A Review of *A Behavioural Approach to Instructional Prescription* by G. L. Gropper (1983) and

its Application to Direct Instruction

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1. Introduction

Gropper (1983) has provided a behavioural model for the efficient design of instruction. The model is highly abstract. It reviews the meaning of learning as a behaviour change caused by practicing an appropriate response in the presence of a stimulus that controls it. The process requires learning discrimination, generalisation, association and chaining to create control of a performance. These concepts are the underpins for all objectives. Gropper (1983) groups objectives according to five classes (recalling facts, defining, explaining, following rules and solving problems) and suggests instructional components for teaching these objectives. Ideas on the analysis and sequencing of objectives are also suggested.

This essay initially summarises Gropper's (1983) theoretical input as succinctly as possible in a theoretical fashion. The main concern, however, is to demonstrate how his behavioural concepts have been used practically in the instructional design of Direct Instruction (DI).

The major features of Direct Instruction have been examined to ascertain those behavioural processes described by Gropper (1983) which are used for remediating the academic difficulties of children. Specifically, the analysis has been structured around the theoretical and conceptual rationales of Direct Instruction. Included have been its approaches to child diagnoses, some strategies, and exercises and activities used in the Direct Instructional treatment of children.

2. A Summary of Gropper's (1983) Instructional Design Concepts

2.1 Learning Concepts

Behavioural theory has impacted heavily on techniques of instructional design explaining how to select units of behaviour best suited for learning, conditions causing learning and factors related to the permanence of learning. Learning is defined by Gropper (1983) as a change in behaviour. Key behavioural concepts include stimulus-response association, stimulus control, discrimination, generalisation, association and chains. Gropper (1983) explains these concepts.

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A stimulus is an environmental event which elicits a reaction or response. Stimulus control is a stimulus which elicits a set response as a result of prior learning which takes the form of reinforcement or rewards. For stimulus control to develop, the subject must discriminate or tell different stimuli apart. Subjects also generalise their response by responding in a similar way to other similar stimuli of a similar class or category. The learner must associate responses with an appropriate stimuli that controls them. Finally they must chain or join multiple responses to multiple stimuli to produce a performance or production.

2.2 Instructional Concepts

Instruction provides techniques to improve learning. On the conclusion of learning, criterion stimuli represent the stimuli that must be recognised with appropriate responses. Cues are responses already known to the learner which elicit similar responses to those desired for criterion stimuli. Using clues increasingly close to the desired response is called shaping or incremental learning, while removal of clues is called fading.

Concrete prescriptions are the means by which specific subject oriented behavioural principles are applied in instructional design.

2.3 Conditions Affecting Skill Acquisition

Through task analysis, learning tasks are structured to maximise opportunities for discrimination, generalisation, association and chaining. Objectives state the task to be learned, by whom, in what situation, and to what criterion level.

The ease with which a response may be learned depends on enhancing dissimilarities among

stimuli of different classes to aid discrimination between classes. Enhancing similarities among stimuli of the same class aids generalisation within the category. Minimising response similarity aids learners to discriminate between responses and to learn associations. Enhancing response similarities aids in generalisation of responses within a class but hinders learning associations.

The number of stimuli and response dimensions and classes determined the difficulty of a task in terms of the ease of stimuli discrimination. Also the larger the number of stimuli and responses joined together in a chain, the greater the difficulty in learning the chain. Associations between stimuli and responses learned in the past also interfere with learning new stimuli-responses.

Recall of responses to stimuli deteriorates with time, competing learning and inadequate practice. Transfer of learning involves identification of similarities among different stimuli in the same class. Other learning factors include student learning capacities and their degree of skills in research and learning.

2.4 Treatments

Objectives must describe what is to be learned, to what level, under what conditions and how and when an evaluation is to occur. Stimulus and response modes need to be stated, tasks performed under any condition and post-instruction requests met.

Practice tasks are designed for learning through consideration of clues, the unit size of behaviour, mode of stimulus and response, variety, content and frequency of practice.

Strong clues are initially used for guidance, and then are faded or diminished. Clue strength refers to close association between clues and responses, similarity between clues and responses, a short time interval between clues and responses, and maximising the attributes that control responses.

2.5 Unit of Behaviour

The size of the unit of behaviour is described by how much must be learned, its complexity and difficulty, the integrity of the criterion behaviour and standards of performance.

2.6 Stimulus and Response Modes

The object is to perform in the criterion mode. Use of practice such as a recognise, edit, production progression may simplify the preparatory process for producing an answer. Use of concrete and visual processes with familiar language prior to abstract symbolic modes of stimuli and responses simplify learning. Doing an activity simplifies learning about the principles and theory behind the activity.

Varied practice aids generalisation and transfer. Factors in practice sequences such as familiarity, similarity and saliency or use of clues or different modes or parts may simplify practice. Exaggerations or distortions, an introduction of errors or different sequencing may help to clarify understandings. Repetition is important.

2.7 Treatment Organisation

Practising a skill in its entirety is efficient. Most instruction involves preparation of sub-component skills involving problem identification, assessment, and selection of the type and extent of practice. Students systematically move from individual tasks to sequenced tasks to the holistic behaviour. Practice tasks must prevent a practice of errors and lead to successful task completion. Transition must be towards progressively challenging tasks which approach the final desired behaviour.

Objectives may be classified on the basis of common skill requirements and this simplifies instructional design. Routine lessons are often fastest and usually include objectives, instructions, cues, examples, rules and frequent varied practice. If easier practice is needed, use smaller units, stronger clues, recognition and editing as well as answer production, simpler examples and practice of easier materials. The simplest lesson considers uses of concrete materials, deliberate distortions, practice of errors, backward chaining, practice prior to stating principles and simplified practice.

In matching objectives and treatments, recalling facts include telling students the facts and providing practice in stating or applying the facts. Cues highlighting associations, and the use of the relevant contexts may help.

Objectives related to defining concepts involve discrimination of instances from non-instances, identification of all instances, definition of the concept, recall over time and transfer to original examples. Routine instruction includes definition of the concept, provision of examples and non-examples, provision of principles and practice. Simplification of the process could include greater similarity between instances and non-instances of a concept, more dissimilarity among instances of the same concept, more stimulus properties for discrimination, more concepts to be discriminated and many examples of the concept. Additional instruction could include more clues, recognition practice, graduated difficulty in practice, and teaching the principles.

Objectives involving explanations involve relationships among concepts, or principles. Instruction rules follow concept definition, but with the addition that flow charts often help to present data in a constructive visual way. Demonstrations may clarify the students' understanding while practice may assist with comprehending principles.

Objectives related to following procedural rules involve discriminating tasks. This includes using one set of procedures over another, and generalising those tasks which may involve similar sets of procedures. Stimulus-response associations are chained to a performance level that meets criteria. Design includes identifying steps to be followed, demonstration of their implementation, and providing rules, practice and varied examples. Additional help includes job checklists, stating explicit criteria for discriminations, breaking chains into smaller units, practising each unit, or backward chaining.

Objectives may demand problem solving. This involves problem identification, and the selection or creation of procedures. Similar design techniques apply.

2.9 Multiple Objectives

The order of sequencing objectives is contingent on fostering learning through task analysis to reveal relationships(Gagne, 1970). Vertical relationships are a hierarchy that must be learned in order. Horizontal relationships refer to objectives that are learned first in time. Learning order usually follows performance order. When subordinate objectives are shared by superordinate objectives, the shared elements should be scheduled with priority.

3. Application of Gropper's (1983) Concepts to Direct Instruction

Direct Instruction (DI) has been regarded by many educators as a behaviourally oriented instructional design with potent force for remediating children with learning difficulties (Gersten, 1986).

Siegfried Engelmann, Douglas Carnine, Wesley Becker and other Americans developed the University of Oregon's Direct Instruction (DI) model(Jacobs & Welch, 1983) to overcome such shortcomings in some traditional packages as vague teacher directions, poor content sequence, poor instructional activities, lack of participation and insufficient practice(Jones & Krouse, 1985). The programme has led to

numerous scripted programmed texts for teaching basic skills in a highly effectively manner(Becker, 1986).

aim (not a theory)

Direct Instruction was underpinned by the theory of teaching more in less time. Otherwise stated DI increased the effective use of time through quality instruction employing behavioural and cognitive theory(Kameewnui & Carnine, 1986).

3.1 Conceptual and Theoretical Rationale

The terminology, direct instruction or (di) was originated in the 1970's by Rosenshine (1987). It was a form of instruction with an academic focus, and was teacher centred with little student choice of activities and materials. The model fits with Gropper's (1983) design in these ways. Tight teacher control of learning enables the teacher to maximise contingencies between stimuli and the correct student responses. Groups were taught with rapid pacing, with teaching characterised by high student participation and a high percentage of correct answers. Teachers modeled correct answers verbally. These answers, termed by Gropper (1983) as clues, informed the students of correct responses.

The model, in accordance with Gropper's recommendations, emphasised practice. Teachers, provided guided practice, checked for understanding, and followed up with independent practice for the students. Teacher feedback was immediate and provided the correct response.

Sequences of objectives also followed Gropper's (1983) dicta. Objectives were stated behaviourally as Gropper suggests. Learning outcomes were explicit and well structured and were task analysed into discrete parts(Jones & Gendernalik-Jones, 1987). Children were required to learn specific component skills through well designed sequences. Consequently, academic learning time was enhanced and performance monitored.

Although not suggested by Gropper (1983), the DI model stressed the need for pretesting of students to determine their appropriate placement. Differential teaching and learning time was organised for the students to allow their mastery of all essential skills.

However, Gropper's recommendation of treatment organisation was adhered to rigidly. There was step by step instruction, based on task analysis.

Bruner's (1966) theory of instruction had incorporated an examination of learner predispositions, a study of the structure of knowledge, ideas for the sequencing of information and some reinforcement theory. These ideas were combined with Gagne's (1970) eight types of learning, summarised by Gropper as his five types of objectives. The result was Engelmann and Carnine's (Carnine & Becker, 1982) theory of instruction focussed on a triad; an analysis of behaviour, knowledge systems and communications. Each of these approaches are reviewed.

Behavioural theories (Gropper, 1983) provided the basis for fostering learning in task oriented homogeneous small groups by the use of prompts, modeling and discriminative signals. These triggered choral responses in unison followed by immediate correction or rewards by the teacher who monitored the students' lips. The structure generally permitted errorless learning.

Motivation was enhanced by many of the techniques suggested by Gropper (1983). These include rapid pacing, meaningful presentation, stimulus changes, use of surprises, and awareness of attention spans. Other techniques included races against the teacher, enthusiasm, use of humour and absurdities (Gropper's exaggerations), games, drills, frequent successful participation, wall and individual progress charts, and frequent activity or social rewards for obtaining the correct answers(Engelmann, 1970; Lockery & Maggs, 1982). As Gropper (1983) suggests deliberate teacher mistakes were used to teach independent thinking.

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The analysis of communication provided the principles for the logical design of teaching sequences to avoid learning misrules, or making over or undergeneralisations. Principles rested on Gropper's (1983) processes of discrimination, being how examples were similar and different and how appropriate generalisations could be made quickly(Moore, 1986).

The analysis of the structure of knowledge led to a taxonomy of knowledge based on how to organise information into basic, joining and complex forms. The model is similar to Gropper's (1983) hierarchy of objectives, with both theories based on Gagne (1970). Basic concepts were joined by instructional design into logical transformations, rules, and facts. Sets of rules and facts formed the basis of building complex forms that were used for problem solving(Becker, 1986, p. 181).

As suggested by Gropper (1983) basic concepts were identified by common stimulus properties which were unavailable in non-instances. Multiple discriminations were undertaken between positive and negative examples found between and within instances. These juxtaposed examples illustrated relevant from irrelevant characteristics.

Knowledge systems were identified to permit the widest possible range of applications. The DI theory differed from task analysis in its gathering of all related problems and its juxtaposing of examples to illustrate sameness and differences.

The implications of this theory of instruction were illustrated clearly in the examination of Direct Instruction teaching methods.

4. Teaching Procedures Used in Direct Instruction.

4.1 Learning Basic Concepts

As Gropper (1983) suggests, much of the basics of Direct Instruction involved development of general cases of concepts, being the ability of learners to discriminate relevant from irrelevant features. Rules suggested by both Gropper (1983) and Becker (1986) for teaching concepts included the use of a number of positive examples of the concept with similar features, followed by negative examples. Both positive and negative examples should share the largest number of irrelevant features.

To show concept limits, minimally different examples were contrasted and labeled as Gropper (1983) has recommended. Learners extrapolated that examples more than minimally different were non-examples. Positive examples that were as different as possible were shown and indicated to be the same. Learners were tested with new examples. The setup was then varied to expand the coverage.

An example provided by Becker (1986, p. 190) was in teaching the concept 'over.' This example illustrates Gropper's (1983) distinction of examples discriminated from non-examples clearly.

Two negative examples of the concept follow.
1. ----
    o   The ball is not over
2. ----o The ball is not over.
Now three positive examples are used ending with a positive minimally different from two.

   o
3. ---- The ball is over
   o
4. ---- The ball is over
   o
5. ---- The ball is over

The teacher now illustrates six random positive and negative examples and tests the students.

6. ----
    o   Is the ball over?
7. ----
    o Is the ball over?

```
       o
8. ---- Is the ball over?

       o
9. ---- Is the ball over?
10. ---- o Is the ball over?
11. ---- Is the ball over?
       o
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Finally the setup was changed. For instance, the child was asked if the ball was over the chair, or the cup over the saucer. This process, as Gropper (1983) notes, permitted generalisation.

Teaching noun concepts involved the additional step of identifying critical attributes and formulating rules to describe objects.

Direct Instruction goes beyond Gropper's (1983) tenets, in ensuring that learning sets of independent members which must be rote learned, were minimalized. Objects were classified as much as possible into general-case sets which followed common rules. Using objectives which stressed rule application met vastly improved learning as Gropper (1983) has stated. For instance, systematic phonics with forty sounds and blending skills were taught rather than sight recognition. This method gave access to 10,000 regular sounding words in the time taken to learn eighty sight words(Carnine & Silbert, 1979). In reading learning 800 morphographs generated more than 12,000 words.

Gropper (1983) warned that errors in learning related concepts resulted when related concepts had many common features and few differences. In DI cumulative programming involved teaching the easier related concepts to the point of discrimination. Then others were added, until the sets were learned.

As Gropper (1983) recommends, sequencing skills in DI involved teaching preskills first, introducing instances of an example before non-instances, introducing high utility skills before lesser utility skills, teaching easier skills before difficult and delaying skills which might confuse.

4.2 Joining Forms

Basic concepts were chained by transformation rules to form fact statements. The teaching process showed what was the same in all examples and how example differences changed responses. The rule 'make both sides of an equation equal' could be taught by using a common setup 'x = ' and using positive examples. Only minimal differences in examples were used to demonstrate sameness. The range of differences was shown by using different examples and processing them similarly. Test examples were used at the end.

Subtypes were exceptions to the rule. For instance, 'eat and ate' were an exception to the rule 'add *ed*' for past tense. All similar subtypes were grouped and learned together(Stein, 1987).

Correlated-feature forms were facts and rules occurring together, and enabled the learner to predict events from an observation. For instance, 'above is another word for over.' If we knew the meaning of 'over,' we could predict the meaning of 'above'(Becker, 1986). Teachers would ask two questions, the first for an inference about the unknown, the second for a reason for the conclusion. For instance, "water boils at 100 C. Water is heated to 90C. What will happen to the water? How do you know?"

4.3 Complex Forms

In DI complex forms were facts and rules joined together. As Gropper (1983) recommends they were often taught by pictorial charts with script to teach critical words and relationships. Students were presented with blank charts containing the necessary configurations and played a dice game to fill in the chart terminology. The teaching steps moved from teaching, to testing, to practice.

Problem-solving in DI rested on grouping sets of problems which could be solved by one routine and by stating a rule for solving the problem(Becker, 1986). Component preskills were determined by task analysis and were taught first as basic concepts or as joining forms. Students practised on a task which contained each step(Engelmann & Carnine, 1982).

4.4 Programme Design

In producing effective teaching sequences all the steps were made overt, then gradually faded as Gropper (1983) exhorts after sets of skills were mastered by practice. The design steps included stating objectives, working out problem-solving strategies, deciding on preskills, sequencing skills, choosing an instructional strategy, designing layouts, selecting examples, and practice and review(Becker, 1986).

Mastery levels and rate or speed criteria were needed for stating objectives. A general problem solving strategy was taught. All preskills were learned. Easier skills were taught first and in separate time spaces from those which could be confused. As in Gropper's prescription, DI teaching involved modeling, fading of help, test and retesting. Layouts referring to the format or steps for problem solving were constructed.

Examples had to work with the strategy with an intermixture of previous problem types for identification and practice. Practice must be given until mastery(Engelmann, 1970). Scope and sequence required curriculum mapping.

5. Conclusion

The origins of Direct Instruction have been shown to be based on many of the behaviourial principles such as described by Gropper (1983). It has incorporated the principles and rationale of previous

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modes of instruction. As an instructional design, Bruner and Gagne are its progenitors but Carnine has successfully added much that was original in the practical application of teaching concepts, joining forms and complex structures.

The model was based on teaching more in less time and has accepted Bloom's (1976) adage that every child could achieve mastery if properly taught.

Principles were behavioural in orientation. Consequently diagnosis was subject rather than child based. Failure was seen as a deficit of the curriculum which could be remedied by rewriting a unit of work. Frequent monitoring ensured that the teacher was aware of a child's weaknesses and progress. Mastery was essential before the child moved on to new work.

The teaching procedures used in DI has followed Gropper's (1983) prescription by providing detailed steps and numerous strategies for teaching basic concepts, joining forms and problem solving. Mastering the skills in designing any behavioural package have been shown to be substantial. However, many commercially available packages with teacher scripts have simplified the teacher's task.

The evaluation of the effectiveness of DI has been highly positive. At a school level, Erickson (1987) has found that students were more on task, experienced success, developed clear logical thinking, learned from their errors, and achieved mastery. Consequently, they become readers by grade 1, a skill which served them throughout their schooling.

Such testimonials of individual schools has supported the results of the research studies.

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6. ~~Bibliography~~ References

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Becker, W. C. <u>Applied psychology for teachers: A behavioural logical approach.</u> Sydney: Science Research Associates.

Blankenship, C.& Lilly, M. S. (1981). <u>Mainstreaming students with learning and behaviour problems: Techniques for the classroom teacher.</u> New York: Holt, Rinehart and Winston.

Bloom, B. S. (1976). <u>Human characteristics and school learning.</u> New York: McGraw-Hill.

Brown, A. L. & Campione, J. C. (1986). Psychological theory and the study of learning disabilities. <u>American Psychologist,</u> <u>43</u>(3) 1059-1068.

Bruner, J. S. (1966). <u>Towards a theory of instruction.</u> Cambridge, Ma: Belnak Press.

Carnine, D. W. & Silbert, J. (1979). <u>Direct instruction: Reading.</u> Chicago: Science Research Associates.

Carnine, D. W. & Becker, W. C. (1982). Theory of instruction: Generalisation issues. <u>Educational Psychology. 2.</u> 249-262

Condon, D. & Maggs, A. (1986). Direct Instruction research: An international focus. <u>International Journal of Special Education.</u> 1(1). 35-47.

Engelmann, S. (1970). <u>Distar Language: II</u> New York: Science Research Associates.

Engelmann, S. & Carnine, D. W. (1982). Theory of instruction: Principals and applications. New York: Irvington.

Erickson, H. L. (1987). Libby, Montana testifies for Direct Instruction. Educational Leadership. 44(6). 28-29.

Gagne, R. M. (1977). The conditions of learning. New York: Holt, Rinehart and Winston.

Gersten R. & Carnine, D. (1983). The later effects of Direct Instruction Follow Through: Preliminary findings. Paper presented at the Annual Meeting of the American Educational Research Association. (ERIC Document Reproduction Service, No. ED 236114)

Gersten, R. (1985). Direct instruction with special education students: A review of evaluation research. Journal of Special Education. 19(1). 41-58.

Gersten, R. (1986). Direct instruction: A research-based approach to curriculum design and teaching. Exceptional Children, 53(1), 17-31.

Gersten, R., & Keating, T. (1987). Long term benefits from Direct Instruction. Educational Leadership. 44(6). 28-32.

Gropper, F. L. (1983). A behavioural approach to instructional prescription. in Reigeluth, C. (Ed.). Instructional design theories and models: An overview of their current states. N.J.: Lawrence Erlbaum.

Jacobs, J.A. & Welch, K. V. (1983). A generic approach to Direct Instruction. Paper presented at the Annual Montana Symposium on Early Education and the Exceptional Child. (ERIC Document Reproduction Service, No. ED 239774).

Johnson, J. (1987). Adaptation of curriculum, instructional methods, and materials component: Instructional aide programme. (ERIC Document Reproduction Service, No. ED 285943)

Jones, E. & Krouse, J. P. (1985). Verbal math problem-solving: What the research on instruction tells us. Paper presented at the National Conference of the Council for Learning Disabilities. (ERIC Document Reproduction Service, No. ED 265719).

Jones, N. K. & Gendernalik-Jones, M. (1987). Teacher effectiveness and education: A case of incompatibility. Paper presented at the Annual Meeting of the American Educational Research Association. (ERIC Document Reproduction Service, No. ED 284829).

Kameenui, E. & Carnine, D. W. (1986). Preteaching versus concurrent teaching of component skills of a subtracting algorithm to skill-deficient second graders: A components analysis of Direct Instruction. The Exceptional Child. 33(2). 103-115.

Kozloff, M. A. (1974). Educating children with learning and behavioural problems. London: John Wiley.

Leach, D. J., Swerissen, H. & Leach, P. (1988). Teaching parents to be direct instructors and child advocates. Chapter for Pieterse, M., Bochner, S. & Bettison, S. Early intervention for children with disabilities. Sydney: Macquarrie Press.

McFaul, S. A. (1983). An examination of Direct Instruction. Educational Leadership. 40(7). 55-58.

Moore, J. (1986). Direct Instruction: A model for instructional design. Educational Psychology. 6(3). 201-229.

Rosenshine, B. (1987). Explicit teaching and teacher training. Journal of Teacher Education. 38(3), 34-36.

Sulzer-Azaroff, B. & Mayer, G. R. (1977). Applying behaviour analysis -procedures with children and youth. New York: Holt, Rinehart and Winston.