# Learners – teachers – researchers: consistency in implementing conceptual change

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## Introduction

In the large volume of recent research which aims to explore student views of and beliefs about natural phenomena, there are important differences and communalities. The differences in basic purpose between numbers of researchers are shown to some extent by the variety of terminology which has been used to describe these views/beliefs- naive theories, naive science, alternative conceptions, children's science, alternative frameworks, misconceptions, intuitive preconceptions, intuitive science, and so on. The most striking communality to be found in the work is a consistent belief that this research can and should influence the practice of science education. How this influence should affect science teachers, learners, curriculum is another area of difference, but belief that there are practical implications is common.

This paper considers issues associated with the influence on science education of research on student views of the world. In particular, we consider the implications of this work for pre- and in-service education and for the fostering of approaches which support these implications for teacher education. The paper argues the need for consistency in considering the promotion of conceptual change in students and teachers (and, in some circumstances, researchers) and elaborates the parallels between the consequences of such consistency and the literature on educational change. As the first step in the analysis, we consider issues arising from research on student views and conceptual change.

## Student views and conceptual change

The studies of student views which have become so common in the last decade are consistent with a constructivist perspective on learning. In summary, individuals generate their own meaning from sensory inputs.

This generation of idiosyncratic meaning is argued either implicitly or explicitly by a number of models of learning: Wittrock's generative learning model (e.g. Wittrock, 1974; Osborne & Wittrock, 1985); Piaget's processes of assimilation and accommodation (e.g. Gruber & Vonèche, 1982); Ausubel's conceptualizations of subsumption, logical and psychological meaning, and assimilation (e.g. Ausubel & Robinson, 1969). In each of these views of learning, the linking of new concepts, ideas, experiences with existing knowledge and beliefs is seen to be a requirement for understanding the new material. As a consequence, the nature of the meaning attached to the new material by the individual will depend on both the nature of the individual's existing knowledge and beliefs and the particular links the individual makes between existing and new.

Given this position, it is no surprise to find that individuals interpret a particular experience in different ways. One important and striking example of this involves observation. Not only does the nature of the observation made of a specific phenomenon often vary according to the existing knoledge/beliefs of the observer (Driver, 1983; Gunstone & Champagne, in press), the legitimacy of an observation can be denied because of its conflict with existing ideas. Examples of both of these responses are given by Gunstone and White (1981). In that study of understanding of physics concepts among a large number of first year university students, considerable use was made of a bicycle wheel arranged as a pulley. A bucket of sand and block of wood of equal weight were placed at rest on the wheel. In one circumstance, students were asked to predict what would happen when a small spoon of sand was added to the bucket. After predictions were made, the sand was added and observations asked for. The large majority observed no movement. Some predicted that the bucket would move a small distance down and then come to rest again. Of these, a number observed a small movement and a few reported that the movement was so slight it could not be observed. The more extreme case of denial of legitimacy of observation occured in another use of the wheel. Again a bucket of sand and the block of wood were at rest at the same level. The wood was pulled down about half a metre and held at this new position. Predictions about what would happen when the block was released were given. About half the predictions involved movement (commonly back to the initial position, occasionally further down). The observation of no movement on release was essentially uniform throughout the group. However, when asked to reconcile any differences between prediction and observation, a substantial majority did so by denying the observation (e.g. would have moved if there was less friction, held too long at the new position, distortion in the plastic bucket due to the weight of sand affected the situation).

Given the extent to which existing knowledge and beliefs influence the meaning an individual takes from a situation, then it is logically consistent to argue the changing of student beliefs involves some form of personal restructuring. Many writers have so argued, particularly in areas where there is conflict between the existing knowledge/beliefs of students and the interpretations of science. This view of conceptual change has been described in a number of ways. One of particular influence on our thinking has been advanced by Posner, Strike, Hewson & Gertzog (1982), Hewson (1981). They argue that for a student to embrace a new conceptualization which is in conflict with an existing conceptualization, becoming dissatisfied with the existing conceptualization is only the first step. Beyond this, the new conceptualization must itself be intelligible, plausible and fruitful. In our experience, fruitfulness is very often both the most significant and most difficult of these. By fruitfulness, Hewson (1981) means that the learner perceives some advantage to him or her in adopting the new conceptualization. There is a further issue associated with the idea of fruitfulness which is touched on by Hewson. White (1985) has recently argued the considerable significance of context in educational research. Fruitfulness is contextual - what is fruitful for one is not for another; what is fruitful on a physics exam may not be in interpreting the world. Examples of this are given by Gunstone, White and Fensham (1986).

Intelligible, plausible, fruitful have been important notions in the development of our ideas. We can also describe these perspectives on conceptual change in somewhat more colloquial terms "if the change doesn't make sense to students, it won't happen"; "change is more likely when students feel the problem is significant to them"; "change produces anxiety in students". These three descriptions have been deliberately chosen for reasons to which we return below.

Teacher change and the use of student views in classrooms

The preceding perspectives on change of beliefs/concepts etc. in students have important parallels in the consideration of the teacher change associated with attempts to use this research to influence classrooms. We support this assertion via an analysis of our own work in conceptual change with students, and in the use of these ideas in the education of teachers. There are four discrete strands to this work, all of significance in the development of the ideas argued here.

(i) Formal research exploring conceptual change: Our early work was with young high school students (Gunstone, Champagne & Klopfer, 1981). That work pointed to the difficulty of achieving genuine conceptual change - the exchange of an existing set of knowledge/beliefs for a new set of knowledge/beliefs. We achieved with those students what appeared to be an understanding of a Newtonian perspective about force and motion, but their pre-instructional non-Newtonian perspectives were also retained.

More recent research has explored conceptual change in physics among pre-service trainee high school science teachers (Champagne, Gunstone & Klopfer, 1985). In that study (conducted in 1982) the subjects were all graduates with majors in biology or chemistry who were undertaking a one year teacher training course. There was strong evidence of genuine conceptual change (i.e. exchange of existing conceptualizations for new conceptualizations) in this case. One of the important differences between this case and the previous research with junior high school students was the much greater fruitfulness in the task for the trainee teachers. The trainees were less than six months away from the possibility of teaching these concepts themselves. Hence the advantages to them of the intellectual struggle needed to understand what was being tackled was much greater than the advantages perceived by the earlier high school students.

One of the sources of evidence of conceptusal change in the trainee teachers also pointed to another aspect of fruitfulness for them. That source was the written comments made by the trainees at the end of each instructional session conducted during the research. Comments such as 'some people fight hard not to change pre-conceived ideas' and 'the effort to hold out when I'm wrong is very draining' (Champagne, Gunstone & Klopfer, 1985) showed that an understanding of their own learning was an important contribution to the conceptual change experienced by the trainees. This led us to see another aspect of fruitfulness for these people. Understanding their own learning had advantages to them because of their involvement in trying to come to grips with the learning of others, in trying to understand classrooms and teaching, etc. As a consequence we have changed aspects of our pre-service teaching of these trainees (see section iii below)

(ii) <u>Exploring constructivist perspectives in day-by-day teaching</u>: In 1984 the authors taught a year 7 science class in a high school for the whole school year. Of the many concextual issues involved in a complete understanding of this experience, two are paramount. Firstly, in the state of Victoria individual schools have total responsibility for curriculum in years 7 to 10 of our 6 year high schools. So complete is this responsibility that the school itself even has to make the initial decision as to whether or not science (for example) has a place in the curriculum of each of these years. Secondly, our arrangement with the school involved taking the class as normal teachers. That is we followed the year 7 curriculum which the school had structured. This curriculum in fact was no more than a set of broad topic outlines. Given this, and the fact that students were not required to have a science text book, we were able to explore the robustness in real classrooms of a number of our ideas about learning while remaining quite faithful to the school's intentions and our roles as 'normal teachers'.

Our analyses of this experience immediately after its completion have appeared elsewhere (Northfield & Gunstone, 1985). Here we consider a few of the issues which arose which had considerable impact on our thinking about the translation of constructivist perspectives into day-by-day teaching.

One of the more major difficulties we encountered involved an issue whose importance and difficulty we had previously thought we understood. In terms of the descriptors used earlier in this paper, that issue was fruitfulness. It became clear to us that often the only form of fruitfulness we could provide to students was achievement on tests. For example, one of our agendas associated with constructivist perspectives involved a heavy emphasis on the occurrence in the students' normal (non-classroom) environment of the science phenomena being considered in the classroom. We believed that the forming of the links between the science room and the outside world was one significant aspect of moving to an acceptance of the science interpretation of the phenomenon. Many students did little more than tolerate this as some form of teacher idiosyncracy. Discussing ways in which this linking would help an understanding was of no value until we included on class tests questions such as "What are two ways in which (e.g. magnets) are used in your home?" It seems obvious to us that such a limited view of fruitfulness will not greatly assist conceptual change.

A somewhat more positive outcome came from our use of a "thinking book" with students. Each class member had a separate exercise book in which we frequently asked them to write answers to questions which we presented as having no correct answer. Tasks which were motivated by our constructivist perspectives included questions such as "For the way you think about the idea of 'animal', is this (picture of e.g. child, tree, worm, etc.) an animal? Write a sentence explaining your answer"; "Here are a number of answers to (some task) given by other students. Write down what you think about each answer"; "Why do we sometimes only see half the moon?" and so on. We found this to be a valuable way to quickly gain information about the range of ideas held by students in the class. On some occasions these ideas were then used in class discussions. At the beginning of the year we tried to make the use of the thinking book quite clear. This we reinforced by choosing early tasks which emphasized the lack of a single answer. However we did not go beyond this in terms of any explanation of our purpose in using the thinking book. At the end of the school year we asked students to write answers to a number of questions. One asked for their perception of why we had a thinking book. Of the 19 respondents, 17 clearly indicated a good understanding of our purpose. However, this does not give evidence of the extent to which the book was found fruitful by students. Some hint of fruitfulness was found in the reasons given by the 15 who indicated that they found the thinking book enjoyable: "hard to express some things to the whole class"; "could write what we thought and still be correct"; "helped me understand".

A few students totally rejected our notions of teaching and learning. One quite happily informed us after about six weeks of the year that she hated science because we "tried to make her think". Subsequent discussion made it clear that she would have much preferred us to dictate notes, as this would have minimized the impact of school on her life. The experiences we were structuring in the classroom were barely intelligible to her, and certainly not plausible or fruitful.

In considering our experiences in both teaching and research aimed at fostering conceptual change, we have arrived at a set of possible outcomes which can result from such teaching. These are shown in table 1. The five possible outcomes are illustrated with examples taken

Table 1: Possible outcomes of a teaching episode which presents a new view of a phenomenon.

| Possible outcomes | Examples for a teaching episode aimed at developing an understanding of the concept of normal reaction (in particular, the existence of this force on a book on a table). |
|---|---|
| - The new view is simply rejected | "How could a table push up on something? It would just fly up in the air." |
| - The new view is misinterpreted to fit in with, or even support, present views. | "That's obvious. it's just the same as the way gravity pushes up on us so we won't fall into the earth." |
| - The new view is accepted, but in isolation to present views. | "O.K., but why don't we fall through this floor we're standing on?" |
| - The new view is accepted but leads to confusion. | "I can see that, but where does the force come from? There doesn't seem to be any way the table can push up." |
| - The new view is accepted and forms a coherent view of the world. | "There must be the same sort of distortion in the floor, and that's why we have our chemical balances on a weighing table that's not joined to the floor." |

from our teaching of trainee teachers. These outcomes are very similar to those described by Osborne and Freyberg (1985). We consider them further below.

As well as attempting to apply constructivist perspectives to the learning of school students, we have also been concerned with their application in teacher education.

(iii) Translating research findings into pre-service teacher training courses: Teacher training which accommodates a constructivist perspective on learning has previously been described, for pre-service courses at Monash University (Northfield & Gunstone, 1983) and for an in-service program for U.S. mathematics teachers (Mundy, Waxman & Confrey, 1984). It is important to note that by a constructivist perspective we mean an approach which assumes the existence of ideas of teaching and learning in the minds of the trainees before they begin. We do not mean the telling of trainees about this view of children's learning. We illustrate this distinction with some examples taken from the first two weeks of the 1986 one year science teacher training course for graduates at Monash University.

In the first week one of the four seminar groups in the course undertook a "Draw-a-Teacher" exercise (Harmin & Gregory, 1974). This commonly used task requires individuals to draw a picture of a teacher teaching a class. Of the 18 students in the group, 16 drew a teacher at the front of a room, pointing at a blackboard, with children in neat rows. When asked to describe in one word what the teacher was doing, all 16 used "showing" or "telling" or "demonstrating". The purpose of the exercise is to bring into the open existing conceptions of teaching and the teacher's role. This purpose also underlies an exercise in which students, among other things, write down three adjectives to describe the best teacher they recall, and three to describe the worst. Table 2 shows the more common responses for the 70 students in the course.

Table 2: Common descriptors of "best" and "worst" teachers given by graduate trainee teachers in week 1 of their course.

| Best | Worst |
|---|---|
| sympathetic, helpful, creative, honest, funny, humorous, enthusiastic, patient, relaxed, understanding, knowledgeable, friendly, encouraging, in-control, interesting, committed, hard-working, confident, competent, punctual, prepared, organized, shos respect, approachable, clear voice, demanding. | nervous, boring, arrogant vindictive, old, narrow minded, impatient, impersonal, unapproachable, lazy, monotonous, indecisive, uninvolved, sarcastic, displays favouritism, belittling, lack of control, poor appearance, non-directional, disorganized, unprepared. |

The list is not surprising. However it is not used to form a lecture on characteristics of good teachers. Rather its value is in elaborating the nature and range of existing conceptualizations, as a first step in the process of understanding and evaluating these conceptualizations.

In the second week of the course trainees begin a serious consideration of learning. This is done through having them learn something, and then reflect on that learning. The learning task involves physics, and is an adaption of the approaches used in the research on conceptual change already described (Champagne, Gunstone & Klopfer, 1985). The content and teaching approach of the two hour session are broadly based on the work of Minstrell (1982), with additions. Participants then react in writing in terms of "What have you learned about your own learning?"; "What have you learned about the learning of others?"; "What connections were there between your learning or lack of learning and the teaching approach adopted?". A brief selection of these comments is given in table 3.

In many ways this selection does not do full justice to the range of and insight contained in the comments, but does indicate that considerable variety and perception is to be found. Comments point to unexpected issues, such as language and learning (see comment A8, table 3), perceptions of aspects of the nature of science (C8), the strain for some in seeking understanding (B6), and even an elaboration of an issue we have long regarded as a fundamental problem for students in a teacher training course (C9).

A wider selection of comments than is given in table 3 has been duplicated and given back to the trainees. Only the compiler of the selection is aware of the identity of the author of individual comments. This selection will be used as resource material in discussion groups through the course; e.g. consider comments C1, C3, C4, C5 and C7 in terms of how and why such differences in reaction arise. (We would add that it is important to be most careful with extreme comments such as C6. Considerable mutual trust is needed in a group containing the anonymous author of this comment before any attempt to discuss it can be 'non-harmful' to the author).

(iv) Considering in-service courses from a constructivist perspective: Our preferred mode for in-service work involves participants meeting with us, returning to their classroom to explore ideas, meeting with us again in one or two weeks time to discuss the use of the ideas and to extend the ideas, returning to classroom, and so on. Experiences from this and other forms of in-service lead us to the outline of possible outcomes shown in table 4. For each possible outcome of an in-service episode, examples are given. The similarities between

Table 3: Selection of responses from trainee teachers to questions about learning after a real learning experience.

A. Reactions about own learning:

A1 "Often hindered by previous "truths"
A2 "Difficult to accept another notion .... when I already have a notion of my own".
A3 "I need to question phenomena more, but find if I do question I become confused."
A4 "... frustrating, I wanted to move on while others needed more time."
A5 "I need to be challenged to grasp an idea myself rather than have it handed to me."
A6 "Something that seemed obvious I couldn't explain and this annoyed me."
A7 "I need to be assured that my original, perhaps simple, ideas were not 'Obvious' or 'Stupid'. If that assurance is given, then I feel more confident in looking at the problem more deeply."
A8 "Necessary that I understand concepts in every day language before I can even begin to introduce scientific language."

B. Reactions aabout other's learning:

B1 "Some pick up obscure ideas from what the teacher said."
B2 "People often need to see something to be convinced of it, but even then they may not be convinced because of their prior beliefs."
B3 "Others can learn by ... having to explain things."
B4 "Observations are dependent on past experiences."
B5 "Influenced by those around them. Few are willing to stand out if they have contrary views to rest of class."
B6 "I was too worried (or involved) about myself to look about."

C. Reactions about teaching approach and learning or lack of learning:

C1 "Learning is 'quite often' associated with the learner actually thinking. This is encouraged in such a teaching approach."
C2 "Using practical things (chairs, books, etc.) made it easy to see the problem but difficult to get a solution."
C3 "The teaching was almost intimidating, and caused us to always be defensive and not free with our comments. The topic was almost child-like but the learning and explaining of the topic was very slow."
C4 ".... it contributed largely to my understanding of something I'd already learned."
C5 "Teaching approach involving questioning and discussion generally contributes to learning but can be confusing when different ideas come out and you are not sure on the concepts."
C6 In the context of explaining why the teaching made no contribution to this respondent's learning" ... I only listen for the facts and disregard what I hear in between."
C7 "Great way to teach concepts."
C8 "..... excellent way of relating science (i.e. complex ideas) with everyday concepts (i.e. book, chair .....)."
C9 "Do we think as students or teachers?"

Table 4: Possible outcomes of an in-service training guide.

| Possible outcomes | Examples for an episode in which Minstrell's (1982) discussion based strategies for teaching the concept of normal reaction are presented. |
| --- | --- |
| - The new strategy is simply rejected. | "It is more efficient and more accurate to tell the students the explanation." |
| - The new strategy is misinterpreted to fit in with, or even support, an existing strategy. | That's just what I do when I'm getting students to work out the correct conclusion for a laboratory experiment. There's nothing new in that at all." |
| - The new strategy is accepted, but the teacher cannot apply the theory to other topics. | "That's a better way to teach normal reaction than the way I use. Pity I can't try it till next year. I've just taught normal reaction. |
| - The new strategy is accepted, but leads to confusion. | "I tried it and this student said 'but isn't mass a force in the oppositie direction' and I didn't know what to do. So I've stopped using discussions." |
| - The new strategy is accepted, and forms part of a coherent long-term personal philosophy of teaching. | "I set test papers with questions based on these ideas." |

tables 1 and 4 are most significant, and emphasize the importance of adopting a consistent view of conceptual change with both students and teachers. This similarity can be taken further, as shown in table 5. This table adds a further five broad issue to the one already elaborated in tables 1 and 4.

Tabel 5: Consistency in conceptual change with students and teachers

| How can we effect ...... | |
|---|---|
| ... a concept shift in students | ... a strategy shift in teachers ? |
| We need to identify, and be familiar with, students' present views. | We need to assess teachers' present strenghths and find out what really happens in classrooms |
| We need to design curricula which build on, rather than ignore, students' views. | The new strategies we propose should utilize and build on existing teacher strengths, extending their present skills rather than undermining them |
| We must provide challenges and encouragement for students to change their views, and, in particular, help them see reasons for changing views. | We must assess which aspects of the content and format of a new strategy will be likely to appeal to teachers. (Intelligibility? Plausibility? Fruitfulness? Feasibility?) |
| We must be sensitive to the possible outcomes of a teaching episode:<br>- the new view is simply rejected<br>- the new view is misinterpreted to fit in with, or even support, present views.<br>- the new view is accepted, but in isolation from present views.<br>- the new view is accepted, but leads to confusion.<br>- the new view is accepted, and forms a coherent view of the world. | We must be sensitibe to the possible outcomes of an inservice training episode:<br>- the new strategy is simply rejected<br>- the new strategy is misinterpreted to fit in with, or even support, an existing strategy.<br>- the new strategy is accepted, but the teacher cannot apply the theory to other topics.<br>- the new strategy is accepted, but leads to confusion.<br>- the new strategy is accepted, and forms part of a coherent long-term personal philosophy of teaching. |
| We must support students' attempts to rethink their ideas. | We must seek out feed-back and provide follow-up activities. |
| We must help students understand the ways in which all the above affect their learning. | We must help teachers understand the ways in which all the above influence their perceptions of an innovation. |

As with students, the individual's perception of fruitfulness is of crucial influence on a teacher being prepared to make fundamental changes. We tend to underestimate the energy, time and emotion required from teachers when making educational changes. However, for teachers, a further aspect of their context is vital, especially at the in-service level. Teachers will inevitably (and quite properly) place the change for which they are being prepared against all of the other demands on their time and thought. If they are to accept the implications for their time and thought of the change, the change must have some priority for them. We term this feasibility - that is, do the efforts involved in understanding and the possible outcomes of adopting the change appear to be feasible to the teacher?

The perspectives outlined in tables 4 and 5 are of course totally concomitant with current views of the characteristics of educational innovation and change - educational change is a long term process requiring time and support for participants as they develop personal meaning for the ideas (Fullan, 1982). This literature has been a most significant influence on the development of the ideas we have advanced above. So strong is the consistency between these views from the change/innovation work and our arguments about conceptual change that the three colloquial descriptions of student conceptual change given earlier in the paper are direct paraphrases of common statements about educational change. Stated as they appear in the innovation/change literature, they are 'if the change doesn't make sense to teachers, it won't happen'; 'change is more likely when teachers feel the problem is significant to them'; 'change produces anxiety in teachers'. In each case, only one change has been made from the statements earlier in the paper - 'teacher' replaces 'student'. Although these perceptives are widely accepted in the literature, it is unfortunately true that they are often neglected in practice.

A substantial Victorian high school initiated project, with assistance from staff at Monash University, illustrates a number of these points. In that project, teachers from a number of discipline areas are all attempting to adopt constructivist perspectives and to make the development of metacognition in their students a prime objective (Mitchell & Baird, 1985). As the project developed, the issue of feasibility became of overriding importance to the teachers. They soon had to face the long-term commitment required to understand the learning issues involved and to explore teaching implications, and to then consider the importance of the project to them in terms of the other demands of their professional life. One intriguing outcome of this process was the extent to which the innovation/change perspectives described above became obvious to the teachers (Baird & Mitchell, in press).

Apart from this single school project, an increasing number of teachers are making these same broad commitments and finding time to participate in networks. These teachers will add to the growing knowledge of teaching/learning approaches, but it will always be necessary for teachers to develop a personal meaning for the learning ideas underpinning these approaches.

## Researchers and conceptual change

The consistency we argue above can profitably be taken one step further. The current wave of research on students' personal understandings of the world is not the first such wave. Very similar research was undertaken in the 1930's and early 1940's in both Europe and North America (see Oakes, 1947, for a review). There are a number of possible explanations for the failure of this earlier wave of research to influence school science, or even survive as acceptable research. One can be derived from considerations of conditions needed for conceptual change. For example, the nature and origin of the school science curriculum in the 1930's was such that the issues addressed by this research did not inform problems of importance to science teachers, curriculum writers. etc. Nor did the research inform problems of importance to more general perspectives on learning research at the time. That is, neither science teachers nor educational psychologists felt any 'ownership' of the problems considered by the research. Our present research shows this to be no longer universally true. Much more significant however is the present understanding of the nature of educational change and conditions likely to foster such change. The present wave of research is taking place in a context of considerable harmony between ideas of learning and ideas of teacher development. It is possible to directly harness this harmony in our approaches to dissemination of work on cognitive structure and conceptual change. Such a harnessing offers our most promising possibilities for having this research on learning affect practice.

## Conclusion

Our work with students and teachers (at both pre-service and in-service levels) has underlined fundamental similarities in the requirements for achieving conceptual change in both groups. For students the problem is one of reconsidering persistent existing views in the light of perceived fruitfulness of science views. For teachers it is a matter of reconsidering existing ideas about learning/purposes of education and so on, and facilitating teaching/learning approaches compatible with developing ideas of learning. There is a great congruence between these perspectives derived from conceptual change research and perspectives derived from research on the acceptance of educational change.

The paper then is a critique of top-down perspectives on teaching and learning. Our current understandings of learning lead to a rejection of such a teaching perspective, if understanding and use by students of what we teach is important. For the same reasons a top-down view of pre- and in-service education is inappropriate if our purpose is to change the nature of classroomn practice. This latter point is well, if anecdotically, illustrated by an exchange early in 1986 between one of us and one of our trainee science teachers. The trainee asserted that she was unconvinced about the persistence of students' pre-instructional views, and that 'if I, as a teacher, tell students something then they will believe it because I am the teacher'. The response from the instructor was 'I am the teacher here, and I assert you are wrong'. The confusion this generated in the trainee typifies the confusion created by asserting to teachers that students generate their own understandings.

Finally we note that, for a considerable time, teachers have expressed great interest in the students' view/conceptual change research. However, consequent teacher change has been far less common. The consistency needed in approaching conceptual change at any level, as argued in this paper, is a crucial element in the encouragement and support of teachers putting ideas into practice.

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