require the recall and transfer of knowledge. Finally, of the feedback phase, Gagné (1975 p 42, says: 'Once the learner has exhibited the new performance made possible by learning, he at once perceives that he has achieved the anticipated goal. This "informal feedback" is what many learning theorists consider the essence of the process called <u>reinforcement</u>'. It is assumed that successful performance in a simulation game affords achievement motivation. This kind of motivation should lead to a process of self-perpetuating positive reinforcement.

Ausubel's learning-retention-practice-transfer model presents a more elaborate set of assumptions than those of Gagné, described above. It differs in a number of respects. Firstly, through <u>practice</u> learning is extended beyond Gagné's single act of learning. Secondly, Ausubel's distinction between <u>rote</u> and <u>meaningful</u> learning, implies that different kinds of acquisition, retention and recall can occur. Thirdly, Ausubel's principle of <u>subsumptive</u> learning gives insight into a process of sequential transfer, which differs from Gagné's explanation of lateral transfer through generalization.

Figure 2, below, sets out Gagné's (1975 p 28) model of the sequences in which an act of learning occurs.

PHASE	LEARNING PROCESS
Motivation phase	EXPECTANCY
	↓
Apprehending phase	ATTENTION - SELECTIVE PERCEPTION
	↓
Acquisition phase	CODING - STORAGE ENTRY
	↓
Retention phase	MEMORY STORAGE
	↓
Recall phase	RETRIEVAL
	↓
Generalisation phase	TRANSFER
	↓
Performance phase	RESPONDING
	↓
Feedback phase	REINFORCEMENT

Figure 2 An act of learning.

Teaching in a subject like economics is usually of an expository nature. Economic concepts are received by learners in material predominantly in verbal form, the symbols of which may be either written (as in text books) or auditory (as when the teacher talks). The process of coding that occurs during the acquisition phase of learning, Gagné (1975 p 78) claims is of critical significance for the learning of verbal information. As he says:

"In the most general sense, coding is enhanced when information is presented within an associated meaningful context."

Gagné mentions three means by which associated meaningful contextualization may be attained, namely: advance organizers; coding by placing of isolated names and labels in a meaningful verbal context; and by using imagery to provide a frame in which to "place" new learning.

Unlike Gagné's model, which is concerned with individual acts of learning, Ausubel's theory is concerned with the learning of concepts which involve many acts of learning and require practice. Ausubel and Robinson (1969 pp 131-132) say:

"Consistent with the theory, practice may be viewed as a sequence of repeated presentations of new material to cognitive structure, each presentation obeying the basic rules of meaningful learning, except that on each successive presentation more of the ideas in the material will have been incorporated into cognitive structure, so that they now facilitate the learning of the remaining areas."

An outline of Ausubel's learning-retention-practice-transfer model is shown in figure 2. As well as a practice extension, this model is an extension of transfer.

Transfer, in Ausubel's model, is a reflection of the process by which existing cognitive structure is organized or reorganized.

EXISTING COGNITIVE STRUCTURE comprising a hierarchically organised system of facts, concepts and generalisations.

↓

MEANINGFUL LEARNING PROCESS

Stage 1: To learn meaningfully a NEW IDEA is related in a non-arbitrary and substantive fashion to one or more of the existing ideas in EXISTING COGNITIVE STRUCTURE, usually to a more general idea. The new idea is distinguishable from the old one, not being immediately assimilated due to the new idea's DISSOCIABILITY STRENGTH.

↓

Stage 2: RETENTION occurs as the DISSOCIABILITY STRENGTH of the new idea declines progressively until it falls below the threshold of availability at which point the new idea can no longer be recalled.

↓

Extension 1 PRACTICE is necessary because most integrated sets of ideas are not learned in a single presentation.

Extension 2 TRANSFER to the learning of NEW IDEAS facilitated by the way in which most ideas in the EXISTING COGNITIVE STRUCTURE are ORGANISED.

ROTE LEARNING

occurs independently of existing cognitive structure, and is therefore not meaningful.

↓

Those FACTS learned by rote which are related to EXISTING COGNITIVE STRUCTURE enter the MEANINGFUL LEARNING PROCESS

↑↓

ARBITRARY AND NON-SUBSTANTIVE rote learned non-meaningful facts.

AUSUBEL'S LEARNING-RETENTION-PRACTICE-TRANSFER MODEL

Figure 3.
Based on Ausubel and Robinson 1969 pp 131 - 132

The way in which existing cognitive structure is organized, is central to Ausubel's assumptions about later learning. He proposes that meaningful new ideas are learned by being subsumed into an already existing cognitive structure, which has been established by prior learning. Gagné (1975 p 149) says:

"In considering retention of newly acquired verbal knowledge, Ausubel theorizes that one must consider, first, the availability in pre-existing cognitive structure of specifically relevant anchoring ideas. A second factor that affects retention is the distinguishability or dissociability of the new ideas from the pre-existing cognitive structure. If new propositions of Buddhism, for example, are not sufficiently distinguishable from those of Christianity, they will tend to be lost in retention. Still a third factor influencing retention is the stability and clarity of anchoring ideas, which act to subsume newly learned verbal propositions."

Whilst Ausubel is concerned with meaningful reception learning, Bruner's name is associated more closely with discovery learning. It is assumed that a simulation game can be designed effectively to cause meaningful discovery learning. Of relevance are Bruner's techniques of simplifying subject content. By "translating" ideas in symbolic modes into iconic or enactive ideas, Bruner (1966 p 59) believes that anything can be taught at any age. Misinterpretations of this assumption are contested by findings of Piaget. Ginsberg and Opper (1969 pp 225-6) say:

"A current trend prevails in the United States which believes that it is possible to teach anything to a child of any level of development, providing the appropriate method is used. Piaget's findings tend to stress the contrary. Certain things cannot be taught at any level, regardless of the method adopted.

It is of course possible to accelerate some types of learning to a certain extent by use of suitable environmental stimuli."

The three modes of representation which serve as techniques to simplify content are termed by Bruner as: enactive, iconic and symbolic. It is assumed that in the classroom situation - where teachers are involved with groups, the individuals of which may be at widely differing levels of cognitive development - simulation games can include material to simultaneously facilitate: enactive, iconic and symbolic modes of representation. Teachers would thus be able to provide for meaningful participation by a greater variation of pupil levels of ability in one planned learning experience.

West and Foster (1976 p 37) define and illustrate the three modes of representation as follows:

"Enactive Representation involves action - psychomotor activity. An infant may enactively represent a rattle by shaking his hand. Young children demonstrate an understanding of the principles of the lever by adjusting their positions on a see-saw. The principles of leverage in this case are enactively represented. The enactive is a very primitive, concrete mode of representation. Enactive representation involves psychomotor acting out of some idea, concept or principle.

Iconic Representation involves the use of imagery or graphics to represent the idea, object or principle. This mode of representation defines the object with more completeness and economy. Drawing a chart or diagram and demonstrating the principles of leverage through these would be an example of iconic representation. It is more abstract than the enactive mode but less abstract than the symbolic mode of representation.

Symbolic Representation uses language to demonstrate the idea, object or event. It is the most abstract of the three modes of representation. The use of these modes appears to follow developmental trends. That is, young children tend to use enactive modes, and as they grow older they make greater use of the symbolic mode. The complexity or difficulty of material may cause any of us to return to the less abstract modes of representation. When we attempt to solve a difficult problem and cannot through the symbolic mode - language - we may draw diagrams, charts, etc. This regression and translation to iconic representation seems to aid us in puzzle solving."

To summarize, assumptions on which this research is based fall into two categories of learning: firstly, meaningful discovery learning with the object of creating in advance, a clear, stable and well-organized cognitive structure which provides a meaningful learning set (the independent variable); and secondly, meaningful reception learning (the dependent variable) to demonstrate the effectiveness of the organized pre-existing cognitive structure.

2 REVIEW OF RELATED LITERATURE

2.1 Teaching for Reception Learning

In a review of educational studies of the years 1952 to 1982, Clarke (1982 pp 48-9) says: 'one of the more exiting areas in educational psychology is the study of factors which influence the reception and retention of meaningful prose material, an activity which occupies perhaps more time in classrooms than any other'. Clarke (ibid.) says that the radical initiator of this movement in cognitive psychology was Ausubel. She says that in Ausubel's first paper on the use of advance organizers published in 1960, and also in the introduction to his text Educational Psychology: a cognitive view (1968), Ausubel 'stated that he was not prepared to consider topics such as child development, adjustment, personality and group dynamics except in so far as they bear on and are directly relevant to classroom learning'. In School Learning: An Introduction to Educational Psychology, by Ausubel and Robinson (1969 p 96), they make this point again when they say it is assumed 'that a large part of the teacher's time will be spent on expository teaching'. They emphasise too (ibid. p 97) that there are good reasons for some of the disenchantment with expository teaching and reception learning. They observe that 'potentially meaningful subject matter is frequently presented to pupils in such a way that they can learn it only rotely'. They give another reason, also of

importance, 'why meaning is perceived as an exclusive product of problem solving and discovery techniques of learning'. It stems from what they consider to be two serious shortcomings of prevailing learning theory. The first of these theoretical limitations is apparent in the cognitive domain, when comparing the Bloom (1956) taxonomy with Ausubel's more elaborate hierarchy of behavioural outcomes. In section 2.11 these are compared. Ausubel's taxonomy takes into account the processes of learning, as well as outcomes. Ausubel and Robinson (op cit) say: 'In the first place, psychologists have tended to subsume many qualitatively different kinds of learning processes under a single exploratory model'. This results in confusion of basic distinctions between reception and discovery learning; and between rote and meaningful learning. The second limitation to contemporary theory, was the absence for many educational psychologists of an appropriate theory of meaningful learning. This led to the interpretation of long-term learning and forgetting of subject-matter, in terms of the same concepts as those used to explain laboratory forms of rote learning (e.g. retroactive inhibition). This confusion has led to reception learning being widely perceived of as a rote learning phenomenon.

In addition to Ausubel's concern about reception learning in schools, Clarke (1972 p 48) says that 'Ausubel maintained that his aim was to furnish the prospective teacher with the basic psychological sophistication needed for classroom teaching'. The concept of advance organisers and his 'assimilation theory' are central to the pursuit of this aim.

Clarke (1982 p 49) notes that early experiments 'suggested that the effects of advance organizers were greatest for those of relatively low ability or poor background knowledge and the differences obtained between groups with and without the use of organizers were chiefly due to students of this kind'. Later research has not clarified the issue to any greater extent. See sections 2.4 and 2.5 for further discussion on empirical research. Clarke (ibid.) concludes: 'Perhaps, as with compensatory education, advance organizers have not failed, but have as yet not been systematically tried in contexts where they might be effective'.

an observation by Clarke (ibid. , that the majority of those who participated in the more recent organizer experiments were college students, has relevance to the subject of this report. Similarly, this research deals with first-year (non-graduate) education diploma students. It may be inferred from Clarke's observation that if this research design were used in a secondary school classroom, it could possibly yield greater differences.

2.2 Discovery Learning

Ausubel (1961 pp 15-25), in his paper: "In Defence of Verbal Learning", concludes with the following comment:

"Much of the opprobrium currently attached to verbal learning stems from failure to distinguish between "reception" and "discovery" learning and to appreciate the underlying basis of meaningfulness. It is widely accepted, for example, that verbal learning is invariably rote (glib verbalism) unless preceded by recent nonverbal problem-solving experience."

This assumption that only discovery learning is meaningful may easily be inferred from statements such as the following by Sprinthall and Sprinthall (1977 p 320) who say:

"Bruner insists that meaningful learning requires the child to actively search for solutions. Such "discovery learning" is far more long-lasting and useful than learning based on memorization and conditioning."

Ausubel maintains that after the elementary school years, or approximately after the age of twelve, verbal reception learning constitutes the most efficient method of meaningfully assimilating the substantive content of a discipline. Problem solving methods are less efficient because they are time consuming. The promotion of problem-solving ability per se is nevertheless a legitimate objective in education, provided it is not overemphasized.

Enthusiasm for discovery methods is attributed by Ausubel and Robinson (1969 p 479) to the progressive education movement and the child-centred approach that originated in the educational philosophies of Rousseau and Froebel. Ausubel and Robinson say the rationale these theories have is that 'the educational environment facilitates development best by providing a maximally permissive field that does not interfere with the predetermined process of spontaneous maturation'. It is the child himself, they assert, who is in the most strategic position to know and select 'those educational ingredients that correspond most closely to his current developmental needs, and hence are most conducive to his optimal growth'. Ausubel and Robinson (ibid.) claim that the

rediscovery and questionable interpretation by North American educational psychologists of Piaget's theoretical speculations, have contributed to the post World War II curriculum revolution. This revival of the discovery method brought with it a great emphasis on the "heuristics of discovery", premised by the argument that in a world of inevitable change, the best way to prepare students for life is for them to "learn how to learn". Finally, Ausubel and Robinson say that the discovery method provided a means of permitting greater student activity and initiative with respect to their own learning. This was a time in the 1960s when high school and college officials felt it necessary to combat 'apparent student disenchantment with both the substance and method of instruction at these levels'.

The essential criterion for discovery learning, Ausubel and Robinson (ibid. p 481) say is 'that the material to be learned is not presented to the learner in final form' as in the case of reception learning. Discovery learning requires that the learner must reorganize or transform the new learning material before it can be incorporated into cognitive structure. Ausubel and Robinson emphasize though, that: 'While we tend, for convenience, to speak of reception and discovery as though we were dealing with a true dichotomy, analysis of teaching methods employed in the classroom indicates that there are a variety of approaches which can be ordered along a dimension of increasing direction on the part of the teacher'. This observation has relevance to the current research. The design of the simulation game in this research is intended to provide discovery learning material which will guide the students, by means of its intra-

organizing capacities to a meaningful discovery of the advance organizer. The advance organizer, in turn, is a subsumer for later teacher directed reception learning. It is assumed in this research design that by varying the learning approach (from discovery to reception activity), motivation and attention will be facilitated and sustained. This is not however an experimental variable, as both the control and the experimental groups experience the same discovery and reception learning milieux (except for the organizer). It is none the less important to the research that all the subjects are well motivated and responsive to the learning material. Otherwise, the empirical replication would not be true to the hypothesis. The Hawthorne effect, by design, applies equally to the control and the experimental subjects.

2.3 The use of games and simulations for training and education

Ellington and others (1981 pp 15-19) define games and simulations and distinguish them from case studies. They say that in 1973, 'Bloomer presented the thesis that games and simulations are in fact quite different types of exercise, and suggested what was to form the basis of a working terminology and classification'.

Bloomer adopted the definition for a game given by Abt, that a game is: 'any contest (play) among adversaries (players) operating under constraints (rules) for an objective (winning, victory or pay-off)'. Ellington and others say that this definition 'identifies two essential features which must both exist before an exercise can reasonably be described as a game'. These are first, overt competition, whether between players or against the 'game system'; and second, the exercise is governed by rules. It is notable that wars of old, fought under rules of chivalry, or in modern times under those of the Geneva Convention, at least in theory, by Abt's definition, would seem to be games.

For simulations, Bloomer adopted the definition of Guetzkow, that a simulation is 'an operating representation of central features of reality'. Ellington and his associates (ibid.) also identify in this definition 'two essential features which must both exist before an exercise can reasonably be described as a simulation'. These are first, that it must represent a real situation; and second, that it must be operational, that is an ongoing process. The latter criterion, Bloomer notes, excludes 'static analogues such as photographs, maps, graphs and circuit diagrams, but includes working

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models of all types'. Ellington and his associates (ibid.) say:

"It immediately follows from the above definition that a simulation game is an exercise that possesses the essential characteristics of both games (competition and rules) and simulations (ongoing representation of real-life), examples being chess and Monopoly. This term is now generally accepted by workers in the gaming/simulation field."

A case study was defined by Walker in 1974 as 'a study in detail of a particular event, problem or situation'. Ellington and others (op cit) add an important general characteristic that Walker's definition omits, that case studies are usually used to identify special features of the case under study or to illustrate general characteristics of the broader set of situations of which it is typical. Ellington and others offer the following extension of Walker's definition of a case study as: 'an in-depth examination of a real-life or simulated situation carried out in order to illustrate special and/or general characteristics'.

While case studies commonly overlap with simulations, games may also be used as case studies. It is therefore possible to have a number of types of hybrids. Ellington and his associates list seven distinct possibilities:

'PURE' GAMES such as Scrabble and the conventional card and ball games.

'PURE' SIMULATIONS such as the Link Trainer developed to teach basic flying skills during World War II.

'PURE' CASE STUDIES as used to train for medical and legal work.

SIMULATION GAMES such as Monopoly and chess. Chess simulates sixth-century battle manoeuvres - the rook for instance representing the movement of a war elephant.

GAMES USED AS CASE STUDIES. Games may be used for abstract disciplines such as formal logic and mathematics, which cannot be said to represent everyday 'reality', e.g. Chemistry-based card games.

SIMULATION GAMES USED AS CASE STUDIES. This combination covers a wide range of activities. For example, military exercises and training by means of computerized business management games.

In this research, an adaptation of the simulation game: TREBIDIES ISLAND: The Economics of Monopoly Management (Simile II 1977), is used as a case study for in-depth examination of the management of a natural monopoly market situation, in order to illustrate and organize by enactive, iconic and symbolic means, a general cognitive structure of principles of 'elasticity of demand' by special reference to a particular product, that is the supply of a telephone service.

Ellington and others (1981 pp 20-23) say that games and simulations can be used to achieve objectives from all parts of Bloom's cognitive and affective domains, and simulations can also be used very effectively in the psychomotor area. They recommend that they should be used not as 'a main, front-line teaching technique, but rather as a complement and support to traditional methods'. The reason they give is that 'it has been found that gaming and simulation techniques are no more effective than other, more traditional, methods when used to teach the basic facts of a subject'. But for achieving high-level cognitive objectives involving analysis, synthesis and evaluation, and affective objects of all types, they claim, games and simulations are particularly useful.

Ellington and others (ibid.) say that research indicates that positive transfer of skills can be achieved by means of games and simulations, both psychomotor and cognitive. They cite the example of training aircrew with the use of a cockpit simulator. Non-cognitive skills such as decision making, communication and interpersonal skills; and desirable attitudinal traits such as willingness to listen to other people's points of view and to view problems from different angles may also be fostered by games and simulations.

Games and simulations have the advantage over traditional methods in that they afford a high degree of student involvement. This is particularly desirable for the less able. The capacity of simulation games for motivation; the basis they provide for integrating concepts from various disciplines; and the creation of situations in which participants with expertise

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Games and simulations have the advantage over traditional methods in that they afford a high degree of student involvement. This is particularly desirable for the less able. The capacity of simulation games for motivation; the basis they provide for integrating concepts from various disciplines; and the creation of situations in which participants with expertise

in different subject areas can interrelate; are further advantages that are mentioned by Ellington and his associates (ibid.).

The main application of simulation and gaming techniques, Ellington and his colleagues (ibid. p 21) say were first utilized in military training. They were introduced to business management training in the mid 1950s. It was only in the early 1960s that such techniques spread to secondary and tertiary education. One of the first areas outside of the military and business fields in which games and simulations were used was teacher training. (ibid., pp 22-3) The first education simulations, published in 1962, required future teachers to deal with 'everyday' situations in a simulated school. They conclude that during the 1970s, techniques of gaming and simulation were adopted in the other subjects, including science.

2.4 The use of games in the classroom

In a review of the history of simulation games, Boocock and Schild (1968 p 16) observed that until 1962 or 1963, very little research on the effect of simulation games as a classroom technique had been done. They say that because the field was new and small most researchers were concentrating their energies in the design of games rather than evaluating them.

However, as a result of studies done during the years 1963 to 1965, some sobering conclusions were reached:

firstly, that games were not a panacea for all educational ills; secondly, that games in their form at the time had serious flaws; and thirdly, that neither standard tests nor the relatively crude instruments designed specifically to evaluate a particular game or games were adequate or sufficient measures for the impact of games.

These results led to a division in attitudes (ibid. pp 16-7):

(i) to continue research on the hypothesis that games do teach, in the hope of arriving at more adequate theorising as well as research designs; and

(ii) to revert to the hypothesis that while games cannot teach, at least they are useful means of motivating learners.

At the time of the Boocock and Schild survey in 1968, they were optimistic on three fronts: (ibid. pp 17-8)

1 Simulation games were being tested in the field in a variety of educational settings.

2 A pool of data on the learning effects of specific games was being accumulated, with increasing objectivity, due to work by independent researchers.

3 Theories on the effects of games in the classroom were being revised and clarified in the light of the results of field testing.

2.5 Simulation games used as advance organizers

In 1967, Scandura and Wells tested the use of a simulation game in terms of Ausubel's theory of advance organizers. Barnes and Clawson (1975 p 652) report that using 104 college students majoring in elementary education, Scandura and Wells 'compared the use of an advance organizer in the form of a game with a historical introduction'. The function of the game, as an organizer, was to present the structure of a mathematical group in terms familiar to the subjects. The duration of the experiment was one class period. It was reported by the investigators that the organizer was superior to the historical introduction ($p < .05$), say Barnes and Clawson (ibid., p 641).

Barnes and Clawson (ibid p 644) also report a study done in 1970 by Livingston. The three experiments that Livingston carried out showed no facilitative effects of advance organizers. Of these experiments:

"Two were with eighth-grade classes, and one was with a high-school class. He used a simulation game designed to teach economic geography as an advance organizer. Livingston compared each advance organizer group with a matched control group that did not use the simulation game as an advance organizer. The duration of his experiments varied. One lasted 1 class period; the content of this lesson was presented text books. In each of his experiments the control group scored higher, but not significantly higher, than the advance organizer groups."

Luiten, Ames and Ackerson (1980 p215) surveyed 135 experiments spanning the duration of two decades form about 1960 to 1980. They reported that in the majority of studies, research into the learning effects of advance organizers presented the participants with organizers in written form.

Luiten and others (ibid. p 217) say that studies involving, inter alia, games as advance organizers were too few in number to treat statistically in their meta-analysis of studies of the effects of advance organizers on learning and retention.

2.6 Assessment of effects of advance organizers (other than in simulation games) on learning and retention

Ausubel and Robinson (1969 p 146) say that despite the limited number of research studies at that time employing organizers, the evidence on their effectiveness is quite convincing:

"In an initial study by Ausubel (1960) an expository organizer was employed in advance of a learning passage on the properties of steel. - - - Although the experimental group outperformed the control group at a statistically significant level, it is believed that the discrepancy in their performances would have been even more pronounced if the subjects had not had some prior knowledge of steel, thus offsetting to some extent the potential advantage of the organizer."

In a later study by Ausubel and Youssef, published in 1963, Ausubel and Robinson (1969 p 147) say that they employed two learning passages in sequence, the first on Buddism and the second on Zen Buddhism. Again the organizing effects on learning and retention were as predicted.

Ausubel and Robinson (ibid p 148) say that 'it has been found in some instances that the facilitating effect of purely expository organizers seems to be limited to learners who have low verbal (Ausubel and Fitzgerald, 1962) and low analytic (Schulz, 1966) ability and hence presumably less ability to develop an adequate scheme of their own for organizing new material in relation to cognitive structure'. On the other hand, they suggest that 'when the learning task is particularly difficult, organizers may differentially benefit high ability students (Grotelueschen and Sjorgren, 1968) and those with more background knowledge (Ausubel and Fitzgerald, 1962) by making it possible to learn material that would in any case be beyond the capacity of the less sophisticated students'.

Researchers have made conflicting claims as to the facilitative effects of advance organizers on learning and retention.

Luiten and others (1980 p 211), came to a conclusion, based on their meta-analysis of 135 studens of written organizers, that 'advance organizers were shown to have a facilitative effect on both learning and retention'.

This was in reply to an earlier survey by Barnes and Clawson (1975 p 65) of thirty-two studies, on the basis of which it was concluded that: 'advance organizers, as presently constructed, generally do not facilitate learning'.

In reply to Barnes and Clawson (1975), Lawton and Wanska (1977) pointed out several inaccuracies in their description and interpretation of Ausubel's conception of advance organizers. Lawton and Wanska also criticised the democratic voting technique they used to arrive at their statistically dubious conclusion, using only thirty-two studies with very diverse variables. Barnes and Clawson (1975 p 651) had on the basis of their review, claimed that: 'The efficacy of advance organizers has not been established'.

Further investigation has been recommended by Barnes and Clawson (1975 pp 651-657) and by Lawton and Wanska (1977 pp 241-243). Barnes and Clawson recommend further research based on understanding of the present status of advance organizer research as revealed by their analysis of the literature. Lawton and Wanska (1977 p 241) recommend research to add clarity to Ausubel's assumptions with regard to implications for organizer construction, use and research.

Mugent and others (1980 pp 445-451) examined the effectiveness of the use of introductory organizers in presenting affective materials through the medium of television to college-level chemistry courses. The idea that there is a cognitive component to the formation of attitudes and values, they say, has support 'from Gagné (1977 pp 249-251), who proposes that the learner must possess some understanding of the concept underlying the desired attitude or value'.

The independent variables tested were a programme title and an organizer. Data obtained from 943 students and 54 teachers were subjected to multivariate and univariate analyses. Results showed that the advance organizer significantly increased student comprehension but had negative affective consequences; that is, it significantly decreased response and ratings of programme appeal. The cognitive component, a comprehension measure, was concerned with students' ability to infer the main issues or point of the instruction.

Ausubel (1980 p 40C) in reply to a paper by Anderson, Spiro and Anderson (1978) says:

"Anderson, Spiro and Anderson assert that my assimilation theory of meaningful learning and retention (and more especially, the nature and functions of anchoring or subsuming ideas in cognitive structure and their effects on learning from text) is "hopelessly vague". They also represent my concept of advance organizers as consisting of "a few abstractly worded sentences" intended to facilitate textual learning directly rather than through appropriate modification of the learner's existing cognitive structure. Lastly, they assert that since the research findings on the effects of advance organizers are allegedly "inconclusive", "there is cause for doubts about the entire theory". Documented examination of these assertions indicates that they are completely unspecified, unsubstantiated, and undocumented, as well as based on indisputable misrepresentation of published material and on logical <u>non sequiturs</u>."

On the nature of organizers, Ausubel (1960 p 402) cites (adding emphasis) the first research paper in which the term "advance organizer" appears (Ausubel 1960 p 270). In this paper it is stated that "advance organizers explicitly draw upon and mobilize whatever relevant subsuming concepts are already established in the learner's cognitive structure and make them part of the subsuming entity. Thus the most relevant ideational antecedents are also selected and utilized in integrative fashion".

Ausubel (1980 p 403) points out that Anderson, Spiro and Anderson (1978) rely completely on Barnes and Clawson (1975) 'for their judgement that the research findings on advance organizers have proven "inconclusive". He furthermore points out that Luiten and others, among others, 'not only question the theoretical and methodological soundness of the Barnes and Clawson review but also reach precisely the opposite conclusion'.

2.7 Simulation in the teaching of economics

There is a well developed market for simulation games produced in the United States at low cost. They serve as teaching aids in, among other fields, those of social studies, economics and business skills. Practising teachers are involved in the design of the materials which are produced through teachers' associations and cooperatives, and also by commercial firms. Examples are the Board of Co-operative Educational Services in New York and Simile II, California.

The Economics Association in Britain (Economics 1981) says in its Journal, that it is 'devoted to the publication of material connected with the teaching and learning of Economics and kindred subjects'. This association also facilitates the development and distribution of teacher aids such as film-strips, sound cassettes, workbooks, etc. and teaching kits. In the Publications Catalogue of Economics (1981), for example, is advertised 'The European Economic Education Teaching Kit', EURECOM, as follows:

"Now available in its English Version by JEAN-JACQUES GUTH and RAYMOND RYBA. A role playing simulation kit suitable for Sixth Forms and Further and Higher Education, and offering a versatile and interesting approach to the teaching of a wide range of economic concepts related to the working of national economics and international trade."

RH Ryba, until 1981 the Vice Chairman of the Economics Association, since elected Chairman, in producing EURECOM, has evidently accepted the educative benefits of simulation learning. Ryba (1975 p 218) seems to have been less convinced when he said:

"There can be little doubt about the power of role-playing and simulation to stimulate interest, even to the point of obsession, in pupils and students who are offered the opportunity of participating in them. What must remain more doubtful is the extent of the benefit in terms of economic(s) education of such participation."

Addressing the First EEC Working Conference on Economics Education in 1976, Ryba (1977 p 97) was again cautious, this time with reference to computer-based games. He asserted that their rules and assumptions could easily lead to misconceptions about decision making in the real world. What Ryba says about computer-based games could also be true of other kinds of entertainment which may be mistaken for, or even lay claim to being educative "simulations". Entertainments such as the well known Monopoly board-game and variations that it has inspired need to be evaluated on educative grounds before any value for school learning is attributed to them.

Ryba (1977 p 96) acknowledges that simulation games are important among a group of teaching approaches in Britain (role-playing, dramatisation, simulation games and computer assisted games) which aim to 'stimulate learning by involving pupils directly in problem-solving and decision making activities'. Their common feature, he says, is their reliance on role-playing.

To find out whether simulations can be designed effectively with advance organizing capacities, as defined by Ausubel (and as distinct from their intra-material organizing effects) is a central point of this research.

Ausubel and Robinson (1969 p 316) make the following distinction:

"Unlike intramaterial organization that successively provides necessary anchorage for, and differentiation of, new ideas at a particularized level just before each new idea is encountered, organizers perform the same functions in advance at a much more global level before the learner is confronted with any of the new material."

2.8 The use of concrete models in teaching

Referring to the course of human cognitive development, Ausubel and Robinson (1969 p 205) say that 'when the adolescent or adult approaches a new area of study or a particularly difficult concept, he will usually revert to a lower stage of cognitive functioning and will therefore require appropriate models and examples as an aid to his comprehension'.

For example, exercises in "mental arithmetic" become easier when recourse is had to a pencil and paper, thus facilitating imagery and enactment. This tendency to revert to more primitive modes of thought before being able to master newly encountered abstract concepts supports the assumption that symbolic expositions would be better understood with the aid of simulated enactive and iconic as well as symbolic representations.

With reference to the three modes of thought in Bruner's theory of cognitive development, namely: the enactive, the iconic and the symbolic, Ing (Lawton 1978 p 83) states that:

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With reference to the three modes of thought in Bruner's theory of cognitive development, namely: the enactive, the iconic and the symbolic, Ing (Lawton 1978 p 83) states that:

"Bruner says that these modes of representing reality develop in that order, but that they all remain with us in adult life. The dominance of any mode will depend partly on maturation, partly on personality, partly on the task in hand and partly on cultural influences."

Since individual pupils, at any given moment, in a school classroom are at different levels of development, the need for latitude in modes of presentation is apparent. Piaget and Bruner indicate the need to move from practical work to more abstract thinking. Ausubel's Theory of subsumptive learning, relevant to classroom and lecture situations, implies that meaningful learning in such situations, is possible only if the learner already has some generalized cognitive structures of greater abstraction than the new learning which is to be accommodated.

If enactive and symbolic simulation is to promote abstract thinking, it needs to be done prior to reception learning. Meaningful reception learning depends upon pre-existing concepts at a sufficiently high level of generality and abstraction. Simulation would thus organize for reception learning.

2.9 Cognitive structure

Ausubel and Robinson (1969 p 604) define cognitive structure as 'the total content and organization of a given individual's ideas; or the content and organization of his ideas in a particular area of knowledge'. This resembles in some respects the schenatic view of learning put forward by Piaget. Ginsburg and Opper (1969 pp 24-5) say of Piaget's theory that all species have the tendency to organize their processes and a tendency to modify structures to environmental conditions. They elaborate:

"The individual inherits physical structures which set broad limits on his intellectual functioning. He also inherits a few automatic behavioral reactions or reflexes which have their greatest influence on functioning in the first few days of life. These reflexes are rapidly transformed into structures which incorporate the results of experience. The third kind of inheritance - the general principles of functioning - is another biological aspect of intelligence. One general principle of functioning is organization; all species have the tendency to organize their processes.

A second aspect of general functioning is adaptation which may be further subdivided into assimilation and accommodation. Accommodation refers to the organism's tendency to modify structures according to the pressures of the environment, while assimilation involves using current structures which can deal with the environment. The result of the principles of functioning is a series of psychological structures which differ qualitatively from one another throughout a person's lifetime."

New experience of the environment is assimilated by the individual (organism) into the existing cognitive structure, but only to the extent that the schemas of the structure can assimilate it. When the reality of the environment disturbs the existing idiosyncratic reality of the individual's structures, assimilation is not possible. So to restore eq[illegible], the individual accommodates the schemas of his cognitive [illegible] his new experience of the environment. Stones (1966 p147) says that Piaget regards the process of development as a series of stages of equilibration. - - - Learning and development involve the acquiring of a series of schemas of increasing complexity'.

The essence of Ausubel's conception of meaningful learning is the concept of existing cognitive structure. Learning that is meaningful, can be related to and assimilated into the existing cognitive structure. Both Piaget and Ausubel hold that new learning is fitted into a cognitive structure that is hierarchical. Stones (1966 p149) describes Ausubel's hierarchy as follows:

"At the bottom of this hierarchy are the most specific concepts, but these specific concepts are subsumed under fewer concepts of greater generality. These more general concepts are themselves included in still more general concepts, and so on to the few extremely general concepts which cover a person's full knowledge in a given field. Ausubel suggests that (cognitive) schemas are the equivalent of concepts of a high degree of generality (i.e. concepts very high in the hierarchy)."

An experiment in the USSR, by AZ Redko, Stones (ibid.) says, 'showed that concepts such as slave and slave owner were learned more effectively when the higher-level concept (or schema) of slave-owning system had been formed'.

Theories of hierarchical cognitive structures imply that if a general concept, such as "elasticity of demand" is first understood, then subsequent reception learning of specific cases of differing market conditions will be more effective. Various types of market demand conditions would in this way be subsumed under the organizing concept of "elasticity of demand".

2.10 Recal by transfer of verbal information

Ausubel's principle of subsumption (whereby a newly presented piece of information is integrated in a meaningful sense with a previously learned structure of ideas), helps to explain the process of recall. Explanations of recall in Gagné's theory centre more on processes of transfer. Gagné (1965 p 82) says of Ausubel:

"The new information may be subordinate to the more inclusive structure, in which case the subsumption is 'derivative', or the new proposition may be coordinate with the pre-existing structure, and the subsumption is called 'correlative'. Remembering of an item of verbal information is affected, according to this view, by the degree of stability the organized structure has and the ease with which the newly acquired item can be dissociated from it."

Recall of derivatively subsumed information is meaningful when related to particular propositions (from the environment - for example, the neighbour's cat climbs trees) which are included in the general subsuming concept (in cognitive structure - for example, cats climb trees). Correlative subsumption occurs, Ausubel and Robinson (1969 p 66) say: 'when the new material is an extension, elaboration, modification or qualification of previously learned propositions'.

Stones (1966 p 150) says that 'Gagné suggests that response learning is at the bottom of a hierarchy of types of learning. Next comes the chaining of responses, then multiple discrimination learning, concept learning, principle learning, and finally problem solving. Gagné is primarily concerned with the methods of learning. The content of this learning, however, is very similar to Ausubel's model, although the terminology is not quite the same. In both cases learning at the higher levels of the hierarchy is more general than at the lower levels. That is, it covers a much greater range of phenomena and thus has greater potentiality of transfer'. (A comparison of Ausubel's hierarchy with the Bloom taxonomy appears in section 2.15 below) Stones (ibid.) says of Gagné's hierarchy of types of learning that 'the higher in hierarchy the form of learning the greater the potentiality for transfer'. At the level of concept learning, Gagné (op cit) holds 'that concepts may be linked into chains which then make up principles which taken together make up what we term 'knowledge' in a given field. For example, the principle water flows downhill is a chain

of three concepts. Once this is learned a child has a principle which he will be able to apply in a variety of situations which may be widely different from the situation in which he learned the principle'.

Ausubel's theory offers an alternative explanation, that of meaningful learning, at a level of comprehension, for the intermediate categories between what Ausubel designates as rote learning and and what Gagné calls problem solving.

Gagné (ibid.) points out that organization is not always meaningful, as principles of 'contiguity' and 'association' seem to show. This accords with Ausubel's distinction between rote and meaningful learning. Two ideas (represented verbally) that happen to occur and are experienced together in time, form an association such that when one of the ideas recurs, it tends to bring about the recall of the other.

Gagné's references to 'intellectual skills' approximates to 'problem solving' on Ausubel's taxonomy (see section 2.15 below). Gagné (1965 p 83) says that: 'It seems improbable that one can account for the retention and retrieval of intellectual skills by means of the laws as apply to the recall of verbal information'. Because the capabilities of intellectual skills, as for motor skills, appear to be more resistant to forgetting, Gagné (ibid.) suggests that 'they are influenced by quite a different set of factors in the individual's experience'. Intellectual skills he

maintains are reinstated when they are remembered, they are not recalled. 'Reinstatement of an intellectual skill occurs when the individual is required to exhibit some particular performance requiring the use of that skill in a "new" situation'

Ausubel's theory, Gagné (1965 p 149) says: 'implies that the conditions for learning meaningful verbal material are quite different' from those for verbal chains. The process of transfer is approached differently in Ausubel's theory. This approach will be reviewed in the next section.

Gagné (1965 pp 149-50) accepts that Ausubel's theory introduces several conditions additional to those established empirically by earlier learning theorists, for optimal learning to take place. These are, Gagné says:

"First, the learning of specific new propositions will be facilitated by the presentation of organizers, verbal propositions that indicate the relevance of the to-be-learned knowledge to the pre-existing cognitive structure. Another condition is called progressive differentiation, meaning that the most general and inclusive ideas are presented first, followed by increasing detail. (It may be noted that this practice is the opposite of that followed by many textbooks) Still a third condition is called integrative reconciliation, the deliberate and explicit pointing out of similarities and differences between the newly presented ideas and those previously learned. Finally, there is consolidation, which means

insistence on the mastery of currently presented material before new material is introduced."

Gagné reiterates that 'these conditions for learning follow from the basic notion that meaningful verbal learning is a matter of subsumption of new propositions into an organized structure that has been previously learned'.

2.11 Transfer of learning and Ausubel's theory of cognitive structure

Ausubel's theory postulates that the ideas presently existing in cognitive structure, according to how they are organized, facilitate or transfer to the learning of new ideas. His theory of subsumptive assimilation helps to explain how at least one kind of transfer occurs, that is sequential transfer. Ausubel and Robinson (1969 p 136) identify various forms of transfer. They say:

"In general terms, the word transfer refers to the influence of learning in one situation or context upon subsequent learning in another situation or context. Thus we would be concerned with transfer when we studied the effect of learning in one school subject on later learning in another school subject, the effect of learning in school on performance outside school or, more generally, the effect of past learning on present learning."

The three kinds of transfer defined by Ausubel and Robinson (1969 p 137-8) that are of interest to the educator, are: lateral, sequential and vertical transfer.

Ausubel and Robinson defined them as follows:

"Lateral transfer refers to the use of learning acquired in one substantive subject-matter area in another subject-matter area or in a nonschool context.

Sequential transfer refers to the use of earlier-acquired learning at a later point in that series.

Vertical transfer refers to the application of learning (for example, comprehension of a principle) at one level of the taxonomy to learning (for example, problem solving) at a higher level of the taxonomy."

2.12 Historical background to transfer theory

Theories of transfer began with the theory of mental discipline or the theory of formal discipline as it was also called. A form of this theory, called "classicism", Ausubel and Robinson (1969 p 139) say, can be traced to Plato and Aristotle. It was held that the mind was best trained by studying classical languages, philosophy and what today could be called the "liberal arts". Another branch of mental discipline theory termed "faculty psychology", originated with the philosopher Wolf, who, in 1734, enunciated a theory that mind was composed of "faculties" which were somewhat analogous to muscles, in that exercise d to strengthen them'.

On the basis of these theories it could be assumed that, with exercise and strengthening of the faculties, transfer would be automatic. By exercising the faculty of reasoning for example, reasoning encountered wherever, would be facilitated.

Empirical evidence early in the twentieth century, by Thorndike in particular, weakened the hold of mental discipline theory. Ausubel and Robinson (1969 p 140) say:

"Perhaps the most damaging research was that conducted by Thorndike (Thorndike, 1924; Broyler and others, 1927), who studied the gain on intelligence test scores made by students who had not studied the supposedly "disciplining" subjects. Contrary to the theory, Thorndike found that there was no greater gain in intelligence by students who had studied Latin and French than by students who had studied physical education. Moreover, he found that there was little overall gain in mental age for any group beyond that which would be expected on the basis of increasing chronological age."

Ausubel and Robinson (1969 p 140) submit that if a strengthening of general intellectual capacity through "mental discipline" were possible, it could be assumed that "massive transfer" would ensue, 'in that the child would tend to learn a great variety of things much more quickly'. This does not in fact appear to be possible.

The mental discipline theory was replaced by Thorndike's theory of identical elements in the 1920s. It went some way, in terms of stimulus-response findings to explain the transfer of learning. Ausubel and Robinson (1969 p 141) say for example that according to this theory, 'oral spelling skills would transfer to the learning of written spelling since the grapheme-phoneme code which the subject must utilize in responding is common to the two kinds of responses'. This line of thinking gave rise to what was called

the "social utility movement" in public education.

Attempts were made to include elements in school learning that were identical to real-life situations outside of the school. For example, the teaching of arithmetic was based on studies of the arithmetical skills required in various occupations.

Ausubel (1963 p 28) points out the difference between his theory and earlier stimulus-response (S-R) theory. He says that the relevant aspects of past experience, in the particular organizational properties in the existing and established cognitive framework, give rise to the transfer paradigm on which school learning depends. In this type of transfer paradigm, he says, the relevant aspects of past experience 'are such organizational properties of the learner's subject-matter knowledge as clarity, stability, generalizability, inclusiveness, cohesiveness, and discriminability (i.e., cognitive structure variables) - not degree of similarity between stimuli and responses in the two learning tasks; and recent prior experience is not regarded as influencing current learning by interacting directly with the stimulus-response components of the new learning task, but only insofar as it modifies significant relevant attributes of cognitive structure'. Ausubel says that cognitive structure variables 'are the principle factors involved in meaningful transfer'. He sees transfer itself as largely a reflection of these variables.

2.13 Vertical transfer

Vertical transfer as defined by Ausubel and Robinson (1969 p 157), 'occurs when prior learning at one level in a hierarchy or taxonomy of behaviors influences present learning at a higher level'.

Unless a student, they say (ibid. pp 158-9), has the underlying skills upon which a high level behaviour depends, it will be impossible to attain the high level behaviour. Teachers must make sure that the preceding links of lower-order behaviours are already in the learner's repertoire.

Gagné's hierarchy of learning is relevant here, as it reconciles Ausbel's theories with S-R theories of transfer at a rote level and Gagné's explanation of problem solving at the top of the hierarchy of cognitive behaviour. Stones (1966 p 150) says of Gagné's theory that: 'he suggests a hierarchy of types of learning ranging from simple response learning to problem solving'.

Ausubel and Robinson, on the basis of Gagné's theory, suggest that teachers should perform a task analysis, even if they do so informally, so that the knowledge to be acquired by the student may be developed in accordance with the hierarchy of the taxonomy. They say (ibid. p 159): 'If the task analysis is correctly executed, the student should be able to perform at any given level in the structure only if he is able to perform all the behaviors involved in the levels below this'.

2.14 Lateral transfer

Ausubel and Robinson (1969 pp 151-7) offer advice, based on logical considerations and empirical evidence, to the teacher about means of facilitating lateral transfer. They say that what students do with knowledge acquired in school when they encounter 'new situations to which this knowledge is potentially applicable is of concern to the individual teacher and to curriculum-builders collectively'. Firstly, they suggest that transferable skills should be taught, such as written presentation, obtaining information, study methods and listening skills. Secondly, real-life situations may be used for the learning of skills which transfer in accordance with the principles of "identical elements". The occasional field experience and simulated field settings that are not inordinately time-consuming are possible in the school situation. Thirdly, the utilization of subject-matter content as a vehicle for training transferable knowledge or skills. For example, it has been found (Haskell, 1923) that transfer can be expected from the study of Latin with an emphasis on derivations, to the improvement of English vocabulary. Fourthly, by stressing underlying principles and generalizations. Here Ausubel and Robinson (1969 p 154) cite the classic 1908 experiment of Judd and later work by Hendrickson and Schroder in 1941, involving principles of refraction of light in conjunction with learning to project a missile at a submerged target. On the basis of these experimerts, it has been advocated, they say, 'that lateral transfer can be facilitated by teaching students general principles rather than specific solutions, know-

ledge, or skills'. Fifthly, the students' attitudes towards transfer are an important factor in determining whether transfer will actually take place. Ausubel and Robinson (1969 pp 156-7) reiterate that meaningful learning always requires a meaningful learning set, 'irrespective of whether the learning involves reception or discovery'. With particular relevance to the question of transfer in this research, they go on to say: 'one method which might be employed involves eliciting the student's interest through some form of discovery learning. The evidence concerning the effectiveness of the discovery method suggests that if students have formulated generalizations as a result of their own discoveries they are more likely to employ these generalizations in other situations'. Finally, Ausubel and Robinson (1969 p 157) point out the importance of cognitive structure variables for lateral transfer. Transfer cannot take place if the initial learning has not in fact occurred and 'notions which are fuzzy, inaccurate, or confused have very little transfer potential'.

2.15 Sequential transfer

Sequential transfer, the main concern of this research, affects the teacher in the classroom most frequently. School subject content is usually presented sequentially. Ausubel and Robinson (1969 p 142) call this "sequential relatedness". They point out that subject areas 'vary in the degree of sequential dependence of their material'.

For example:

"At one end of the scale, mathematics learning exhibits such a high order of sequential dependence that unless the student masters each step in the development of the subject further progress is impossible except on the basis of rote learning. On the other hand, the degree of sequential dependence in the field of history would seem to be considerably less."

Ausubel's theory of cognitive structure, by its principles of subsumption, provides an explanation for meaningful learning of sequentially related material. Ausubel and Robinson (1969 p148) give a summary of how organizers facilitate learning through sequential transfer:

"Organizers probably facilitate the incorporability and longevity of meaningfully learned material in three different ways. First, they explicitly draw upon and mobilize whatever relevant anchoring concepts are already established in the learner's cognitive structure and make them part of the subsuming entity. Thus, not only is the new material rendered more familiar and potentially meaningful, but the most relevant ideational antecedents in cognitive structure are also selected and utilized in an integrated fashion. Second, by making subsumption under specifically relevant propositions possible, organizers at an appropriate level of inclusiveness provide optimal anchorage. This promotes both initial learning and later resistance to obliterative subsumption. Third, the use of organizers renders unnecessary much of the rote memorization to which students often resort because they are required to learn the details of an unfamiliar discipline before having available a sufficient number of key anchoring ideas."

A major factor in meaningful learning and retention that Ausubel and Robinson (1969 p 148) point out is the degree of discriminability of new learning material from previously learned concepts in cognitive structure. They say (ibid. p 149, that: 'The discriminability of a new learning task is in large measure a function of the clarity and stability of the existing ideas to which it is relatable in the learner's cognitive structure'. They postulate that 'as clarity and stability increase so should discriminability and, therefore learning and retention'. Empirical evidence in research of Ausubel and Fitzgerald (see section 2.5) is cited in support of this assertion.

Discriminability may be improved under certain conditions that Ausubel and Robinson (1969 pp 149-50) suggest, on the basis of empirical research. These are: To increase the stability and clarity of the anchoring idea itself by review and rehearsal. To use comparative organizers that explicitly delineate similarities and differences between the existing ideas and the new material to be learned. To follow the newly learned material with additional material which is potentially conflicting but which forces the learner to review the relationship between the anchoring ideas and the first-learned material. And finally to overlearn the material to be retained.

2.16 Bloom's Taxonomy and Ausubel's hierarchy of behavioral outcomes.

Ausubel and Robinson (1969 pp36-7) say that although the Bloom taxonomy has merits, they have certain reservations about it. They point out 'the apparent necessity of modifying the general format to accommodate the unique characteristics of intellectual performance in a particular subject matter field'. A more central difficulty, they maintain, is that Bloom's taxonomy does not make allowances for differences in conceptualizations by any experimenter or teacher. How any experimenter or teacher 'will classify a particular item will depend upon his conception of the psychological processes involved in its completion'. Differences of conceptualization, Ausubel and Robinson say; 'will be particularly important in dealing with those items which lie in marginal areas, as for example between comprehension and application, or between application and problem solving (analysis and synthesis)'. They maintain that a learning theory consistent with the range of possible behavioural outcomes can illuminate the hierarchical distinctions inherent in a taxonomic description of behaviour. In their 'meaningful learning paradigm', Ausubel and Robinson

> formulate such a theory. This theory postulates as behavioural outcomes: representational learning (naming), concept formation, concept assimilation, proposition learning, problem solving, and creativity. They say that their 'categories are derived from the assumed process underlying the acquisition of knowledge and the development of mental

abilities rather than from a predetermined classification of abilities'. This system of outcomes is hierarchical in nature and corresponds roughly with the Bloom taxonomy, as follows:

	Bloom	Ausubel	
		ROTE LEARNING	
Outcome:	knowledge	representational learning	Process
		by reception or discovery.	
		MEANINGFUL LEARNING	
	comprehension	(1) formation of concepts and generalizations, or assimilation of concepts and generalizations; (2) by reception or discovery.	
	application	proposition learning	
	analysis	problem solving	
	synthesis	creative behaviour	

Figure 4 Comparison of the Taxonomies of Bloom and Ausubel

Ausubel and Robinson say that their taxonomy 'seems generally compatible with Bloom's so long as certain important process distinctions are admitted'.

At the comprehension level for instance, Ausubel's taxonomy introduces two additional considerations which derive from the hypothesized underlying psychological processes:

"First, it is recognized that the learning of propositions (or generalizations) should be considered a more complex process than the learning of concepts, for the former typically involves the combination of concepts to form more comprehensive ideational units.

"Second, an important process distinction, with both psychological and pedagogical implications, can be made between discovery and reception learning."

Ausubel considers it important that we not only test the product of the student's learning, but that we recognise the process (reception or discovery) by which the product (the rote or meaningfully acquired concept or proposition) is generated. He furthermore, distinguishes the inductive formation of concepts - as in the case of young children - and generalisations on the one hand, from their assimilation on the other hand through reception learning.

Bloom's category of application, in the view of Ausubel and Robinson (1969 p 73), presents difficulties primarily because it is exceedingly difficult to ascertain the boundary between it and comprehension.

Ausubel and Robinson (ibid.) employ the term problem solving instead of analysis, largely because they find the latter term too restrictive. They query whether intellectual tasks that might be described as "problems" exist in the humanities (such as history or English). While 'the content of such fields exhibits fewer formal propositions and less clearly defined transformational rules (strategies)', they content that it 'is still useful to think of problem-solving tasks in these areas. Their criteria for problem-solving relate more closely to fields such as mathematics and science. Problem solving is at a higher level in Ausubel's hierarchy than reception learning. As with creativity, it is a process of discovery learning.

The material to be learned is not presented to the learner in final form as it is in reception learning. It requires of the learner, mental activity such as rearrangement, reorganization or transformation of given learning material, prior to incorporating the final result into cognitive structure. Ausubel and Robinson (1969 p 69) state the following criteria for problem solving:

"In addition to the minimal requirement that a 'problem' must involve discovery learning, we would add that there should be no clearly defined or frequently practiced procedure leading from the student's existing knowledge to the solution of the problem. In other words, there should be a gap between where the student now is and where he has to get in order to attain a solution."

Finally, synthesis in Bloom's taxonomy and creative behavior in Ausubel's, Ausubel and Robinson (ibid. pp 73-4) say: 'are clearly similar in that both involve the emergence of a product that is unique in terms of the individual's past experience'. They furthermore stipulate an additional requirement for creative behaviour which distinguishes it from problem solving: 'this requirement is that the background propositions and strategies that are brought to bear to produce the solution have not been taught as specifically relevant to the task at hand'.

The dependent variable in this research, the learning of reception material, was pitched at the level in Bloom's taxonomy of comprehension, in an expository teaching environment. Discovery learning material was used as the means of organizing the subsumer for the

experimental group. The object was to ensure the clear and stable formation and assimilation, in advance, of the highly generalised, meaningful and subsuming concept of "elasticity of demand". It was intended by means of the simulation game that acquisition of this general subsuming concept should be learned meaningfully and not by rote.

2.17 Recommendations for research design

Barnes and Clawson (1975 p 657) recommend the following research procedures in order to avoid the weaknesses they found in thirty-two designs which they examined:

"Carefully meet all the required conditions for experimental research including random assignment of subjects to treatment groups, maintain independence of subjects, use the appropriate statistical tests, test for mastery of the organizer prior to presentation of the material to be learned, be certain that the test of the advance organizer and all tests of the material to be learned are different from one another, include a retention measure if possible, follow established procedures for test construction and maintain high reliability and validity."

3 THE RESEARCH DESIGN

3.1 Methodology

An experimental pretest-posttest control group design, with one experimental variable, is the research method. The sequence of the procedure is as shown below, from A to F.

A	-> B	-----> C	-------> D	-----> E	----> F
PRE- TEST ALL	TWO MATCHED GROUPS	INDEPENDENT EXPERIMENTAL VARIABLE	TRANSFER RETENTION TEST	DEPENDENT VARIABLE (LESSON)	POST TEST ALL

Figure 5. Sequence of the research procedure

The same criterion-referenced test is presented to all the subjects as a pretest and again as a posttest. On the basis of pretest scores, pairs are matched. The pairs are then split and randomly allocated into two groups. One of these groups becomes the experimental group and the other the control group. These groups are not samples. Together they constitute the population for the experiment.

The class of students is divided into two matched groups of equal number. The dependent variable (i.e. an expository lesson) is presented to all the subjects - both control and experimental - as a class of business economics students. The control variables used for matching are the pretest scores on the dependent variable; tests of mental alertness and abstract reasoning; and chronological age.

Pairs are matched on the prescores and randomly split into the two groups. The groups are checked for equivalence and adjusted where necessary so as to counterbalance, on the means of their scores for mental alertness and abstract reasoning. Chronological ages of the pairs should be approximately in the same age groups. The proportion of males to females in each of the experimental and control groups should be as near equal as possible.

The prescore of each student is used as a basis of evaluating achievement prior to the experimental intervention (the organizer).

The experimental intervention or independent variable, in this case, an 'advance organizer', is experienced as an essential part of a simulation, but only by the experimental subjects. All the subjects experience the simulation game as a combined class of students. Except for the independent variable, in all other respects, the control and the experimental subjects participate together, under the same conditions, at each stage of the experiment.

A 'transfer retention test' is done to ensure that the experimental subjects have acquired a sufficiently stable, clear and well-organized knowledge of the subsuming concept (the independent variable), before the whole class together experience the new reception learning material (the dependent variable, i.e. the expository lesson). It may be necessary to repeat the independent variable until the organizing concept is mastered by the experimental group.

The dependent variable is measured by the differences between the pre and post test scores, giving an assessment of the effect of the experimental intervention.

The dependent variable, that is, the reception learning material, is presented to the combined class of control and experimental subjects, but not until it has been established by means of the transfer retention test that the experimental group has acquired a sufficiently stable, clear and well-organized comprehension of the subsumer concept.

The post test, in order to measure retention of the reception learning, follows one week after the expository lesson (i.e. The dependent variable).

This research does not claim 'external validity' beyond the population of the business economics class that is tested. It does aim to be internally valid and may be replicated with any other group of students. The groups tested are not samples of any larger populations.

Leedy (1980 pp 170-1) describes the pretest-posttest control group design by means of the following paradigm:

$$R \; - \; - \; \begin{cases} O_1 \rightarrow X \rightarrow O_2 \\ O_3 \rightarrow - \rightarrow O_4 \end{cases}$$

Figure 6.
Paradigm for the pretest-posttest control group design.

The bracketing in figure 6 of the experimental group (above) with the control group (below); shows that R, the randomization process, is common to both groups. External validity can be claimed if both groups are selected as random samples of a greater population. In this experimental design, the total population of the business economics (or any other) class of students, matched on pretest scores, is randomly split into control and experimental groups. These equivalent groups are randomly allocated for internal validity. The R - - in figure 6 shows that before random separation the two groups are kept isolated from the influence of the experimental variable X. O_1 and O_3 represent separate pretest evaluations of the groups drawn as samples of a population. O_2 and O_4 are the posttests.

This research design is a departure from the paradigm shown in figure 6. The business economics class population is pretested before random separation into matched groups takes place. See figure 7. O_1 represents the pretest and R the random separation. Both groups are kept isolated from the experimental variable X, until the simulation game is experienced, then only the experimental group is exposed to the independent variable.

$$O_1 \text{ -- } R \text{ - - } \begin{cases} X \rightarrow O_2 \rightarrow YO_4 \\ - \rightarrow O_3 \rightarrow YO_5 \end{cases}$$

Figure 7. Paradigm for the research design.

The purpose of the transfer retention test (TRT), shown as O_2 and O_3 in figure 7, is to measure the extent to which each of the subjects has a stable, clear and well-organized knowledge of the organizing subsumer concept. If the simulation is effective for the experimental group in this respect, as compared with the control group, virtually all of the experimental group should pass the TRT and virtually all the control subjects should fail. Fisher's contingency test provides a measure of the significance of the comparison between the results of the experimental and control groups. (Quod vide 3.4.6)

The reception learning material Y - the learning of which is measured in the posttest O_4 - is not presented until it has been shown by means of the TRT (O_2) that all, or most, of the experimental subjects have attained the required knowledge of the organizer concept.

Comparison of the postscores O_4 with the prescores O_1 gives an indication as to whether the 'organizer' X, is effective in causing improved achievement scores for the experimental group in their retention of the reception material Y, as compared with the control group. For the latter comparison, achievement gains of the control group are measured by means of the postscores O_5.

For a parametric analysis, Leedy (1980 p 171) recommends analysis of covariance in a pretest-posttest control group design. The research paradigm used here, illustrated in figure 7, is nonparametric. Unlike the traditional paradigm, as shown in figure 6, this research involves a distribution-free design. The pretest is in this case administered to the whole population and not to two sample groups as shown in figure 6. The pretest as a benchmark from which to measure gains, is common to both the experimental and the control groups in this design.

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3.2 The Pretest and the Posttest

The achievement test - appendix A - is comprised of two sections, A and B. They are allocated, respectively, 12 and 100 marks.

Section A of the test has two questions to test the ability of the students:

(1) to write a paragraph explaining the word 'elasticity': its meaning in the context of the analysis of market demand; and

(2) to distinguish (expressed in writing) between demand that is 'elastic' and demand that is 'perfectly inelastic'.

A score of twelve marks is allocated to these two questions. They test the student's comprehension of the concept 'price elasticity of demand' as manifest in the ability to explain and discern meanings of the concept.

Section B of the test comprises 20 multiple choice questions to which 100 marks are allocated. Each question has only one correct response out of five choices. Correct answers score 4 marks each. All 20 correct answers multiplied by 4 scores 80 marks. The student commences with a basic score of 20 marks. Every incorrect response is penalised by -1 and unanswered questions score 0. The students are warned not to guess and of the penalty of -1 mark for each incorrect response. If 20 incorrect responses are given the student would score 0, i.e. the basic 20 + (20 x -1) = 20 - 20. This procedure is intended to compensate against guessing.

The test, as a whole, is not designed with the intention of testing problem solving or creative behaviour as defined by Ausubel (quod vide 2.16). These behaviours, not intended to be tested, approximate to the analysis and synthesis outcomes in the taxonomy of Bloom (quod vide 2.16). The questions are designed to test for achievement of the behavioural objectives of the subsumptive reception learning material which is presented after the simulation game. These objectives are shown in appendix S. The outcomes defined by these objectives are pitched at the level of 'comprehension' in the hierarchy of Bloom's taxonomy. That is, above the level of 'knowledge' (or rote learning, which in Ausubel's taxonomy is termed 'representational' learning. The test thus measures outcomes which in terms of Ausubel's learning theory should be attained most effectively as a result of a meaningful learning process.

By comparing experimental and control group differences in score gains, the null hypothesis - that these should be equal - is put to the test. Differences of individual students between post and pretest scores, represent their gains in achievement. These differences in gains, taken all together, make up the dependent variable. The same set of questions (appendix A) is used for the pretest and the post-test.

3.2.1 Content validity of the pre/post test instrument

To ensure content validity, the test of achievement coincides with the stated learning objectives for the expository material as shown

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