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IDENTIFYING WORLD VIEWS PROJECTED BY TEACHERS' CLASSROOM DISCOURSE USING KILBOURN'S ANALYTICAL SCHEME BASED ON PEPPER'S WORLD HYPOTHESES

by

Herman Proper

B.Sc.(Agr.), University of Guelph, 1967

A THESIS SUBMITTED IN FULFILLMENT OF THE REQUIREMENT FOR EDUCATION 898 AND PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE DEGREE OF MASTER OF ARTS (EDUCATION)

in the Faculty

of

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SIMON FRASER UNIVERSITY

July 1982

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SIMON FRASER UNIVERSITY BURNABY BC CANADA V5A 1S6

May 27, 1982

Dr. Brent Kilbourn
Department of Curriculum
Ontario Institute for Studies
in Education
252 Bloor St. W.
Toronto, Ontario
M5S 1V6

Dear Dr. Kilbourn:

Many thanks for your letter of Dec. 2nd, 1982 and the literature you enclosed with it. That, and the issue of Paunch which you recommended, has been most helpful in my work.

As I indicated to you in my earlier letter, I plan to study world views in the classroom using your scheme as outlined in your Ph.D. Thesis. There are two major thrusts to the study. The first is to test the reliability of the scheme. I have used it myself in a limited way and the preliminary indication is that the scheme will stand up. The plan now is to train two research assistants to use the scheme in identifying world views in sections from Speed's General Biology, and to compare their results (and mine) with yours. The second major thrust is to test the usefulness of the scheme in detecting world views in teacher talk.

This letter is specifically to ask for your permission to copy for inclusion in my thesis your analytic scheme, specifically Tables 1 through 6.

I will of course be most happy to inform you of the results of the study. I look forward to your favourable reply.

Sincerely,

Herman Proper
M.A. (Ed.) Candidate

Dr. Marvin F. Wideen
Senior Supervisor

MFW:ss

Permission granted, with appropriate citation (cited ref to Report) —
B Kilbourn
30 June 82

Wideen

APPROVAL

Name: Herman Proper

Degree: M.A. (Education)

Title of Thesis: Identifying World Views Projected by Teachers' Classroom Discourse Using Kilbourn's Analytical Scheme Based on Pepper's World Hypotheses

Examining Committee:

Chair: L. Prock

M. Wideen
Senior Supervisor

G. Ivany
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D.A. Roberts
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Faculty of Education
University of Calgary
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IDENTIFYING WORLD VIEWS PROJECTED BY TEACHERS' CLASSROOM DISCOURSE USING KILBOURN'S ANALYTICAL SCHEME BASED ON PEPPER'S WORLD HYPOTHESES

Author:

(signature)

HERMAN PROPER

(name)

JULY 23, 1982

(date)

ABSTRACT

The concept of world view has received little direct attention in science education though it has significant potential for influencing curriculum decisions and teaching practices. The argument underlying this study is that world view plays a determining role over knowledge and is therefore central to education. The study is designed to analyse the projection of world views in teachers' classroom discourse.

Kilbourn developed an analytical scheme, based on Pepper's World Hypotheses, to identify six world hypotheses--animism, mysticism, formism, mechanism, contextualism, and organicism--in a biology textbook. The present study extends Kilbourn's work by applying his scheme to teachers' classroom discourse in chemistry, physics; earth science, and biology.

Although Kilbourn did not attempt to demonstrate inter-rater reliability for his scheme, it was felt necessary, for this study, to do so. Accordingly, the investigator trained two independent judges to use the scheme and compared their analyses of passages from a biology textbook with Kilbourn's analyses of the same passages. The level of agreement indicated that an adequately trained judge can use the scheme to reliably attribute world hypotheses that are projected, without making many wrong attributions.

The scheme was then used to identify world hypotheses projected by teachers' classroom discourse. From a bank of sixty-five audio-taped lessons of junior secondary science classes involving twenty-two teachers, the investigator selected for analysis fifty-four segments of teachers' description and/or explanation that appeared to project one or more world hypotheses.

The study showed that Kilbourn's scheme is useful for identifying world hypotheses in teachers' classroom discourse in the four subject areas, and at the same time pointed out certain limitations of the scheme. The teacher talk analyzed projected a limited set of world hypotheses, consisting mainly of formism and mechanism, and at times of contextualism and organicism. Certain topics tended to project certain world hypotheses. For example, topics in physics and chemistry regularly projected mechanism. The teachers' discourse generally did not project world views openly, but by implication or as underlying assumptions.

To DIANE, my wife,

without whose faithful support and

typing into the wee hours this thesis

would not now be

done.

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CHAPTER I

INTRODUCTION TO THE STUDY

Context of the Problem

The concept of world view has received little direct attention in science education or science education research until quite recently. For example, Kilbourn claims that "there seem to be no studies in science education dealing centrally with the comprehensive and systematic notion of world view.... But, partly because of the richness of the concept world view, there are studies which are peripherally related to it" (1974, p. 115). A world view is a person's set of beliefs, whether held consciously or subconsciously, about the basic nature of reality and how one comes to know about it. I assume in this study that all people have world views, and that their world views are important in what they think and do. The concept of world view is closely related to the concept of knowledge; it is therefore central to education and has significant potential for informing curriculum decisions and teaching practices.

People acquire their world views through a wide variety of influences. Their childhood family lives no doubt have a profound influence. Daily, people are confronted with world

view messages through the media, through interpersonal relationships, and through the ways our institutions are structured and function. Schooling too, plays a large role in shaping people's world views, if only because young people are required to spend so much time at it during their formative years. Indeed it has been argued that the purpose of education is precisely the examination and transformation of the students' world views. "To be educated is to have one's view of the world transformed by the development and systematization of conceptual schemes," says Peters (1975, p. 256). Soltis says:

> We can view education as helping others to see the world from a new perspective in two ways. One way is to think of it as actually providing students with a particular world view or interpretation of experience. The other way is to provide them with lenses to be able to see it, that is, with concepts, relational systems, and standards of judging. (1981, p. 106)

Science teaching is especially important in shaping students' world views. Science is the only school subject that deals directly with the physical and biological world, thus playing a major role in shaping students' views on the nature of physical and biological reality, and, to a lesser extent, on their own human nature. Furthermore, science and its offshoot technology, have played a major role in shaping our society and culture, and our views, attitudes, and expectations. It is not uncommon to hear the notion that "science" will solve the energy crisis (or pollution problem or cure cancer, etc.) As Aoki and Harrison (1978) say, "technical knowing (or as it is

commonly labelled, science) is perhaps a dominant way through which many of us in our culture are taught to approach our everyday world" (p. 56). Aikenhead claims that science

> must be viewed as a social phenomenon in which people are trained to view the world in certain ways. These world views are bound by traditional habits of perceiving and thinking . . . . we see what we have been taught to see . . . we see as much with our brain as we do with our eyes. (1980, p. 59)

By world view, Aikenhead means perception or "way of seeing", a somewhat different meaning of the term than that used in this thesis. However, he clearly makes the point that our way of seeing depends on the conceptual framework and ways of thinking that we have learned. In the terms used in this study, we tend to see what our world views prime us to see.

Given then that science teaching plays a large role in forming students' world views, two issues are of concern to me: What world views and associated attitudes are projected, and how--in what manner--are they projected?

The Projection of World Views--Content

Science teaching in North America commonly projects a limited set of world views or perspectives, including mechanism, scientism and evolutionism. As a consequence, students are given only a few ways of interpreting or making sense of their experiences. For example, Kilbourn analyzed a biology textbook widely used in Grade 13 biology in Ontario, F.M. Speed's General Biology, and found that mechanism was commonly projected when-

ever a causal explanation was sought[1] (1974, pp. 199-201; 1980, p. 41). Ausubel (1966) criticized the B.S.C.S. Blue and Yellow Versions for their strong mechanistic[1] bias. He claimed that the "desirable degree of theoretical tolerance and open-endedness is found only in the Green Version. For example, the mechanistic bias in the other two versions is excessively and unabashedly polemical." This is of concern because, as Kilbourn says,

> the outcome of all this, the potential consequence for an individual of adopting a mechanistic world view as the only way of interpreting phenomena, is a vacuum in the very area which concerns us most as human beings. Existential vacuum and meaninglessness enter at precisely the point where morality, responsibility, and holistic interpretations of humanness leave. Mechanism cannot fill the gap. (1980, p. 39)

Eastman (1969) claims that "public education in the United States, from kindergarten through to graduate school, is actively (though in most cases not intentionally) fostering scientism," which he defines as the assumption that science "designates the true and ultimate way to solve the problems of nature and man." (Thus scientism is not a world view, but one aspect of it, more like a perspective or attitude.)

---

[1]Kilbourn used mechanism in the sense of Pepper's technical conception of the world hypothesis mechanism, whereas Ausubel appears to use mechanism in the more popular sense of the belief that everything in the universe can be explained in terms of matter in motion. The two are, however, closely related.

He continues:

> What view is in fact being taught in the classroom? Here the content and organization of the textbooks is a partial indicator, and these, plus observations of and discussions with science teachers, suggest to the author that scientism is probably being taught in well over half of the classrooms. (pp. 20-21)

Although it may project scientism more strongly than any other area of the curriculum, science education is not alone in this projection. Aoki and Harrison (1978) show that the British Columbia Social Studies curriculum documents project three perspectives -- technical-scientific, situational, and critically-reflective -- as ways of interpreting man-in-his-world, but emphasize the technical-scientific perspective. "Through such an emphasis teachers and students are made dependent on one particular way of viewing the social world." The projection of scientism, like the projection of mechanism, is of concern because of the potentially harmful consequences it has for students. Eastman states this concern strongly:

> We are trained in scientism, learn to adulate its technological extension, and live for the acquisition of technology's perpetual products. . . . Continuing to teach scientism significantly contributes to one of the most pressing dangers of our time. Those who accept scientism for science are especially likely to fall victim to the grossest dehumanizing and depersonalizing aspects of our postcivilization. They are likely to have a blind faith in the Great God Science (i.e. scientism) and so to uncritically and irrationally absorb its claims and its products and eventually to become its docile pawns. (1969, pp. 21-22)

A third member (popularly called a world view) of this set

projected by science teaching is evolutionism. That evolutionism is projected by biology curricula and materials hardly needs saying. It is so common that evolutionism has become a significant component of many people's world views. As Ernst Mayr (1978) says,

> man's world view today is dominated by the knowledge that the universe, the stars, the earth and all living things have evolved through a long history that was not foreordained or programmed, a history of continual, gradual change . . . . The theory of evolution through natural selection . . . stands today as the organizing principle of biology.

The projection of evolutionism is of concern to me because of the potential consequences for students' views of themselves as human beings. Does evolutionism address adequately such typically human attributes as morality and responsibility? Furthermore, the projection of evolutionism in biology teaching to the exclusion of alternative world views has become an issue for many people, as seen in recent attempts to force school boards to give creationism equal time in the classroom. The potential impact on biology teaching of these attempts is a concern for biology teachers in general.

Sometimes projected along with a certain world view is an inappropriate attitude regarding the status of that world view. The claim may be made that no alternative world view is possible: The world view projected is the true interpretation. An example is found in McElroy et al.: "What evidence do we have that life has evolved? It is so overwhelming that evolu-

tion cannot be rationally disbelieved" (1968, p. 396). At issue is not whether evolutionism is true or not; the issue is that this statement claims that no alternative world view could possibly be entertained because no other interpretation of the evidence is possible. This claim smacks of hubris; at best it is simply inappropriate in a textbook for students since what is needed is not passionate denunciation of alternatives, but dispassionate examination of how various alternatives (or even one alternative) account for the evidence. Ausubel's (1966) conclusion regarding the projection of mechanism in the BSCS texts is similar: "The desirable degree of theoretical tolerance and open-endedness is found only in the Green Version." His judgment is:

> Such philosophical indoctrination is also indefensible when students are too unsophisticated to evaluate the merits of a given theoretical orientation. Until they are sufficiently mature to form independent judgments, it is important that they be permitted to retain an open mind on controversial issues in the philosophy of science.

Part of what is projected is a negative content: What world views are not projected? Eisner, for example, discusses the consequences of the null curriculum, of what schools do not teach. He says,

> it is my thesis that what schools do not teach may be as important as what they do teach. I argue this position because ignorance is not simply a neutral void; it has important effects on the kinds of options one is able to consider, the alternatives that one can examine, and the perspectives from which one can view a situation or problem. The absence of a set of considerations or perspectives or the

> inability to use certain processes for appraising a context biases the evidence one is able to take into account. (1979, p. 83)

Schumacher (1978) describes his experience of the null curriculum as follows:

> All through school and university, I had been given maps of life and knowledge on which there was hardly a trace of many of the things that I most cared about and that seemed to me to be of the greatest possible importance to the conduct of my life. (p. 1)

In terms of this study, every world view that students do not learn about reduces their abilities to explain and interpret their experiences and the nature of reality. Roberts (1970) makes a similar point. He argues that while the scientific mode is the only explanatory mode given systematic treatment in the curriculum, it is only one of at least three modes of explaining commonly used by people, and is inadequate for coping with the full range of human experience. Therefore he calls for " a perspective for science in the school curriculum which is comparative rather than absolute, and which highlights both the power and the limitations of explanation as a way to cope with experience" (p. 138).

In short, science teaching projects a limited set of world views, accompanied at times by the attitude that other world views are unworthy of consideration as legitimate ways of interpreting one's experience. The potential consequence for students is a severe limitation in their abilities to cope

with the full range of human experience.

The Projection of World Views -- Manner

Of equal concern with what is projected is how it is projected -- in what manner. The projection may be overt or hidden. An overt projection occurs when it is stated that the world view offered is an interpretation of reality. A hidden projection occurs when this is not stated, but the world view offered is implied, or must be assumed in order to make sense of what is said.

It seems to be the case that, in science education, world views are projected primarily by means of "hidden" expression; an overt expression of world views is much less frequent. In his analysis of F.M. Speed's General Biology, Kilbourn found that

> in no case was a conceptual framework expressed overtly. At no point in the textbook was an effort found that makes the student aware that knowledge claims stem from conceptual perspectives. Nor was any attempt found to make the student aware that there are alternative conceptual perspectives, even though alternative conceptual perspectives are often implicit in the issues discussed. (1974, p. 204)

Ausubel (1966) implies that the mechanism projected in the BSCS texts, although "excessively and unabashedly polemical," is yet to some extent hidden: "Although it is legitimate to express this type of reductionistic bias in the philosophy of science, it should at least be stated as a bias." Recall, too,

Eastman's comment that "public education in the United States... is actively (though in most cases not intentionally) fostering scientism" (emphasis mine). At least one of the reasons for this, he says, is the lack of training in philosophical awareness of new teachers:

> Looking at science teachers in our schools and colleges for a moment, we may ask how much thought have they given to their activity as an expression of a new and significant and, perhaps, crucial world view? How many of the undergraduate or graduate programs in science require majors to take work in -- at least -- a philosophy of science course. (1969, p.21)

Aoki and Harrison (1978) imply that the perspectives they described are also hidden when they say,

> it is recommended that a full description of the perspectives incorporated into the British Columbia Social Studies program be carefully described in the Curriculum Guides. Students and teachers are entitled to a full explanation of the curriculum developers' knowing stance. The curriculum developers' perspective towards the social world should not, in other words, be hidden from users of the curriculum.

Evolutionism also is often projected in a hidden way; it is assumed in much of biology without its being stated as an explanatory and organizing principle. For example, classification is based on deduced evolutionary relationships and "family trees" are drawn showing purportedly real relationships.

World views then, -- in particular mechanism, scientism,

and evolutionism -- are projected, it seems, primarily in a "hidden" way without the students being aware that an explanation or interpretation is being presented. This bypassing of the student's independent judgment violates the core of what it means to teach and to know. To use Ausubel's term, it is indoctrination. Scheffler describes teaching as follows:

> To teach, in the standard sense, is at some points at least to submit oneself to the understanding and independent judgment of the pupil, to his demand for reasons, to his sense of what constitutes an adequate explanation.... We try also to get him to believe it for reasons that, within the limits of his capacity to grasp, are our reasons. Teaching, in this way, requires us to reveal our reasons to the student and, by so doing, to submit them to his evaluation and criticism. (1968, p. 57; see also 1965, p. 131; 1978, pp. 106-107)

Munby (1980) makes the same point when he relates the concept of intellectual independence to the concept of teaching. His concern is the consequence that teachers' classroom discourse can have for students in terms of shaping the "intellectual climate" of the classroom. "More specifically, the provisions made for students to assess the truth of knowledge claims independently is the central concern." He argues also that the concept of teaching requires that teachers provide for the intellectual independence of their students. To intentionally make students intellectually dependent would be, not to teach, but to indoctrinate. For students to "assess the truth of

knowledge claims independently," they must be provided with the relevant evidence, proofs, and arguments; this includes the provision of alternative interpretations where these are available. In terms of this study, since world views provide the most-encompassing explanations and interpretations of our experiences, students must be provided with alternatives at that level. To do otherwise, argues Kilbourn (1980) is wrong:

> One reason the hidden curriculum is considered vicious by many educators is that covert messages to students give them little freedom to judge the merits of what is hidden. Student choice in matters which can affect them personally is circumvented to whatever extent alternatives remain invisible and such teaching is a morally questionable practice.

In summary, the context of the problem is the role that science teaching plays in shaping the world views of students. The limited set of world views that present-day science teaching projects, and the hidden manner of much of that projection, are both cause for concern.

Statement of the Problem

The projection of world views in written materials was studied in depth by Kilbourn (1974). Because the term world view is vague and imprecise, Kilbourn substituted for it the concept world hypothesis taken from Pepper's World Hypotheses (1942/1970c). Pepper's six world hypotheses--animism, mysticism, formism, mechanism, contextualism and organicism--are his way

of conceptualizing and cataloguing world views. In this thesis, then, world view is used for the less precise non-technical generic concept, while world hypothesis refers to Pepper's precise and technical concept, which can be considered a species of the generic term. Kilbourn developed an analytical scheme and used it to identify Pepper's six world hypotheses in F.M. Speed's General Biology. He found that the scheme, or conceptual framework, was a powerful way for dealing with the issue of world views in written science teaching materials. In discussing the implications of his study, he suggested that

> further analytical research of interest would be an examination of teaching according to this conceptual framework. It would be of interest to determine whether world hypotheses can be distinguished in teachers' utterances, especially with a view to examining consistency of teachers' interpretations and explanations with teaching materials presented to students. (1974, p. 206)

The present study is designed to follow up on that suggestion. Specifically, answers are sought to the following questions:

1. Is the analytical scheme developed by Kilbourn reliable to the extent that someone else can apply it and obtain similar results?
2. Can Kilbourn's scheme be used to identify world hypotheses projected in teacher talk?
3. What world hypotheses are projected in teacher talk, and are they linked to content areas?
4. How are world hypotheses projected in teacher talk--openly, or in a hidden manner?

To a degree, the present study is a replication of Kilbourn's work. This investigator, for example, analyzed Pepper's World Hypotheses and compared Kilbourn's analytic scheme to Pepper's descriptions of the six world hypotheses. Some of the questions which this study is designed to answer are similar to questions that Kilbourn posed. However, this study extends Kilbourn's work in a number of important ways. Most important, the application of the scheme has been extended to teachers' classroom discourse. Whereas Kilbourn's study focussed on biology, the present study includes also physics, chemistry, and earth science. Both extensions will provide valuable additional knowledge about the use of the analytical scheme, and about the projection of world hypotheses in science education. Finally, additional and more recent literature has been consulted, providing additional insights into the concept of world view and Pepper's theory.

Organization of the Study

In chapter two, the literature review focusses on the concept of world view and examines some related studies; the concept of world view is linked with the concept of knowledge. Some catalogs of world views are surveyed and Pepper's world hypotheses discussed. Chapter three describes the procedure and results of the reliability test done on the analytical

scheme, and the collection of the sections of teacher talk to which the scheme is to be applied. In chapter four, sample analyses of teacher talk are given, followed by summary results and some observations on the problems encountered in analyzing teachers' classroom discourse. The final chapter discusses the results of the analysis and the limitations of Pepper's theory. It concludes with a discussion of the significance of this study and possibilities for further work.

Limitations of the Study

The first limitation of this study is that the results regarding the projection of world hypotheses in teacher talk are not generalizable since the sample was not totally random. The data bank used in the study consisted of audio-tapes of sixty-five junior secondary science lessons by twenty-two teachers (in all cases but one, three lessons by each teacher). The teachers were from two school districts, but those who were eventually observed gave their consent. "The attrition rate was high as many of the teachers did not like to have their lessons observed and taped"(Seah, 1980, p. 8). Therefore the results are treated as suggestive and no attempt is made in this study to make generally valid empirical claims about the projection of world hypotheses in teacher talk.

The presence of an observer and recording apparatus are presumed to have had no effect on the outcome of this study.

This judgment is based on observers' comments recorded during observation and in the final reports (Cusack, 1979, p. 102; Seah, 1980, p. 39), and on my own listening to these tapes. (I have thirteen years' experience as a science teacher.) It would also seem a reasonable assumption that a teacher's explanation--the vehicle for world views projection--would not change due to, for example, nervousness induced by observers.

A further limitation is the nature of teacher talk in the classroom. It tends to be disjointed, interrupted by student responses, repetitious, and interspersed with anecdotes, banter, and managerial comments. It is often accompanied by blackboard and other illustrations which can only be estimated from the audio-tapes and observation sheets. (This investigator did not personally observe the lessons.)

A last limitation to be noted is the lack of broader context. When a textbook is analyzed, the whole textbook forms a context for any particular passage. With only audio-tapes of individual lessons, this broader context is missing. Therefore the claim about projection is limited to the actual teacher talk as it is written in the transcripts.

CHAPTER II

REVIEW OF RELATED LITERATURE: A THEORETICAL BASIS FOR THE CONCEPT "WORLD VIEW"

Introduction

The literature dealing with the third and fourth questions guiding this study -- what world views are projected and how they are projected -- has already been reviewed in the previous chapter. In this chapter, the focus is on the theoretical foundations underlying the first two questions (and, indeed, the whole study). This chapter combines a literature review with a philosophical analysis[1] that is designed to clarify the concept world view and elaborate its theoretical basis in terms of other educationally important concepts. To some, such a philosophical analysis may seem unnecessary since they can readily agree that world view is a concept that is important in education. To others however, the concept is either meaningless, or so vague that it lacks any educational significance. This investigator takes the position that the concept world view is an important concept in education, but that it requires further clarification and elaboration of its theoretical basis in order for it to be recognized as educationally significant and to be

---

[1] By philosophical analysis, I mean what Kneller has termed informal analysis, as described in Roberts & Russell (1975, pp. 112-113).

used for the improvement of teaching. Pepper's world hypotheses, a more systematic and precise concept than world views, is also examined and his catalogue of six world hypotheses is compared with several other catalogues of world views.

The Concept of World View

The term world view derives from the German Weltanschauung --way of looking at the world. Davis (1961) credits William Ernest Hocking of Harvard University for first making the term current in English usage. It now appears regularly in the literature. The imprecision and richness of the concept world view are seen in the number of terms substituted for it and the descriptions given of it by various writers. Yet the common elements in the descriptions show that the various writers are dealing with the same very real "something".

Davis (1961) describes world view in various ways: "a comprehensive conception of the universe with interpretive entailments," "web of interrelationships," "reference frames." "World-views, the fine-spun theories of totality, are then the enablers of knowledge, patterns which make sense of the casual data of perception."

J.C. Greene (1981) relating it to the history of ideas, defines world view as "the presuppositions of thought in given historical epochs" (p. 3).

For Kilbourn (1980) world view is "a person's view of the structure of the universe and how it works - how things, events, and people come to be as they are, how they interrelate and fit in the general scheme of things, and how we know all this." For both Kilbourn and Davis then, world view has ontological (the way things are) and epistemological (how we come to know) dimensions.

Hart (1968) in a more limited conception defines "perspective" as "vision-with-a-view-to-our-task"; "perspective" then is that aspect of world view that has to do with man's place in the world. Hart argues that perspective has two aspects: spirit and ground-motive. Ground-motive means "the basic law or 'word' setting the context for the direction of a movement." It is in a sense the core content of a world view, and is very similar to Pepper's concept of the root-metaphor which determines the basic categories of a world hypothesis. "Spirit" is meant not in an abstract hypostatized sense (like disembodied spirits that move ouija boards) but in the sense of ordinary talk, as in "the spirit of Karl Marx is still strong in Chinese Communism, " or "she is a very spirited woman." Spirit is "the characteristic dynamic of what inspires (people's) acts, the motor in the grip of which they move on." Hart is the only writer I've read who tries to give some account not only of the structure or content of a world view, but also of its drive, its dynamic.

Perhaps the most precise definition of the term "world view" is given by Sire (1979). Like Davis, he equates it with "a frame of reference." He defines it as "a set of presuppositions (or assumptions) which we hold (consciously or subconsciously) about the basic makeup of our world." A well-rounded (not necessarily adequate) world view includes answers to six basic issues:

1. The nature and character of God,
2. The nature of the universe,
3. The nature of man,
4. What happens to man at death,
5. The basis of ethics,
6. The meaning of human history.

Sire's definition does not explicitly include any epistemological dimension.

Pepper uses the term "world view" only once as far as I know (1970b, p. 188). His term world hypotheses denotes a more precise and systematic philosophical conception. However he commonly interchanges "world hypothesis" with "world theory" which he equates with Weltanschauung. In one place he calls world hypotheses "schools of philosophy." The word hypothesis indicates that the claim to knowledge is tentative, not certain. A world hypothesis is distinguished from an hypothesis in the special sciences in that it cannot ignore or reject the relevance of any fact: "A world hypothesis is an unrestricted

hypothesis." A world hypothesis "synthesizes the enormous diversity of evidence the world offers . . . (and if confirmed) explains the interrelationships of the evidence and gives insight as to its meaning for man - thus furnishing an enveloping evaluative system for human action and decision" (Pepper, 1970b, pp. 154, 161).

Ross (1970) defines world view and describes why world views are important in terms of how they function in our lives:

> A world-view is a suggested way of looking at things. It always involves some 'root metaphor', analogy, 'archetype' or model. . . . What is important about these views is that they seek to give some special significance to our experience by offering a key interpretative principle . . . . The adoption of one or other of the positions would involve: (1) a feeling of satisfaction that some insight has been gained about what the world is and how it works, (2) a basis for . . . the right attitude to take up in our practical lives, (3) an attitude recommended for our theoretical activities. (pp. 210-211)

Concepts Related to World View

World view is such a broad concept that, as with the Indian elephant, taking hold of it at different points gives rise to different conceptions. Thus in the literature we find various concepts that are less comprehensive than world view but clearly a (sometimes indirect) part of it. Kuhn's paradigm is like world view in both of the two meanings that

Kuhn has given it:

> On the one hand, [paradigm] stands for the entire constellation of beliefs, values, techniques, and so on shared by the members of a given community. On the other, it denotes one sort of element in that constellation, the concrete puzzle-solutions which, employed as models or examples, can replace explicit rules as a basis for the solution of the remaining puzzles of normal science. (1970, p. 175)

Also these shared examples, when assimilated by the student, give him "a time-tested and group-licensed way of seeing" (p. 189). In other words, the shared world view of a community of scientists gives its members both common concepts and common principles of interpretation. The affinity between Kuhn's paradigms and Pepper's world hypotheses was recognized by both (Pepper, 1980, pp. 61-62; Efron, 1980, pp. 23-24).

Campbell (1971) defines epistemological posture as "the totality of an individual's attitudes and beliefs concerning the nature and conditions of truth and knowledge." This is clearly one dimension of a world view, as Campbell recognizes: It is "a variable representing a factor or dimension of an individual's Weltanschauung or world-view--the conceptual structure in which an individual organizes his perceptions of the world." He then developed a taxonomic structure of epistemological posture and began to develop an instrument to identify "separate and distinct S groups based upon their measured differences along several statistically fundamental

dimensions of epistemological posture."

Whereas Campbell is concerned with the epistemological posture held by students, Kilbourn in his 1971 study is concerned with the "epistemological posture" (one might say) of science textbooks: What provision do they make for students to understand the basis for knowledge claims? Kilbourn developed an Analytical Scheme of five questions based on Scheffler's three conditions of knowledge--the truth, evidence, and belief conditions. This scheme obviously taps world view because world view includes a certain stance on how we come to know. Specifically, one of the questions asks, "Which theory of truth seems to be implied by the text as the basis for considering a given claim to be true?" (p. 23). A "theory" of truth is included in every world view. The use of the scheme to analyze a six-page passage from a biology textbook demonstrates "a specific way to view problems in science teaching by using considerations from theory of knowledge."

A similar epistemological scheme is Prusso's (1972) Profile and Epistemological Analysis Scheme designed to determine whether science lessons are epistemologically consistent with science. The scheme has three epistemological dimensions. The dimension "kinds of meaning" describes the context of the science statements, whether empirical, theoretical, or both. The dimension "strategies of arguments for verification" has the positions assertion, analytic, empirical, or pragmatic. The third dimension,"nature of support", contains authority,

reason, and sense-experience, and is used to assess "what opportunities pupils have in a lesson to acquire evidence and to use it in making independent judgments of the truth of statements" (Abstract). Like Kilbourn's epistemological scheme then, Prusso's scheme is concerned with the epistemological posture taken, in this case by classroom teaching. I question whether Prusso's scheme is sufficiently open to alternatives, for only the Empirical and Pragmatical "Models of Knowledge" are considered appropriate to the truth of scientific statements. Thus, for example, a coherence theory of truth, associated with the world hypothesis organicism, seems to be ruled out.

Roberts (1970) is concerned with the fact that curriculum materials make little provision "for students to understand the limitations of science as a way of thinking." Specifically, science is but one of at least three explanatory modes (sets of explanatory rules, ways of thinking) which are, like world views, ways of understanding or interpreting the world. The three modes Roberts describes are the religious, magical and scientific. Especially interesting is Roberts' development of the anatomy of an explanatory mode. It has three parts:

1. Mythology--"an inference about one reason why this explanatory mode was developed as a way to cope with experience."

2. Philosophy--(ideas, principles) statements which allow one to "thread one's way around in the explanatory corpus", which allow one "to understand features of an explanatory statement".
3. Explanatory corpus--the set of explanatory statements.

This anatomy of the explanatory mode is somewhat similar to Pepper's structure of a world hypothesis: The philosophy of the explanatory mode is like the categories of a world hypothesis, while the explanatory corpus is the same for both--the set of detailed interpretations. The mythology of the explanatory mode does not correspond to the root metaphor of the world hypothesis, since the former deals with why, and the latter with how, the way of explaining arose.

World View a Unique Variable

Some philosophers--notably analytic philosophers--have been critical of traditional world-view philosophizing (Soltis, 1968, p. 66) and consider the concept world view a vacuous term. However, there is good evidence that world view is a unique educational variable. Campbell (1971) compared his construct epistemological posture with various instruments designed to test such psychological variables as rigidity/

flexibility, dogmatism/open-mindedness, and tolerance/intolerance of ambiguity. His analysis led him to conclude that

> epistemological posture as defined and described . . . appears to be substantially dissimilar to other psychological variables in common use today . . . . . With respect to statistical criteria, epistemological posture is likely to turn out to be a relatively independent, and therefore non-redundant, variable. (p. 7)

Harris, Fontana, and Dowds (1977) developed a twelve-item scale based on Pepper's four adequate world hypotheses--formism, mechanism, contextualism, and organicism--and used it to measure individuals' preferences for these world hypotheses. To establish the independence of this World Hypotheses Scale (WHS), they tested male subjects with the WHS and with established personality and cognitive variable tests. There was no reliable correlation between preference for any of the four world hypotheses and any of the following variables: authoritarianism, rigidity, dogmatism, Machiavellianism, self-reported college grade-point average, and locus of control. For verbal IQ there was one reliable correlation of -.33 ($p < .01$) between vocabulary level and the preference for formistic thinking. The authors conclude that "the four orientations of the World Hypotheses Scale are independent entities and are not essentially other ways of measuring already established personality and cognitive variables."

World View, Belief and Knowledge

World views are so basic that no thinking or communication is possible apart from them. "It is only the assumption of a world view . . . that allows us to think at all" says Sire (1979). As Pring (1976) points out, communication is only possible because peoples' world views overlap: Certain commonsense beliefs "provide the fundamental framework within which any thinking takes place . . . . [and] provide a shared framework between teacher and pupil within which communication is possible" (p. 87). In this section I show how the concept of world view can be developed as a logical extension of the traditional concept of propositional knowledge.

Scheffler (1978) develops the following definition of propositional knowledge:

> X knows that Q if and only if
>
> (i) X believes that Q
>
> (ii) X has the right to be sure that Q
>
> (iii) Q [is true] (p. 65)

These three conditions are called, respectively, the belief condition, the evidence condition, and the truth condition.

Propositional knowledge is therefore always belief, though qualified as true belief backed by appropriate evidence. Scheffler defines belief as "a 'theoretical' state characterizing, in subtle ways, the orientation of a person in the

world" (1978, p. 90). He recognized too that our beliefs are not held in isolation from each other.

> A man's beliefs hang together and exercise mutual influence upon one another [and are], furthermore, in delicate interaction with his aims and attitudes. (p.86)

The topology of belief systems has been described by Green (1968) in some detail. The word "topology" is appropriate because it points to the fact that beliefs are held in a certain pattern of relationships to each other. There is a quasi-logical relationship whereby some beliefs are held to be primitive and others derivative (the order is assigned by the believer and is not necessarily an objective logical order). The psychological or spatial order refers to the strength with which beliefs are held; beliefs may be ranged on a continuum from strongly held, central beliefs to weakly held, peripheral ones. A third characteristic of belief systems is the clustering of beliefs. Various beliefs are held together and sometimes are shielded from other clusters of beliefs. The shields are other beliefs such as the belief that "religion and politics don't mix," or "religion is one thing; science is another." Finally, Green describes "enabling" beliefs--firm passionate convictions--which, he argues, we must also hold open to evidence. Genuine teaching is possible only where teacher and learner have a psychologically central regard for truth. "The

[enabling] belief that truth is powerful, attainable and to be treasured whenever identified--such a belief is indispensable if any belief is to be held evidentially." Green's description of a person's belief system can be read very well as a topology of a person's world view.

Sinclair (1951) described "philosophical views or attitudes" in a somewhat similar way, but conceived of them as being ranged in a hierarchy or pyramid. This conception seems to be true to some extent, but too static and rigid as a model of world views. Like Green, Sinclair holds a person's epistemological attitudes to be of key importance (pp. 11-16).

Armstrong's analogy of a belief as "a map of neighbouring space by which we steer" seems very appropriate to the concept of world view, especially as it addresses not only the nature of a world view but also its function.

> If we think of beliefs as maps, then we can think of the totality of a man's beliefs at a particular time as a single great map of which the individual beliefs are sub-maps. The great map will embrace all space and all time, past, present and future, together with anything else the believer takes to exist, but it will have as its central reference point the believer's present self . . . . The great belief-map will be much like the maps of old, containing innumerable errors, fantasies and vast blank spaces. It may even involve contradictory representations of portions of the world. This great map, which is continually being added to and continually being taken away from as long as the believer lives, is a map within his mind. (1973, pp. 3-4)

There are three points to the analogy that are particularly germane to world views: Like maps, world views are interpretations of reality and states of affairs, real or imagined; like maps, we steer by our world views, they guide thought and action, they orient us, to use Scheffler's term; like maps, the more accurately they interpret actual states of affairs, the better they are.

The Evidence Condition and World Views

In determining whether a certain belief is true or not, we are driven to the evidence for that belief. Different situations require different kinds of evidence: Mathematical propositions require proof; empirical matters require empirical evidence; moral deliberations require moral reasons. Therefore, evidence is to be understood as roughly equivalent to good reasons or a good case. For phenomenalistic knowledge--"I have a headache"--although there is logical room to ask for evidence, we normally do not require it. We are willing to grant that a person knows he has a headache without requiring him to explain what clues he has pieced together as evidence that he knows he has a headache (Scheffler, 1978). Whenever we do give support for a certain belief though, we are drawing to a greater or lesser extent on our world view; for no piece

of support--whether proof, evidence, or reason--can stand on its own, but is in turn supported by other proofs, empirical evidence, or reasons.

Evidence, like belief, is never atomistic, but very much web-like. Every belief finds evidential support in a network of other beliefs, often unexpressed. Scheffler states:

> Arguments such as these, bring out the systematic context of judgments and stress the fact that no statement, physical or phenomenal, can be construed as an isolated unit, absolutely immune from error. (1978, p. 39)

For example, after half a year of Grade Twelve Chemistry, I knew that "the 'Inert Gases' do not react chemically." However, sometime during the year, our class was informed that scientists now knew that they did react. (Curiously, in both cases the statement about the "Inert Gases" was true; before chemists made them react, they did not!) One of the unwritten qualifiers to the original statement was: "Given the soundness of the theoretical framework within which this fact finds its place." Such qualifiers surround all our knowledge claims and beliefs. Whenever we are called on to justify a belief, we "judge (the) belief in question by its general impact on all other beliefs we have some confidence in" (Scheffler, 1969, p. 263). This seems to imply only a coherence theory of truth, but it does not, for belief includes knowledge--true belief held evidentially--which has factual reference to reality outside the person's world view.

Pepper's World Hypotheses (1942/1970c), the basis of Kilbourn's scheme and therefore central to this study, is sub-titled A Study in Evidence. Pepper recognizes two kinds of evidence. The second, criticized or refined evidence, arises out of the first, uncriticized evidence or common sense. Within criticized evidence, there are again two types of evidence, multiplicative and structural. Multiplicative evidence is corroboration of person with person about the same fact. For example, two or more people may each test the strength of a chair and agree that it is strong. Structural evidence is corroboration of fact with fact. A person examines a number of facts about a chair--the kind of wood, the thickness of the pieces, the manner of construction, the manufacturer's reputation--all of which point to the same conclusion: The chair is strong.

Any sort of explanation or interpretation--an hypothesis--requires evidence, specifically structural corroboration. Conversely, structural corroboration depends on hypotheses. (Consider what hypotheses are involved in the example of the chair linking its manner of construction with its strength). To become more reliable, a hypothesis must acquire more and better structural corroboration; that is, it must grow in scope and precision.

> In the pursuit of reliability, structural corroboration does not stop until it reaches unlimited scope. For as long as there are outlying facts which might not corroborate the facts already organized by the structural hypothesis, so long will the reliability of that hypothesis be questionable. The ideal structural hypothesis, therefore, is one that all facts will corroborate, a hypothesis of unlimited scope. Such a hypothesis is a world hypothesis . . . . Thus structural corroboration inevitably leads to the conception of a world hypothesis. (1970c, p. 77).

The evidence condition thus requires the concept of world view.

Pepper's World Hypotheses

The Root-Metaphor Theory

Pepper's root-metaphor theory, developed in World Hypotheses (1942/1970c), is a hypothesis concerning the origin of world hypotheses and was derived from an empirical study of schools of philosophy. "The root-metaphor theory is simply a recognition of the fact that there are schools of philosophy, and an attempt to get at the roots of these schools" (Pepper, 1970c, p. 328).

The root-metaphor theory can be briefly expounded as follows: From common-sense experience, one item is picked as a clue--"a good sample of the nature of things" (1980, p. 56)--to describe and explain by analogy all experience. The

sample is the root-metaphor and the explanation is a hypothesis. From analyzing the structure of the sample, categories (guiding concepts) are developed which become the basic categories of all description and explanation. To increase its reliability, a hypothesis must increase its precision and scope. During this elaboration the root-metaphor and the categories are developed and refined. If the root metaphor proves fertile, it may eventually be able to subsume more or less well all facts, thus becoming a relatively adequate world hypothesis.

Pepper makes a number of critical generalizations about world hypotheses which further describe their characteristics and use:

Maxim I: A world hypothesis is determined by its root metaphor. This has two meanings. In the first place, the root metaphor is used as the basic analytic tool to classify various philosophies into their respective schools. Secondly, the categories must follow from the root metaphor.

Maxim II: Each world hypothesis is autonomous. This means that no world hypothesis can judge by its own categories the interpretations of another. Data (refined facts) cannot judge a world hypothesis, for although all data must be accepted, they need not be accepted at face value. Common sense also cannot judge a world hypothesis, though it is convenient and useful to use common-sense facts as a basis for comparing

the interpretations of various world hypotheses.

Maxim III: Eclecticism is confusing. Since the world hypotheses are autonomous, they cannot be mixed in cognition without confusion. Pepper's general stand is "for rational clarity in theory and reasonable eclecticism in practice" (p. 330).

Maxim IV: Concepts which have lost contact with their root metaphors are empty abstractions. The categories and concepts become empty abstractions. For example, when Tolstoy depersonalized all the concepts of fundamentalism, he cut them off from their animistic root metaphor of spirit, and that form of fundamentalism lost all its appeal and power.

The Six World Hypotheses

At this point, Pepper's theory is sufficiently developed to describe the various world hypotheses he has identified. The generating substance theory (For example, Thales: "All things are water") lacked scope and did not achieve lasting significance; it failed to become a viable world hypothesis. For the remaining six, Pepper described the root metaphor, the categories, and the associated theory of truth.[1] The

[1]For a detailed description of the root-metaphors, categories, and theories of truth for these six world hypotheses, the reader is referred to Kilbourn's analytical scheme, reproduced in Appendix A.

root metaphor of mature animism is spirit. In animism, Pepper includes "primitive" animism, theism, and Christian fundamentalism. Animism is found to be inadequate because it lacks precision: The same phenomenon can be interpreted in multiple ways. The root metaphor of mysticism is love and unity. Mysticism is inadequate because it lacks scope: Much of reality it simply calls unreal.

There are four world hypotheses which Pepper judges[1] to be adequate: Formism, mechanism, contextualism, and organicism. The root metaphor of formism is similarity: Events or objects are similar to each other, or they are made or grow according to the same plan. Plato and Aristotle represent this world hypothesis. Mechanism takes machine as its root metaphor, either a mechanical device in discrete mechanism, or an electrical machine such as a dynamo in consolidated mechanism. Mechanism is associated with Democritus and Descartes. Contextualism springs from the active present event in its context; its common name is pragmatism. The root metaphor of integration or organic integration gives rise to organicism. Its best known representative is Hegel.

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[1]Pepper claims that each world hypothesis judges itself from the inside. It is my contention that Pepper convicts animism and mysticism from the outside, since scope and precision are not recognized as valid criteria by these world hypotheses. (See also Kilbourn, 1974, pp. 170-181).

These six world hypotheses, then, Pepper recognizes as the major ways in which people have interpreted their experiences. Each of the four adequate world hypotheses

> synthesizes the enormous diversity of evidence the world offers, and the hypothesis . . . . explains the interrelationships of the evidence and gives insight as to its meaning for man--thus furnishing an enveloping evaluative system for human action and decision. (1970b, p. 161)

Pepper does not claim that no other adequate world hypothesis can appear. He in fact later developed "what seems to be a promising fifth type of world hypothesis, selectivism, based on a fresh root metaphor" (1970b, p. 162), the selective system. Furthermore, he argues that no present world hypothesis is totally adequate. We need all four, he says, for "to sacrifice the insights into fact which any one of these theories gives would be to sacrifice cognitive values possessing a degree of value which we have no means of estimating" (1970c, p. 148).

Other Catalogues of World Views

Pepper's six (or seven) world hypotheses are not the only ways in which world views have been classified in the literature. In this section we examine some other characterizations of world views and compare them to Pepper's catalogue.

Roberts' concept explanatory mode was discussed earlier. Roberts (1970) describes three explanatory modes, the religious, the magical, and the scientific. The first two are somewhat like Pepper's animism and/or mysticism, while the scientific mode could include any of Pepper's four adequate world hypotheses.

Of special interest in Aoki's (1978) three orientations to knowing--or perspectives of knowing--is the fact that he bases his orientations on root activities which man experiences. Aoki's three orientations with their root activities are (1) the Empirical-Analytic (Technical)--intellectual and technical WORK; (2) Situational-Interpretative--COMMUNICATION, and (3) Critical--REFLECTION. Aoki's orientations are more limited than Pepper's world hypotheses, and they do not map onto them. However there is some affinity between the two sets, and they seem to relate in the following ways:

1. Empirical-Analytic (Technical) to Mechanism and/or Formism
2. Situational Interpretative to Contextualism
3. Critical to Organicism and/or Selectivism

Barton (1963) proposed a curriculum model based on four visions of life. He pictured the world

> as like those charts which doctors use to test color blindness--a world with four great kinds of pattern running through it, printed in four different colors. Then let us stipulate that we must all wear colored glasses, all the time. While I am wearing red glasses,

> I see only the red pattern. While I am wearing green glasses, I see only the green pattern. And so on. In the terms of this new image, we must discipline men to satisfy their curiosities and to act practically with reference to all four kinds of order. (p. 259)

The four visions through four kinds of glasses were (1) the purposive, (2) the organic, (3) the mechanistic, and (4) the classificatory. These are almost exactly the same as Pepper's selectivism, organicism, mechanism, and formism, respectively. The similarity may be due to the fact that Barton was familiar with Pepper's World Hypotheses, though Pepper does not mention selectivism in that book; Barton himself credits Richard McKeon with greater influence on his exposition (p. 258, Note 1).

A catalogue of world views which rivals Pepper's in its scope and thoroughness of treatment is Sire's The Universe Next Door: A Basic World View Catalog (1979). The two treatments are, however, quite different. Pepper's primary interest is the theoretical framework of world hypotheses underlying various philosophies, which are then analyzed so as to fit his framework. Sire's catalog is a historical survey (and a more traditional treatment). He describes each philosophy or movement holistically, using as a heuristic device his set of six basic questions (outlined earlier). Sire describes seven world views: Christian theism, deism, naturalism, nihilism, existentialism (theistic and atheistic), Eastern pantheistic monism, and new consciousness. Practically none of these

world views can be matched directly with any one of Pepper's world hypotheses.

Of the other catalogues surveyed in this section, Kilbourn refers only to Roberts' scheme.[1] Roberts' scheme is not useful for the purposes of analyzing world views in science teaching because it makes no discriminations within science teaching as it is usually carried on. Barton's scheme is similar to Pepper's but is lacking in that its description of each vision of life is very sketchy; Barton's purpose lay elsewhere. Aoki's and Sire's schemes, while no doubt useful for other purposes, also lack discriminatory power within the content of science teaching. Pepper's scheme does have a sufficient degree of discriminatory power within science content possibly because two of his root metaphors, machine and organic integration, come originally from the natural world, while a third, similarity, is also closely linked to science which uses observation of similarity and "plan", especially in biology. For these reasons, Pepper's work is judged to be still the best choice as the basis for the analysis of world views in science teaching.

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[1] Aoki's and Sire's works were published since Kilbourn did his thesis.

Uses of Pepper's Theory in Education: Curriculum Organization

Although Pepper wrote extensively in a wide variety of fields, he seems to have written little in the field of education (Duncan, 1970; Duncan & Efron, 1980). Not very many authors have made use of Pepper's theory directly in education either. Yet Pepper's work has potential for both criticism of teaching and curriculum, and for organization of curriculum. In this section we review two studies which use Pepper's theory as a basis for curriculum organization.

Quina (1971) introduces Pepper's hypotheses as the organizers of knowledge so as to attain adequate scope and precision in "providing structural insights of relatedness between fields, as well as insights into related components within fields" (p. 312). He would use the world hypotheses in several ways.

First the four hypotheses can all be brought to bear on the same fact, e.g. a poem. Each hypothesis accounts for various kinds of evidence, thus giving a different interpretation of the fact. In this way we get a maximum of knowledge about that fact.

Secondly, the four hypotheses can be used across fields of knowledge. If a teacher learns that a student has a mechanistic bent, (through discovering say, his conception of chemistry), the teacher can present knowledge in literature from a mechanistic viewpoint. Hopefully the student will "latch onto it" better that way. A second-order task is to

gradually introduce other ways of interpreting from other world hypotheses.

Thirdly, the world hypotheses could be used as the "routing patterns" for inter-disciplinary studies (i.e. topical studies).

In a second article, Quina and Alessio (1980) show how one could use the four world hypotheses in the first way--use all four hypotheses on the same fact--by describing in great detail and precision how this might be worked out in teaching the humanities, especially the arts and literature, at the secondary level. They develop possible goals and objectives for such a curriculum, and describe activities to confront students with each of the four world hypotheses. They have shown how one could actually carry out teaching based on Pepper's world hypotheses.

Curriculum Criticism: Kilbourn's Analysis of a Biology Textbook Using Pepper's World Hypotheses

Kilbourn (1974) developed an analytical scheme (reproduced as Appendix A in this study) based on Pepper's descriptions of six world hypotheses: animism, mysticism, formism, mechanism, contextualism, and organicism. The scheme was developed "in response to the lack of systematic and comprehensive frameworks in science education for assessing the potential consequences for students of messages about world views" (Abstract).

Kilbourn's main concern was thus the scheme and not the textbook that he used it on. "Emphasis is upon conceptualization of a framework for systematically examining issues related to world view and the science curriculum" (Abstract). The analytical scheme consisted of one table for each world hypothesis listing and summarizing its root metaphor, categories, and theory of truth. It was then used to identify world hypotheses projected by a biology textbook.

The use of the scheme demonstrated that it was a powerful tool, not only for identifying world views in written materials, but also for clarifying certain issues in biology such as the creation/evolution controversy.

The analysis of the textbook pointed out several significant conclusions. In the first place, only some world hypotheses were projected: Animism and mysticism were never found (though one case of anti-animism was found). The other four were all found, and seemed to be associated with underlying issues in the textbook. Formism was associated with the description of organisms and with classification. Causal explanations tended to project mechanism. Historical accounts were associated with organicism (1974, p. 205).

In the second place, world views were never found expressed openly; they were always projected by implication or by the necessity to assume them. In other words, students were

never given the chance to openly assess various explanations and interpretations given to them, or alerted to the fact that there might be alternative ways to explain and interpret. They were in effect told: These are the facts; there is no other interpretation.

Summary

In this chapter, the concept world view has been discussed and its relationship to other concepts examined. It was argued, and evidence was given, that the concept is a unique educational variable. The theoretical basis of the concept was elaborated by showing that the concept can be derived from an analysis of belief and knowledge, and of the evidence condition of knowledge. An examination of Pepper's world hypothesis theory showed that world hypotheses were also derived from the evidence condition: In order to gain reliability, a root metaphor gathers more and more evidential support until it becomes a world hypothesis, able to give a more or less adequate account of any fact whatsoever. Pepper's scheme of six world hypotheses was compared to four other catalogues of world views and judged to be more adequate for curriculum criticism in science teaching because of its greater ability to discriminate between world views in the typical science

content. The use of Pepper's scheme for curriculum organization was noted and the chapter closed with an overview of Kilbourn's use of the scheme for identifying world views in a biology textbook.

The present study is designed to extend the application of Kilbourn's analytical scheme--and thus of Pepper's world hypotheses--to teachers' classroom discourse, and it is to this that we now turn.

CHAPTER III

METHOD AND PROCEDURES

Introduction

This study is an application of Kilbourn's analytical scheme (Appendix A) to a selection of teachers' classroom discourse drawn from normal junior secondary science classes. One major aim of the study is to determine whether the scheme is useful for this purpose. The second aim is to discover **what world hypotheses** are projected in teacher talk and how they are projected. This chapter discusses the validity of the analytical scheme, and describes and discusses an assessment of its reliability. Also described are the collection of the samples of teachers' classroom discourse, and the procedures and conventions to be adopted for the use of the scheme to analyze the teacher talk.

Validity of the Analytical Scheme

Kerlinger (1973) says that "the commonest definition of validity is epitomized by the question: Are we measuring what we think we are measuring?" (p. 457). He distinguishes three

kinds of validity: Content validity, criterion-related validity, and construct validity. Only the first and last apply to the analytical scheme.

Content validity is established by judging whether the content of the measuring instrument is representative of the total content of the variable being measured. "Content validation consists essentially in judgment" (p. 458). Although it is customary to seek independent corroboration of judgments, Kilbourn did not do so with his analytical scheme because of the complexity and size of such a task: Each judge would have had to study Pepper's entire World Hypotheses. Having studied Pepper's World Hypotheses and compared the analytical scheme to it, I can now corroborate Kilbourn's judgment that the scheme accurately reflects Pepper's descriptions of the various world hypotheses. This judgment is the only kind needed to establish the content validity of the scheme, because the "total content of the variable being measured" is Pepper's descriptions of the world hypotheses. To require validation beyond this is to question the construct validity of the instrument.

"Construct validity", says Kerlinger (1973), "since it is concerned with the nature of 'reality' and the nature of the properties being measured, is heavily philosophical" (p. 473). "One must try to validate the theory behind the test" (p. 461).

Kerlinger treats this problem mainly in terms of empirical inquiry. Although all of our theories must be empirical[1] in the sense that they reflect reality and our experience of it truly, empirical inquiry need not be numerical measurement, and a good measure of construct validity can be established through theoretical considerations, especially by logical argument. In a sense, all of chapter II in this study was a construct validation of the analytic scheme: It presented both theoretical considerations and empirical evidence to establish the genus world view and the species world hypothesis as unique concepts.

Reliability of the Analytical Scheme

An assessment of the reliability of the analytical scheme is concerned with the inter-rater reliability and stability of the scheme. Inter-rater reliability is a measure of whether different people using the scheme on the same set of objects will obtain similar results. Stability means that the same

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[1]Empirical: derived from or guided by experience or experiment. The American College Dictionary, Random House, 1965.

person using the scheme at different times to measure the same set of objects will obtain similar results both times. A measure was obtained for both of these kinds of reliability.

Kilbourn, because of the complexity of using the scheme, did not attempt to measure the inter-rater reliability of the scheme. For this study, it was necessary to establish such a measure for two reasons. First, in order for me to use the scheme in this study and ensure that its findings could be compared with those of Kilbourn, it was essential to demonstrate that I could use the scheme in essentially the same way as Kilbourn did. However, of broader concern is the scheme itself. My correct use of the scheme could have been due simply to my having learned, through a study of Kilbourn's thesis, how to mimic Kilbourn. Therefore a second measure had to be obtained using independent judges; this measure would be an indication of whether or not the scheme had the power to identify and discriminate world hypotheses.

Using the Analytic Scheme

Before the procedure and results for the reliability assessment can be understood, it is necessary to review how Kilbourn used the scheme. This will be illustrated from Kilbourn's use of the scheme to analyze F.M. Speed's General

Biology (Kilbourn, 1974).

The first step in the procedure is to choose the unit of analysis. Kilbourn chooses not to use a rigid unit--for example, always one sentence--but a flexible unit. The flexible units which he chose from General Biology varied in length from one sentence to one chapter. Kilbourn's criteria for selecting the flexible unit are not very clear: "The primary rationale for a flexible unit of analysis is that it permits the investigator to treat sections as wholes" (Kilbourn, 1974, p. 159). This criterion does not tell which units to use, nor how long they should be. The decision of how long a particular flexible unit (called a section) will be is a judgment based primarily on a consideration of context.

The second step in using the analytical scheme is to compare the section with the world hypotheses as outlined in the scheme. Statements from the section are chosen that correspond to characteristics of world hypotheses and the claim of projection refers only to these statements, called the substantive units of analysis. It is quite possible that several substantive units are chosen within the same flexible unit and are judged to project either the same or different world hypotheses.

Procedure for the Reliability Assessment

Procedure for the Independent Judges. Two judges were chosen for the reliability assessment, both of them students at Simon Fraser University with above average academic records. The total time required of them was about twenty-four hours spread over a period of about three weeks. In order to become familiar with the analytical scheme, the two judges first read chapter II of Kilbourn's thesis (1974), comparing it with the analytical scheme. Chapter II, about sixty pages long, is Kilbourn's derivation of the scheme and quotes extensively from Pepper's World Hypotheses. Then, in a joint session with both judges and myself, the scheme was discussed and the judges were given a brief practice: They were asked to identify which one world hypothesis was projected in each of thirteen "transparent" sections taken from Kilbourn's Preliminary Analysis (1974, Appendix II). After they had analyzed each section, the judges were given Kilbourn's attribution of a world hypothesis and his reasons for his judgment.

The material for the reliability assessment was drawn from F.M. Speed's General Biology by Kilbourn. These sections were split by a random numbers process into two groups. The first set of 53 units was analyzed by the judges as a Practice Set. After their analyses, in a joint session the judges were

given Kilbourn's attributions with his reasons, and discrepancies in attributions were discussed.

By this time it had become apparent that at least some of the differences in attributions were due to the fact that the judges chose different substantive units than Kilbourn chose. This could cause substantial differences in attributions in view of the facts that some of the flexible units were quite long, and that in 41 percent of the units, Kilbourn attributed more than one world hypothesis. Therefore for the actual Reliability Assessment, the remaining 49 sections were divided by a random numbers process into two groups. Group One , consisting of 25 sections, was analyzed by the two judges as flexible units: They were required to choose their own substantive units. For Group Two, consisting of 24 sections, the judges were again given the flexible units, but in addition they were told the line numbers of all the substantive units identified by Kilbourn in his analysis as projecting a world hypothesis. The judges were not told how many world hypotheses Kilbourn had identified in the section. The substantive units were not grouped by world hypothesis, but were presented in order of their appearance in General Biology. Therefore, the judges still had to group the substantive units that projected the same world hypotheses, and weigh the possibility that more than one world hypothesis was projected

in the section. Thus the task for this second group, though simpler than for the first group, still required careful deliberation and judgment.

Procedure for the Investigator. This investigator followed a somewhat different procedure to assess his use of the scheme. A half-year before the present assessment, twenty-seven sections from General Biology had been analyzed and the results compared with Kilbourn's attributions. Nevertheless, in this assessment, the same practice set was used as for the two judges. Group Two was used as a second practice set, and Group One was the final test. For Groups One and Two, scores were calculated first for all the sections in each group. Then those sections which had been analyzed previously were withdrawn and scores calculated again. Both sets of scores are reported. The two analyses of the twenty-seven sections done twice were compared to assess the stability of the scheme.

In no case were Kilbourn's substantive units identified for this investigator. However care was taken in the analysis to record the substantive units that were the basis of his attributions. In comparing this investigator's attributions with Kilbourn's, additional scores were calculated for those sections where both had chosen the same or overlapping substantive units (identified by page and line number). In Group One, this occurred in 22 of the 25 sections; the high proportion is due to the fact that a deliberate attempt was made to find multiple substantive units for each world hypothesis attributed.

Method of Scoring the World Hypothesis Attributions

For each rater's attributions on each group of sections, a table was drawn up showing for each section Kilbourn's attributions, missed attributions and additional attributions[1]. The terms correct, missed, and additional are defined strictly in terms of Kilbourn's attributions which are defined to be the "correct" ones. An example will clarify this: In one passage Kilbourn attributed formism and mechanism to the passage, whereas a rater attributed mechanism and organicism. The rater's attribution of mechanism was correct; formism was missed, and organicism was an additional attribution . The columns of the tables were totalled by adding up the number of attributions, and the totals used in calculating the scores given below.

Results of the Reliability Assessment

Scoring the world hypothesis attributions is a complex matter because of the variety of ways in which a judge can differ from Kilbourn. The number of attributions in one section is not fixed; especially in the longer sections a judge could conceivably attribute four[2] world hypotheses to different sub-

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[1]See Tables 12 to 18 in Appendix B.

[2]After the practice sessions, the raters concluded (correctly) that animism and mysticism were likely never to be attributed by Kilbourn; thus they tended to think of the other four world hypotheses as the range of options.

stantive units. Thus for any one section, a judge could make one or more correct attributions, miss one or more attributions, and make one or more additional attributions. This was the case in nine percent of the sections in Groups One and Two. Three scores are thus reported so as to preserve the maximum information about the use of the scheme: These are the Index of Correctness, the Index of Accuracy, and the Index of Economy. It is mathematically not possible to combine the three scores into a composite score, because they do not all have the same range. Acceptable values for considering the scheme reliable were not set prior to the actual test; instead, it was decided to obtain the scores first and then make a common-sense judgment about the reliability of the scheme. This was considered the preferred procedure since each score needs to be interpreted in the light of the other two scores. A low value for any one score does not necessarily mean that the analytical scheme is unreliable, nor does a high value necessarily mean that the scheme is reliable: In each case one needs to examine the three scores together, evaluate why they were either high or low, and make a judgment about the reliability of the analytical scheme.

The interrater reliability is treated first. The three scores are first discussed and then reported individually in the order of their perceived importance. Scores are reported not only for the final tests but also for the practice set so that the effects of practice can be judged. The stability of

the analytical scheme is reported next, and this is followed by a summary interpretation of the reliability of the scheme.

Index of Correctness. This score measures what portion of the correct, i.e. Kilbourn's, attributions were found by the rater. It is calculated as follows:

$$\text{Index of Correctness} = \frac{\text{No. of correct attributions}}{\text{Total no. of Kilbourn's attributions}}$$

This index is considered to be the most important of the three scores because it indicates whether or not the scheme can identify those world hypotheses that are projected. The scores are reported in Table 1. The judges' average score for the test sets was .72 when the raters were given flexible units (Group 1), and .81 when they were given substantive units (Group 2). Some attributions were missed simply because the analysis depended on context outside the flexible unit, context to which the judges were not directed. Given such context, these scores would likely have been a little higher. Thus it is judged that if two people analyze the same section they are likely to identify the same world hypotheses most of the time.

Index of Accuracy. It may be that a rater exercises an over-abundance of caution in the use of the scheme and thus chieves a low score on the index of correctness. Yet those attributions that he does make may be consistently correct. On the other hand, a rater may be over-zealous and find world hy-

TABLE 1

Index of Correctness: Ratio of Rater's Correct Attributions to Total Correct Attributions

Rater	Practice Set (53 units)	Group 1 (24 units)	Group 2 (25 units)
Investigator			
Flexible units	.55(.46)[a]	.80(.80)	.91(.89)
Same substantive units identified	—	.92(.93)	.96
Judge No. 1	.59	.70	.80
Judge No. 2	.49	.73	.83

Note. Underlined scores are for final test sets. Group 2 had substantive units identified for the judges only. All other units were flexible units only.

[a] Parentheses indicate scores after removing previously-analyzed units.

potheses "lurking behind every semi-colon". Thus he may achieve a high index of correctness without really using the scheme accurately. This score then is a measure of how accurately the rater uses the scheme, regardless of how many attributions are made. The score is calculated as follows:

$$\text{Index of Accuracy} = \frac{\text{No. of correct attributions}}{\text{Total no. of rater's attributions}}$$

This score is considered second in importance to the index of correctness. The scores are reported in Table 2. The judges' average score with flexible units (Group 1) was .50, and with substantive units (Group 2) .68. Having to choose which statements to analyze (i.e. the substantive units) made a greater difference in this score than in the previous one. This is to be expected, since the previous score looked only at a judge's correct attributions while this score took into account a judge's total attributions. Where the attributions were correct, it is more likely that the judge in fact chose the same substantive units as Kilbourn.

Somewhat surprising is the fact that the scores with flexible units were, for the two independent judges, higher for the practice set than for the final test. This is thought to be due to the fact that in analyzing the practice set, the judges found they were making too few attributions--Kilbourn made 81 attributions; the judges made 74 and 63,--and in the final test overcorrected by making too many attributions. In Group 2, Kilbourn made 35 attributions; the judges made 44 and 40. There was a

TABLE 2

Index of Accuracy: Ratio of Rater's Correct Attributions to Rater's Total Attributions

Rater	Practice Set (53 units)	Group 1 (24 units)	Group 2 (25 units)
Investigator			
Flexible units	.65(.57)[a]	.73(.67)	.76(.77)
Same substantive units identified	—	.85(.82)	.86
Judge No. 1	.66	.47	.64
Judge No. 2	.64	.52	.73

Note. Underlined scores are for final test sets. Group 2 had substantive units identified for the judges only. All other units were flexible units only.

[a]Parentheses indicate scores after removing previously analyzed units.

perfect rank-order correlation between score and fewness of over-attributions: The greater the number of over-attributions, the lower the score. The average scores must be interpreted, then, in the light of these considerations. A score of .50 with flexible units is judged to be not unreasonably low but does point to the need for due caution in making attributions and the need to support attributions with sound reasons.

Index of Economy. Although additional attributions are counted in this scoring system as not "correct", that does not mean that they are therefore wrong. It is possible that a good case could be made that Kilbourn missed or chose to omit some projections of world hypotheses. In fact, for one section (which consists of 20 pages of a 22-page chapter), in the Analysis Kilbourn (1974, pp. A155-159) identifies only organicism, so only that one was used in calculating the scores. However, elsewhere Kilbourn says that that chapter "contains elements which project formism, mechanism, contextualism, and organicism" (p. 160). Therefore to make additional attributions is not necessarily wrong: In every case, one would have to examine the reasons given for the additional attributions to judge whether the attributions were warranted. However, doing this would have added no information about the reliability of the scheme, so it was not done in this study.

Therefore it seems clear that making at least some additional attributions is not unreasonable. However, to make a

large number of additional attributions would rightly be questioned. For this reason, it seems desirable to have some measure of the economy with which a rater uses the scheme that is free of any connotation of "correctness". For this reason, an index of economy was calculated as follows:

$$\text{Index of economy} = 1 - \frac{\text{No. of rater's additional attributions}}{\text{No. of flexible units}^{1}}$$

The formula is cast in this form so that a high score is favorable. If a rater made an average of one additional attribution per flexible unit, this score would be zero. Such a score might not be unreasonable, though a careful analysis would have to be made of each attribution to judge whether it was warranted. A general indication of reasonableness for the group as a whole is obtained by placing the score on the range as a percentile of all possible scores. The lowest possible score would be obtained if a rater were to attribute every world hypothesis that Kilbourn did not attribute, a highly unlikely possibility. The range and the percentiles for the judges' scores along with the scores themselves are given in Table 3.

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[1] For the investigator's score on sections where the same substantive units were identified as Kilbourn's, the denominator became the number of Kilbourn's attributions for which this was the case.

TABLE 3

Index of Economy: A Measure of a Rater's Economy in making Additional Attributions Compared to the Number of Flexible Units

Rater	Practice Set (53 units)	Group 1 (24 units)	Group 2 (25 units)
Investigator			
Flexible units	.55(.47)[a]	.64(.59)	.58(.63)
Same substantive units identified	—	.83(.80)	.85
Judge No. 1	.52[81][b]	.04[59]	.33[62]
Judge No. 2	.56[82]	.20[66]	.54[74]
RANGE	-1.47 to 1.00	-1.33 to 1.00	-.74 to 1.00

Note. Underlined scores are for final test sets. Group 2 had substantive units identified for the judges only. All other units were flexible units only.

[a] Parentheses indicate scores after removing previously-analyzed units.

[b] Brackets show in what percentile of the range the score falls.

The average score for flexible units was .12. This means that if all the attributions were distributed one to each flexible unit, twelve percent of the units would have had no additional attributions. When the raters were given substantive units, the average score was .44 --forty-four percent of the units would have been free of additional attributions evenly distributed. In no case did any of the raters make as much as an average of one additional attribution per section. The scores were considered to indicate a sufficient degree of economy for using the scheme, though they pointed out the need to make careful judgments backed by reasons.

Stability of the Analytical Scheme

Stability was described earlier as the ability of a scheme to give similar results at different times. As stated earlier, this investigator had analyzed 27 sections[1] also a half year before the present assessment. The two analyses were compared and the results are summarized in Table 4. (Detailed results are presented as Table 18 in Appendix B.) The important comparison here is taken to be the agreement on correct attributions. Although the possibility of some pure recall cannot be altogether ruled out (one passage and its attribution was remembered) the 87 percent agreement nevertheless is judged to show that use of the scheme is stable.

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[1] These sections, it was found, were in the practise set, Group One, and Group Two.

TABLE 4

Stability: Two World Hypothesis Attributions by Investigator at a Six-Months Interval Compared to Attributions by Kilbourn

Item	Number of Attributions[a]			% Agreement[b]
	First Trial	Second Trial	Same	
Attributions				
Total	38	40	31	79
Correct	29	31	26	87
Missed	9	7	4	50
Additional	9	9	5	56

Note. These sections were found to be in the practise set, Group One, and Group Two. See Table 18 for a detailed report of attributions.

[a]Kilbourn made 38 attributions.

[b]Calculated by taking same as a percentage of the first and second trials.

Summary Interpretation of Reliability Scores

Two concerns were addressed by the reliability assessment: The reliability of the scheme, and the ability of this investigator to use it. The first question was addressed by the use of two independent judges whose analyses of sections from General Biology were compared with Kilbourn's analyses. The results of both the judges' and the investigator's analyses show the following: The scheme has, for the purposes of this study, sufficient ability to correctly detect world hypotheses that are projected; it can be used accurately; with due caution it can avoid over-attributions, some of which may be wrong. In other words, the scheme has sufficient power to identify and discriminate between world hypotheses. Its main weakness may be that in the hands of a bold investigator it finds too many world hypotheses in written materials. Therefore caution and sound reasons for judgments are urged.

It has further been shown that this investigator is able to use the scheme reliably. For Groups One and Two, his scores were higher in every case than the corresponding scores for the two independent judges. This was expected due to his much longer and more thorough acquaintance with the works of Pepper and Kilbourn.

One last comment about the scheme's reliability is in order. Some of the judges' scores on the Practice Set were

higher than the corresponding scores on the test Groups. Similarly, the investigator's scores on Group Two, considered a second practice set for him, were generally higher than the corresponding scores for the final test, Group One. This could have been a chance result (Group One contained the hardest sections?) or due to "battle fatigue" (not considered likely), or due to an inherent ambiguity or vagueness in the analytical scheme. Again caution is urged.

This study seeks to determine whether the analytical scheme is useful in analyzing teacher talk, and what world hypotheses are projected and how they are projected. It aims at no statistical claims. Therefore to miss some world hypotheses due to excessive caution will not invalidate the study. To err on the other side--finding world hypotheses where they are not projected--would be a serious fault.

The Sample

The sections of teachers' classroom discourse analyzed in this study were drawn from a bank of sixty-five audio-taped lessons in junior secondary science (grades eight, nine, and ten). The data was collected by a research team from the Faculty of Education, Simon Fraser University, for the purpose of studying teaching practices and change strategies (Cusack, 1979; Seah, 1980). Schools were randomly selected from two

school districts in British Columbia and teachers were asked to allow observers in to tape three normal classroom science lessons. Three lessons from each of twenty-two teachers were taped while the observer who did the taping recorded non-verbal data which would help a later listener to understand what was happening. Such details were recorded as blackboard work, use of an overhead projector, references to texts, experiments, and demonstrations.

Selecting the Data

This investigator listened to all sixty-five audio-tapes systematically, making brief notes mainly to establish the context. The concern was to find any sections of teacher talk that might project world hypotheses. Thus the talk had to be about subject matter--not managerial--and should preferably involve explanation and/or description. In order to find such segments, the tape was scanned systematically. Where it appeared that no significant (in terms of this study) teacher talk was occurring, the tape was advanced by pushing the fast forward control. However, the tape was stopped each time the counter turned over another tens digit. Therefore the segment missed during fast forward was only 24 seconds near the beginning of the tape to 55 seconds near the end of the tape. Therefore, it can be

claimed with some confidence that no significant section of teacher talk was not heard and evaluated. When a section of teacher talk was found that seemed promising for detecting the projection of a world hypothesis, it was listened to very carefully and re-spoken onto a second tape with typing instructions.

From this second tape, transcripts were prepared. In this way, 54 segments of teacher talk were selected for analysis, comprising 145 pages of transcripts (double-spaced). Transcripts varied in length from one to nine pages. Segments were chosen from 21 teachers and 42 lessons. The 54 segments represented the following subject areas: biology-- 20 segments, physics-- 16, chemistry-- 13, earth science-- 5.

The segments chosen were edited slightly where that was felt desirable. This editing removed a minimum of material that was clearly not relevant to the actual content; for example, strictly managerial or disciplinary comments, bantering interchanges, one ethnic joke, irrelevant comments--Teacher: "My pen is dying",--and straight repetition. The amount of spoken material left out is actually very small, comprising likely less than one comment per transcript. From long sections of teacher talk segments were chosen that seemed most promising for the projection of world hypotheses. Each transcript was prefaced by a brief description to establish relevant context.

Analyzing the Data

The actual steps in analyzing the written material in transcript are quite straightforward. Note was made of the context and the transcript was read through in its entirety, underlining sentences and phrases that seemed to project a world hypothesis. A second reading was made, comparing sentences and phrases in the transcript to characteristics of world hypotheses. Sometimes the analysis was quite obvious; at other times detailed reference to the analytical scheme was necessary. An attribution was made only where some degree of confidence could be had in the judgment, and this was achieved when some link could be shown to a characteristic of a world hypothesis.

The manner of projection was also noted. Here Kilbourn's stipulative definition of projection was used (1974, pp. 148-149). A section can project a world hypothesis or world view in three ways. An overt expression occurs when the passage expressly states that it is giving an interpretation of the nature of reality. An example is the statement: "The theory of evolution was advanced to account for these three aspects of life" (McElroy, Swanson, Buffaloe, Galston, & Macey, 1968, pp. 394-395). A world view is also projected when it must be assumed for a certain section to make sense, or when it is

implied, but it is not stated that an interpretation of the nature of reality is being presented. The title "DNA - The Molecule of Life" (McElroy et al., 1968, p. 272) requires one to assume that life is explainable in terms of discrete particles (this is a characteristic of mechanism); otherwise the title makes no sense. On the other hand, the statement that "the forelimbs of all vertebrates show striking similarities in bone structure" (McElroy et al., 1968, p. 67) implies formism, but it makes sense even if one does not assume formism.

Several methodological conventions are also adopted from Kilbourn (1974, pp. 149-155). A world hypothesis is judged to be projected if at least one identifying feature of that world hypothesis is projected. The claim of projection is, strictly speaking, limited to that substantive unit which corresponds to some characteristic of a world hypothesis. The attitude taken in judging which world hypothesis is projected is exemplified by the question guiding the analysis: Which world hypothesis best accounts for what is said in this section?

Summary

In this chapter it has been established that the analytical scheme is a valid and reliable tool for detecting world hypotheses in written material, though care must be taken to

give good evidence linking statements in the passage to characteristics of world hypotheses. From 65 audio-taped science lessons, transcripts of 54 segments of teacher talk were prepared as the data for analysis. The systematic process used to select these segments ensured that they are an accurate representation of the teachers' classroom discourse in those lessons from which they were drawn. The definition of projection and the adoption of certain methodological conventions set the ground rules for the analysis to which we now turn.

CHAPTER IV

APPLICATION OF THE ANALYTICAL SCHEME TO TEACHERS' CLASSROOM DISCOURSE

Introduction

The analytical scheme was used to identify world hypotheses projected in 54 segments of teachers' classroom discourse from the following subject areas: Biology, N=20; physics, N=16; chemistry, N=13; earth science, N=5. In this chapter the results of the analysis are summarized. First, however, in order to help the reader understand and judge how the analysis was conducted and how world hypotheses were projected, a number of sample analyses are given. Lastly, the difficulties of analyzing teacher talk are noted. The conclusions and discussions of the findings are left to the next chapter.

Sample Analyses of Selected Portions of Teacher Talk

From the 54 transcripts of teacher talk, 19 samples were selected for inclusion in the thesis. The following samples were selected: From biology - 7 samples, from physics - 5, from chemistry - 4, and from earth science - 2. The selection process was designed to represent as many teachers and lessons as possible in the sample, but the main selection criterion

was to illustrate a wide range of world hypotheses and issues relating to their projection. Since the inclusion of all 19 samples in this chapter would have interrupted the flow of the material, most of them are presented in Appendix C. Six of the ones considered most interesting (not necessarily representative) are included in this chapter, enough to give the reader a flavor of the analysis. The transcript of each sample is followed directly by its analysis.

TRANSCRIPT 024-1a[1]

TEACHER: Now first off, we're dealing with how life works. How it got started . . . . By the way, at 10 a.m. this morning, speaking of how life got started, Science was on and it mentioned something about the theory of creation. Anyone know how the universe may have gotten started? You guys cover that last year in grade 9 Astronomy? . .(?). . a really central term. Anyone taken it? Okay. Basically what it says is the universe got started as one central mass that blew up.

STUDENT: It expands . . .

TEACHER: . . . (?) it expands. That's one. Some scientists say it will come back again. But what he said is, the latest information is that the universe would have to have ten times the mass that it has right now in order for the gravity to be strong enough to pull it all back together. So, whether it is going back again or not, what it comes down to is where did it all come from to start with. That was his point that he was making: But you know the Bible, in its saying creation, is not necessarily that far out in terms of scientific terminology. It was kind of interesting to hear that. Well you don't see many scientists actually talking about things like that because it's a belief and not something that can be proven. However, they do have proof that the creation, or, that creation did happen at some time billions of years ago. So, I mean that's something you can't prove.

ANALYSIS. The reference to the Bible, a holy book, and

[1]Code number means: School - 02, teacher - 4, lesson - 1, transcript - a(First transcript from that lesson).

the implied reference to a Creator are characteristics of Pepper's animism. However the teacher's attitude appears uncertain about the issue: On the one hand he appears pro-animistic--"the Bible . . . is not necessarily that far out in terms of scientific terminology", and "they do have proof that . . . creation did happen at some time". On the other hand, the phrase "it's a belief and not something that can be proven" could project either an anti-animistic bias (if it's not provable, it's not worthwhile), or a pro-animistic bias (it's not provable so science can't judge it; it's O. K. to think that way in private). Without the context of that teacher's daily classroom performance and attitude, it is impossible to be certain in which direction the projection lies. This investigator reads the projection as cautiously pro-animism.

TRANSCRIPT 024-1c

TEACHER: (We come to) these long spaghetti-like strands which stretch on through the cell. They literally form a maze in the cell. This is called the endoplasmic reticulum. . . . . This material forms basically like tubes and they hook the outside of the cell with the nuclear membrane. Now there's a number of (?) (theories?). This may be some form of communication. It may be a means of gaining material or information from the outside. It may be a means of getting rid of material. You don't need to know that. Just realize that the endoplasmic reticulum at this time is a series of tube-like canals which connect the cell membrane with the nuclear membrane. Now, on this endoplasmic reticulum is something that's crucial. . . . These structures are called ribosomes. Ribosomes

- their function - key function - making protein. . . and amino acids. And amino acids are the building blocks for proteins. If you remember from last year in the food section. Now, your hair is protein. Your skin, muscle, all these structures are protein. Why should such a tiny little structure as this be found on these tubes? What might be the advantage to the cell? They're not found spread through the cell that much. Usually they're found on these tubes. Can anyone tell me what might be an advantage of that?

STUDENT: They might (?) nucleus.

TEACHER: That might be one of the things. Maybe, at the last minute they (. . ? . .) the nucleus. They also think that maybe - well each of these things makes protein, right - maybe the protein is put into these canals, and then it moves throughout the system. That could be possible too. . . .
. . . . The golgi body - I've seen a couple of definitions as to what it does. Some scientists don't even think this thing exists. It's kind of a debatable structure. Golgi body - one thought on it is that it makes the endoplasmic reticulum . . . . . .The golgi body - another thought is this - these structures are building all this protein. Well what if the cell doesn't want it or need it at that particular time? Well, they think that possibly the golgi body is this collecting depot. It stores the material until it's needed or until enough of it is produced that it can be used in some structural or some other function. Well, both of those theories really are okay as far as I can see. I can't see anything wrong with either of them. They both seem to explain that. If the golgi body stored material, well, that's fine because it's just a special sort of vacuole in that case. And if it made the endoplasmic reticulum, well, the structure of the golgi body kind of looks like endoplasmic reticulum. So it could be that it does that too. It's still really in its formative years. They don't know a lot of this stuff yet.

ANALYSIS. The analysis of this section focusses on the issue of scientists' knowledge of the endoplasmic reticulum and the golgi body. There are a number of contradictory theories, according to the teacher's explanation, such as the following: There may be several advantages to the position of the

ribosomes on the endoplasmic reticulum, but that is unsure; there are a couple of definitions of the function of the golgi body: both theories are okay since they both seem to "explain that." The implication seems to be that these contradictions and conflicting theories will be transcended someday in a theory that will integrate more facts. The image behind "it's still really in its formative years" suggests growth, and the root metaphor of organicism is organic integration. Contextualism is ruled out here because the theories are said to "explain," which rules out an operational theory of truth; in contextualism, human constructs are useful, and account for reality, but do not reveal reality. Therefore this section is judged to project organicism in its discussion of scientists' knowledge of the cell.

Within this section, there is also the implication of mechanism. "Ribosomes--their function--key function--making protein. . . and amino acids. And amino acids are the building blocks for proteins," which make up hair, "skin, muscle, all these structures." Observable features are explained in terms of discrete particles.

TRANSCRIPT 042-1a

(Discussion concerning a ray diagram of light from a light bulb).

TEACHER: Okay. If your eyeball is up here, you can see light coming from here. Right? From the light bulb, right? Going up to your eye? . . . Heh? Of course it is that light, because the light ray's going up there. Right? Now there's a light ray coming out here and I want you to place your eyeball right here (he draws on the board). I want you to look at the top edge of the light bulb right there. Do you have a light ray going to your eyeball there?
STUDENTS: Yes.
TEACHER: Do you have . . do I have one drawn there?
STUDENTS: No.
TEACHER: Can you see the light bulb there?
STUDENTS: Yes.
TEACHER: What should be on the diagram?
STUDENTS: The ray.

ANALYSIS. Which world hypothesis is projected in this section is not clear. A correspondence theory of truth is clearly projected, but that will fit with either mechanism or formism. The projection is clearly against contextualism, for in that world hypothesis, schemes are only "instruments which do not reveal reality but are considered useful for prediction, explanation, and control."

This section was chosen for analysis because of its contrast with the next section, drawn from the very same lesson, and dealing again with human devices for coping with reality.

TRANSCRIPT 042-1b

TEACHER: All right. Next item I want to get into is, I want to pose you a little philosophical idea. I know of something which has a name but does not exist. Contrast - this book exists, it has a name. This table exists, it has a name. I know something that we give it a name, but I'll argue it really doesn't exist.
(He argues that a shadow does not exist because if the object causing it is removed, the shadow no

longer exists.)

TEACHER: It's much like something else that we give a lot of time and energy to simply because if we don't ignore the fact that "it isn't? there" and we fall into it, we get hurt. But the thing is that the thing that really is there but isn't there, um, is only a result (it's like that?) has not been there and has been taken away. This other item is called a hole. So, you talk about a hole as being something, when really a hole is only the absence of something else. So, you can fall into a hole but you don't get hurt falling in a hole, actually. You get hurt when you hit the bottom of the hole . . . . . Believe it or not . . .

STUDENTS: . . . You don't think . . . You're just trying to string . . . You don't know what you're talking about . . .

TEACHER: Now, there's actually a deeper reason for considering these ideas that are difficult (. . ? . .) especially when we're talking about shadows. A lot of people do, especially in the sciences dealing with atomic physics and other things, trying to deal with something . . . A lot of mistakes have been made in the past because they forgot (. . ? . .) something existed that didn't. It was only the absence of something else. Take darkness, for example. That's another idea. Does darkness exist?

STUDENT: Yes.

TEACHER: It only exists as a concept in our mind. What happens when you put an equal quantity of darkness with an equal quantity of light?

STUDENTS: . . . light . .

TEACHER: There is no darkness. Consider that point that even the tiniest amount of light, you won't have darkness anymore. But it doesn't matter how much darkness you've got, it cannot overcome the tiniest amount of light. Okay? Darkness is really the absence of light, light being something, darkness being a concept of a lack of something . . .

. . . Where a holes were the only, the absence of a material (?) you would expect it to be because you think of a hole, but because of our method (?) of people (. . ? . .) falling into holes and hurting themselves when they hit the bottom, we give it an idea so that we can work with it again.

ANALYSIS. In this segment, contextualism is projected, because concepts such as "shadow", "hole", and "darkness", it is said, do not reveal reality. Each one "only exists as a concept in our mind," and we created these concepts because they are useful: "Because of our method (?) of people (. . ? . .) falling into holes and hurting themselves . . . we give it an idea so that we can work with it." These concepts are not true, but useful, and "a lot of mistakes have been made in the past" because scientists forgot and treated certain concepts as if they referred to existing things. This operational theory of truth and this attitude to schemes and other human constructs are characteristics of contextualism.

TRANSCRIPT 011-3a

TEACHER: One thing about chemical equations too, they follow a law called the law of conservation of matter. Does anybody know what the law means?
STUDENT: Um . . . nothing can be created or destroyed.
TEACHER: Right - matter cannot be created or destroyed. Okay. So in other words what they're saying here or what this law means is that during a chemical reaction you don't put in atoms and you don't lose any atoms when a chemical reaction takes place. So, all the material that is there . . .
STUDENT: Stays there.
TEACHER: It reacts, forms new substances and the atoms on the left side of the equation must balance to the atoms on the right and I'll give you some examples. . . Okay, next . . . so this for an example here . . . so our first step will be to start off with a word equation and that word equation looks like the following (he writes on board). Okay, your second step is . . . you write in your symbols and formulas to the equation . . . and the third step that you'll do is

to balance the equation - you have to add up the number of atoms on the left - this is FeS.
STUDENT: How come sulphide's the same as sulphur?
TEACHER: Sulphide is the non-metal part . . .
STUDENT: Of sulphur.
TEACHER: Of sulphur . . . and we just change the ending. When they chemically combine, it becomes sulphide. To balance this you have to add up the number of atoms . . . on the left have to balance with the right. It obeys this law of conservation of matter. One atom of iron . . . you get one atom of iron on the right, one atom of sulphur on the left - you get one atom on the right, so that it's balanced the way it is.

ANALYSIS. Formism is strongly projected in this segment. Chemical equations, it is said, "follow a law called the law of conservation of matter"; "it obeys this law." It is only in transcendent formism that laws are the "norms which regulate the occurrences of nature." Mechanism is assumed because observable phenomena of chemical reactions are explained by reference to discrete particles, atoms.

TRANSCRIPT 063-1a

TEACHER: First of all, the . . . a statement describing the four major regions that we divide the earth into. And this is, as we'll see later, sort of a convenience. Instead of always having to, in a sentence, say what we mean, we have a name for these major sort of blotches of this planet we live on. Doesn't matter which order we do them in. One of them, Andrea?
(The four regions: lithosphere, hydrosphere, atmosphere, biosphere. During this discussion the following interchange takes place.)
TEACHER: The atmosphere is . .
STUDENT: The ocean of air in which we live (rest ~~in~~distinguishable).
TEACHER: The ocean of air in which we live, that's how the book described it or the ocean of air surrounding the earth, surrounding our planet. Why do they use the word ocean? . . . . .
STUDENT: Maybe because the ocean covers the (. . ? . .) of the earth?
TEACHER: But if normally you use the word ocean, you normally think of a liquid. The atmosphere is not a

liquid. But it's often referred to as this ocean of gases or this sea of gases.

STUDENT: (Remark indistinguishable.)

TEACHER: Well, it's nothing to do with its size. What do gases and liquids have in common?

STUDENT: Always moving?

TEACHER: Always moving. Uum, well, I guess, you know most of the bodies of water on this earth or the atmosphere, in no place are they ever perfectly still. Very seldom, anyway.

STUDENT: Um, they've got water vapor in it?

TEACHER: There's water vapor in liquid water? No. It's liquid. Gases in general, any gas has what in common with any liquid? What is the same for gases and liquids?

STUDENT: They take the shape of their container.

TEACHER: They take the shape of the container. They both flow. You can swish them in a sense and so in science we have a name for gases and liquids together. Do you know what that is? . . . . Well, okay, when a scientist or engineer talks about a fluid, he's not just talking about a liquid. Gases are fluids too. They flow. The word flow is from fluid or fluid is from flow. They're basically the same thing. So that's why they talk about this sea or ocean of gases that surrounds our planet. Or that we live in. We're at the bottom of this ocean. If you ever have a chance to see good colour photographs taken of our planet from satellites, you tend to see that - here's this ball and it seems to be surrounded by sort of a . . fluid thing and then you get this reflection just as you do get this reflection off the true oceans. And so, when you get far enough out there, this blanket of air that we can't see when we're right in it, sort of has a bit of a liquid fluid appearance from a distance. Next one?

STUDENT: The biosphere?

TEACHER: The biosphere is . .

STUDENT: . . . . all the living things.

TEACHER: All the living things. . . . All the life, wherever it's found. Above, beneath the earth, in the water, etc. And I guess that does it all; biosphere, hydrosphere, lithosphere, atmosphere.

ANALYSIS. The first part of this transcript depicts the division of the earth into four regions as being useful--"sort of a convenience"--but not necessarily revealing anything

about reality. Thus the attitude to this grouping reflects contextualist categories.

The second part projects formism. Gases and liquids are "basically the same thing", having properties "in common," especially fluidity, but also "reflection" and a "liquid fluid appearance." These similar properties are described and accepted literally, and become the basis for putting both gases and liquids into the class of fluids.

Now that the analysis of the transcripts of teacher talk has been completed,[1] it is possible to answer the last three of the four questions that guided this study. To these we now turn, in order.

Considerations on the Analysis of Teachers' Classroom Discourse

The question was asked: Can Kilbourn's scheme be used to identify world views projected by teacher talk? It was found that the analytical scheme was able to do this, but a number of qualifications emerged, related to the differences that exist between teachers' classroom discourse and

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[1] For further samples of analyses, see Appendix C.

written material in textbooks. The recording made of a teacher's classroom discourse is rarely a perfect one, probably especially in capturing students' questions and responses. In the set of tapes used for this study, students' remarks were at times indistinguishable. However, at no time was this a problem for the identification of world hypotheses, since their projection rarely depends on isolated fragments.

However, teacher talk itself differs from textbook "talk" in a number of ways that does call for more caution on the part of the investigator. In the first place, in a textbook, each passage has as its context the entire textbook, but in the present study, a context outside of the one lesson was totally missing since one could not infer what the teacher had projected earlier. Therefore the claim of projection may in a few instances be more tenuous. In this study, care was taken to give good reasons for attributions.

The character of classroom discourse is also markedly different from the character of textbook presentation. There is dialogue with students whose responses may be elicited (or unelicited!) and become part of the explanation. Besides explanation, teacher talk contains a good deal of extraneous material, such as quips, anecdotes, banter, managerial and disciplinary comments. Teacher talk is generally much less

coherent than textbook explanation and less precise; this is no surprise, for the teacher is in a dynamic, interactive situation where students' offerings may redirect the flow of thought. Often experiments, demonstration, action, facial expressions, and written notes enrich the teacher's presentation, all of which audio-tapes miss. One of the more important factors, tone of voice, is of course captured by the audio-tape. All of these demand that an investigator be more cautious, but in the opinion of this investigator, it would be rare that any of these factors would seriously affect the projection of a world hypothesis.

Thus it is judged that Kilbourn's analytical scheme is as able to identify world hypotheses in teachers' classroom discourse as in textbook material. The claims about projection can always be made with confidence about the words as they are documented on a transcript, and it is this investigator's judgment that where the transcript is accurate, the claim also holds for the words as they were spoken in the classroom.

A question that is reserved for discussion until the next chapter is whether there are not aspects of world views that are not captured by the analytical scheme, based as it is on Pepper's world hypotheses.

World Hypotheses Projected by Teacher Talk--Content

This study was also designed to answer the question: What world hypotheses are projected in teacher talk, and are they linked to content areas? A numerical summary of the world hypotheses found by subject area is given in Table 5. Animism and mysticism are conspicuous by their almost total absence, though this is no surprise at all. It is also no surprise that mechanism is dominant in both physics and chemistry. Physics includes mechanics where the categories of mechanism--quantification, mass, location, action-by-contact--are of central concern; chemistry and many topics in physics have the atomic or kinetic molecular theory as their foundational paradigm; both physics and chemistry use quantification extensively. That biology includes the broadest spread of world hypotheses was not unexpected either. Living things have physical as well as biological characteristics, and humans are included in the subject matter of biology.

Some links to certain topics within subjects were also noted. Classification and comparisons, whether in biology--organisms, or physics--sound sources, or earth science--soil and rocks, tended to project formism. Discussions of laws sometimes also projected formism.

Mechanism was projected whenever atomic or kinetic

TABLE 5

World Hypotheses Projected in 54 Segments of Teacher Talk By Subject Area

World Hypothesis Projected	Subject Area				Totals
	Biology N=20	Physics N=16	Chemistry N=13	Earth Science N=5	N=54
Animism	*1	-	-	-	1
Mysticism	-	-	-	-	-
Formism	7	3	*7	*4	21
Mechanism	*8	*13	*9	-	30
Contextualism	3	*1	1	*1	6
Organicism	*6	1	-	1	8

*These world hypotheses for these subject areas were found in transcripts analyzed in this chapter. The others were found in transcripts analyzed in Appendix C, which presents representative sections of teacher talk.

molecular theory was assumed. This occurred not only in many of the physics and chemistry segments, but in parts of biology as well. In biology, mechanism tended to be projected in genetics and cell biology.

Contextualism was generally projected only in attitudes to human opinions or constructs, such as rules, concepts, and grouping schemes.

Organicism was projected by descriptions of interdependent systems in biology and earth science, and by descriptions of the growth of human knowledge.

Although the sample was not large and may not have been representative, these patterns are thought to be fairly general, not only on theoretical grounds--there are conceptual linkages between content areas and characteristics of world hypotheses--but also because Kilbourn found some similar patterns (1974, pp. 198-205). The implications of the content projected by teacher talk is further discussed in chapter V.

World Hypotheses Projected by Teacher Talk--Manner

How, or in what manner world views are projected in teacher talk was a third question to be answered by this study. The manner of projection was defined by using Kilbourn's stipulative defintion of projection. A world hypothesis can be projected overtly, or by assumption, or by implication. An overt projection occurs when it is clearly stated that an

explanation is being given. If the projection is not overt, it is part of a hidden curriculum.

In the segments of teacher talk, world hypotheses were generally projected not openly, but by implication or by the necessity to assume them. Teachers did not alert students to the fact that a certain conceptual framework supported their assertions, and that alternative frameworks might be available. In only one case did that happen (Transcript 024-1a), when a teacher suggested that the Bible might not be "that far out" in regards to the question of the origin of the universe. In transcript 024-1c, the teacher states that he is talking about theories and explanations, but he does not state that he is also presenting a theory about how human knowledge grows. Thus in his description of the latter, organicism is not projected openly but is only implied.

Summary

In this chapter, six samples of teachers' classroom discourse were analyzed. A projection of a world hypothesis was identified by linking some characteristic(s) of a world hypothesis with some statement(s) or phrase(s) in the segment. Each segment was found to project one or more world hypotheses. Thus the analytical scheme was found to be useful for identifying world hypotheses in teacher talk. In the 54 segments analyzed, animism was projected once, mysticism not at all, contextualism

and organicism 6 and 8 times respectively, formism 21 times, and mechanism 30 times. The teacher talk thus projected certain world hypotheses and tended to exclude others to a greater or lesser extent. World hypotheses were almost never projected overtly, but primarily by implication. In the next and final chapter, some conclusions are drawn from the study and discussed, with respect both to the analytical scheme and to the findings resulting from its application.

CHAPTER V

CONCLUSIONS AND DISCUSSION

Introduction

The central concern of this study was the analysis of world views projected by teachers' classroom discourse. World views were characterized in terms of Pepper's six world hypotheses and the intent was to ascertain both what world hypotheses are projected and how they are projected. The literature on science teaching indicates that only a limited set of (popularly conceived) world views or perspectives is projected--including mechanism, scientism, and evolutionism--primarily by means of a hidden curriculum. The projection of these world views in this manner is of concern to me because of the perceived potential consequences for students and for society of uncritically adopting these world views, and because the manner of projection by-passes students' independent judgment. The literature review concentrated on the uses of the concept world view and on related concepts, and showed that the concept world view is a unique educational variable. The argument was advanced that the concept of world view is closely linked with the concepts of knowledge and evidence and is therefore central to teaching. Pepper's theory of evidence leading to world hypotheses was shown to support this argument. Pepper's catalogue of six world

hypotheses was compared to several other catalogues of world views and was found to be the most useful one for analyzing science material because of its greater ability to discriminate world views within the typical school science content.

Kilbourn's analytical scheme, based on Pepper's six world hypotheses, was the tool used to identify world hypotheses in teacher talk. An assessment of the scheme showed that it was useful in discriminating world hypotheses correctly and accurately when used with care. The scheme was applied to 54 segments of teacher talk selected from 65 audio-taped lessons in junior secondary science. Of Pepper's six world hypotheses, formism and mechanism were found projected most often, contextualism and organicism less often, and animism and mysticism almost never. It was found that world hypotheses were almost always implied or assumed, but rarely projected openly.

This chapter presents the conclusions and discusses them under three headings: the limitations of the analytical scheme and of Pepper's catalogue of six world hypotheses; world views projected in teacher talk; and implications for further research and for teaching.

As a result of this study, the following conclusions were drawn:

1. Kilbourn's analytical scheme is a useful tool for identifying world hypotheses in teacher's classroom discourse. The claims of projection are limited to the teacher talk as transcribed since it was not possible to

consider context beyond the recorded classroom interactions.

2. As the theoretical underpinning to the analytical scheme, Pepper's six world hypotheses are limited in that they are only one way to conceptualize and categorize world views as they are actually held by people; they seem to miss what this investigator takes to be an important aspect of world views, namely the epistemological attitude with which it is held: An example is scientism. In addition, the linkages found in this study between content areas and certain world hypotheses seem to suggest that reality demands a variety of modes of explanation: Pepper's concept of the autonomy of each world hypothesis seems to reject this notion.
3. In the lessons analyzed in this study, teachers projected only a limited set of world hypotheses consisting mainly of mechanism and formism, at times of organicism and contextualism, and almost never of animism and mysticism. There were definite links between certain content areas and certain world hypotheses.
4. In the lessons analyzed, world views were projected primarily by assumption or implication; students were almost never told openly that explanations were given from within a conceptual framework.

We turn now to a discussion of these conclusions.

Limitations of the Analytical Scheme and of Pepper's Catalogue of World Hypotheses

It was concluded from the study that Kilbourn's analytical scheme is a useful tool for identifying world hypotheses but is able to give only a crude measure of the quantity of each world hypothesis projected. Although a count of how many times a world hypothesis is projected seems to be precise, one could raise several questions about how precise such a count really is. For example, suppose that in one flexible unit, there are five separate sentences that project mechanism; ought the investigator to count mechanism once, or five times? If only once, how can one compare the projections of different world hypotheses without taking into account the duration of the flexible units. In this study, a world hypothesis was counted no more than once in a flexible unit, and no attempt was made to quantify the projection of the various world hypotheses any further, for example, in terms of time spent on each world hypothesis. The issue of such further quantification is of some significance in light of the claims noted in chapter I, that present science teaching regularly projects mechanism, scientism and evolutionism. Such claims need empirical backing in terms of how much time is spent on each perspective. Even if the problem is cast only in terms of Pepper's world hypotheses, a precise measure of quantity of projection would seem to be in principle unreachable. How would we compare how much mechanism is projected

with how much contextualism is projected? If we were to make the attempt, would we count time spent on each, or sentences, or substantive units, or flexible units, or topics? If that problem were worked out, how would we measure the strength of the effect that the manner of projection has?

This investigator recognizes the need to corroborate judgment with empirical data, but is inclined to believe that an attempt to quantify projections so precisely would add little to our understanding of how world view projections affect students. A different approach to estimating the potential effect is perhaps to analyze curriculum offerings and materials by content areas, and to measure how much time students spend, or are required to spend, on each area. This approach assumes that there is a link between content areas and certain world hypotheses and that therefore a measure of amount of content area will be a rough measure of the amount of world hypotheses projected. The link between content areas and certain world hypotheses is treated further under the next heading.

A second conclusion was that, as the theoretical underpinning to the analytical scheme, Pepper's six world hypotheses are limited in a number of ways. In the first place, the six world hypotheses are only one way to characterize world views, and therefore miss certain aspects of world views. World views are complex realities. As the comparison of various catalogues of world views has shown, each particular formulation of them is just one turn of the kaleidoscope; no one turn captures the

whole of that reality.[1] Thus Pepper's characterization too, although it is a construct that captures what is really there, nevertheless misses certain aspects of world views, and misrepresents others. Pepper's scheme seems to miss evolutionism: That world view (Mayr, 1978) is spread over three world hypotheses: Contextualism, mechanism, and organicism (Kilbourn, 1974, p. 205). This conceptualization is certainly legitimate, but it fails to capture the unified thrust of this fundamental paradigm in biology which has become an important component, I believe, of many people's world views. Similarly, scientism, which is more properly an epistemological attitude--science gives the truth--, is a part of people's world views, but finds little place in Pepper's world hypotheses.

Pepper's characterization also misrepresents certain world views. Pepper's treatment of animism misrepresents theism with which he lumps it. Pepper has a definite bias against theism (Hartshorne, 1980, p. 81: Monast, 1980, p. 82) as shown in his prejudicial tautology: "A fairly reflective civilized man cannot stomach fundamentalism" (1970c, p. 123). The difference between theism and Pepper's description of animism lies in the admissibility of empirical evidence to establish knowledge claims. The notion that empirical evidence could have a bearing on revealed truth does not enter Pepper's description, nor

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[1]For this metaphor I am indebted to Conrad VanderKamp, my former principal at Vancouver Christian Secondary School, who used it of objectives.

Kilbourn's interpretation of that description (Kilbourn, 1974, p. 101). However, this investigator holds, with Scheffler (1967, p. 137), that the concept of evidence is applicable to revealed knowledge.

The incompatibility, in Pepper's conception, of revealed truth and empirical evidence is part of a larger difficulty in Pepper's theory. Pepper has not only distinguished, but also separated, these concepts, and the world hypotheses themselves, claiming they are autonomous and that their interpretations are incompatible,--"irreconcilable" (p. 105)--in cognition. (In practice, eclecticism is permissible, even advisable: If an engineer were contextualist in his personal thinking, would we not want him to take a mechanistic approach to building a bridge?) However, this claim of autonomy is questionable in the light of other characteristics linking the world hypotheses. Pepper himself indicates relationships between world hypotheses. "When we say that world theories are mutually exclusive, we do not mean that they stand apart from one another like so many isolated parts" (1970, p. 104). Some world hypotheses tend to combine to fill in each other's inadequacies (formism with mechanism, mechanism with contextualism). Contextualism and organicism are almost the same, Pepper says. Furthermore, the pattern of adequate world hypotheses seems to draw together in the centre, says Pepper, as if the most cognitive adequacy was somewhere between mechanism and contextualism. Each world hypothesis is strongest in certain areas, especially those closest to its root metaphor (1970c, p. 109). This recogni-

tion of Pepper's was supported by the findings of this study, which showed a linkage between certain content areas and world hypotheses. We need all four hypotheses, Pepper says: "To sacrifice the insights into fact which any one of these theories gives would be to sacrifice cognitive values possessing a degree of value which we have no means of estimating" (1970. p.148). Finally, Pepper leaves room for world hypotheses to merge into one completely adequate world hypothesis, at least in principle.

This last suggestion points to a way of approaching the difficulty in Pepper's theory. It seems to me that an adequate world view must include the recognition that reality comprises a variety of functions or modes (for example: numerical, physical, biological, social, economic), and therefore demands a variety of modes of explanation, of which Pepper's mechanism, for example, might be one. Such a world view need not be eclectic or unsystematic. It would recognize the diversity of reality, posit various modes of explanation for the various aspects of reality, and recognize the limits of each mode of explanation. For example, it would include a mechanistic mode of explanation as that mode which focusses on the particulate nature of reality and its cause-effect relationships, not only in the realm of physical things, but in any area of reality, for example language, economics, etc. Such an adequate world view would clearly recognize that a mechanistic mode of explanation offered a legitimate, but one-sided, explanation of reality and by no means a complete interpretation. If any mode of explanation were claimed to be a full explanation, that would in effect be a claim of autonomy

and in reality be an example of reductionism--all of reality identified with one aspect of it. Thus, for example, to discuss the cell in terms of the molecular structure of its parts would be legitimate, but it would be reductionism to imply or state that this was the only true, or even best, explanation of cells. Such reductionism of cells to molecules would deny our students' experiences of living creatures as being different from physical things.

The kind of world view suggested here[1] would recognize the legitimate role of any of Pepper's six hypotheses (though it would not accept them as world hypotheses) and would be able to explain many, if not all, of the features and difficulties noted in Pepper's theory. Although this analysis of the limitations of Pepper's world hypotheses points to the need for a further conception, it is beyond the scope of this thesis to pursue this line of inquiry.

World Views Projected in Teacher Talk--Content and Manner

While this study focussed on teacher talk it must be remembered that in the classroom world view messages are projected

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[1]Such a world view is found in the Philosophy of the Cosmonomic Idea developed by Herman Dooyeweerd. It has not become widely known, probably because it originated in the Netherlands (the Dutch language is not well known) and, more important, because it is thoroughly theistic. See Kalsbeek, L. Contours of a Christian philosophy. Toronto: Wedge Publishing Foundation, 1975. (Address: 229 College Street, Toronto, Canada).

in other ways too. These include assignments given, films, experiments, types of responses encouraged, teacher dominance, and the structure and organization of the classroom. However, teacher talk is probably the major way in which this projection occurs.

It was concluded that in the sample of lessons used in this study, teachers projected only a limited set of world hypotheses. Of the six world hypotheses in the scheme, only four--formism, mechanism, contextualism and organicism--are generally considered to be compatible with science. The findings of this study were that, with one exception, only these four were projected. This is consistent with Roberts' (1970) assertion, at least in science teaching, that the scientific mode of explanation is the only one given systematic treatment in the curriculum. Of the four, formism and mechanism were projected much more than the other two, in every subject area (except mechanism in earth science). There is no claim that these results are representative, but they certainly suggest that a very limited set of world views is being projected to the young. Surely mechanism and formism are of very limited help to people in coping with the meanings they find in or give to their experience. In fact, this investigator is of the opinion that, when projected as world hypotheses--i.e. with purported total explanatory power--their effect is negative. The writings of some social critics in the sixties and seventies suggested the same (Kilbourn, 1974; 1980-81). Especially mechanistic explanations of humans,

for example in cell biology, must have a negative impact on people's images of themselves and their place in the world.

It was further concluded that in the lessons analyzed, world views were projected mainly by implication or assumption, and almost never openly. Such a manner of projection--via the hidden curriculum--violates what it means to teach, because it does not respect the students' independent judgment. It must be recognized that context outside the sample could have--potentially radically--altered this judgment. However, the sample certainly suggests that "hidden" projection is the regular manner. Teachers were thus shaping the world views--the beliefs --of students without telling the students what shape was being given or even that any shaping was occurring. Students' independent judgments were systematically by-passed. This judgment on the part of the investigator is not intended as an indictment of teachers; rather, it points to how deeply we are committed to a few dominant paradigms, so deeply committed that for us, interpretation has become fact. In Pepper's terms: "In a world theory it is impossible to say where pure fact ends and interpretation of fact begins" (1970c, p. 79). This judgment regarding the manner of our teaching has, however, important implications for teaching.

Implications for Research and Teaching

Research into both the content and the manner of world

views projection in teaching are suggested by this study. This study and Kilbourn's (1974) converge on the same findings: A limited set of science-related world views is projected primarily in a hidden way, both in text material, and in teacher talk. What would happen if a text projected mainly one world view while the teacher contradicted this world view and/or projected another? What world view would the students in such a situation tend to adopt? If students were openly presented with alternative world views, how would this influence their world views? Would they tend to adopt attitudes of tolerance and open-mindedness? Answers to such questions would have implications for what and how science is taught. However, for the concerns that underlie this study to have an influence on teaching, it is not necessary to await empirical answers to these questions (Kilbourn, 1980-81). The answers obtained already, and more important, the theoretical perspectives underlying this study, have direct bearing on the practice of teaching.

Implications for Teaching

Finally, it is this investigator's conviction that teachers and teaching ought to change so that teaching is done both with greater world views awareness on the part of the teacher, and for greater world views awareness on the part of the students. The findings of this study and the conceptual framework which underlies the study suggest a number of characteristics which

teaching and/or teachers ought to have. These are discussed under curriculum, teacher attitude and training, and style and manner of teaching.

Curriculum is perhaps the easiest of the three areas in which to effect a change toward teaching that values an awareness of world views. Courses ought to be constructed so that a variety of perspectives is openly brought to bear on the subject matter content. Wherever possible, alternatives to the major paradigms ought to be presented. In addition, the curriculum needs to draw on the common sense understandings of the student; if it does not make contact with the world view of the student, it cannot be said to be educating that student's mind (Pring, 1976).

To be effective, such a curriculum depends on teachers with an appropriate awareness of and openness to alternative perspectives. Such teachers will be aware that scientific description is interpretation, and that the materials they use and their own classroom talk project ways of looking at the world. Less essential, but still highly desirable, is that teachers know what world views are commonly projected in science discourse. Teachers will know what their own world views are like and will be able to describe and explain them and defend them against at least some other positions. It is probably true that the description given of the "ideal world views teacher" is not matched by the average classroom teacher. This certainly suggests the need for philosophical training of teachers in the area of

their subject specialties. And it is perhaps expecting too much of the average teacher: The bottom line is awareness of and openness to alternatives.

Teaching with and for world views awareness seems to demand also certain characteristics in teaching manner and style. A manner is required that provides for intellectual independence (Munby, 1980) thus respecting students as thinking individuals. An appropriate teaching style would encourage active observation, interpretation, and explanation on the part of students, perhaps along the lines of Roberts and Silva's trialogue style (1968). This would be accompanied by exposure to a variety of alternative modes of explaining so that students could test their views against other views. Such teaching will help students to choose and hold with awareness their own world views.

APPENDIX A

KILBOURN'S ANALYTICAL SCHEME TO IDENTIFY WORLD HYPOTHESES

TABLE 6

CHARACTERISTICS OF ANIMISM AS A WORLD HYPOTHESIS*

Categories and identifying features:	Comments:
A. Root Metaphor: MAN, SPIRIT	•The personification of events in the universe culminates in a concept of spirit. Man is the primitive root metaphor. Spirit is the mature root metaphor.
B. Categories	
•PERSONIFICATION	•Non-human entities (wind, rain, trees, etc.) lead lives conforming to human or animal analogies.
•CONTROLLING DEITIES and SUBORDINATE SPIRITS	•Controlling and subordinate spirits are extensions of the personification of all entities and natural phenomena. Some phenomena control others (e.g. fire destroys trees) and therefore have more powerful spirits. Spirits are sometimes envisaged to be monstrous, half-human creatures.
•TRANSCENDENT SPIRITS	•Spirits are the "life-blood" of the objects and individuals they control. Spirits are often vaporous and have the ability to leave the object or organism which they inhabit. Spirits cause life, thought, and volition. Spirits can manifest physical power and exist after the death of the organism they inhabit.
•FUTURE EXISTENCE	•This follows from the transcendent nature of the spirit. After death the organism experiences a future existence.
C. •Animistic truth	•Truth lies in the authority of the spirit and is infallible. Greater truth is possessed by the more powerful spirit. Truth can come from the spirit's designate (shaman, medicine man, priest). A spirit's words can come from his immediate presence, dreams, voices, omens, holy books.

* Adapted from S.C. Pepper's World Hypotheses (Berkeley: University of California Press, 1942)

TABLE 7

CHARACTERISTICS OF MYSTICISM AS A WORLD HYPOTHESIS*

Categories and identifying features:	Comments:
A. Root Metaphor: LOVE	•Mysticism is the philosophy of love, peace, and unity. The emotion of love is the substance of the universe.
B. Operating principles of love	
•INTENSITY	•The stronger the emotion is, the greater the reality.
•FUSION	•The stronger the emotion is, the greater the tendency for things to fuse and be seen as generated from love.
•INCLUSIVENESS	•As the emotion becomes greater, more things are fused and there is more reality.
C. Quality of the experience	•This refers to how the experience of love is felt by the individual.
•SUPREMELY COGNITIVE	•A mystical experience gives immediate knowledge and denies other modes of cognition.
•IMMEDIATE AND UNINTERPRETED	•Senses and imagination are not used. The experience comes through revelation.
•CERTAIN	•Cognitive certainty is intense in a mystical experience.
•EMOTIONALLY ECSTATIC	•The revelation has a beatific quality.
D. Mystical truth	•Truth comes through the mystical experience. The greater the emotional experience is, the greater the truth revealed. The most intense experience reveals absolute truth.

* Adapted from S.C. Pepper's World Hypotheses (Berkeley: University of Californis Press, 1942)

TABLE 8

CHARACTERISTICS OF FORMISM AS A WORLD HYPOTHESIS*

Categories and identifying features:	Comments:
A. Root Metaphor: SIMILARITY	•Observation of similarity gives rise to immanent and transcendent formism.
B. Immanent formism	•Similar events or objects are described and the results of the description are accepted literally.
•CHARACTERS	•Characterization of things is in terms of quality or relation. Character, quality, and relation are all forms.
•Quality	•Color, size, shape, texture, luster, etc. are qualities of things.
•Relation	•"Side by sideness" is a relationship between two particular things.
•PARTICULARS	•These are numerical entities characterized by qualities and relations. Two aspects of objects of perception are particularity and character. These two aspects are distinct but never are experienced separately.
•PARTICIPATION	•This is the tie between characters and particulars. It is the characterization of a particular or vice-versa. A class is a collection of particulars that participate in one or more characters. The basis for classification lies in the simliarity of specimens to ideal forms.
C. Transcendent formism	•The observation of similarity comes from two sources: goods made according to the same plan, and natural objects growing according to the same plan.
•NORMS	•A plan to make something is a norm which transcends the thing made, and natural growths develop according to a norm. In both cases, because of contingencies (available materials, skills of the artisan, natural conditions, etc.), the norm is not fully realized but transcends the material objects. Natural laws are norms which regulate the occurrences of nature. The aim of science is to discover the laws which nature "follows."

	•MATTER	•Matter exemplifies the norms. (This category parallels the second category of immanent formism - particulars.)
	•PRINCIPLE OF EXEMPLICICATION	•This is the tie between norms and matter and materializes the norms. (This category parallels the third category of immanent formism-participation.)
D.	Existence and subsistence	•These concepts reconcile the first categories of immanent and transcendent formism. (Since the second and third categories of both types of formism are compatible, reconciliation of the first categories produces "unified" formism.) Existence refers to particulars or matter. Primary existence refers to bare particulars which have no characters and therefore cannot be perceived. Concrete existence refers to particulars with participating characters (perceivable concrete objects). Subsistence refers to characters and norms not particularized. Characters and norms are both forms and are subsistently related.
E.	Correspondence theory of truth	•Truth is the similarity of correspondence between two or more things, one of which is said to be true of the others.
	Historical truth	•Truth concerns existence and consists of describing characteristics of particular events.
	Scientific truth	•Truth concerns subsistence and consists of descriptions of norms and laws. It is arrived at by induction.
	•Empirical uniformities	•Empirical uniformities are half way between contingent fact and necessary law. They do not show the necessity for regularities and therefore are not completely scientific.
	•Natural laws	•Regularities necessarily follow from natural laws.

*Adapted from S.C. Pepper's World Hypotheses (Berkeley: University of California Press, 1942).

TABLE 9

CHARACTERISTICS OF MECHANISM AS A WORLD HYPOTHESIS*

Categories and identifying features:	Comments:
A. Root Metaphor: MACHINE	•Discrete mechanism accounts for the mechanics of a watch. Consolidated mechanism accounts for a dynamo.
B. Primary categories	•Primary categories describe the way a machine works and give insight into its reality. (Primary categories below are treated according to discrete and consolidated mechanism.)
1. Discrete mechanism	•Structural features of the universe are distinct e.g., space, time, mass, number, motion, etc. are unrelated concepts. Action is by contact. Because all structures in the universe are independent, anything could have been otherwise. The universe accidentally is as it is. However, once the structures are given events inexorably follow. Statistical laws are not really laws, but are approximations to reality.
•FIELD OF LOCATION	•Parts of a machine must have spatial location for the machine to work. An exact description of a machine specifies the location of the parts. Things are real by virtue of a location. Nothing exists without a location in space and time.
•PRIMARY QUALITIES	•These refer to quantifiable aspects relevant to the efficient functions of a machine. Primary qualities ultimately reduce to differentiating qualities of particles distributed in time and space (size, shape, motion, solidity, mass and number).
•PRIMARY LAWS	•These laws (e.g., F=MA) determine the configuration of elementary particles in time and space.
2. Consolidated mechanism	•Recent advances in physics (especially relativity theory) collapse a number of discrete mechanistic categories. Action can be at a distance. There are no statistical laws. The universe is completely determined since the

only existing particular is the spatio-temporal-gravitational-electromagnetic field.

- •FIELD OF LOCATION — •The field of location is the spatio-temporal field.
- •PRIMARY QUALITIES — •Mass is the only differentiating quality. General relativity theory consolidates the gravitational field (a phenomenon of mass) with the spatio-temporal field. The electromagnetic field law (involving the qualities of electric charge and magnetic attraction tion) operate in the spatiotemporal field.
- •PRIMARY LAWS — •Descriptive laws are shorthand for structural modifications of the consolidated spatiotemporal-gravitational electromagnetic field (the only existing particular).

C. Secondary categories •These refer to qualities that have no bearing on a machine's operation. The descriptive reality of a machine (lying in the primary categories) is inferred from secondary categories (human perception is of secondary qualities). Mechanistic reductionism is the explanation of secondary qualities in terms of primary categories (e.g., explaining mental events in terms of physiological processes).

- •SECONDARY QUALITIES — •These are aspects of the machine perceived by individuals (e.g., color, texture, odor, sound, etc.).
- •PRINCIPLES OF CONNECTION — •These elucidate the relationship between secondary qualities and primary categories. Three theories about the connection between primary and secondary categories are identity, causation, and correlation.
- •SECONDARY LAWS — •These laws show the regularity of the relationships among secondary qualities. Laws of association in human psychology can be considered secondary laws.

D.	Causal-adjustment theory of truth	•Statements are manifestations of physiological responses to stimuli. Truth is adjustment of physiological attitudes to the organism's environment and is ultimately explained by causal relationships among primary qualities. In discrete mechanism the nature of adjustment seems to imply a correspondence theory of truth. Consolidated mechanism seems to imply a pragmatic theory of truth.

*Adapted from S.C. Pepper's World Hypotheses (Berkeley: University of California Press, 1942).

TABLE 10

CHARACTERISTICS OF CONTEXTUALISM AS A WORLD HYPOTHESIS*

Categories and identifying features:	Comments:
A. Root Metaphor: HISTORIC EVENT	•The historic event is the active, present event and its context and is characterized by verbs (seeing, doing, being, teaching, etc.). Contextual categories are derived from the intuited quality of the historic event. Reality is not inferred.
B. Basic categories: CHANGE, NOVELTY	• Contextualism denies absolute structures or inherent order in the universe. Change and novelty are basic to this hypothesis.
C. Categories of this epoch	•Quality and texture are categories that account for order in the present epoch.
•QUALITY	•Quality is the intuited wholeness or total character of an event.
•Spread	•Every present event has connections with the past and future. A present event has spread and is not a point on a dimensional time scale.
•Change	•Qualities of events change according to perspectives from which they are viewed.
•Fusion	•Textures coalesce to form a quality. Individual textures are difficult to discern in highly fused events.
•TEXTURE	•Texture refers to the elements that make up qualities. Textures also exhibit qualities and are made of strands lying in a context. No analysis of an event leads to absolute reality. The results of analysis depend on context.
•Strand	•A strand is whatever contributes directly to the quality of a texture. Strands can be seen in terms of purposes or goals.
•Context	•Context is whatever contributes indirectly to the quality of a texture.
•Reference	•This subcategory is discussed in terms of initiation, direction, and satisfaction of a strand. If strands are taken as purposive behaviour, observation of an action will note

		the initiation of the action, the goal of the action, and the satisfaction of the goal. Linear references consist of a single initiation and proceed directly to a satisfaction. Convergent references consist of several initiations converging upon one satisfaction, or one initiation culminating in several satisfactions. Blocked references are those in which no satisfaction of a strand is reached. Instrumental references involve actions which are intended to relieve a blocked reference and which permit a strand to reach satisfaction.
D.	Schemes (formulas, diagrams, etc.)	•These are instruments which do not reveal reality but are considered useful for prediction, explanation, and control.
E.	Operational theory of truth	•Truth is in the context of human action.
	Successful working	•Truth is successful action. Those actions which are successful, in terms of their goals, are true. Truth does not give insight into the textures and qualities of nature.
	Verified hypothesis	•Truth lies in the hypothesis that leads to a successful act. Truth does not give insight into the textures and qualities of nature.
	Qualitative confirmation	•Truth lies in the hypothesis that leads to a successful act. Truth does give some insight into the textures and qualities of nature.

* Adapted from S.C. Pepper's World Hypotheses (Berkeley: University of California Press, 1942).

TABLE 11

CHARACTERISTICS OF ORGANICISM AS A WORLD HYPOTHESIS*

Categories and identifying features:	Comments:
A. Root Metaphor: INTEGRATION	•Events and processes are seen to be integrated to varying degrees.
B. Categories	
•FRAGMENTS	•Fragments refer to experience. An isolated datum is a fragment. Experience is no longer fragmented when seen as integrated in a coherent whole.
•NEXUSES	•Nexuses are connections among fragments and imply larger, more coherent, integrated wholes.
•CONTRADICTIONS	•Contradictions occur when the nexuses of an experience lead to conflicting experiences. The conflict can be resolved by a higher level of integration.
•ORGANIC WHOLE	•The absolute organic whole is approached when all experience is found to be successively integrated into larger and more coherent wholes. The Absolute is the ultimate integration and most coherent organic whole. As the Absolute is approached, the system becomes more inclusive, more determinate, and more integrated. There is no change; therefore, time is not real.
•IMPLICITNESS	•When an organic whole is reached, the fragments that led to its development are seen to be implicit in the whole.
•TRANSCENDENCE	•The contradictions of fragments are resolved or transcended when an organic whole is reached.
•ECONOMY	•All experiences are valid (and are economized or saved) when an organic whole is reached.
C. Coherence theory of truth	•There are degrees of truth in relation to the amount of fact obtained. More truth is revealed when there is higher integration of facts. The criteria of truth are the categorial features of the organic whole-inclusiveness, determinateness, and organicity. Truth includes formal consistency but is more than that. It is the positive relatedness of material facts to pro-

duce a coherent whole. Accurate predictions are considered evidence for the truth of the organization of the data that produced the predictions.

* Adapted from S.C. Pepper's World Hypotheses (Berkeley: University of California Press, 1942).

APPENDIX B

A COMPARISON OF WORLD HYPOTHESIS ATTRIBUTIONS BY KILBOURN AND BY THE INVESTIGATOR AND TWO JUDGES

TABLE 12

World Hypothesis Attributions by Investigator Compared to Attributions by Kilbourn for Group 1, Flexible Units

Unit	Attributions				
	Kilbourn	Rater	Correct	Missed	Additional
1	M	M	M	-	-
2	F,M	F	F	M	-
3	M	M	M	-	-
4	M	M,O	M	-	O
5	F,M	F,M	F,M	-	-
6	M	M	M	-	-
7	M	M	M	-	-
8	M	M	M	-	-
9	M	M	M	-	-
10	M	O	-	M	O
11	M	M	M	-	-
12	M	M	M	-	-
13	O	M	-	O	M
14	F,M	M,O	M	F	O
15	O	O	O	-	-
16	F	F,M	F	-	M
17	O	O	O	-	-
18	M	M	M	-	-
19	M	M,O	M	-	O
20	C	F,C	C	-	F
21	F	F	F	-	-
22	F,C	F,C	F,C	-	-
23	C,O	F,O	O	C	F
24	M	M	M	-	-
25	F	M	-	F	M
TOTALS	30	33	24	6	9

TABLE 13

World Hypothesis Attributions by Judge No. 1 Compared to Attributions by Kilbourn for Group 1, Flexible Units

Unit	Attributions				
	Kilbourn	Rater	Correct	Missed	Additional
1	M	F	-	M	F
2	F,M	F	F	M	-
3	M	F,M,O	M	-	F,O
4	M	M,O	M	-	O
5	F,M	M,O	M	F	O
6	M	M	M	-	-
7	M	M,O	M	-	O
8	M	F	-	M	F
9	M	M,O	M	-	O
10	M	F	-	M	F
11	M	M	M	-	-
12	M	M	M	-	-
13	O	F,O	O	-	F
14	F,M	M,C,O	M	F	C,O
15	O	M,O	O	-	M
16	F	F	F	-	-
17	O	O	O	-	-
18	M	F	-	M	F
19	M	F,M,O	M	-	F,O
20	C	F,O	-	C	F,O
21	F	F	F	-	-
22	F,C	F,C,O	F,C	-	O
23	C,O	F,O	O	C	F
24	M	M,O	M	-	O
25	F	F,M,C,O	F	-	M,C,O
TOTALS	30	45	21	9	24

TABLE 14

World Hypothesis Attributions by Judge No. 2 Compared to Attributions by Kilbourn for Group 1, Flexible Units

Unit	Attributions				
	Kilbourn	Rater	Correct	Missed	Additional
1	M	F	-	M	F
2	F,M	O	-	F,M	O
3	M	M	M	-	-
4	M	M,C,O	M	-	C,O
5	F,M	F,O	F	M	O
6	M	M	M	-	-
7	M	M,O	M	-	O
8	M	M,O	M	-	O
9	M	M	M	-	-
10	M	M,O	M	-	O
11	M	M	M	-	-
12	M	M,O	M	-	O
13	O	M,O	O	-	M
14	F,M	O	-	F,M	O
15	O	O	O	-	-
16	F	F,M	F	-	M
17	O	O	O	-	-
18	M	M,C	M	-	C
19	M	F,M	M	-	F
20	C	F,C	C	-	F
21	F	F	F	-	-
22	F,C	F,M,O	F	C	M,O
23	C,O	F,O	O	C	F
24	M	M,C	M	-	C
25	F	F,C	F	-	C
TOTAL	30	42	22	8	20

TABLE 15

World Hypothesis Attributions by Investigator Compared to Attributions by Kilbourn for Group 2, Flexible Units

Unit	Attributions				
	Kilbourn	Rater	Correct	Missed	Additional
1	M	F,M	M	-	F
2	M	M	M	-	-
3	O,(or C)	M,O	O	-	M
4	F	F,C	F	-	C
5	M	M	M	-	-
6	M	M	M	-	-
7	M,O	M,O	M,O	-	-
8	F,O	F,M,O	F,O	-	M
9	M,O	M,O	M,O	-	-
10	M,O	M,O	M,O	-	-
11	O	M,O	O	-	M
12	F,M,O	F,O	F,O	M	-
13	M,O	F,O	O	M	F
14	C(weak)	M,O	-	C	M,O
15	M	F,M	M	-	F
16	M	F,M	M	-	F
17	F	F	F	-	-
18	F	F	F	-	-
19	F	F	F	-	-
20	F,M	F,M	F,M	-	-
21	F,C	F,C	F,C	-	-
22	F,M	F,M	F,M	-	-
23	F,C	F,C	F,C	-	-
24	M	M	M	-	-
TOTALS	35	42	32	3	10

TABLE 16

World Hypothesis Attributions by Judge No. 1 Compared to Attributions by Kilbourn for Group 2, Substantive Units

Unit	Attributions				
	Kilbourn	Rater	Correct	Missed	Additional
1	M	F,M,C	M	-	F,C
2	M	M	M	-	-
3	O(or C)	O	O	-	-
4	F	O	-	F	O
5	M	M	M	-	-
6	M	F,M	M	-	F
7	M,O	M,O	M,O	-	-
8	F,O	M,O	O	F	M
9	M,O	M,O	M,O	-	-
10	M,O	F,M,O	M,O	-	F
11	O	M	-	O	M
12	F,M,O	F,M,O	F,M,O	-	-
13	M,O	M	M	O	-
14	C(weak)	C	C	-	-
15	M	F	-	M	F
16	M	F,M	M	-	F
17	F	F	F	-	-
18	F	F,C,O	F	-	C,O
19	F	F,O	F	-	O
20	F,M	F,M,O	F,M	-	O
21	F,C	F,C,O	F,C	-	O
22	F,M	F	F	M	-
23	F,C	F,M	F	C	M
24	M	M,O	M	-	O
TOTALS	35	44	28	7	16

TABLE 17

World Hypothesis Attributions by Judge No. 2 Compared to Attributions by Kilbourn for Group 2, Substantive Units

Unit	Attributions				
	Kilbourn	Rater	Correct	Missed	Additional
1	M	M,O	M	-	O
2	M	M	M	-	-
3	O(or C)	O	O	-	-
4	F	C,O	-	F	C,O
5	M	O	-	M	O
6	M	M,C	M	-	C
7	M,O	F,O	O	M	F
8	F,O	C,O	O	F	C
9	M,O	M,O	M,O	-	-
10	M,O	M,O	M,O	-	-
11	O	O	O	-	-
12	F,M,O	M,O	M,O	F	-
13	M,O	M,C,O	M,O	-	C
14	C(weak)	C	C	-	-
15	M	M	M	-	-
16	M	M	M	-	-
17	F	F	F	-	-
18	F	F,O	F	-	-
19	F	F	F	-	-
20	F,M	M,O	M	F	O
21	F,C	F,C	F,C	-	-
22	F,M	F,M	F,M	-	-
23	F,C	F,C	F,C	-	-
24	M	M,O	M	-	O
TOTALS	35	40	29	6	11

TABLE 18

Two World Hypothesis Attributions by Investigator at a Six-Months Interval Compared to Attributions by Kilbourn

Unit	Attributions								
	Kilbourn	Rater		Correct		Missed		Additional	
		#1	#2	#1	#2	#1	#2	#1	#2
1	F	F,O	f	F	f	-	-	O	-
2	M	M	m	M	m	-	-	-	-
3	F,M	F,M	f,m	F,M	f,m	-	-	-	-
4	M	M	m	M	m	-	-	-	-
5	F,M	F,M	f	F,M	f	-	m	-	-
6	M	F	f,m	-	m	M	-	F	f
7	F,M,O	F,M,C	f,m	F,M	f,m	O	o	C	-
8	M	F,O	o	-	-	M	m	F,O	o
9	F,M	M	f,m	M	f,m	F	-	-	-
10	M,O	F	f,m	-	m	M,O	o	F	f
11	M	M	m	M	m	-	-	-	-
12	M	M	m	M	m	-	-	-	-
13	M,O	F,M,O	m,o	M,O	m,o	-	-	F	-
14	M	M	m	M	m	-	-	-	-
15	F,O	M,O	f,m,o	O	f,o	F	-	M	m
16	M	M	o	M	-	-	m	-	o
17	F	F	f	F	f	-	-	-	-
18	M	M	m	M	m	-	-	-	-
19	M	M	m	M	m	-	-	-	-
20	M	M	m	M	m	-	-	-	-
21	M	M	m,c	M	m	-	-	-	c
22	M	M	m	M	m	-	-	-	-
23	M,O	M,O	m,c	M,O	m	-	o	-	c
24	M	F,M	f,m	M	m	-	-	F	f
25	F,C	F	f	F	f	C	c	-	-
26	F	F	f,m	F	f	-	-	-	m
27	M,C	M	m,c	M	m,c	C	-	-	-
TOTALS	38	38	40	29	31	9	7	9	9
SAME		31		26		4		5	

APPENDIX C

THIRTEEN SAMPLE ANALYSES OF SELECTED PORTIONS OF TEACHER TALK

BIOLOGY TRANSCRIPTS

TRANSCRIPT 021-1a

TEACHER: Okay, what does that tell you about the infor . . . . what's in the nucleus?
STUDENT: Genes.
TEACHER: Genes. Not GW jeans. When she says 'genes', when people start saying genes . . .
STUDENT: Chromosomes.
TEACHER: Chromosomes. These are words that she's coming up with there. They're all found in the nucleus. What does this do for the cell?
STUDENT: It makes the features.
TEACHER: It makes the features. It makes the characteristics. The nucleus tells the cell what it's going to do with its life. Okay? And . . . . it is in effect, it carries what we'll call for no other reason than that it's easy to understand - the blueprint for that cell. All right. So, when I've got an amoeba sitting on a table . . . . that blueprint tells that cell what it's going to do with its life. It tells it how it's going to grow, well it doesn't tell it what's going to happen to it perhaps, but it tells the amoeba how it's going to grow, how it's going to divide and reproduce. All the chemistry inside that amoeba is controlled by information inside that nucleus. So the nucleus is the blueprint for the activities of that cell.

ANALYSIS. This section is judged to project mechanism because secondary qualities--"what it's going to do with it's life . . . .how it's going to grow"--are explained as being controlled by invisible primary particles--genes and chromosomes. The context of the rest of the transcript makes it clear that this reductionism (of secondary to primary) is applied to all life, including people. (All the underlined are features of mechanism.)

TRANSCRIPT 032-2b

(The discussion is about cloning.)
TEACHER: Think of it this way though. I'm the guy in charge. I don't like (student's name) . . . but I like (student's name), so I'm going to have 459 of him.
STUDENTS: (Various exclamations!)
TEACHER: Now, think (rest indistinguishable) . . . . Now it gets down to a lot of moral (and ethical?) stands. Who has the right to decide that there should be a whole lot of Martins and none of you. And then, is that in fact good for us?
STUDENTS: (Various remarks.) . . . .
TEACHER: Well, see, what happens is this. Genetic traits, okay. We could produce another Bobby Hull or Guy LaFleur exactly the same, okay? Except, there's the environmental. Now we produce another Guy LaFleur exactly the same and we give him to some guy who lives in (name of place) who's never seen a hockey rink in his life and he grows up as a hunter. He's got all of the basic material necessary to be a Guy LaFleur, but he never has the chance to use it. But he could be a great hunter. Okay? Or - okay, environmental is what you're brought up with . . . Or you take him and put him somewhere where the family mistreats him, doesn't feed him, or even too much.
(A little later in the discussion.)
You have to have, if you want to get two people to come to the same point, they've got to be raised the same way. And everything's different of course. Every household's different . . . . If you changed the environmental aspect, than you change their life.

ANALYSIS. For this section it is easier to say what is not projected than what is projected. There are no traces of formistic or mechanistic characteristics. The phrases "it gets down to a lot of moral . . stands. Who has the right to decide . . . . Is that in fact good for us?" suggests indeterminacy (and organicism is determinate) and the root metaphor of contextualism, the historic event "characterized by verbs " - in this case, deciding. Similarly, the

blend of genetic makeup and environment seem best accounted for by the categories of contextualism: They are textures that make up the quality of the person. There is no suggestion in this section of determinateness, which would disallow the projection of contextualism; contextualism denies absolute structure or inherent order. Therefore, this section is judged to project contextualism.

TRANSCRIPT 062-2a

TEACHER: (Referring to a list of eye parts on the blackboard.) There's a few things that are missing here. I haven't got everything up there because there's some things you just won't see during the dissection. But these seven here, yes you will. The optic nerve - you'll see a little white - it's white - the little round stub where it's been chopped at the back of the eye - of course it used to go on here right on to the brain. It doesn't any more. The lens you'll be able to pick out. You'll see it. It looks like a lens. It's like a little sack of jelly, lens shaped. The cornea - that is the part right in front here. This - of course there's a tough, transparent outer layer here - that's the cornea. That's one of the things you're going to separate out and be cutting around here . . . . the iris of course is inside the eye . . . . now you can recognize it . . . . it's flat. That's how you can recognize it. If you can get it out in one nice piece, show the black circle with the elliptical opening in the middle - that is the pupil - fine. The retina is the lining on the inside of the eye. You can recognize it, it's a very pretty kind of iridescent blue and it'll peel off the inside of the sclerotic coat. The vitreous humor is a - you should be able to get a nice big blob of jelly which is the vitreous humor - that's inside the eye and then, when you do this the lens will probably come out in the vitreous humor and you'll see the two of them sitting there together . . . . and the sclerotic coat, that's the outside (hide?) of the eye that you'll be left with at the end.

ANALYSIS. The eye--meaning that this eye which the teacher is holding is representative of other eyes--is described and the results of the description accepted literally. The quality of the eye is described in terms of its shape, colour, size, etc. Thus this section is judged to project formism.

TRANSCRIPT 072-1b

TEACHER: Okay. We're not just talking about external characteristics. We're talking about every, the tiniest detail of your body that, not only external features, but the - all the processes that take place in your body - all the reactions that go on. There's thousands of them going on all the time. They're all decided by these strands of material called chromosomes . . . . . in a normal human being, there are in say, a skin cell, forty-six . . . . . On those chromosomes in the case of human beings anyway, there may be forty or fifty thousand tiny invisible units and each of those units is called a . . . these units that are lined up along the chromosome are called . . genes . . . They're invisible. Invisible units. We can't see them, but we know that they're there and we know that they govern these characteristics.

STUDENT: If they're invisible, how(rest indistinguishable).

TEACHER: Exactly. That's what somebody always asks. If they're invisible, how do we know these genes are there? Any theories how we can tell . . . .? How do we know that they govern certain characteristics?

STUDENTS: (Various remarks.)

TEACHER: . . . It turns out that they can't even really be seen under the microscope. But even if they could be seen, how do we know that a certain gene covers a certain characteristic?

STUDENT: We don't.

TEACHER: Because they don't . . the gene doesn't look like what its characteristic is . . . . Well, here's how they tell if a little bit of a chromosome is

missing, they find that certain features do not turn out the way they'd be expected to turn out. And when similar bits of chromosomes have been missing, it's always been the same features that have not turned out the way that they would have expected. And so from that, they can tell. And there's such a thing as gene mapping now. Scientists are working towards finding out what every little bit of a chromosome governs.

ANALYSIS. This section projects mechanism because obser-- vable characteristics are decided, i.e. determined, by unobservable discrete particles, genes. Quantity--"forty or fifty thousand tiny invisible units"--and the attempt to locate the genes on the chromosomes are also characteristics of mechanism.

TRANSCRIPT 072-3a

TEACHER: Vertebrates. Now, is the fish a vertebrate? If you dissected a fish, would you find that it had a backbone?
STUDENTS: Yes.
TEACHER: Okay. You definitely would . . . . We're going to take a look at one later on this period, but first of all,
STUDENT: Can you eat fish eggs?
TEACHER: What can you tell me about fish that all fish have in common?
STUDENTS: They swim, (etc.).
TEACHER: Can you make a list of some features that all fish have in common?
STUDENTS: Gills, (etc.).
TEACHER: (Presumably writing down list as he speaks.) They all have gills. For what purpose?
STUDENTS: For breathing.
TEACHER: For breathing.
STUDENT: Fins.
TEACHER: Fins. Now, do all fish have fins?
STUDENT: No. Yes, the back one, only the rear part.

TEACHER: Well, I'd have to say that pretty well any fish I've seen has fins. They may take on a variety of shapes and sizes and so on, but they do have fins, don't they . . . .
STUDENT: All their fins go up, like up and down, not sideways.
TEACHER: Okay. There's lots of different shapes and sizes and they may have different functions, but fish have fins. That's definitely what we'd have to call a common feature.
STUDENT: They've got eyes.
TEACHER: They've got eyes. Okay. Let's just see if we can just talk strictly about features which fish have,, which fish share. We can go into lots of different things.
STUDENT: Backbone?
TEACHER: Okay. I guess we could put that down although lots of other animals have eyes as well. Let's put down that they all have a backbone.
STUDENT: Scales?
TEACHER: Okay. Um. Scales.

(A little later.)
STUDENT: All fish lay eggs.
TEACHER: Do all fish actually lay the eggs first?
STUDENTS: (Various remarks.)
TEACHER: Well, that's not true but most do . . . . . .
STUDENT: They all have eyes?
TEACHER: Okay. That's true, but a lot of animals do. Let's just leave that one. Anything else that just the fish have in common . . . . . Well, I'll tell you something that many fish have and it's a way of hearing in the water.
STUDENTS: Ears.
TEACHER: It's not really strictly hearing, but if you look at the side of the fish's body, you'd see what looks like a line going down the side of its body, almost like stitching on either side. It's called the lateral line.

ANALYSIS. The fish are treated here as all members of one class or group, sharing fish characteristics, the set of which is the plan or norm for all fish. This section thus projects transcendent formism.

An interesting projection which seems to be not captured by any world hypothesis is the strong implication that only some answers are correct. This is seen in the teacher's twice rejecting the answer "They all have eyes". The teacher, apart from saying, "a lot of animals do", gives no explanation for this. Saying "a lot of animals do" avoids the issue because it can be said also of other characteristics which he did accept, such as "lay eggs," and "have scales." By giving no reasons for his rejection of the one offering, the teacher has left his students intellectually dependent (Munby, 1980) on his authority. Such a projection via the manner of teaching seems not to be captured by world hypotheses which focus on the content of what is taught.

PHYSICS TRANSCRIPTS

TRANSCRIPT 041-2a

(Discussion is on the apparent position of a penny in water, and the apparent position of the sun in the sky.)
TEACHER: The dotted lines, if you draw them back . . . from the refracted ray, they will show you where the penny is . . . . (Teacher draws diagram.) . . . . Here's your coin. Here is the water surface. A ray of light comes here like this and because it comes from a thick into a thinner medium - that's the normal - it bends away from the normal like that and the light appears to be coming from here. So the (farther?) penny appears to be here. So what you look at is a penny that's not there, but appears to be over here. And also, because of the way the angles of light show, the penny might be a little higher than what it

appears to be over here , . . . (Draws again.) So this is your image. This is your penny. And this, of course, is all water.

(Later in the lesson.)

(The class is dealing with the question whether the sun appears to be higher or lower than it really is in the sky. The teacher directs their attention to a diagram which shows the answer.)

TEACHER: It appears to be higher as the diagram there shows you. Now, notice one thing. The atmosphere above us is not that large, I think at the most 30 miles or so. Beyond 30 miles, the air is so thin, there's really nothing there. You're just talking about empty space. In other words, no density at all. There's nothing there. Nothing. And when you're going from no meduim at all to something that's thicker, namely the atmosphere, the light rays are going to bend. And this bending, or refraction, gives you a false idea of where the sun is. So, because of refraction, the sun appears to be higher than where it actually is. If we look at the sun on that diagram - they've got a little, tiny sun because it's far away-- and here's the earth, here's the atmosphere, which means there's air there - if there's nothing, no difference, light rays will go straight from your eye, straight like that. Right? But here you're going from a . . . . less dense medium . . . into a - see here's our normal - it's not going to continue that way, is it?

STUDENTS: It's going to refract. It's going to go down.

TEACHER: It's going to refract from less dense to more dense towards the normal, like that. So here light rays actually refract. So they appear to be coming from up here. In other words, instead of lower, they appear to be higher. Okay? That diagram explains it quite well if you look at it closely.

ANALYSIS. The analysis of this section focusses on the word "appears". In both cases the object appears to be in one place, but is actually in another. This apparent contradiction is resolved by integration into the theory of refraction. It is to be noted that the contradiction with respect

to the sun's position(s) only arose after the theory of refraction had been established. However, that contradiction is presented to the students in the same way as the contradiction with respect to the position(s) of objects in water. In both cases the contradiction is posed, and then resolved by the theory of refraction. Thus organicism is projected.

TRANSCRIPT 061-2a

TEACHER: (In response to a student's answer.) It was . . . vibrating. Right. Okay. So the (tuning)fork (. . ? . .) vibration. You can see the motion, you can probably hear it a little bit, and you could also feel it. Okay. Number two: it says, "touch your throat while you hum." And you have - what is apparently happening as you hum? Dave?
STUDENT: Your throat vibrates?
TEACHER: Right. Okay. So your vocal cords also vibrate. So these's a constant type of thing there - -similar situations.
(A little later.)
TEACHER: Okay. What do we need to produce a sound?
STUDENT: (Answer indistinguishable.)
TEACHER: Right. We need some sort of motion, something that is - how do you describe it . . something that is -
STUDENT: Vibrating?
TEACHER: Vibrating. Right. Okay. And you'll need a certain amount of force to get it vibrating.

ANALYSIS. In the first section of the transcript, the tuning fork and the vocal cords are treated as examples of the same class of things: "There's a constant type of thing there --similar situations." This description of similarity is accepted literally. Therefore this section projects formism. In the second section, sound, a secondary quality, is explain-

ed as the product of some thing that is moving (vibrating), a primary category of mechanism, which is projected here.

TRANSCRIPT 064-3a

TEACHER: What I'm going to do is just quickly give you a few explanations about Ohm's Law. Just recall we did that experiment the other day using the overhead projector. We took three different resistances, then we applied different voltages to these resistors, and we measured the current. Then you drew a graph. Your graph turned out to be a straight line which showed you that there is a relationship between the resistance, the voltage and the current. By considering the slope of the line . . (?) . . you saw that the voltage equals the I X R. That's what you noticed. This relationship is called Ohm's Law. It may be expressed in three different ways. That's one of them . . . . Now you need that information to calculate whatever quantity you're trying to find. If you know two quantities, you can always find the third one. You can always do that. Now in order to apply Ohm's Law, you have to know a little bit about resistances in series and resistances in parallel. . . . . (The teacher develops the idea of resistances in series and draws a circuit diagram showing three resistances in series and the voltage source. He analyzes the currents and voltages in the circuits using Ohm's Law.)

ANALYSIS. The treatment of laws is the focus of the analysis of this section, because it is different from the treatment of laws in some other sections, e.g. transcript 011-3a. In that segment, the law is obeyed; however that seems not to be the case here. The attempt to quantify current, and to explain it in terms of primary invisible particles, electrons (later in the lesson) strongly suggests mechanism. The treatment of Ohm's law fits this world hypothesis. The law seems

to be treated as a "descriptive law", not as a prescriptive law (which would be formistic). Therefore this section is judged to project mechanism.

TRANSCRIPT 071-3a

(The discussion is about recrystallization from a hot solution, and solubility.)
TEACHER: So when it cooled off, because the particles of water moved closer together, there wasn't as much room for the sugar particles between any more. And so some of them - what do we call it when they become sugar particles again? Do any of you know the term we use?
STUDENT: Crystallize?
TEACHER: Yeh. They crystallize again.
(Later in the lesson, discussing another question.)
TEACHER: When they tell us the solubilitv as so many grams per litre, then we know that's what we could add to produce a saturated solution. That's the most that could be dissolved. Now, why did they say at twenty degrees celsius? Ricky? Why did they tell us twenty degrees celsius?
STUDENT: . . .say it's zero right . . . ice . .
TEACHER: Okay. Well, what if it was five degrees celsius?
STUDENT: You wouldn't get as much . . . because the spaces between the particles are smaller.
TEACHER: Yeh. So you wouldn't be able to dissolve as much. That's right. It's important. The temperature in (. .? . .) of the spacing of those particles, the warmer it is, the more you can dissolve and so in order to make a statement like this (about solubility), you've got to state the temperature or it's no good, because it might be 150 grams at ten degrees celsius, 200, 225 at twenty five degrees celsius and so on. So it's only a good statement if it includes the temperature. Because we've learned now temperature changes the picture.

ANALYSIS. This segment projects mechanism in a number of ways. In the first place, the recrystallization upon cooling,

and the effect of temperature on solubility, are both explained in terms of the spacing (location) of discrete particles. Secondly, the solubility is expressed quantitatively and stating the temperature in quantitative terms is taken to be an important issue.

CHEMISTRY TRANSCRIPTS

TRANSCRIPT 021-2a

(Teacher has just given back an exam on chemical names and formulae.)

TEACHER: These were the type of mistakes that I noticed. Various ones like this. When you're writing your radicals, a lot of you were making the second letter a small letter when it should have been a capital. Some of you when you were writing names and formulae like, say something like this - sodium chloride - then you would put a one after it or some thing to indicate the number of, in your case, springs (?) of phosphorus that you were dealing with. Ah . . a chemist doesn't need to be told this. He knows it . . . for chloride. There's only a few elements for which you've got to say what the combining power is. And those are the ones like - that have only one combining power - ah, copper and iron -copper, only one or two, iron being two or three. You have to say with a Roman numeral what you're dealing with there. So a lot of you lost marks when you left out Roman numerals. A lot of you lost marks when you put capitals where they shouldn't be. A lot of you were putting in brackets where they shouldn't be. For instance, um, example sodium phosphate - Na_3PO_4. And because there's only one phosphate here, some of you were still busy putting in brackets . . . . Now, that's not strictly speaking incorrect in the sense that it's wrong, like it's understandable. But the point is, there's a series of conventions or rules that you're just going to have to learn. Okay? It's like, um, logic in the English language. You know, it don't make a whole lot of sense, but I'm afraid it's just a state of affairs that you're just going to know the rules.

(Later in the lesson)

TEACHER: Describe the two liquids, then weigh them. Okay, so your first observation before the experiment should include a description of the two liquids before they're mixed and the weight . . . . And then you simply turn it upside down and mix it . . . . look at it for a while and describe what happens and weigh it again . . . . In grade 8 we would have said, yes it's a chemical reaction. In grade 9, we're going to actually describe it in a chemical sentence called an equation. And in grade 10, you're going to go one step beyond that and describe exactly what's happening to the atoms in the sentence - what do they do to each other. So it's just one step each year.

ANALYSIS. In the first part of the transcript the issue is using exactly the right ways to write chemical names and formulae. The "right" ways are right by "convention". The "rules" may not make sense but they must be observed. They are made by chemists but do not reveal reality. These are all best accounted for by the categories of contextualism, which denies absolute structures or inherent order, and holds that human constructs are merely useful instruments; they do not reveal reality.

The last part of the transcript projects mechanism because of the implication that greater understanding of chemical reactions comes through quantification and explanation in terms of discrete particles.

TRANSCRIPT 063-2c

TEACHER: Now why is propane easier to liquefy than methane? And you know, this is in a sense a guess,

but you've got a description of the molecule here. What's different about the propane molecule?

STUDENT: There's more hydrogen.

TEACHER: More hydrogen, more . . .

STUDENT: Carbon?

TEACHER: More carbon. It's a bigger molecule, in a sense a more sluggish molecule. It's easier to turn into a liquid . . . . .(A little later.) . . . Well, acetylene, you see, well it's a different type. C_2H_2. And it's more difficult to liquify than this, becuuse it's a smaller molecule . . . (A little later.) That's butane. And being one step bigger than a propane, it's much more easy to liquefy and so for lighters, for example, you can have little cylinders of butane and they don't have to be really tremendously able to withstand high pressure. So that's why you'd use butane instead of propane . . . . (A little later.) The next step I should mention, is, now maybe the C_8, maybe some seven carbons, maybe some nine, here's what a typical gasoline molecule looks like. (On the board he writes C_8H_{18})) And now the molecules are big enough so that you don't really need pressure to liquefy them. At normal temperatures, that's a liquid. Now . . . as you start going up, I think when you get somewhere between fifteen and twenty carbon atoms, you're now talking about your lubricating oils - it not only is a liquid, but the liquid is getting thicker - the bigger, and I think by the time you get to about thirty carbon atoms, you're talking about your greases. And at about forty carbon atoms, paraffin wax. Paraffin wax comes from petroleum. They're all hydrocarbons, they all burn, they all produce carbon dioxide and water. Per kilogram of material they're all equal in fuel value. . . . . So it doesn't matter what - which of those materials, of those materials in petroleum you burn, it's the same type of thing and you notice they're all compounds of carbon and hydrogen.

ANALYSIS. This section is judged to project mechanism and formism. Mechanism is projected because observable

properties, such as ease of liquefaction and state, are explained in terms of the properties of invisible discrete particles. Formism is projected because the hydrocarbons are all classed together because of similar properties such as "they all burn, they all produce carbon dioxide and water . . . . they're all equal in fuel value." Differences between members are explained as differences along a continuum of the same property.

TRANSCRIPT 063-3a

TEACHER: What's it (i.e. an upcoming test) going to be on? Well, it would be mostly on the balancing of reactions and the writing of reactions too. You know, it's one thing to be able to sit down like, you know, those questions on that sheet - you know, all right, I have to put this number here, that number there, to make it balance, but as far as people concerned, that's not a very practical thing, where you go and read, say, an encyclopedia article describing a certain reaction and you sort of in your mind, you know, think of it in terms of symbols and formulas. In other word,, take a word description of the reaction and get it into a chemical reaction. And then of course, balance it. That I think is just a little bit more practical. You know, you've all read about chemical reactions somewhere along the line. And, you know, probably it's been a bunch of words to you. You have no idea of what elements a e involved - yes, in a sense you do, but not until you actually write it down in terms of symbols and formulas do you really see what's going on.

ANALYSIS. This section projects mechanism for the same reason as section 012-2a, but here the projection is stronger. Explaining things in the categories of mechanism (quantity, discrete particles) gives real

understanding; "Not until you actually write it down in terms of symbols and formulas do you really see what's going on." It must be remembered that this was in the context of balancing numbers of atoms in equations.

EARTH SCIENCE TRANSCRIPT

TRANSCRIPT 015-1a

TEACHER: Examples of interdependence.
(Teacher is eliciting responses from the students.)
STUDENT: . . . .if there's no glaciers, then you can't have glacier runoff . . . .
TEACHER: That wouldn't have been one that I'd pick, but it sounds reasonable. Who's got another one? (Various remarks.)
TEACHER: In between the fish and, and the river, there's some interconnection there?
STUDENT: Trees and plants depend on water in its many forms for nutrition, and they build dikes for further vegetation . . .
TEACHER: Trees and plants depend upon the river, then you've got trees and plants falling down; they die-ing and collecting as he suggested - (Student: . . . birds . . . etc. . . .) Do you see what they're saying? Where you get - ah - the plants depend on the water, the water, the plants - ever been in a forest when it's really warm out?
STUDENTS: Yeh, yeh.
TEACHER: What does it feel like?
STUDENTS: Warm. Damp and musty. Cold.
TEACHER: Very damp. So the forest is giving off water. Where does that water go?
STUDENTS: . . . up in the sky . . . make more clouds and then rain . . .(etc.) . .
TEACHER: Is there a connection there?
STUDENT: Yeah.
TEACHER: Sure there is . . . . . So you've got the birds, you've got homes for plants and animals there and so on and so forth. All kinds of things.

ANALYSIS. This whole section focusses on interdependence. The focus is on interdependences with water, since the context is a discussion on a question assigned after watching a film "The Ways of Water". The teacher draws in, through suggesting or accepting students' responses, also trees and plants, fish, the air, the water cycle, birds and animals; "All kinds of things" are suggested as being in a state of mutual interdependence. Interdependence is best accounted for by the categories of organicism, in which each part of nature is a fragment which interdependencies (nexuses) connect into an integrated whole.

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