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ABSTRACT

At the heart of the matter of restructuring American education is the goal of enhancing students' abilities to process complex content in cognitively sophisticated ways. To accomplish this goal, two sub-goals must be met: infusing knowledge application tasks across the curriculum; and changing the interaction patterns between teachers and students. Knowledge application tasks that reinforce the processing of complex content in cognitively sophisticated ways have certain characteristics. They are production oriented (producing rather than retrieving knowledge), partially specified, multi-dimensional, long-term, and student directed. Infusing these tasks would require restructuring the curriculum from emphasizing covering information to using information and from isolated facts to "big ideas." Infusing these tasks would also require that assessment emphasize the mental processes students engage in while accomplishing the tasks, as well as the products of those mental processes. The role of the teacher needs to be changed from a presenter of information to the teacher as a mediator of learning. The workshop approach is an instructional format that facilitates the one-to-one teacher student interaction important in the teacher as mediator approach. The workshop approach prescribes that the class period should be divided into three components: a mini-lesson, an activity period, and a sharing period. Accomplishing these goals will require changes in current educational practice that cut across curriculum, assessment, and instruction. (A figure listing steps involved in multi-dimensional tasks, a figure containing examples of application tasks useful in a science class, and 27 references are attached.) (RS)

CHANGING CLASSROOM TASKS AND INTERACTION PATTERNS:

THE "HEART OF THE MATTER" OF RESTRUCTURING

by

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Recent years have seen increased calls for the restructuring of American education. For example, Hennes (1990) notes that "In the past few years, a number of states, many school districts and schools and a variety of national education groups have begun rethinking the way education does business" (p.4). David Kearns, Chairman and Chief Executive Officer of the Xerox Corporation notes that "The first wave of reform has broken over the nation's public schools, leaving a residue of incremental changes and an outmoded educational structure still firmly in place. The second wave must produce strategic change that restructures the way our schools are organized and operate. We've been tinkering at the margins of the education problem for too long. It's time now to get to the heart of the matter" (1988, p. 565).

It is the purpose of this article to identify at least one component (arguably, the most important) of the "heart of the matter". Specifically, the basic assumption underlying this article is that any effort at restructuring must have as its primary focus increasing students' abilities to deal with complex content in cognitively sophisticated ways. This orientation was strongly echoed in the "Educational Summit" meeting of 1990. Specifically, goal 3 of the six adopted by the National Governor's Association in February of 1990 is that by the year 2000, American students will demonstrate competency over challenging subject matter and will learn to use their minds well.

This focus for restructuring is validated by much of the current research in student performance. Specifically, virtually all of the recent "national report cards" in reading, writing and mathematics sponsored by the National Assessment of Education Program (Applebee, Langer & Mullis, 1986a, 1986b; Dossey, Mullis, Lindquist & Chambers, 1988) indicate that while students' performance on low level skills commonly referred to as the "basics" (e.g., answering comprehension level questions, writing simple narrative or descriptive pieces, performing basic computations and solving routine problems) has improved over the decade, performance on more complex tasks (e.g., answering questions that require interpretation and reorganization of information, writing pieces that require detailed analysis and/or construction of a supportive argument, solving word problems that involve high level mathematics abstractions) has been consistently poor and has not improved. At a more general level, students' inability to use complex content in cognitively sophisticated ways is being evidenced in the workplace. Again, David Kearns (1987) reports that one out of three major corporations already provides new workers with instruction to make up for the lack of complex reasoning ability of new employees. Kearns asserts that absorbing this lost productivity while their new workers are learning will cost industry $25 billion dollars a year for as long as it takes and nobody knows how long "it will take". Corroborating this, Gilder (1987) reports that a Japanese plant located in the United States was forced to use graduate level United States students to perform mathematical operations characteristically performed by Japanese high school graduates.

If a primary goal of restructuring efforts is to increase students' abilities to deal with complex content in cognitively sophisticated ways, a natural question is how is it to be done? The current system certainly does not support this goal. Fortunately, there is growing research and theoretical information to provide an answer. Specifically, two sub-goals must be reached to accomplish the primary goal. These sub-goals are: 1) infuse more tasks into the curriculum which require students to apply knowledge in meaningful ways and 2) change the interaction patterns between teachers and students.

INFUSING KNOWLEDGE APPLICATION TASKS ACROSS THE CURRICULUM

Ever since Bloom and his colleagues developed the taxonomy of tasks within the cognitive domain (1956), educators have recognized the positive effects on student learning of engagement in knowledge application tasks. More recently, research and theory has indicated that knowledge application tasks not only help develop the knowledge base of learners but also their ability to develop and use strategies to accomplish those tasks (Vosniadou & Brewer, 1987). In short, knowledge application tasks tend to reinforce the use of complex content in cognitively sophisticated ways.

As powerful as knowledge application tasks are, their nature has been relatively illusive. For example, research using Bloom's taxonomy (Hopkins & Stanley, 1981) has indicated that teachers are characteristically unable to identify or create knowledge application tasks. In recent years, however, the characteristics of knowledge applications tasks that reinforce the processing of complex content in cognitively sophisticated ways, have been identified. Specifically, such tasks are: 1) production oriented 2) partially specified, 3) multi-dimensional, 4) long-term and 5) student directed.

Production Oriented

A production orientation refers to the extent to which the information necessary to complete a task is in long term memory versus must be created by the learner. It is intuitively obvious that a task which simply requires a learner to search and retrieve information from long term memory does not require processing content in cognitively sophisticated ways. On the other hand, Anderson (1982, 1983) has shown that when learners must create or produce knowledge rather than simply retrieve it, they utilize an entirely different type of cognition referred to as "production thinking".

Partially Specified

There are some tasks for which the outcomes are fully specified. Take, for example, the task of answering a multiple choice item on a test. The outcome of this task is fully specified. There is only one way of correctly completing the task, and there is only one format in which the outcome can be expressed. There are a number of tasks for which the outcomes are characteristically fully specified. They include:

- answering true/false questions
- answering fill in the blank questions
- answering matching questions
- answering short answer questions

The problem with such tasks is that they commonly do not involve complex content. That is, complex content by definition has a variety of component parts interacting in diverse ways. The short and fully specified nature of the products of the tasks described above do not allow for the expression and representation of complex content simply because of their brevity.

Fortunately, there are a number of tasks for which outcomes are characteristically not fully specified. These include:

decision making:	making an informed selection among equally appearing alternatives.
investigation:	developing an explanation for some past event or a scenario for some future event and then supporting the explanation or scenario.
problem solving	developing, testing and evaluating a method or product for overcoming an obstacle or constraint.
experimental inquiry:	generating, testing and evaluating the effectiveness of hypotheses generated to explain a physical or psychological phenomenon and then using those hypotheses to predict future events.
invention:	developing a unique product or process that fulfills some articulated need.

None of these tasks fully specify the content or format of the mental products they require for their completion. Additionally, they characteristically involve the processing of complex arrays of information interacting in a variety of ways. For example, decision making involves multiple alternatives and criteria with which to assess those alternatives; investigation involves developing an explanation or scenario based on as many primary sources as possible. Almost by definition, the mental products of these tasks would involve complex information.

Multi-dimensional

Closely related to the characteristic of partial specification is multi-dimensionality. Multi-dimensionality refers to the variety of ways a task can be completed. To illustrate, consider the task of experimental inquiry. Even if a teacher carefully structured or described the phenomenon to be studied, there would be many possible explanations of the phenomenon, many hypotheses that could be developed and many ways to test these hypotheses. In short, there are many options inherent in the task. In general, decision making, investigation, problem solving, experimental inquiry, and invention provide the learner with multi-options because of the many decision points inherent in their execution. To illustrate, Figure #1 lists the steps involved in each process.

Figure #1 here

A careful analysis of Figure #1 illustrates that options are available within almost every step of every task. For example, consider invention. While performing this single task, the learner has options as to the situation or need to attend to, the purpose of the invention, the standards used to judge the invention, the format of the initial model and final product and the manner and extent to which polishing will occur.

Long-term

It seems intuitively logical that knowledge application tasks, which involve the processing of complex content in cognitively sophisticated ways, cannot be accomplished in a short period of time. Recently, theorists have supported these conclusions. In fact, Jacques (1985) asserts that knowledge application that involves the most sophisticated cognition occurs only after years of intense engagement. Of course, there are constraints on the longevity of the tasks students can engage in within a regular classroom setting. Specifically, classroom tasks could probably not extend beyond a quarter or a semester since these are the intervals within which courses are traditionally offered. In practice, long term tasks would probably span one to three weeks since this is the range of time most "units" within a class are completed.

Student Directed

The last characteristic of knowledge application tasks that foster processing complex content in cognitively sophisticated ways is that they are student directed. Ideally, this means that students are allowed to specify all components of the task. That is, students should be allowed to decide on most and preferably all options relative to the steps for each task described in Figure #1. For example, students directedness within decision making means that the student, rather than a teacher, specifies the alternatives to be considered, the criteria to be used to assess the alternatives, the extent to which the alternatives possess the criteria and the final selection.

Student directedness also refers to the freedom and opportunity to identify the manner in which the outcomes or final products of a task will be reported. Characteristically, outcomes and products in school are reported in written or oral form (Durst and Newell, 1989). That is, students are commonly required to write an essay or make an oral report about their tasks. As useful as these techniques are, they exclude other modes of information presentation. To illustrate, all of the methods below are valid ways of reporting the results of the tasks described in Figure #1.

- a videotape
- a newscast
- a graphic organizer with an explanation
- a slide show
- a dramatic presentation
- a demonstration

What this list indicates is that after a decision making task, a student might report on both process and product of her effort via a videotape, or a newscast.

The outcomes of knowledge application tasks can be expanded even beyond the list presented above if students are allowed and encouraged to develop artifacts along with their tasks. Artifacts are physical or artistic products (e.g., a song, poem, mural, poetry, sculpture) that represent some aesthetic or symbolic by-product associated with a task. For example, within a decision making task about which action would be the best for the United States to take in Iraq, a student might develop a sketch as a supplement to her written report. Where the written report would be used to communicate the process used within the decision making task and the conclusions drawn from it, the artifact (the sketch) would be used to communicate a specific affect associated with the conclusions drawn by the learner.

Restructuring Necessary to Infuse Knowledge Application Tasks Across the Curriculum

Infusing the types of tasks described in Figure #1 into the curriculum would mean a major restructuring of current educational practices in at least two areas: curriculum and assessment. Quite obviously, curriculum would necessarily be restructured in that emphasis would shift from covering information to using information. Work by Doyle (1983) and others (e.g., Goodlad, 1984) indicates that the current curriculum focuses on coverage. That is, in today's classrooms, most tasks focus on students understanding a certain body of information and then demonstrating their understanding at some later date. Although the tasks listed in Figure #1 require a certain amount of coverage of content, by their very nature, they are geared more toward using content so as to create new knowledge.

In addition to a shift from content coverage to content use, curriculum would have to be restructured to emphasize "big ideas" rather than isolated facts. Specifically, knowledge coverage tasks commonly focus on lower order, factual information. However, knowledge application tasks focus on broad concepts and principles. To illustrate, Figure #2 contains examples of application tasks that might be used in a science class within a unit on nuclear energy.

Figure #2

The decision making task in Figure #2 focuses on the broad issue of the suitability of certain types of nuclear reactors within specific locations, the investigation tasks focus on the broad issue of why President Truman elected to use atomic weapons and so on. Although each of the tasks described in Figure #2 involves a certain amount of lower level factual information, the emphasis within or driving force behind each task is some larger, central issue.

Finally, infusing knowledge application tasks across the curriculum would require a change in current approaches to assessment - specifically a change to an emphasis on assessing the mental processes students engage in while accomplishing the tasks as well as the products of these mental processes. This shift is quite consistent with the current trend toward performance assessment. For example, Wiggins (1989) notes that an assessment system geared toward reinforcing enhanced and higher level student performance should rely on a diverse set of tasks that allow students a wide range of modes of presentation and response. He proposes that such assessment should be the standard operating procedure for large scale assessment efforts. As evidence that such a proposal is feasible, Wiggins cites Great Britain's plan to assess all students from age 7 to 16 using a variety of tasks that more authentically display competence. In fact, Wiggins notes that the best way to describe the rethinking underway in assessment design is a shift to more "authentic assessment tasks". He specifies that if our interest is in enabling students to read critically, write gracefully, pose and solve real scientific or historical problems, then our tests should ask them to explore literature, write thoughtful and readable prose, and do laboratory or primary-source research.

It is no coincidence that the examples of authentic tasks alluded to by Wiggins bear a strong resemblance to the various types of knowledge application tasks described in this article. Knowledge application tasks are for the most part "authentic tasks". That is, individuals usually don't learn content for the sake of learning. Rather, they learn content as a by-product of making a decision, investigating a past or future event, solving a problem and so on. Knowledge application, then, and authentic assessment have a symbiotic relationship with one not only reinforcing the other but making its existence possible. However, for authentic assessment to survive within public education (and, subsequently, knowledge application tasks) there must be a dramatic shift in assessment policies from relying on the highly objective but narrow information provided by testing companies to relying on the more subjective but robust information provided by the teacher. In short, the teacher, not the standardized test, must be the ultimate source of information about the student (Wiggins, 1989).

CHANGING INTERACTION PATTERNS BETWEEN TEACHERS AND STUDENTS

Changing interaction patterns between teachers and students is the second sub-goal necessary to accomplish the primary restructuring goal of increasing students' abilities to process complex content in cognitively sophisticated ways. Currently, the predominant interaction pattern between teacher and student is one in which the teacher is the presenter of information and the student is the consumer of information (Doyle, 1983).

As important as the teacher's role of knowledge presenter is to the teaching/learning process, it is overshadowed, in terms of impact on students, by the role of mediator of learning. The concept of teacher as mediator of learning can be traced back to Vygotsky (1978) who described mediation in a learning situation as working in the zone between what a student can do independently and what he can do with the help of a competent other (e.g., a teacher). As the teacher mediates the process of a student engaging in tasks that are slightly beyond their reach, the teacher helps the student cultivate mental skills and dispositions which will transfer to a wide variety of tasks. In recent years, Feuerstein, et al (1980) has demonstrated the power of such transfer. That is, the mediational process engenders in students mental skills and dispositions which transfer well beyond the tasks that were mediated. If we combine the recent work of Costa (1984), Ennis (1987), Paul (1987) and Perkins (1984), a list of mental skills and dispositions which are enhanced by teacher mediation can be identified. These skills and dispositions, which have been associated with higher level learning (Resnick, 1987), include:

- planning
- managing resources
- evaluating the effectiveness of one's actions
- seeking clarity and precision
- avoiding impulsivity
- being open minded
- engaging intensely in tasks even if answers or solutions are not apparent
- pushing the limits of one's knowledge and performance
- generating and following your own standards
- generating new ways of viewing a situation

When mediating instruction, then, the teacher interacts in such a way as to enhance these dispositions. That is, as the teacher mediates a student's progress through a knowledge application task, she helps students plan, manage resources, seek clarity and precision and so on. To accomplish this the student must be involved in tasks which challenge their present level of knowledge and skill, such as those in Figure #2. Additionally, the teacher must have the time to interact with students on a one-to-one basis as they progress through these tasks.

Restructuring to Change Interaction Patterns between Teachers and Students

The necessity of one-to-one interaction between teacher and students at first appears problematic because current instructional models such as those designed by Hunter (1984) and Rosenshine (1986) are greatly skewed toward large group instruction and information presentation. Fortunately, there is an instructional format that facilitates one-to-one teacher/student interaction and is perfectly suited to knowledge application tasks. That format is the workshop approach.

Quickly becoming a staple within the writing process movement (Atwell, 1987) and the whole language approach to reading (Hansen, 1987), the workshop approach prescribes that a class period should be divided into three components: 1) a mini-lesson, 2) an activity period and 3) a sharing period. Mini-lessons, as the name implies, are relatively short, lasting between 5 and 20 minutes. During the mini-lesson new content is presented to students or students are provided guidance in setting up their knowledge application tasks (henceforth referred to as "projects"). New content can be presented in the traditional manner - through reading, lecture, films, demonstrations and so on. When providing guidance for setting up student projects, the mini-lesson is used to teach students the processes necessary to complete their projects (i.e., the steps described in Figure #1) or make students aware of possible resources they might use. For example, during a mini-lesson, the teacher might walk students through the construction of a decision making task, helping them design a decision question, pointing out possible alternatives they might consider, suggesting possible criteria with which to judge the alternatives and so on. A useful activity to this end is to present students with clear models of the knowledge restructuring tasks they might construct like those in Figure #2.

During the activity period, students work independently or in small groups on their projects while the teacher conferences with individual students. It is the act of conferencing that allows for one-on-one interaction between the teacher and students. Specifically, during a conference, the teacher interacts with students about: 1) their projects and 2) their use of the skills and dispositions of higher level learning. Learning logs are a basic record keeping tool necessary for successful conferences. As a record keeping tool, learning logs require two types of entries corresponding to the two foci of conferences - those relating to student projects and those relating to student use of the skills and dispositions of higher level learning. That is, as students progress through their knowledge application tasks, they make entries in their learning logs relative to their progress on those tasks, and they make entries about their use of the skills and dispositions of higher level learning. This is facilitated if the teacher stimulates student thinking by utilizing focusing probes - questions that elicit specific responses. For example, on a given day a teacher might stimulate student responses about their knowledge application tasks by asking them to respond to probes like the following:

> "Describe the biggest problem you are currently facing in your project and how you will solve it."
>
> "Describe some ways your thinking relative to the topic of your project has changed as a result of working on your project."

Similarly, the teacher might stimulate student thinking about the skills and dispositions of higher level learning by presenting them with probes like the following:

> "Describe what you have done to be as accurate as possible in completing your project."
>
> "Describe what you have done to view your project in new ways."

Students would record their responses to these probes in their learning logs. These responses would then become the content of teacher/student conferences.

In addition to focusing discussion within conferences, the use of student learning logs with specific teacher probes expands the type of writing students engage in within the classroom. Specifically, research has shown that classroom writing is commonly limited to informational purposes (Durst & Newell, 1989). Learning logs used in the manner described above expand the use of students writing to include more expressive forms of writing - those that require internal reflection.

The last part of the workshop approach is referred to as sharing period. As the name indicates, during this relatively short period of time (e.g., two to five minutes), students share new insights and awarenesses they have gleaned from their work during activity period. For example, a student might share a new insight about the process she is engaged in or a new insight about the subject matter of her knowledge application task.

In short, the workshop approach, which is a staple within English and language arts education, is an instructional format that provides the necessary shifts in instruction to facilitate the accomplishment of the sub-goal, of changing interaction patterns between teachers and students.

SUMMARY AND CONCLUSIONS

At the "heart of the matter" of restructuring is the goal of enhancing students' abilities to process complex content in cognitively sophisticated ways. To accomplish this goal, two sub-goals must be met: 1) infusing knowledge application tasks across the curriculum and 2) changing the interaction patterns between teachers and students. This article has described how these two sub-goals (and, consequently, the primary goal) can be accomplished. Their accomplishment will require changes in current educational practice that cut across curriculum, assessment and instruction. The changes seem worth the effort required to effect them, however, for if the current calls for restructuring are accurate, we, as a nation, have little choice.

Figure #1

Decision Making Tasks: Making an informed selection among equally appearing alternatives. The process involves:

a) identifying the alternatives to be considered
b) identifying the criteria used to assess the alternatives and their relative importance
c) identifying the extent to which each alternative possesses each criteria
d) making a selection

Investigation: Developing an explanation for some past event or a scenario for some future event and then supporting the explanation or scenario. The process involves:

a) generating an initial inquiry question to be answered and the significance of the question

b) identifying the specific issues that will be addressed or the standards with which to evaluate the final product

c) identifying and using primary and secondary sources

d) drawing a conclusion from the information gathered and articulating and the relationships between the information and the conclusion

e) identifying the extent to which the final explanation/scenario addressed the stated issues or met the stated standards

Problem Solving Tasks: Developing, testing and evaluating a method or product for overcoming an obstacle or a constraint. The process involves:

a) identifying the important factors affecting the problem situation along with the characteristics of the desired outcome and the constraints or obstacles in the way of achieving the desired outcome

b) identifying the standards or criteria for a successful solution

c) identifying the possible alternative ways of overcoming the obstacle or the constraint

d) selecting and trying out an alternative

e) identifying the extent to which the selected alternative produces a solution that meets the stated standards/criteria

f) if multiple alternatives were tried, articulating the reasoning behind the order of their selection and the extent to which each met the stated standards/criteria

Experimental Inquiry Tasks: Generating, testing and evaluating the effectiveness of the hypotheses generated to explain a physical or psychological phenomenon and then using those hypotheses to predict future events. The process involves:

a) explaining a phenomenon initially observed

b) identifying the facts or principles behind the explanation

c) making a prediction based on the facts and principles underlying the explanation

d) setting up and carrying out an activity or experiment to test the prediction

e) evaluating the results of the activity/experiment in terms of facts and principles that have been articulated

f) making another prediction of future events based on the combined information from the original explanation and results of the activity

Invention Tasks: Developing a unique product or process which fulfills some articulated need. The invention process involves:

a) identifying a situation to improve or an unmet need

b) identifying a purpose for the invention

c) identifying specific standards or criteria the invention will meet

d) developing a rough model, sketch or outline of the product

e) developing the product

f) continually revising and polishing the product until it reaches a level of completeness consistent with the criteria/standards that were articulated.

Figure #2

DECISION MAKING

In class we have learned about three different types of nuclear reactors. We have also studied the resources and environment nuclear reactors require. Assume you are on a panel to select the type of new reactor that will be built in the state and where it will be built. Make your selection of both the type of reactor and the site where it should be built. Report on:

- the criteria you used to decide on the type of reactor to build and why you used those criteria.
- the extent to which each reactor measured up to each of your criteria.
- the alternative sites you considered.
- the criteria you used to assess the sites.
- the extent to which each site measured up to your criteria.
- your final selection.

INVESTIGATION

One of the most interesting questions around the use of nuclear weapons is why President Truman agreed to drop the atomic bomb and why he selected the sites that he did (Hiroshima and Nagasaki). Investigate the reasons behind these important historic moves, using as many primary and secondary sources as possible. Report on:

- the resources and sources you used.
- the specific questions your investigation answered.
- your conclusions and how you came to them.
- the questions that are still unanswered.

PROBLEM SOLVING

You are a part of a team of engineers whose job it is to design the safety system for a new nuclear reactor to be built in our city. The most important part of your job is to ensure that no radiation can ever escape from the plant when it is operating under normal conditions and during crisis situations in which some accident has occurred. Unfortunately, you can use none of the materials commonly used to absorb radiation in today's nuclear reactors (these are listed on page 75 of the textbook). Describe how you would make the plant safe even without the use of these materials. Report on:

a) your plan of action.
b) those resources you would need.
c) the information you had to gather.
d) how the material or process you have developed substitutes for the materials you are not allowed to use.

EXPERIMENTAL INQUIRY

Our school is located within five miles of a nuclear power plant. Some people believe that such plants have an adverse effect on the people and environment around them. Based on your understanding of nuclear energy, make a prediction about some things you should find in our community given that we live in such close proximity to a nuclear plant. Then test out your prediction. When you're done, report on:

- o the information on which you based your predictions.
- o how you gathered information and why you chose the sources you did.
- o how you analyzed the information to draw conclusions from it.
- o the extent to which your initial prediction was accurate and what original concepts you have had to change as a result of your study.

INVENTION

Your job is to design a house that is totally run by nuclear energy. After you have designed your system, report on:

a) the specific things you would want your house to do.
b) your initial design or your initial ideas about how you might design the house.
c) the changes you made in your initial ideas.
d) the information you had to gather.
e) the changes you made in your initial design and why you had to make these changes.
f) how your design would ensure that your house is able to do those things you initially identified.

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