The Relationship of Teacher's Philosophical Perspectives to Planning Curriculum

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Background

For the past two years I have endeavoured to implement a new model for the teaching and learning of science within the school in which I am presently placed. The model is based on constructivist theory and has been discussed at some length in a previous paper (van Oostveen 1994). A copy of the model has been included in Appendix A. The focus of this discussion is not the model but the group of teachers in the science department with whom I have been interacting in the day-to-day planning of the curriculum that puts this model into action. The strategy that has been the basis of most of this work is one of consensual team development. The interaction of the entire group with the model is of interest to me, not merely as a means to advance the ideas proposed in the model but also to give some insight to the ways in which teachers react to new curricular situations. This paper deals with the philosophical perspectives of the teachers involved. Understanding the philosophical positions of the teachers hopefully leads to a better understanding of the way in which these teachers in particular, and perhaps most teachers in general, interact with one another. In addition, understanding these philosophical positions will provide insight into why these professionals react the way they do to curricular initiatives of this type.

The secondary school and the science department of which I am presently a member are in some ways unique. The school has been set up as an alternative program within the public school system in Ontario. The dress code, which calls for a uniform, and the timetable are perhaps the most visible of the contrasts between this school and other public high schools. However, the significant differences are not as easy to identify. They, in my opinion, have more to do with the establishment of a climate that is dedicated to fostering a community that consists of students, teachers and administration. For the teachers there is an atmosphere that is supportive of risk taking. With this support and for reasons which deal with the institution of <u>The Common Curriculum</u> (1993), it was decided to attempt to rewrite the Grade 9 science curriculum for use in our school.

Although hierarchical curricular reviews are not usually effective due to the differences between the curriculum as intended by those writing it and the actual curriculum as delivered by those in the classroom (Fensham 1992, Roberts 1988, Prophet 1990, Rowell and Gaskell 1987, Hodson 1986), it was decided by the heads of the department that we would attempt to rewrite the curriculum based on the model that I was concurrently developing with another group. The school development team consists of the teachers that are assigned to teach Grade 9 science during the semester. The number of teachers varies from semester to semester, however the number of team members generally ranges between five and seven members. The team meets on a weekly basis. The agenda for the meetings generally deals with personal reflections of week gone by, setting long term (semester) aims and short term objectives. The use of the term objectives is reserved for providing a sense of direction for the events of the coming week and not in establishing traditional educational objectives.

The majority of meeting time is spent in this last area. Specific, detailed plans are established for the coming week. The plans are to be used by each individual teacher in their own classrooms. While a definite sense of uniformity is to be maintained between all of the classes, for the purpose of providing all Grade 9 science students in this school with similar learning experiences, there is room for teachers to capitalize on their own strengths and interests by modifying, to some extent, the methodology by which the materials are presented to their classes. The emphasis, however, is to gain consensus among the teachers involved during the planning meetings and thereby to allow each teacher to provide input and direction to the methodology used. In practice there is no difference between the intended methodology for each of the classes. There are small differences that occur between classes in terms of the emphases that are actually delivered. Examples of some of the lesson plans that were developed in this way have been provided in Appendix B.

Rationale for Study

The study that this paper is based on was derived for a number of reasons. They include the following:

1. a need to, at least informally, determine some of the philosophical perspectives of the teachers involved in the development of this educational program and so to account for some of the reactions that were occurring,
2. a need to continue an on-going evaluation of the program under development,
3. a need to determine the "stages of concern" and the "levels of use" of the participating teachers regarding the program under development, and
4. a desire to determine the perspectives of the teachers with regards to the nature of science.

Each of these reasons offers a slightly different aspect to the study and also accounts, at least partially, for the methodology that was used to gather the data.

Informally, I noticed differences between teachers in classroom delivery and I also found that when the team would meet for its regular planning sessions there would be significant differences in the way in which members would approach the task. While this should not have been surprising, it did lead me to question the source of these differences. I had my own theories as to why the people involved would react in the ways that they exhibited, however there was a definite lack of definitive, less-subjective data to support my observations and hypotheses. This study is partially an attempt to provide some concrete evidence for philosophical differences between teachers and how these differences affect the way in which curriculum development is approached by different teachers.

Perhaps the best way to illustrate this point would be to provide a brief description of how a normal weekly team meeting proceeds so that the approaches used by the team members and the difficulties that arise as a result become clear. The meetings are chaired by one of the team members assigned on a rotational basis. The first order of business is generally a sharing of the perceptions of each teacher regarding the classroom events of the preceding week. This usually becomes, more or less, a debriefing session. Suggestions are presented for changes to be entertained for the next semester. Discussion of these items is limited but is somewhat dependent on the topic. Quite often wording changes to the materials are dealt with. This portion of the meeting is quite amicable in nature with a fair amount of collaborative work. Eventually the topic will turn to the plans for the near future and specifically the week to come. Here the discussion tends to become more confrontational. Typically the interactions will revolve around which pedagogical strategy should be used to best present the concept which must be taught. One group (or an individual teacher) will contend that the concept must be open-ended and rely much more on teacher facilitation of small groups. The other side of the argument sides with control of the classroom environment and being able to direct what the students are going to be doing on a very strict scale. The picture that the reader might get from this would be of two different classrooms. One classroom has the teacher in the 'traditional' stance, at the chalkboard or overhead while explaining some concept or entering into question and answer session with some students in the class while the others listened or wrote notes. The other classroom would have small student groups working (in controlled pandemonium) with the teacher circulating between the groups assisting as required. These contrasting pictures can be augmented when the type of activity is taken into account. The emphasis in the first class would typically centre around 'core concepts in science' (read content). The second classroom would be working on the testing of ideas by way of open-ended investigations. The model is referred to primarily by the one group only. Quite often during the course of the meeting all members will have an opportunity to add to the discussion. At some point consensus will be reached. However this becomes a laborious process when most issues must be dealt with in this manner. Hopefully this provides a framework within which the rest of the discussion will revolve.

The rationale for this study also includes a number of other concepts. Since the model of the learning of science that is being used is quite new, it would be appropriate to evaluate it as thoroughly as possible following Habermaas' notion of emancipatory evaluation (Hodson 1994a). Evaluating the curriculum in this light should involve not only determining the influences that shape the curriculum but also to place oneself in the role of as many of the individuals who are involved in the curriculum and to look at the various aspects of the curriculum from these perspectives. The evaluation models of other authors have had their influences on the survey that was developed for this study. These authors include Parlett and Hamilton (1976), Kemmis (1974) and Stake (1978). The major points involved in the models listed above are briefly described by Brady (1992).

James (1981) describes a model that can be used to "establish the extent" to which developed programs have been implemented and how the model can be used to "gain understanding of the implementation process." The concepts of stages of concern and levels of use seemed to be useful for the purpose of grouping the responses of the teachers that are involved.

It occurred to me that some of the reactions to the constructivist model that I was noting could have another underlying cause besides variances in teaching philosophies. The responses could derive from different underlying perspectives regarding the nature of science. The positions regarding the nature of science are directly related to individual teachers' philosophy, they can have great impact on how the teacher interacts with students and therefore on the delivery of the 'actual' curriculum (the materials and activities used in the classroom) and on the 'attained' curriculum (curriculum which occurs in the heads of participants) as compared to the 'intended' curriculum (the intended plans) (Hodson, 1994b).

Methodology of Study

The results of this study are based on two surveys that were combined. A sample of the questions used and their present format is provided in Appendix C. The 'Nature of Science Education Survey' questions are based on questions that were developed by L. Bencze. Originally these questions were used during an interview session with subjects of an investigation that provided evidence to be used in a doctoral thesis on a related topic (Bencze, 1994). The ideas in the original questions were modified, reformatted and arranged in ways that were more appropriate to a survey that would be completed by the teachers involved individually, at their own pace and without the artificial stress of an interview. The teachers were asked to fill out the questions to the best of their ability within a reasonable time frame.

It is recognized that the questions were interpreted by each of the teachers in light of their own experiences and frame of reference, however, since I was interested in this (their interpretations) I did not think that this was going to cause many difficulties, except perhaps in the interpretation of the responses. I am convinced that an interview would probably provide more appropriate data but this would also be provided at the cost of time and the possibility of increased teacher discomfort at being scrutinized in this way. Some indication of this type of reaction occurred even in response to this survey.

The 'Nature of Science' survey is a modification of the original work of Nott and Wellington (1993). Essentially the statements developed by Nott and Wellington have been modified very little. The use of this survey was primarily to provide some data regarding the perspectives of the teachers with regard to the nature of science. This survey seemed appropriate to those ends.

All of the teachers in the department were given an opportunity to respond to the survey. Some of the teachers who answered the survey were not directly involved in the Grade 9 program. In fact a student teacher who was assigned to the department in the time period during which the survey was distributed also responded to it. The responses of these teachers indicated a certain difficulty in answering some of the questions in the 'Nature of Science Education Survey' primarily because, I think, they were not familiar with the terminology that was used. All of the teachers who are directly involved in the Grade 9 program responded to all facets of the survey.

The results were compiled and studied to determine if the responses could be categorized. There was no systematic plan of attack used in the analysis of the results. Basically I looked for evidence which would lead me to an understanding of the teachers perspectives and philosophies.

Preliminary Results of Survey

The data seemed at first glance to be strikingly diverse. It was obvious that many of the teachers interpreted the questions that were asked of them in a variety of ways. However I found that there are a number of responses which were very closely related and that any variation in these responses had to do with the interests and level of understanding of the teacher. I have attempted to concentrate on the responses of the teachers that are actively involved in the Grade 9 science program. At times I will refer to the responses from the other teachers in the department who are not involved in the Grade 9 program. These responses point out interesting dichotomies and similarities in thinking between the two groups.

It may be interesting to study the responses of individual teachers to each of the questions that were asked. In the interests of time, space and to relieve tedium however, I will limit myself to describing the results by attempting to group them by the content of the original question. The original survey data is available for review if desired.

Science education, according to the teachers involved in the study, has a variety of aims. These aims range from training in thinking and logic to pursuing a career in science. The range of responses was diverse but there seemed to be a consensus in three areas. These were that science education provides: training in problem solving, an awareness and appreciation of nature and an enrichment of life through the development of curiosity and thinking skills. Two members of the team put a fair amount of stress on the development of a knowledge base as an aim of science education. Grouping these answers provides an initial inkling of concern regarding the "content" versus "process" discussion with most of the teachers in the department squarely in the "process" camp.

None of the teachers involved in this survey found any problems in attempting to help students to distinguish between "observations" and "inferences" much to my chagrin since I have discussed this many times with the group as a whole and with many of the teachers individually. One of the teachers (whom I will call James, a new member to the group this semester) even responded with a resounding "yes" to this question of helping students to distinguish between the two terms and then proceeded to say "even though you (the author) don't think (that) there are any." One teacher, (whom I will refer to as Grace, a one of the original members of the team) suggested that "observations are frequently over laid with false assumptions ... which can obscure interesting phenomenon and blind students to other observations."

The responses to the question dealing with professional development was also interesting, more so because of what was not shared than because of what was. Most of the replies suggested that professional development occurred at sessions set aside specifically for professional development. The most consistent response regarding the usefulness of these sessions was that the material suffered from a lack of time, specificity, follow-up and applicability. One of the teachers, Michael (a team member for the second semester), found the level of professional development from these sessions satisfactory. The idea that I found most interesting is that only one of the teachers even associated the team work with professional development. This teacher, Grace, responded saying "I've been involved with three different groups of teachers that have created their own professional development in 'leading edge' areas. Each experience has been very rewarding."

A number of the respondents expressed concern that teachers in general, tend to place a lot of pressure on themselves in an attempt to meet perceived expectations from various groups such as the Ministry of Education, parents, and industry. One teacher (not presently on the Grade 9 development team) expressed this directly saying "Many groups such as parents, industry, and government all seem to want certain things done but this doesn't really seem to translate into <u>direct</u> pressure on the teachers. Teachers probably put the greatest pressure on themselves by trying to address all these <u>apparent</u> pressures." (Emphases his.) Other teachers perceived direct pressure from the above mentioned groups and from other sources. The most pertinent comment regarding this pressure came from several teachers who complained that this pressure lead to a concentration of emphasis on knowledge type objectives. The teachers stated that these types of objectives were important but probably not of lasting value to the students especially in a course such as the Grade 9 program discussed here. One teacher confessed that he felt no pressure at all. This teacher did not indicate whether he just disregarded any outside pressure or as he states, in response to another question, that his ideas in this area were "well entrenched" indicating that he wouldn't change his behaviour and views regardless of the pressure exerted by others.

Turning to questions that dealt specifically with the model in question, most of the teachers understood 'open-ended' investigations to imply that the outcomes of the practical or theoretical work could not be predicted by the investigator/student or the teacher. One teacher expanded this definition to include investigation which were not limited in materials, scope or phenomena. One teacher understood these types of investigations to be a "never-ending, continuous process of knowledge/model building." This last observation is fairly nebulous and can be interpreted in any of a number of ways. This teacher, whom I will name Sue for the purposes of this discussion, had views which were quite often at variance with the remainder of the group and at times was the source of friction during planning meetings. I will return to the views of the teacher frequently throughout this discussion.

The responses to the questions concerning benefits of 'open-ended scientific investigations' were varied. Paraphrasing the comments they included all of the following: allows students to understand that all knowledge is 'relative' (changing and changeable), allows for selections for investigations based on student interest, allowing for "creative construction by student to meet cognitive needs" (read provides motivation), allows for practice of problem solving skills, exercising of judgement and achieving self-confidence, and finally, involves the students in 'doing' science. A majority of the teachers had attempted some form of open-ended investigations previously, primarily in "Independent Study" components of existing courses. Some teachers had not attempted this type of study at all previous to this course.

The teachers had no problems in identifying difficulties with using 'open-ended' investigations in the course. These ranged from concerns regarding the perceived lack of sophisticated equipment to support the program to initial student resistance due to the lack of a 'correct' answer. Many of the teachers expressed reservations based on traditional difficulties such as the equipment concern mentioned above or a lack of time. Sue suggested that the "students were not 'trained' in a method of attack" and therefore "required more and more details" while carrying out this type of task.

Sue returned to this topic when asked about the kinds of things that might motivate student to do these investigations. She mentioned the need for "a structured method of attack, that is, show them 'how to.'" Other teachers alluded to the need for the teacher to trigger the curiosity of the students. A teacher, whom I will call Roger, expanded on this, saying that these types of investigations "require an attitude change starting in earlier grades where curiosity, etc. is not cut off by the need to acquire marks. It needs a change in our whole approach to education and evaluation." Several other teachers suggested that interest on the part of the students in the topic and the freedom to choose the topic of investigation were also important for the purpose of motivation.

The model incorporates the use of non-traditional investigational styles in an attempt to show students their applicability in the study of particular phenomena. When the teachers were questioned regarding the perceived value of these types of investigations the responses were interesting. Sue found that a correlational study is merely "one" (emphasis hers) method of investigation leading to some understanding of the relationship between variables. Grace expressed that as yet in the program too much time has been spent on "soft science topics" using this method of study and that the team has yet to "link this method to issues of wider concern." Roger suggested that these studies are valid since "the student can see the trend or lack of (a trend) when the data is not 'perfect.'"

Innovations (the creation of a process or a technology to solve a practical 'real-world' problem) garnered a variety of discussion. Michael, another teacher in the team for a second semester, agreed that students should engage in innovations since "technological literacy as well as investigational processes should be taught." James and Sue chose not to respond to this question. Roger states that this type of investigation must be done within context since "inventing for the sake of doing it has no long term value." Grace thinks that "this activity has great appeal to students and is an important/marketable skill." She also states that she "believes that we don't do this area justice."

Most of the teachers who are directly involved in the Grade 9 program development team are not prepared to comment on the impact that the program has had on the students' perceptions of their image of scientists, their understanding of scientist's methodologies of working, and their views of the nature of teaching. Sue, James and Roger state that the program has very little effect on the students regarding these matters or that it is too early to tell. Michael suggests that the students have shown some change in that no longer do they view scientists as "guys in white coats." Only Grace feels that "many students feel that most people are able to 'put on the white coat.'" However she also feels that the students have not assimilated the methods that scientists use (as taught in this program) into their own thought and action structures. All of the teachers feel that the students have not been aware of a change in the ways in which the teacher has interacted with them in this program.

While the above implies that the program seems to be having little effect on the perceptions of students, at least according to this small sampling of teachers, the reflections of the teachers on their own understanding of the same topics examined in the above paragraph is telling. One teacher, Michael, left this question blank. Two teachers, Sue and James, said that no changes have occurred. These reactions can be interpreted in several ways. One interpretation might be that the teachers are not prepared to change their stance in regards to these ideas. One teacher, James, states that very distinctly. Another interpretation might be that the teachers were not aware of having any change occur. One other interpretation might be that the teachers have changed their views in the recent past as a result of other experiences and then this program would merely reinforce these existing ideas. Grace offered that she has "learned much about how teachers (emphasis hers) change."

The most positive sign of change in teacher perception might be found in the number of teachers who are prepared to incorporate some of the concepts and practices used in one program into another. Here there are signs that changes may be occurring in the thoughts of the teachers involved. Grace states that she is "beginning to create a Grade 10 course which will bridge from the constructivist theory ... to the 'fact' laden senior courses." Michael wishes to incorporate "constructivist methodology" in sections of biology programs which would "permit" it. I read this to mean that the theory should be 'fit' to the course. James and Roger refuse to commit themselves, saying that "it is too early to tell." Sue bluntly states that she has "no plans for the future."

One of the main aims of the model, as designed by the original team, was to foster intellectual independence. When asked about this aspect of the program the teachers responded with a qualified "maybe." Most teachers were willing to concede that some students seemed to become less dependent. (How this was evaluated, I am not sure.) Weaker students were noted as requiring a lot of support in this program. The most impressive comment came from Michael who stated that the program causes a "shift from whole class (remediation) to (individual) remedial mentoring." Perhaps this is as it should be since this mode of teacher-student interaction may be more effective.

Philosophical Perspectives of Teachers

It is difficult to generalize from the data that has been collected. This is mainly due to the wide variations that appear in the responses and the small number of responses that I am able to study. However there are a few appropriate statements that can be made.

Half of the teachers in the team seem to view science education as an opportunity to expose students to a large selection of scientific topics or what is generally regarded as 'content.' This can be related to the difficulties that these teachers perceive to be prevalent with open-ended investigations including, not only a lack of time and equipment but also difficulties in getting unmotivated students to start these types of activities. This focus does not seem to be found in the teacher's personal views of the nature of science, as I will show later, but may be attributed to difficulties with the techniques involved in the pedagogy itself. Perhaps the most relevant statement that can be made here is that there is resistance on the part of these teachers merely because they are not used to teaching in this style. It seems relevant to add that these teachers are also the teachers who stated that they have no plans to incorporate constructivist theory (and this model of teaching science) into other courses that they teach or that they intend to introduce it only where it fits the existing content.

The other teachers in the group seem to realize that the existing teaching methodologies could not meet the requirements of the Ministry of Education as stated in The Common Curriculum for a destreamed situation. Some other method had to be tried and this model seemed to have some benefits. This type of attitude can be seen in response such as "incorporating open-endedness into a well crafted curriculum is an additional method of providing the student opportunities to practice and refine problem solving skills, to exercise judgement and to achieve self-confidence." Roger talks about open-ended scientific investigations allow students "to be involved in 'doing' science rather than just verifying concepts and ideas." This type of an attitude can also be seen in the plans that these people have to incorporate constructivist theory into their teaching in the future.

Evaluation of Program

This portion of this report will be brief since this study is part of an on-going evaluation of the program. The teaching team that is responsible for the development of this program continues to refine the methodology used, the content chosen for consideration, the support strategies to be implemented and how the evaluation should fit into all of the above. Every semester brings new teachers into the program along with differing numbers of clientele. New situations demand new responses. The team attempts to address these as they arise by modifying the curriculum as the need appears.

Perhaps a few comments are relevant regarding the approach that is being used by the team. First the curriculum is being developed by a team. While this makes the process long and laborious, it also allows the team to work collaboratively. There is much in the way of constructive- (and at times not-so-constructive) criticism that occurs within the group but the teachers are not isolated. Secondly, the team takes time away from other activities, many of them personal, since the meetings occur outside of regularly scheduled class-time. The team members ought to be congratulated for their dedication. Thirdly, the structure of the science department in this school has augmented the climate required for changes of the type reported upon here to occur. The department heads are truly attempting to create, as far as they are able, an environment that allows teachers to design curricula that are for the benefit of the students. The initiatives here, while under the guidance of the department heads, are not set up at the express wishes (read coercion) of the department heads. There is an honest attempt to supersede the politics and develop a program that respects the contributions of each team member. Fourthly, assessment is being radically changed for the science students in this school. The emphasis is on 'authentic assessment' as this is perceived in the school. The program not only incorporates most of the concepts set out in constructivist theory but also makes provision for different learning styles but providing different forms of assessment and a matching of evaluation with the activities that occur in the program. The types of assessments include hands-on, collaborative exams, projects that incorporate peer and self-evaluation, and a fair smattering of non-objective, anecdotal type evaluation. These points attempt to address some of the concerns that were raised by Hodson (1994b) as areas that need to be changed in schools.

Stages of Concern and Levels of Use of Teachers

The Stages of Concern and Levels of Use concepts introduced in the Concerns Based Adoption Model (James 1981) is of some use in understanding the concerns of and the views of the teachers involved. I have attempted to fit each of the teachers who are directly involved in the development of the program into the categories that are described in this model. This will be a subjective baseline against which to measure the changes that may be observed in these teachers as the program progresses. The positioning of each teacher is very much subject to the perceptions of the author based on the survey results and personal interactions.

From her reactions to the development process, I would place Sue in the Management stage of concern. She has been involved in the team for two semesters and she continually expresses her concerns regarding the task of conveying information and processes called for in the model with much forcefulness. She makes statements such as the model "increases dependence on the direction of the teacher (for the) "how" of the course (the process must by explained by the teacher)." This concern with management is also reflected in the Level of Use which seems most appropriate for her behaviour. Sue focusses most of her 'effort on the short-term, day-to-day use of the program.' This places her in the Mechanical Use and Routing levels. There is some evidence that some of her concerns occasionally bring her into the Refinement level.

Michael exhibits many of the same tendencies as Sue if not as strenuously. He writes of students having difficulties "due to multiple process flaws" indicating that in his mind, perhaps, there is a 'correct' way for the student to investigate his concepts.

James communicates different worries from the two teachers listed above. He exhibits a general awareness of the program and is uncertain about his role with respect to the program. He tends to defer to the rest of the group when decisions need to be made. This would place him in the Personal Stage of Concern. Since he recently (this semester only) became involved in the program he shows many of the characteristics of the Orientation Level of Use.

Roger and Grace can be placed in other stages and levels. This may be due to having to listen to the author for extended periods of time (approximately two years). The level of awareness of these individuals is much higher than the other teachers involved in the development process. Much of the time and emphasis of these teachers is spent in the Collaboration and Refocussing Stages. This again is illustrated by the plans Grace has for continuing course development using constructivist theory. Both of these individuals play a large role in leading the weekly meetings and in directing the activity of the individuals on the team. The Levels of Use characteristics exhibited most frequently by these individuals lie in the areas of Integration and Renewal.

Perspectives Regarding the Nature of Science

One of the most interesting aspects of this study lies in the apparent discrepancies that exist between the tendencies that appear in pedagogy styles used by individuals and their communicated beliefs with regard to the nature of science. Hodson (1993) states that quite often there is this mis-match between the rhetoric that a teacher preaches and the practice that the same teacher engages in. This was also the case in this study.

I found that the nature of science philosophy of Sue was most at odds with her most often chosen pedagogic style. The survey which was used identified her as a Relativist, believing that 'theory will depend on the norms and rationality of the social group considering it' (Nott and Wellington, 1993), and as a Contextualist, holding that the 'truth of scientific knowledge and processes is interdependent with the culture in which the scientists live' (Nott and Wellington, 1993). This is not exhibited in her emphasis in directing the students quite rigidly while they are attempting to use an open-ended type of investigation. Equally interesting is that the same survey shows that Sue is also strongly oriented towards Content as opposed to Process. This is what would be expected in terms of her behaviour in the development team and in the classroom.

While there are other apparent mismatches in the data, none were as striking as the example related above. Most of the teachers expressed an inclination towards Relativism but these were slight, if exhibited at all. Most also expressed that they were neutral on the Inductivist/Deductivist scale which differentiates between the primary methods used to determine the 'secrets of nature.' The methodology that most used, in their other courses, tends to be inductivist to a large extent. This is probably not fair to some individuals who do use both modes.

A match did appear with most teachers in terms of their orientation towards Process over Content. This is supported by the views communicated repeatedly by many of these individuals regarding how important it was to assist the students to work through the investigational part of the model.

Conclusion and Implications

It needs to be stated that the results of this study are very preliminary. It is very much a time dependent type of analysis also in that the teachers may respond in very different ways to the same questions at other times. It is also expected that the teachers will change their philosophies in response to their experiences as I expect I will. I hope to be able to add many other components to this study to increase its depth and to provide extra evidence as the development of the program upon which this study is based continues. Much of the data from the teachers who are not directly involved in the program has been ignored in the interests of focussing on the teachers who are part of the team. As these and other teachers become part of the team, as it is the desire of the department heads to involve as many of the department members as possible, the team complexion will change. These changes will have to be analyzed. The role of the author, who is also an active member of the development team, has not been discussed. This could add a completely different dimension to the issues at hand since the author has had a distinct influence on the initiation of the program. Changes in the underlying philosophy and perspectives of the teachers need to be noted as a means of determining the validity of this method of curriculum development.

In the meantime there is one aspect of this study that is of particular concern. The students may receive mixed and confusing messages from their teachers with regards to the nature of science due to the mismatch of philosophy and practice that teachers themselves exhibit inside the classroom and outside. As the teachers involved in the development of this program progress in their understanding of the model and determine the best ways to translate this understanding into practice it is hoped that this confusion will recede both for the teacher and the student. Recognition of the problem on the part of all involved would be a start towards developing a solution.

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Appendix A

Appendix B

Transition Years Course Outline
Unit 2

SNC 1W Teacher Lesson Plan Sequence Semester 2

Day 1, 2 (Mon., Tues. Mar. 21, 22)

Enlightening Experience (all of class time)
-14 stations spread over 2 days
-arrange students into groups of 4's to ensure that all students will have access to the observations from each station

K- to modify existing plan to incorporate new ideas for stations. All team members are required to accumulate necessary equipment on Tues. Mar. 8 so that stations may efficiently set up on Mar. 21.

Instructions to the students should include:

Let's investigate light. The first step in this is to find out what you know about light. Go around to the stations and do the following:

1. Manipulate the equipment.
2. At each station, write down, in your journal, your observations regarding light and its behaviour when you manipulate the equipment.
3. Make sure that you also record your explanation for each observation.
4. Each station observation\explanation should start on a new page.
5. Finish up your explanations at home.

Day 3
(Wed.
Mar. 23)

Nature of "Facts"

-have students take notes about the definition of "Facts"

-def'n

-statements become facts when all observers agree that they should be
-reaching agreement is difficult because everyone approaches new situations with different past experiences

Activity to Illustrate Reaching Consensus

-choose 3 students (volunteers) to go into the hall and wait there until they are individually brought in blindfolded. Each will be given a different part of an object (slide projector, vacuum cleaner, microprojector, coffee maker, etc.) to feel and describe
-record observations on the board
-when observations are noted have student return to hall (can't talk)
-students should not view object until all have given their observations
-class may not participate except to observe what is occurring
-when all 3 have finished observations remove object
-bring all 3 students back to class and ask them to decide what kind of object that they were observing (come to a consensus)
-bring out object
-have 3 students make visual observations
-has the "fact" changed? how? why?

Additional def'n statement to be added after activity

-a "fact" is a "fact" until observations which don't agree cause doubt and people begin to rethink their ideas

Back-up Idea

-show the students the optical illusions and have students describe what they see on the overhead and then compare their observations with a partner

C please provide master copies of these so that overheads can be made by each teacher.

Film re. Light

-view the film with the students and have them complete the handout re. the film

K will book the films to be used here and will disseminate the handout to be used for this activity

HomeWork

-have students complete the handout particularly the text references re. terms for tomorrow

Day 4-6 (Thurs. Mar. 24 to Mon. Mar. 28)

Providing Alternatives

-teacher directed conceptual material based on outcomes re. light

1. What is light? Nature of..
   - A energy relationship
   - B sources of...
   - C composition of ...
   - D types of materials (opaque, transparent, translucent)
   - E rectilinear propagation
2. Interactions with Materials
   - A reflection
   - B refraction
   - C dispersion
3. Applications
   - A Mirrors
   - B Lenses
   - C Prisms

> A will decide the subset of content and materials to be used out of the list found to the left. She will also prepare any required materials for the students and teachers based on materials produced last semester.

Day 7 (Tues. Mar. 29)

How to do an Experiment

-explain to students how to set up an experiment and the requirements for good experimental design
-use overhead sheets -**"Considerations common to all investigations-Experiments"**

Examples of Good Experimental Design

-using examples on handout **"Typical Designs for Experimentation"** -demonstrate example #3
-discuss with students how the requirements mentioned above are actually planned into the design using the examples

> R will provide the overhead sheets and all other supporting materials for this period

Day 8 (Wed. Mar. 30)

Designing Experiment Activity

-use the handout **"Designing Experiments"** and have students work through the activity to give them some practice at designing a relevant experiment
-work with students individually as they work through the activity
-review the worksheet with the students when finished

> R will provide the handout needed for this activity

Experimental Design

-have students design their own experiment by using the ½ page technique again in their journal
-all students should hand in a list of equipment needed by the end of this class (any equipment that cannot be provided by the school will have to be provided by the students)
-deal with students individually and in small groups

> K will request Special Ed. help for Mar. 30, Apr. 5 & 6.

Day 9 (Thurs. Mar. 31)

Test #2

-topics to include correlational studied, nature of facts, light, experimental design

> Volunteers are required to write two versions of this test.

Day 10 (Tues. Apr. 5)

Experimentation

R will provide copies of an appropriate log sheet for the students to use for each day of the

-check with students who claim that they are ready to set up equipment or who need further resources or whatever else
-those students who are ready can start carrying out their plan
-require the students to constantly update the teacher
-teacher must be in facilitation mode (wander through the class room and help with individuals and small groups)
-students to use log sheets to keep track of their work
-log sheets are to be used

Day 11 (Wed. Apr. 6)

Log Sheet Check

-use the existing homework check scheme to check for the completion of the log sheets

Packaging of Experiment

-students should be given the class to complete their work in packaging the report on their experiment (***for portfolio***)
-report to be handed in at the end of the class

Debriefing of Experiment

-review the ideas that were being tested in the correlational study ie. changes of state, particle theory, structure of correlational studies, etc.

Day 12 (Thurs. Apr. 7)

Preparation for Lab Practical Exam

-take 20 min. at the beginning of the class to run through expectations for the exam
-work through an example experiment with the class (similar to what they would experience during the exam)

Completion of Experiment Report

-students to use remaining time to finish their reports
-report due to be handed in at the end of the class

Day 13 (Fri. Apr. 8)

Lab Practical Exam Day 1

-students to go through one station (experiment or correlational study; Part A or B) (30 min.) and to complete the reading assignment previously distributed (Part C) (15 min.)

Day 14 (Mon. Apr. 11)

Lab Practical Exam Day 2

-students are to complete the second of the stations (30 min.)and complete Part D when the choice of which part is to be evaluated has been made (15 min.)

Day 15 (Tues. Apr. 12)

Wrap-up Day

A number of possible modes of operation can occur on this day. They can include:
-completion of **one** outstanding piece of work by students designated by the teacher and handed in at the end of the class
-updating of portfolio materials (see list below)
-reflective writing based on page 27 in the planner on a lined piece of paper (if students do not work on this during the class time on this day, this assignment is to be completed during the exam days and handed in completed on Apr. 18 by all students)

☞ **List of Materials that should be included in the Portfolio**

-Independent Study - CricketGraph
-Test #2 (Light, etc.)
-Correlational Study Report
-Rating the News Assignment
-Reflective Writing regarding light (not done by all classes)
-Experiment Report (when evaluated and returned)

Appendix C

Nature of Science Education Survey

The following are questions that deal with how you view the nature of science, the part that you believe science education plays in the shaping of science and specifically how the model that is currently in use in the Grade 9 program meets your requirements for an authentic science program. The questions that follow are adapted from Bencze, L., (1994) Open-ended Scientific Investigations (working title), Unpublished, (part of a Ph.D Thesis Project). The results of this survey are intended to establish a working basis for determining the belief structures of the members of the Grade 9 Destreamed team. They will not be distributed beyond the scope of a paper that I hope to submit to the professor of a course in my Masters program. Please answer the questions as fully as possible in the space available. If there is not enough space, I invite you to attach additional pages as necessary.

1. What do you perceive to be some of the benefits of science education?

2. What is your understanding of the meaning of the phrase "open-ended" scientific investigations?

3. What do you perceive to be the benefits of students doing open-ended scientific investigations, if any?

4. To what extent have you used open-ended scientific investigations in other courses that you have taught?

5. What kinds of problems have you encountered in getting students to do open-ended scientific investigations?

6. What kinds of things might motivate students to do open-ended scientific investigations?

7. What do you think about the correlational study as a way of understanding more about cause-effect relationships?

8. Do you believe that students of science should engage in projects in which the purpose is to invent solutions to practical problems which people perceive?

9. Do you help students to distinguish between "observations" and "inferences"?

10. What do you think of the professional development in which you have been involved since you left teacher's college?

11. From your experience in the Grade 9 program as conceived now, how have students'
    A images of scientists changed?
    B understanding of how scientists come to know things changed?
    C understanding of teaching changed?

12. How has your understanding of the things listed in #11 above changed as a result of this program?

13. To what extent, if at all, does the program lessen the student's intellectual dependence on the teacher?

14. What are your plans for the future regarding the use of constructivist theory in planning the curriculum of the courses that you will teach?

15. To what extent, do you believe, are secondary school teachers of science under pressure from others to perform/exercise their jobs in a certain way?

Please complete the attached Nature of Science Survey. This will give me additional information regarding your views of the nature of science. The survey is, I believe, quite self-explanatory. I have attached the category definitions for your own benefit. Thank you for your assistance in filling out all of this information for me. I deeply appreciate it.

Nature of Science Survey

The survey below is intended to identify your present position with respect to several aspects of the nature of the practices of science and technology.

Read each of the statements below carefully, and assign each statement a number between -5 and +5, where "-5" means that you strongly disagree with the statement, while "+5" means that you strongly agree with the statement. If you assign the statement a "0", that means that you believe that it is equally agreeable and disagreeable.

	Statements	[Rating]
1.	The results that pupils get from their experiments are as valid as anybody else's. [PR]	
2.	Science is essentially a masculine area of work. [DC]	
3.	Science facts are what scientists agree that they are. [DC, PR]	
4.	Scientists expect to eventually fully reveal reality. [RI}	
5.	Scientists have no idea of the outcome of an experiment before they do it. [ID]	
6.	Scientific research is economically and politically determined. [DC]	
7.	Science education should be more about the learning of scientific processes than the learning of scientific laws, theories and inventions. [CP]	
8.	The processes of science are divorced from moral and ethical considerations. [DC}	
9.	The most valuable part of a science education is what remains after the laws, theories and inventions have been forgotten. [CP]	
10.	Scientific theories are valid if they work. [RI]	
11.	Science proceeds by drawing generalizable conclusions [laws and theories] from the available data. [ID}	
12.	Most widely-accepted theories are very close to the truth. [PR, RI]	
13.	Human emotions play no part in the creation of scientific knowledge. [DC]	
14.	Scientific theories usually describe a real external world which is independent of human perception. [PR, RI]	
15.	A good solid grounding in basic scientific laws, theories and inventions is essential before young scientists (e.g. students) can go on to make discoveries of their own. [CP]	
16.	Scientific theories have changed over time simply because experimental techniques and devices have improved. [PR, DC]	
17.	The methods of science can be transferred from one scientific investigation to another. [CP}	
18.	In practice, choices between competing theories are made purely on the basis of experimental results. [DC, PR]	
19.	Scientific theories are as much a result of imagination and intuition as inference (concluding) from experimental results. [ID]	
20.	Scientific knowledge deserves higher status than other kinds of knowledge. [PR]	
21.	There are certain physical events in the universe which science can never explain. [PR, RI]	
22.	Scientific knowledge is morally neutral; only the application of the knowledge is ethically determined. [DC}	
23.	All scientific experiments and observations are determined by existing theories. [ID]	
24.	Science is essentially characterized by the methods and processes it uses. [CP]	

Nature of Science Profile

Based on the ratings assigned to each statement, fill in the spaces opposite the corresponding number of the statement, and change the sign of the rating as indicated (i.e. multiply by the factor indicated to the right of each value.

PR Scale	ID Scale	DC Scale	CP Scale	RI Scale
1. ___ X +1 = ____	5. ___ X -1 = ____	2. ___ X +1 = ____	7. ___ X +1 = ____	10. ___ X +1 = ____
3. ___ X +1 = ____	11. ___ X -1 = ____	3. ___ X +1 = ____	9. ___ X +1 = ____	21. ___ X -1 = ____
21. ___ X +1 = ____	19. ___ X +1 = ____	6. ___ X +1 = ____	17. ___ X +1 = ____	4. ___ X -1 = ____
12. ___ X -1 = ____	23. ___ X -1 = ____	8. ___ X -1 = ____	24. ___ X -1 = ____	12. ___ X -1 = ____
14. ___ X -1 = ____	===================	13. ___ X -1 = ____	15. ___ X -1 = ____	14. ___ X -1 = ____
16. ___ X -1 = ____	TOTAL = _____	16. ___ X -1 = ____	===================	===================
18. ___ X -1 = ____		18. ___ X -1 = ____	TOTAL = _____	TOTAL = _____
20. ___ X -1 = ____		22. ___ X -1 = ____		
===================		===================		
TOTAL = _____		TOTAL = _____		

After the total in each column above is calculated, place a dot on the scale of the appropriate continua below. To determine the person's Nature of Science Profile, connect the dots with a smooth curve.

Nature of Science Profile for ____________________

Date ____________________

Positivist	PR	Relativist
-40 -36 -32 -28 -24 -20 -16 -12 -08 -04	00	+04 +08 +12 +16 +20 +24 +28 +32 +36 +40
Inductivist	ID	Deductivist
-20 -18 -16 -14 -12 -10 -08 -04 -02	00	+02 +04 +08 +10 +12 +14 +16 +18 +20
De-contextualist	DC	Contextualist
-40 -36 -32 -28 -24 -20 -16 -12 -08 -04	00	+04 +08 +12 +16 +20 +24 +28 +32 +36 +40
Content	CD	Process
-25 -24 -22 -20 -18 -16 -14 -12 -10 -08 -06 -04 -02	00	+02 +04 +06 +08 +10 +12 +14 +16 +18 +20 +22 +24 +25
Realist	RI	Instrumentalist
-25 -24 -22 -20 -18 -16 -14 -12 -10 -08 -06 -04 -02	00	+02 +04 +06 +08 +10 +12 +14 +16 +18 +20 +22 +24 +25

This profile can be used in longitudinal studies in order to monitor the effects of a particular programme on a person's perception of the nature of science.

Nature of Science Profile

Explanation of Terms

1. Positivism vs. Relativism

   Positivists believe strongly that scientific knowledge is more 'valid' than other forms of knowledge. The laws and theories generated by experiments are our descriptions of patterns we seed in a real, external objective world. To the positivist, science is the primary source of truth. Positivism recognize\s empirical facts and observed phenomena as the raw material of science. The scientist's job is to establish the objective relationships between the laws governing the facts and observables. Positivism rejects inquiry into underlying causes and ultimate origins.

   Relativists deny that things are true or false solely based on an independent reality. The 'truth' of theory will depend on the norms and rationality of the social group considering it as well as the experimental techniques used to test it. Judgments as to the truth of scientific theories will vary from individual to individual and from one culture to another; ie. truth is relative, not absolute.

2. Inductivism vs. Deductivism

   Inductivists believe that the scientist's job is the interrogation of Nature. By observing many particular instances, one is able to infer from the particular to the general and then determine the underlying laws and theories. According to inductivism, scientists generalize from a set of observations to a universal law 'inductively', Scientific knowledge is built by induction from a secure set of observations.

   Deductivists believe that scientists proceed by testing ideas produced by the logical consequences of current theories or of their bold imaginative ideas. According to deductivism (or 'hypothetico-deductivism') scientific reasoning consists of the forming of hypotheses which are not established by the empirical data but may be suggested by them. Science then proceeds by testing the observable consequences of these hypotheses; i.e. observations are directed or led by hypotheses - they are theory-laden.

3. De-contextualism vs. Contextualism

   Decontextualists hold the view that scientific knowledge is independent of its cultural location and sociological structure.

   Contextualists hold the view that the truth of scientific knowledge and processes is interdependent with the culture in which the scientists live and which it takes place.

4. Content vs. Process Orientations

   Content-oriented persons think that science is characterized by the facts and ideas it has and that the essential part of science education is the acquisition and mastery of this 'body of knowledge'.

   Process-oriented individuals see science as a characteristic set of identifiable methods/processes. The learning of these is the essential part of science education.

5. Realists vs. Instrumentalists

   Realists believe that scientific theories are statements about a world that exists in space and time independent of the scientists' perceptions. Correct theories describe things which are really there, independent of the scientist; e.g. atoms.

   Instrumentalists believe that scientific theories and ideas are fine if they work, that is, they allow correct predictors to be made. They are instruments which we can use but they say nothing about an independent reality or their own truth.