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ABSTRACT

Presented are abstracts and abstractors' analyses of nine studies related to curriculum and instruction. These studies focused on: (1) the status of environmental education in Kansas; (2) attitudes of Israeli students toward two versions of a curriculum titled Agriculture as Environmental Science; (3) interrelationships among teacher intentions, curriculum materials, teaching methodology, and potential outcomes through a qualitative analysis of a teaching episode in biology; (4) the effect of different amounts of structure in instruction on student performance; (5) a review of investigations using the Learning Environment Inventory (LEI) to assess classroom climate; (6) student cognitive level as a predictor of success in high school chemistry; (7) concerns of junior high school teachers who were implementing an Intermediate Science Curriculum Study (ISCS); (8) a self-paced instructional mode for basic chemistry and physics and its effects of college student achievement and attitudes; and (9) student beliefs about heat phenomena. (JN)

SCIENCE EDUCATION INFORMATION REPORT

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SCIENCE EDUCATION

Volume 11, Number 1, 1985

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Volume 11, Number 1, 1985

NOTES FROM THE EDITOR:

This issue contains reviews of nine articles related to curriculum and instruction. James and Potts assessed the status of environmental education in Kansas. Blum measured attitudes of Israeli students toward two versions of a curriculum entitled Agriculture as Environmental Science. Kilbourn described the interrelationships among teacher intentions, curriculum materials, teaching methodology, and potential outcomes through a qualitative analysis of a teaching episode in biology. Kozma tested the effect of different amounts of structure in instruction on student performance. Hofstein et al. reviewed investigations using the Learning Environment Inventory (LEI) to assess classroom climate. Howe and Durr looked at student cognitive level as a predictor of success in high school chemistry. James and Hall examined concerns of junior high school teachers who were implementing ISCS in their science classes. Tuckman and Waheed looked at a self-paced instructional mode for basic chemistry and physics and its effects on student achievement and attitudes. Erickson assessed student beliefs about heat phenomena.

Patricia E. Blosser
Editor

Stanley L. Helgeson
Associate Editor

CURRICULUM AND INSTRUCTION

James, Robert K., and George Potts. "Assessing Environmenta[illegible] [illegible]on in the Public Schools." School Science and Mathematic[illegible], [illegible] (2): 103-114, 1981.

Descriptors--*Curriculum Development, *Educational Research, Elementary Secondary Education, *Environmental Education, Mathematical Applications, Program Development, *Science Curriculum, *Science Education, Science Instruction

Expanded abastract and analysis prepared especially for I.S.E. by William H. Frase, University of Cincinnati.

Purpose

This purpose of this study was to assess the status of environmental education in Kansas by an attitudinal survey of school board presidents, superintendents, school principals, teachers, and environmental education specialists in rural, urban, and metropolitan districts. The motivation for this research was to assemble a data base on which a state plan for environmental education could be built.

Although no specific null hypotheses were presented, it was clear that the authors of this research were:

1. Comparing school environmental education goals among urban, rural, and metropolitan sub-populations.

2. Comparing district-wide goals for environmental education.

3. Comparing the attitudes toward environmental education of elementary principals, secondary principals, elementary teachers, secondary teachers, superintendents, school board presidents, and environmental education specialists.

Rationale

The rationale of this study was that by analyzing the opinions and goals of participants, a clear picture of the status of environmental education of a model state system would appear. An underlying assumption was that the concept of environmental education would vary with the type of population, and the individual being surveyed.

As with any research in the affective domain, the authors attempted to identify population trends which would contribute to more meaningful and appropriate curricula and better teaching.

Research Design and Procedure

The paradigm was to conduct a multivariant analysis of opinion surveys by the Scheffe Method by sub-populations from rural, urban, and metropolitan environments sampled. The sub-populations sampled were:

1. School board presidents
2. Superintendents
3. School principals
4. Teachers
5. Environmental Education Specialists

Each of these sub-populations completed two goal and two status instruments. The goal instruments were assessments of:

1. student performance;
2. local environmental education policies;
3. outside funding;
4. curriculum material, resources, and development;
5. community involvement in the development of the local program;
6. determination of program goals; and
7. in-service personnel training.

The goal instruments were of 18 items each, where respondents were asked to indicate their feelings on a five-point scale, ranging from strongly agree to strongly disagree. The status instruments assessed;

1. local environmental education policies, and programs;
2. student involvement; and
3. personnel training.

A second status instrument assessed:

1. community involvement;
2. environmental education policies;
3. outside assistance;
4. curriculum materials, and
5. personnel training.

An N of 448 principals, teachers, and environmental education specialists was realized. Of the 188 instruments sent, 957 items were completed and returned for an 81 percent return. The split-half technique, (Spearman-Brown correlation) yielded reliability coefficients of 0.8913 for the school goals instrument and 0.9145 for the district goals instrument.

An ANOVA was conducted within and between all groups and F-values were measured for significance at the 0.05 level (alpha = 0.05).

In metropolitan school districts, environmental education had a significantly higher status than it did in urban school districts where it in turn had a significantly higher status than in the rural districts as reported by their superintendents, using the Scheffe Test.

Interpretations

The authors of this research summarized their conclusions by saying that attitudes toward environmental education showed no significant difference between rural, urban, and metropolitan elementary principals, but did indicate differences of opinion among secondary principals, with metropolitan secondary principals having a significantly more positive attitude. Also, metropolitan elementary teachers were found to be more significantly positive than their counterparts. When principals, teachers, and environmental education specialists were compared, the specialists were found to be significantly more positive toward school goals for environmental education. The authors inferred from these data that:

1. The more positive report by metropolitan schools indicates their openness to and inclusion of environmental education in their curricula as compared to rural and/or urban districts. This prompted a recommendation that state agencies evaluate promotional strategies so that more positive attitudes be developed towards environmental education in the latter instances.

2. Greater attention should be given to evaluating the current level of environmental education curriculum practicing of non-metropolitan school districts, and Kansas is in need of a state-wide coordination effort, prompted by the disparity between rural and metropolitan districts.

3. Due to a low frequency of certain status items, the authors recommended further assessment of the status of environmental education in all schools. Establishment of student learnings and the assessment of current levels of achievement were of highest concern.

Findings

The authors of this study chose to isolate their results in the following areas:

1. School Goals
2. Present Implementation Status
3. District Goals
4. District Implementation Status

School Goals

Significant F values occurred in the analysis of rural, urban, and metropolitan secondary principals and elementary teachers. The Scheffe Test indicated that metropolitan elementary teachers and metropolitan secondary principals were significantly more positive toward school goals than urban and rural members of their respective groups. Elementary education specialists had a significantly more positive attitude toward goals than did principals or teachers. Such items as commitment to student learning; materials for teachers; and integrated curriculum were of high priority, while such goals as specific budgets; full-time coordinators; and full staff involvement were of lower priority.

Present Implementation Status

Significant F values were found for both elementary and secondary school principals for such items as environmental education policies; school programs; student involvement; and personnel training. The Scheffe Test revealed that metropolitan schools had a significantly higher status than did urban and rural sub-groups.

District Goals

The Scheffe Test revealed that superintendents of metropolitan school districts had a significantly more positive attitude towards the goals for environmental education than did urban and rural superintendents. Environmental Education specialists had a significantly more positive attitude towards the goals for environmental education than did the other two groups.

District Implementation Status

Metropolitan school districts had a significantly higher status for environmental education than did the urban school districts, which in turn had a significantly higher status than the rural districts as reported by their superintendents using the Scheffe Test.

Interpretations

The authors of this research summarized their conclusions by saying that attitudes toward environmental education showed no significant difference between rural, urban, and metropolitan elementary principals, but did indicate differences of opinion among secondary principals, with metropolitan secondary principals having a significantly more positive attitude. Also, metropolitan elementary teachers were found to be more significantly positive than their counterparts. When principals, teachers, and environmental education specialists were compared, the specialists were found to be significantly more positive toward school goals for environmental education. The authors inferred from these data that:

1. The more positive report by metropolitan schools indicates their openness to an inclusion of environmental education in their curricula, as compared to rural and/or urban districts. This prompted a recommendation that state agencies evaluate promotional strategies so that more positive attitudes be developed toward environmental education in the latter instances.

2. Greater attention should be given to evaluating the current level of practice in non-metropolitan school districts, and Kansas is in need of a statewide coordination effort, prompted by the disparity between rural and metropolitan districts.

3. Due to a low frequency of certain status items, the authors recommended further assessment of the status of environmental education in all schools. Establishment of student learning and the assessment of current levels of achievement were of highest concern.

ABSTRACTOR'S ANALYSIS

The research of Professors James and Potts is reflective of several trends presently found in science education; the move towards accountability of various curricula especially on the national and state levels and research into the affective domain. Studies of this nature are especially useful in that it has only been popular to handle such research in recent years because of better statistical tools and higher validity, matrices are now being established nationally. Although this research does not introduce new conceptual and/or interpretive ideas, it does contribute to the basic body of science education knowledge and curriculum accountability.

The validity of the study is well-founded, and the methodology and procedure as presented indicate no basis for doubt and/or question. The use of an ANOVA is becoming more significant and relevant to modern science education research.

James and Potts should be encouraged to continue their research and work towards a goal of establishing a state-wide environmental education coordination effort. This might be better accomplished if they were to somewhat alter their research design according to the following parameters:

1. Poll more teachers and fewer board of education presidents, superintendents, and principals. Although it is important to sample school administrators, the effectiveness of a curriculum, and its significance might better be found with those individuals who actually implement it.

2. Adopt a uniform questionnaire. Reliability and validity would be better accomplished if <u>all</u> respondents were to answer <u>all</u> questions. The fact that school board presidents and superintendents of schools responded to different questions than did principals and teachers, and that not all individuals responded to goal and status instruments on both the district and the school level further complicated this research and made it very difficult to arrive at proper interpretations.

3. A future avenue of research might well be developed around including student response. This may well be meaningful to this research as the opinions of teachers, principals, superintendents and board presidents are only based on impressions while the opinions of students are based on first-hand exposure to a particular curriculum.

In summary, James and Potts are reflective of a new and very important trend in science education research: the establishment of state, regional and national curriculum accountability. This research contributes significantly to the body of knowledge of science education and/or learning.

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Descriptors--*Agriculture; Attitudes; *Curriculum Evaluation; Educational Research; Elementary School Students; Elementary Secondary Education; *Environmental Education; *Inquiry; Junior High School Students; *Program Evaluation; Science Curriculum; Science Education; Surveys

Expanded abstract and analysis prepared especially for I.S.E. by David R. Stronck, California State University, Hayward.

Purpose

The purpose of this study was to measure seventh-grade Israeli students' attitudes toward the usefulness of the Agriculture as Environmental Science (AES) curriculum taught with two different texts: one posing problems to be solved through experimentation, the other providing information in a conventional way.

Rationale

In the early 1970's, the Israeli school introduced a new Agriculture as Environmental Science (AES) curriculum. The new text emphasized an open-ended inquiry approach with applied science aspects. Both the earlier traditional and the new AES curriculum stressed attitudes toward the growing of and caring for plants. The AES is similar to Rural Studies in other countries but is adapted to the urbanization of Israel and the environmental crisis. The AES curriculum planners intended to enhance the students' attitudes toward the subject, including the feeling of usefulness.

Research Design and Procedure

The AES text "Let's Grow Plants" was used in the experimental classes. This text poses open-ended questions and requires the students to grow plants within the framework of field experimentation. A special control curriculum was devised for this study. The control group used the text "Growing Plants" which covered the same topics found in "Let's Grow Plants," i.e., changing the time of flowering in plants, and plant propagation. The text of the control curriculum presented information as a factual account. The two curricula differed mainly in the use of an inquiry method only in the experimental text.

A 76-item questionnaire was sent to 375 agricultural teachers in all parts of Israel to identify the most suitable sample of teachers and schools. A total of 108 responses were received. Of these teachers, 68 were using the experimental AES curriculum and 40 were accustomed to the conventional style and curriculum. These teachers were then screened according to the following criteria:

1. identify with either the experimental or the conventional method and agree to participate in the investigation;
2. have at least two years experience in the method in which he was to teach as a participant in this investigation;
3. teach in a state school, which had a suitable land laboratory;
4. be certified to teach agriculture and/or nature studies (science); and
5. be considered by his subject matter inspector to perform "fair" to "good" (grades 3 and 4 in the 5 scale report of inspectors).

The screening process provided a final total of 17 teachers with 480 students using the new curriculum and 15 teachers with 490 students using the conventional system.

At the beginning of the year, the students were given a Reading Comprehension Test. Anyone with a level of achievement at least two years below the 7th grade average was excluded from the research population. The Reading Comprehension Test had demonstrated a 0.68 correlation to the Standard verbal form of the Milta IQ test and was a good indicator of average school achievement. The difference between the reading comprehension of the experimental and of the control students was not significant at the one percent level of confidence.

Facet Theory was used to design the questionnaire on the usefulness that the students attributed to their studies. This process gave three facets of interest to the evaluator:

1. Purpose with three elements: studying plant flowering and propagation -
   a. to obtain high yields;
   b. to beautify the environment;
   c. to understand scientific articles on plant growing.
2. Time Period with two elements:
   a. present: "to what extent do your agricultural and environmental studies help you;"
   b. future: "to what extent will your agricultural and environmental studies help you."
3. Framework with three elements: where will the studies be useful?
   a. in the school garden;
   b. as a hobby at home;
   c. on a farm (if you will farm).

The three purposes, two time periods, and three frameworks generated a Cartesian product of 3 X 2 X 3 or 18 possible responses to the basic question on the extent of helpfulness from agricultural and environmental studies. Only half of these 18 possible questions were asked. The researchers recognized that it was not logical to ask an elementary-school student if his agricultural studies help him now to get high yields on a farm or if they will help him in the future in the school garden. The future is interpreted as the future of an adult. Moreover, the purpose of obtaining high yields relates only to the framework of "on a farm" in the future and "in the school garden" now. Beautifying the environment was not related to the framework of "on a farm."

Responses to the nine questions on the questionnaire could range from "very much" to "not at all" on a four-point scale. A preliminary version of the questionnaire was given to 251 seventh-graders in four schools not belonging to the research sample. A week later the questionnaire was given again to 211 students from the preliminary sample. The test-retest reliability was 0.76.

Construct validity was established by the Smallest Space Analysis in which each variable is represented by a point in a multidimensional space. The empirical structure shown by the Smallest Space Analysis coincided with the hypothetical structure on which the evaluation instrument was based.

Findings

In the experimental group, all nine ratings increased from the beginning to the end of the year. In the control group, the ratings remained constant or dropped slightly. The F test showed all differences to be significant at the one percent level of confidence. The largest increases in rating of the experimental group were "at home" (as the place of usefulness) and "for understanding articles." There was also a rather large increase "for beautifying the environment" (as a purpose of usefulness). The increase over the year in the rating of usefulness in the experimental group was 0.27 for boys and 0.30 for girls. The decrease in the control group was 0.16 for boys and 0.10 for girls. These differences between the sexes in both student groups were negligible.

Interpretations

The researcher concluded that the significant differences between the two comparison groups for all questions and sub-tests supported the hypothesis that the introduction of an inquiry type curriculum can change students' perception of the usefulness of a school subject.

ABSTRACTOR'S ANALYSIS

The researcher observed correctly that instruments of evaluation in which learners are asked to rate the usefulness of their studies are uncommon. Educational psychologists have well explained that the students' psychological status must be recognized to provide appropriate instruction. Excellent teachers are persons who can match the instruction to the attitudes and abilities of their students. Probably there has been a neglect of instruments measuring students' attitudes because such instruments can often be weak both in reliability and in validity. On the other hand, cognitive tests emphasizing knowledge can be easily constructed with relatively high reliability and validity.

In this study the researcher has done admirable work in constructing an appropriate instrument. The construct validity of the nine items is most appropriate for this carefully limited study. The test-retest reliability was only 0.76 with the 211 students in the preliminary sample. Nevertheless, the preliminary sample consisted of students not involved in the research sample. Although the administrators reported that these students were cooperative in completing the questionnaire, this abstractor suspects that they gave rather random responses. The final results of the study with the experimental group and the control group gave very consistent results which imply a much higher level of reliability for the instrument.

The study concludes that the inquiry type curriculum can change students' perception of the usefulness of a school subject. Many other studies have emphasized that the inquiry approach to instruction does increase the levels of cognitive understanding and of concept formation. The conclusion about attitudes is a valuable contribution to this literature.

Students in the control classes studied some new topics in the theoretical lessons. The researcher notes from interviews that these new topics encouraged improved attitudes toward the subject. Students in the traditional classes complained that they grew the same plants in the same way as they had done in earlier years. Obviously one of the advantages of the inquiry approach is to encourage the students to identify new problems of interest. Educational psychologists have observed that boredom caused by unnecessary repetition of what has already been learned is a major problem in traditional instruction.

Many studies have concluded that boys are more highly motivated to study science than are girls. This study observed no differences between the ratings of the boys and those of the girls. The AES curriculum emphasizes the application of science to relevant and interesting situations. Other researchers should note that girls can be highly motivated to study topics which seem applicable to their needs and interests.

This study demonstrates that the Facet Design is a valuable tool for constructing an evaluation instrument. The writing of Likert-type questions on opinions and feelings is an easy task after the completion of the facets and their elements are defined. It is to be hoped that other researchers will use this technique for evaluating the effectiveness of their curriculum.

Project Synthesis recently observed that academic preparation is usually the only purpose of science education in American schools. Recommendations were made to introduce the purposes of meeting personal needs, dealing with societal issues, and providing for career education and awareness. The AES curriculum clearly meets all of these purposes and serves as an excellent example of an appropriate curriculum in science for students in the seventh grade.

Kilbourn, B. "Curriculum Materials, Teaching, and Potential Outcomes for Students: A Qualitative Analysis." Journal of Research in Science Teaching, 19 (8): 675-688, 1982.

Descriptors--Beginning Teachers; *Biology; Classroom Observation Techniques; Grade 9; High Schools; Outcomes of Education; *Science Instruction; Science Materials; Science Teachers; Secondary School Science; Teacher Behavior; *Teaching Methods

Expanded abstract and analysis prepared especially for I.S.E. by George I. Za'rour, American University of Beirut.

Purpose

The study aimed at describing the interrelationships among teacher intentions, curriculum materials, teaching methodology, and potential outcomes through a qualitative analysis of a teaching episode in biology. The data interpretation was utilized to develop the concept of epistemological flatness.

Rationale and Background

The research can be described as ex post facto. Data were already available as they were collected during an inservice clinical supervision of a beginning teacher. The study concentrated on the teaching of a part of a major unit entitled "Fundamental Interrelationships Among Living Things." The three broad goals of the teacher were for students a) to see the interrelationships between organisms and their environment; b) to develop some understanding of scientific process (a goal applying generally to the whole course); and c) to experience some degree of academic success, to feel competent, and to realize that they could do the work. There were no explicit hypotheses to guide the investigation, although there is suggestive evidence that the researcher had the idea of epistemological flatness already budding.

As a background, the researcher outlined situational factors such as: nonacademic ninth grade biology class, repeated disruptive behavior of students, high degree of student apathy, and students' difficulty in working independently in the individualized school program. The teacher attempted to make the students feel capable of academic success through simplification of material and reducing expectations. Reportedly, the approach was not stimulating and produced tedious and boring intellectual activity. The researcher's work with the teacher was directed towards elevating the intellectual stimulation of the classroom discussion and to make students feel more accountable. The teacher was described as adhering closely to the textbook and extremely reluctant to change the sequence or substance of the text.

Research Design and Procedures

The researcher zeroed in on the teaching-learning activities of one session of data collected during an inservice clinical supervision of a beginning teacher. The biology curriculum materials and the teaching were analyzed in terms of their potential contribution to the realization of the broad goals of the unit. Relevant paragraphs, diagram, and exercise were reproduced in the article and it was pointed out that "... the student is required to make inferences, speculate, interpret, and judge" (p. 678). The episode centered on investigating the relationships between structure of beak or foot of birds, and the kind of food they eat or where they live. It also included matching beaks and feet. With respect to teaching, the researcher analyzed 10 pages of transcription of about 20 min. of classroom discussion and presented 7 excerpts of teacher-student interaction through questions and responses. Excerpts were commented on in terms of level of probing student responses and type of reasoning involved, if any.

Regarding selection of teacher, sample, and materials it is not clear why or how a) this particular beginning teacher; b) this particular nonacademic ninth grade biology class; c) this particular unit of teaching; and d) this particular teaching episode--were selected for the investigation. In the absence of randomness, control, reliability and validity checks, among others, the directions that were pursued in data selection and interpretation seem to have been dominated by the philosophical and pedagogical outlook of the researcher.

Findings

In the judgment of the researcher, a) the investigation embodied in the teaching episode was difficult, artificial, and lacked context for developing adequate interpretation of the data; b) the implicit claim that the exercise was a proper scientific investigation was not upheld; and c) it "is unlikely that adequate provision has been made here for the students either to experience academic success or to acquire some understanding of the process of science" (p. 683).

In general, the teacher's questions were judged to be satisfactory but lacked high levels of probing or following up. The major finding was that both the curriculum materials and the teaching act have fallen short of fulfilling the desired outcomes.

Interpretations

The researcher proposed epistemological flatness as a conceptual organizer to interpret the major features of the episode. He defined epistemological goals as those involving understanding the process of science. The exercise of the episode is epistemological because it is meant to provide students with some insights into how scientists think about scientific issues as well as make them engage in intellectual operations similar to those practised by scientists.

The term 'epistomologically flat' was used by the researcher "to characterize teaching situations where epistomological issues are central to fulfilling intended outcomes but the teaching falls short of dealing adequately with those issues" (p. 685). In the opinion of the researcher, teaching the foot/beak exercise could have been improved by a) supplying students with additional context; b) probing more into their responses to questions; c) making them aware of the intellectual operations that they utilized to analyze the data; and d) pointing out the limitations of the available data. These suggestions direct the path to move the teaching-learning situation along the continuum from epistemological flatness to epistemological richness.

ABSTRACTOR'S ANALYSIS

At first glance, the article makes interesting reading, especially for the reader with a biology background - which the abstractor is not. The analysis of the excerpts and the curriculum materials provide the biology teacher with useful insights. Directing attention to the validity of the research, the way it is reported, and its general methodology--several questions and issues are raised. It is true that the study is qualitative in nature and thus does not lend itself easily to be judged in terms of the rig us criteria required by experimental techniques Nevertheless, all types of research require the researcher to observe the fundamentals of research procedures and the scientific collection and analysis of data. In several places in the article, especially in the 'Conclusion,' one detects a degree of assertion by the researcher to the effect that relevant data were selected to develop the point of view of epistemological flatness.

Kilbourn's reference in the Canadian Journal of Education was not available to the abstractor nor were the curriculum materials. Relying on the information as presented in the article, the abstractor identified certain unclarities and/or inconsistencies in the context of depicted events. For example:

a) In what sense are the biology curriculum materials individualized? Does this call for independent and individualized work on the part of the students? To what extent was this carried out? Were the cards with the correct information (p. 682) available to the students prior and/or during the teaching episode?

b) The teacher's strategy to simplify material and to reduce expectations is inconsistent with the statement that (s)he was extremely reluctant to modify the substance of the text.

c) How do relaxed demands on the students produce tedious intellectual activity? How does this compare with the conditions under unrelaxed demands?

Other observations and comments that may have a bearing on one's outlook towards the study are exemplified by the following:

a) It is difficult to evaluate curriculum materials on the basis of a small selected sample. What is more important is that curricula are developed with a certain population of students in mind. Were the curriculum materials under consideration intended for nonacademic ninth grade students? Thus, a problem that needed addressing revolves around any mismatch between the curriculum materials and such groups of students. This becomes more of a problem when one considers the reported lack of motivation of the students, their disruptive behavior, their being unsure of themselves, and their difficulty in working independently in the individualized school program.

b) One of the problems of this type of research is that of objectivity as it relates to agreements in perception among teacher intentions, curriculum materials, teaching methodology, and potential outcomes are so complex that several interpretations of data are plausible. As pointed out candidly by the researcher, other interpretations may be advanced to fit the facts.

c) There is suggestive evidence that the researcher tended to influence the teacher "to make the classroom discussions intellectually more stimulating" (p. 676). The abstractor assumes that intellectually stimulating discussions necessitate some sophistication in modes of thinking and abilities to abstract that are unlikely to predominate in a nonacademic class of ninth graders. Probably, the lack of sophistication in modes of thinking and the inability to abstract were indirectly major factors that influenced the categorization of the students as nonacademic. Several research studies have indicated that a considerable proportion of 'regular' high school students has not attained the stage of formal reasoning. If it is safe to assume that most of the group of nonacademic ninth grade students of the study are in the concrete stage of thinking, then expectations, selection of curriculum materials, and teaching methodology should take this into consideration. It is expected that these students rely heavily on sensory experiences and are likely to benefit more from a well-planned and guided visit to a zoo or from viewing a film on the topic. They need to be guided in what to look for.

d) The excerpts of questions and answers are practically all two-way between the teacher, on the one hand, and one student at a time, on the other. Since students were not identified, the excerpts do not indicate whether many students were involved, i.e., whether the teacher distributed participation among students through the questions. The comment on the excerpt (p. 684) suggests that questioning in that excerpt was basically directed at one student. No students were invited to respond to the first student's answer and there were occasions in which the teacher repeated the student's answer, which is to be avoided according to Blosser (1973, p. 27). It could be imagined that in such a class, three or four students who were interested in birds answered all questions while the others were not involved. The extent to which the actual teaching of this episode was close to or different from this scenario is not known. From another angle, it is not stated in the article if the teaching included aspects other than questions and answers.

e) Epistemology has traditionally been defined as the theory of knowledge. It deals with issues such as the sources of knowledge, how it is acquired and verified, and the relation of the knower to the known. As a philosophical study of the nature of knowledge, epistemology is related to other major philosophic disciplines and, with time, has become associated with learning theory and with cognitive psychology, among others. In the article, the researcher used the term 'epistemological' to reflect inquiry-orientation or involvement in the processes of science. The idea of a continuum with flat or poor at one end, and rich at the other, is attractive for further development and potential scaling or quantification. But, it is the abstractor's view that the adverb 'epistemologically' adds an impressive term to an already confused state of terminology in the literature as it relates to processes of science. To illustrate the broader usage of the term, reference is made to its multiple use in one paragraph of a recent publication (Olstad and Haury, p. 305). The teaching episode, as described in the study under review, touches upon a very narrow band of the wide spectrum of processes of science and, as such, does not seem to form an adequate basis for the development of a meaningful conceptual organizer on the topic.

f) It is possible to develop in students processes of science without strict replication of what scientists, in this case biologists, do. Matching 'disconnected bird heads and feet' can be developed into a lesson that may teach observation, comparing, judging, analyzing, and inferring. It is the abstractor's impression that the researcher's insistence on the presence of relevant and available context has been excessive. Absence of context (whole bird) in the exercise and failure of the teacher to provide it were the basis for labelling these as epistemologically flat. The same judgment was given for failure of the teacher to actively attempt to help the students "be aware of the intellectual skills they are using or to see what aspects of the investigation are analogous to scientific work and what aspects are not" (p. 685). Actually, attempts to realize the objective of making students aware of the intellectual skills they are using may better be delayed until students acquire intellectual skills and get into the habit of using them repeatedly.

g) No systematic and appropriate method of evaluation seems to have been followed to determine whether the students have developed some understanding of scientific process or not. Similarly, on what basis can it be claimed that the goals have or have not been realized? How can it be judged whether students have experienced success and felt competent or not?

To conclude, the idea of the study is commendable as it attempts to place learning in the whole of its context rather than concentrating on a small artifical fraction of what takes place in the classroom. Unfortunately, the wider context makes it more complex, necessitating either deeper study of the different facets of the problem or limiting its boundaries. Whether the investigation is quantitative or qualitative, great care needs to be exercised in the design, data collection, and interpretation in order to arrive at an appropriate account and analysis.

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Descriptors--Academic Achievement; Academic Aptitude; Aptitude Treatment Interaction; *Chemistry; *College Science; College Students; Higher Education; *Science Instruction; Student Attitudes; Student Characteristics; Teaching Methods

Expanded abstract and analysis prepared especially for I.S.E. by Thomas R. Koballa, Jr., The University of Texas at Austin.

Purpose

The purpose of the investigation was to test the effect of high versus low structured instruction and differences in college students' cognitive and noncognitive aptitudes on their performance in a chemistry laboratory course and attitudes toward the instruction provided and knowledge acquired.

Rationale

Advancements in instructional design by Gagne (1963, 1977) and studies by Snow (1976) and Peterson (1977) provide the contextual framework for the investigation. Gagne recognized the need for the instructor to arrange the conditions of instruction that are likely to effect the desired change in the learner. Focusing on conditions external to the learner that support the internal learning process, the investigator selected instructional strategies from those identified by Gagne (1977) that are likely to enhance student performance in the laboratory if incorporated in the instruction. Studies by Snow and Peterson suggest that when instruction is altered to effect the desired change in the learner, such instruction affects students differently according to individual differences in cognitive and noncognitive aptidude patterns. In the investigation, Kozma extends the work of Peterson by ascertaining the effect of selected instructional strategies and student aptitudes on cognitive and affective learning outcomes in a science laboratory.

Research Design and Procedures

A posttest only control group design was used in the investigation. The treatment took place during one laboratory period lasting three and one-half hours. The independent variable was the degree of structure provided in the written instructional materials, pre- and post-lab lectures, and laboratory assistance. The two conditions of the independent variable were low structure and high structure.

Low structure. Written materials consisted of information introducing the concepts and rules needed to conduct a laboratory investigation on kinetics. The instructors gave brief pre- and post-lab lectures and circulated in the laboratory answering questions, but not volunteering comments and suggestions.

High structure. Motivational introductions, explicitly stated objectives, attention-directing devices (e.g., emphasizing key points), reviews, examples, questions, and feedback were added to the written and aural instructions provided the low structure sections. During the pre- and post-lab lectures, the laboratory instructors stressed the learning strategies included in the laboratory manual used by the students in the high structure group. In addition, the instructors circulated during the laboratory period asking questions and providing feedback to students.

The sample consisted of 217 students enrolled in an introductory chemistry laboratory course. The students were assigned to one of ten sections of the course as part of the normal registration process at the university where the investigation was conducted. By means of random selection, five of the ten sections received the "high structure" treatment; the other five sections received the "low structure" treatment. Each of the five instructors who taught the laboratory course was assigned two sections, one participating in each treatment.

Students' scores on several measures of cognitive and noncognitive aptitude were obtained prior to the investigation and used as moderator variables. The measures used to assess the cognitive aptitude of students were the Scholastic Aptitude Test (SAT) and the American

Chemical Society High School Chemistry Exam (ACS-HCE). The State-Trait Anxiety Inventory, A-Trait Scale and shortened versions of the Achievement-via-Conformance (Ac) and Achievement-via-Independence (Ai) scales of the California Psychological Inventory were the measures employed to assess the students' noncognitive aptitudes. The Ac scale purports to identify students who are capable, efficient, organized, responsible, and sincere. Students who possess the traits of maturity, foresight, and self-reliance can be identified by high scores on the Ai scale. In combination, the scales provide measures of motivation (Ac + Ai) and cognitive style (Ac - Ai). When measuring cognitive style, a high score indicates conformity and a low score, independence.

There were four dependent variables measured in the investigation: 1) the application of concepts and rules learned, 2) the time required to solve a set of laboratory problems, 3) the degree of comfort associated with the knowledge acquired, and 4) feelings toward the instructional presentation. A five-item multiple choice test was used to measure the application of concepts and rules learned in the laboratory investigation to new situations. Two attitude statements were used to measure the students' degree of comfort with the knowledge acquired during the laboratory investigation and their feeling toward the instructional presentation. Both the multiple choice test and the attitude statements were constructed by the investigator. In addition to measures used to assess the effect of treatment, the perceived fidelity of the two treatments was ascertained via student responses to a single question.

Findings

The mean rating for structure was significantly higher for the high structure group than for the low structure group, verifying the fidelity of the two treatments.

The group receiving the high structure treatment scored significantly better on the five-item multiple choice test, and took less time to solve the instructional techniques used during the laboratory period than the group receiving the low structure treatment. No difference was detected between the two treatment groups regarding their comfort with the knowledge acquired.

Multiple regression was used to determine the significance of interactions. Ability (represented by SAT scores) was found, regardless of the treatment condition, to moderate each of the dependent variables. For example, high ability students scored better on the multiple choice test, required less time to solve the laboratory problem set, felt more comfortable with the knowledge acquired during the treatment period, and were more satisfied with the instructional presentation. Prior chemistry-achievement and anxiety were also found to moderate comfort with knowledge. Illustrative of this interaction was the finding that anxious students who scored high on the High School Chemistry Exam felt more comfortable with their newly acquired knowledge.

Very few significant interactions were found between the independent variable and moderator variables. Treatment interacted with both motivation and style. The more conforming students preferred the instruction provided in the high structure treatments. The more motivated students, while satisfied with the instruction provided in the high structure treatment, preferred the instruction provided in the low structure treatment. A complex interaction among treatment, anxiety, and ability was also found. The high structure treatment was preferred by both high-ability, high-anxiety and low-ability, low-anxiety students. Students possessing the traits of high-ability, low-anxiety and low-ability, high-anxiety preferred the low structure treatment.

Interpretations

The instructional strategies that composed the mainstay of the high structure treatment served to enhance students' understanding, performance, and satisfaction in the laboratory. The benefits of the instructional strategies accured to students regardless of individual differences in cognitive and noncognitive aptitudes.

ABSTRACTOR'S ANALYSIS

The investigation represents a logical and needed extension of an existing body of knowledge regarding the effect of instructional design and learner aptitudes on student performance and attitudes. It should be of interest to those responsible for secondary and college laboratory instruction.

The investigation was prompted by observations made by Tamir (1977) and Kyle, Penick, and Shymansky (1979) that suggest that college laboratory courses are generally of a cookbook nature and do not emphasize the processes of science. In attempting to enhance students' outcomes, several instructional strategies, identified by Gagne (1977), were added to an existing college chemistry laboratory course. Previous investigations by Peterson (1977) and Snow (1976) illustrated that treatments and aptitudes may interact. Student aptitudes were, therefore, taken into account when the affect of treatment was assessed.

The basic idea of the investigation is sound. There are, however, several aspects related primarily to the manner in which the investigation was reported that makes the interpretation and replication of it difficult. To begin with, why the investigator believes that the affective dependent variables measured are likely to be affected by the instructional treatment is not obvious. A rationale for assessing the students' degree of comfort with their newly acquired knowledge and feeling toward the instructional presentation should be included in the report.

The description of the instruments used to assess the outcomes or the dependent variables was too brief. The multiple choice test and the attitude items and how they were scored are not sufficiently described. If the measures were specifically developed for this investigation, a complete description, including a representative question and distractors from the multiple choice test and the two attitude items, should have included in the report. If the measures were used in earlier investigations or described in other documents, the report should have included references to those sources.

Critical details are also omitted from the description of the instruments used to measure the students' cognitive and noncognitive aptitudes, the moderator variables. Neither reliability estimates nor validity data are reported for any of the instruments used. No details as to how the two subscales from the California Psychological Inventory were shortened are provided.

Weaknesses in the research design suggested alternative explanations to the reported findings. Using a posttest only control-group design, random assignment is an investigator's only means of assuring that no initial differences exist between treatment groups. To the extent that he could, the investigator made a diligent effort to achieve random assignment of instructors and students. However, with a subject attrition rate of 13%, one can argue that the differences between treatment conditions noted on the outcome measures may be due to the differential characteristics of those students who chose not to participate.

To lessen the possibility of such a conclusion, a pretest-posttest control group design could have been employed. In using this design, concerns about students' responses to the short multiple choice test and the attitude items influencing their response to the same measures at the end of the treatment period would have necessitated the development of a parallel form of the multiple choice test and longer forms of the attitude measures. While requiring the development and piloting of the newly developed instruments, this experimental design would have greatly lessened the possibility of alternative explanations of the findings.

The nature of the independent variable limits the usefulness of the reported findings. Using instructional strategies identified by

Gagne (1977), the investigator constructed a high structure treatment that proved to enhance students' performance in the laboratory and attitudes toward the instruction provided beyond that of the low structure treatment. The strategies that composed the mainstay of the high structure treatment were many, including motivational introductions, explicitly stated objectives, and a host of attention-directing devices that were added to the written and aural instructions. Amassed, these instructional strategies compose an independent variable that is extremely gross in nature; one cannot even begin to speculate as to which strategy or combinations could have caused the outcomes reported. It is also possible that some of the instructional strategies may have deterred further positive outcomes. To this extent, the investigation by Kozma must certainly be viewed as preliminary. Further investigation along this line should focus on identifying the instructional strategies that serve to enhance the outcomes desired from laboratory experiences.

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Descriptors--*Curriculum Enrichment; *Educational Environment; Evaluation; *Evaluation Methods; Instruction; Science Curriculum; *Science Education; Science Instruction

Expanded abstract and analysis prepared especially for I.S.E. by Richard Duschl, University of Houston-University Park.

Purpose

The authors' purpose was to review recent research studies in science education that used the Learning Environment Inventory (LEI) to assess the climate of the classroom. The science classroom is a complex social system in which many events occur. Interactions among students and teachers, feelings between student and teacher, management techniques, and the actual teaching that occurs represent some of the factors which establish the classroom environment. Ten research studies were included in the review.

Rationale

In the past, teacher concern and energy has emphasized the selection and slight adaptation of new instruction and curricular materials. Research (Schulman and Tamir, 1973) now suggests two new phenomena which need to be addressed:

1. Teachers must be increasingly involved and interested in school-based curriculum development which aims at organizing experiences for meeting the needs of individual students.
2. A new era has emerged where the importance of the affect, imagination, and attitudes as outcomes of science instruction are at least as important as their cognitive counterparts.

Getzels and Thelen (1960) suggest that the classroom is a unique social system which is guided by certain goals, rules, and expectations that both influence and predict student achievement and attitudes.

Walberg (1971) argues that learning environment has the same relationship to instruction that student ability has to achievement. A number of research studies have shown that there can be either positive or negative relationships between student perception of classroom environment and student achievement in science. Such studies are the focus of the authors' review of research on classroom environments.

Research Design and Procedures

The investigators' review of the research on the effect learning environments have on the science classroom is limited to only those studies which used the "Learning Environment Inventory" (LEI) developed by Anderson and Walberg (1974). The LEI consists of 15 scales with 7 items in each scale. Each scale is designed to measure a student's perception of the various components of classroom environment. The instrument is based on the hypothesis that the student is in the best position to assess the classroom environment in which he/she is enrolled. The fifteen scales of the LEI are listed in Table 1.

Names of Scales Contained in LEI, MCI, CES and ICEQ

Learning Environment Inventory (LEI) (Anderson & Walberg, 1974; Fraser, Anderson & Walberg, 1982)

Cohesiveness	Friction	Democracy
Diversity	Goal Direction	Cliqueness
Formality	Favoritism	Satisfaction
Speed	Difficulty	Dissorganization
Material Environment	Apathy	Competitiveness

My Class Inventory (MCI) (Fisher & Fraser, 1981; Fraser, Anderson & Walberg, 1982)

Cohesiveness	Difficulty	Competiveness
Friction	Satisfaction	

Classroom Environment Scale (CES) (Tickett & Moos, 1973; Moos & Tickett, 1974)

Involvement	Task Orientation	Rule Clarity
Affiliation	Competition	Teacher Control
Teacher Support	Order & Organization	Innovation

Individualized Classroom Environment Questionnarie (ICEQ) (Rentoul & Fraser, 1979; Fraser, 1983a)

Personalization	Independence	Differentiation
Participation	Investigation	

The paper and pencil administered inventory asks students to choose among four responses: strongly agree, agree, disagree, or strongly disagree. The authors feel that the instrument is thereby easy to administer and the results are easily analyzed. Further, since the teacher is not mentioned in any of the items, the instrument is not perceived to be a threat to the teacher.

Findings

Three catagories of research studies which utilized the LEI are summarized:

a. assessment of science curricula.

b. assessment of instructional techniques,

c. assessment of class size.

In each case, class environment as reflected by student responses on the LEI is viewed as a dependent variable.

Based on three studies of the effect curriculum has on class

TABLE 1

Names of Scales Contained in LEI, MCI, CES and ICEQ

Learning Environment Inventory (LEI) (Anderson & Walberg, 1974; Fraser, Anderson & Walberg, 1982)

Cohesiveness	Friction	Democracy
Diversity	Goal Direction	Cliqueness
Formality	Favoritism	Satisfaction
Speed	Difficulty	Dissorganization
Material Environment	Apathy	Competitiveness

My Class Inventory (MCI) (Fisher & Fraser, 1981; Fraser, Anderson & Walberg, 1982)

Cohesiveness	Difficulty	Competitiveness
Friction	Satisfaction	

Classroom Environment Scale (CES) (Trickett & Moos, 1973; Moos & Trickett, 1974)

Involvement	Task Orientation	Rule Clarity
Affiliation	Competition	Teacher Control
Teacher Support	Order & Organization	Innovation

Individualized Classroom Environment Questionnaire (ICEQ) (Rentoul & Fraser, 1979; Fraser, 1983a)

Personalization	Independence	Differentiation
Participation	Investigation	

environments (The Project Physics Course, 1971; Shaw & Mackinnon, 1973; and Welch, 1979) the authors report that research suggests that the curriculum itself could cause different student perceptions of their science classroom. Further, such results suggest that the science teacher must adopt a reflective attitude about curriculum and its potential effect on learning environments.

The review of studies on the effect instructional techniques have on learning environments included an investigation into inquiry-centered science by Fraser (1979), an investigation by Johnson and Johnson (1975) on cooperative and competitive learning environments, and investigations in the role of the laboratory in maintaining select environments (Hofstein et al., 1980; Egelston, 1979).

Based on these four studies it is suggested that student perceptions can be used by teachers to select the optimal instructional methods for their students. Inductive, deductive, laboratory focused, discussion, and individualized instructional strategies are cited as examples of options teachers may consider adopting in response to students' perceptions, needs and expectations in the science classroom.

With respect to the effect class size has on the learning environment, the authors based their conclusions on the comprehensive results of the Project Physics study of 150 classes. In that study it was found that students enrolled in smaller classes perceived their classroom environments as more cohesive and difficult and less formal compared to those students enrolled in larger classes.

In general, the authors feel that the findings of the research review suggest that the atmosphere and environment in which students encounter science affect students' attitudes towards science and their achievement in science. The interaction between students and students, students and teachers, and students and subject matter represent significant variables in the education process.

Interpretations

The LEI is a sensitive measure for explaining and predicting important cognitive and affective educational outcomes. The authors also found the LEI to be a valid and reliable instrument for use in self-evaluation, for planning by individual teachers, and for analyzing classroom discussions. It is the position of the investigators that teachers can improve their classrooms based on the perceptions of students' goals and values. Also, the research studies suggest that such improvements can affect curriculum, teaching strategies, student learning, and the dynamics of the classroom/ laboratory.

Therefore, given that a critical goal for the teachers and schools should be to optimize classroom environments, the LEI provides a mechanism for reaching such an objective. However, the authors warn, interpretation of results and application of conclusions should both be made with caution.

ABSTRACTOR'S ANALYSIS

The educational environment is indeed a very complex setting. Social and physical elements of the classroom, faculty, the administration, school policies, and curricula are some of the factors that make up the educational environment. The environment is reported to be so complex (Shavelson, and Stern, 1981) that teachers often create models of reality based on select information just to cope with the barrage of stimuli. Which information to focus on, to select, in making effective pedagogical decisions is a separate and dynamic domain of educational research (Walberg and Peterson, 1979).

The present study summarizes research which has examined one portion of the educational environment-the environment of the science classroom. The perspective for establishing the nature of this environment is from the student's point of view. The environment being assessed is the social-psychological environment of learning; otherwise referred to as the classroom climate (Chavez, 1984). In the sections below both methodological and epistomological issues of classroom climate research are addressed. Preceding this is an assessment of the current state of research on learning environments.

The LEI is but one of several instruments available for assessing the classroom learning environment. Other available instruments are My Class Inventory (MCI) (Fisher and Fraser, 1981; Fraser, et al, 1982), a simplified form of the LEI; Classroom Environment Scale (CES) (Trickett and Moos, 1973; Moos and Trickett, 1974) which grew out of research on a variety of human environments; and Individualized Classroom Environment Questionnaire (ICEQ) (Rentoul and Fraser, 1979; Fraser, 1983) which differentiates conventional classrooms from classrooms that individualize instruction. The scales contained withing each of the instruments are listed in Table 1. A distinction among the four instruments beyond the different scales which are used, is that the CES and ICEQ have forms that test preferred classroom environments as well as actual classroom environments. The LEI and MCI forms are only for assessing the perceptions of the actual classrooms. Short forms of the MCI, ICEQ, and CES are available (Fraser, 1982; Fraser and Fisher, 1982). Chavez (1984) has provided a comprehensive review of the historical genesis of classroom climate research. Contemporary classroom climate research has grown out of the pioneering work done with Flander's Interaction Analysis Scales. From this review it is evident that the LEI has been used more extensively than the present article suggests. Important works in science education classroom climate research that are not reported by Hofstein, Yager, and Walberg but perhaps should have been included are studies reported by Fraser (1978, 1980, 1981), Lawrenz (1977), and Fraser and Walberg (1981). Outside of science education, the number of research studies which have used the LEI, or its spin-off the MCI, are too numerous to report in this analysis (See Chavez, 1984 or Haertel, Walberg, and Haertel, 1981 for comprehensive bibiographies of classroom climate research.) Given the type of conclusions drawn from the review made by the authors, the implications would have been much stronger if more studies were included.

Classroom learning environment scales have been used to conduct various types of research. Fraser (1983) summarizes research in four areas:

a. Associations between student outcomes and classroom environment.

b. Differences between scores on various froms of scales.

c. Use of environment perceptions as criterion variables.

d. Person-environment fit studies of whether students achieve in their preferred environments.

Fraser (1983) also discussed how classroom environment perceptions can be used in guiding practical attempts to improve the classroom. However, he indicates that such research is relatively new.

Classroom climate/environment assessments have an elaborate history and great potential for a variety of purposes in the future. The investigators are accurate in pointing this out. But the authors did not adequately address two issues pertaining to the use of data gathered by the LEI: one, the use of students as sources of data and two, the caveats surrounding the interpretation of the data. A major assumption of classroom environment studies is that students are capable of providing an accurate description of the classroom social-psychological climate. It is important to recognize that perceptions are governed by prior knowledge and experiences. Thus, students' perceptions about the classroom are limited. An important question which must be asked is, What are students capable of perceiving? The answer is provided by the scales listed in Table 1. The focus is on the interactive aspects of teaching, i.e., what occurs during the implementation of instructional tasks. Consequently, the research studies on class climate are only addressing how to teach and how to structure the learning environment.

Haertel et al, (1981) found, from a meta-analysis which included 10 data sets reporting 734 correlations from a total of 17,805 students in 823 classrooms, that the LEI scales that were related positively with productive learning environments were: cohesiveness, satisfaction, task, difficulty, formality, goal direction, democracy, environment, and competition. Cerebus paribus (all other things being equal), these factors are important for improving educational practice. But, as Bloom (1984) has pointed out, teachers do not control all of the factors which impact on the environment of learning. I am skeptical then of the investigators' sweeping claim, "If teachers know how their students perceive their learning environment, they can select the best and optimal instructional methods for their students." Essential knowledge for making teachers effective decision-makers is identified (Boyer, 1984) as including competence in three areas:

1. knowledge of the curriculum as it relates to what is taught and how it is to be assessed.
2. knowledge of the student.
3. knowledge of the setting of instruction - the classroom and the school.

The research on learning environments addresses only one of the three essential areas. Subsequently, the authors' suggestion that the LEI is an "instrument that can be used for self-evaluation and planning by individual teachers" is hastily drawn. Fraser (1983) reports that such research questions have only begun to be explored.

The evidence cited in the review being analyzed does not support the recommendation that the LEI can be used to analyze class discussions. Nor does the research support the inference that the LEI can be used to cause changes in the curriculum, teaching strategies, student learning, and the dynamics of the classroom/laboratory. Rather, the research cited supports the counter claim that curriculum, etc. can cause changes in the learning environment. The research does support the authors' principal claim that the LEI is a useful instrument for finding differences in class environments. Why such differences exist and how teachers might effect changes in class environments are questions which have only begun to be addressed (Festermacher, 1978; Walberg and Peterson, 1979; Fraser, 1983).

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Descriptors--Aptitude Treatment Interaction; *Chemistry; *Cognitive Development; Cognitive Processes; *Developmental Stages; Predictor Variables; *Science Curriculum; Science Education; Science Instruction; Secondary Education; *Secondary School Science; Secondary School Students; Student Characteristics

Expanded abstract and analysis prepared especially for I.S.E. by Charles R. Ault, Jr., Indiana University, Bloomington.

Purpose

The authors investigated the use of an assessment of student cognitive level as a predictor of success in a high school chemistry unit and developed a technique for estimating the cognitive demand of each item included in an achievement test for that unit. They addressed the problem of matching the "cognitive requirements of the curriculum" with the "cognitive levels of the students." Their aim was to validate tools and a strategy useful to classroom teachers interested in improving the curriculum-cognitive level match.

Rationale

The Piagetian distinction between "concrete" and "formal operational" thinking provided a framework for the study. The authors acknowledged that student success in the secondary science curriculum frequently demands facility with formal thought. However, they also noted that many high school students consistently fail to use formal operations. The authors accepted the assumption that the mental logic of formal operations is simply unavailable to many secondary students at their level of cognitive development.

Howe and Durr linked their research to several highly respected investigations that have addressed the "mismatch between pupils' levels of thinking and the cognitive demand of the curriculum." They accepted Lawson and Renner's (1975) claim that Piagetian stage classification usefully predicts a student's science achievement. In the work of Herron (1975) and Karplus, et al. (1977) they found progress towards the goal of determining the cognitive demands of specific science concepts and problems.

Most importantly, the authors drew upon Shayer's (1978) procedures for determining the cognitive difficulty of topics in the secondary science curriculum. Howe and Durr claimed as their major purpose the adaptation of Shayer's procedures to a unit of the New York State Chemistry Syllabus. They judged Shayer's guidelines and techniques the answer to the "unsolved problem" of transmitting findings on the relationship between Piagetian developmental stage and science achievement into classroom practices.

Research Design and Procedures

Because the authors wished to transmit Piagetian findings into classroom practices by means of testing procedures teachers could usefully apply to their own students, they constrained their research to a one group, pretest-posttest design. As a treatment they used content from the New York State Regents Chemistry course of study as taught by one experienced teacher. The pretest observations consisted of two measures of Piagetian development. They drew posttest observations from two sources: 1) students' scores on a 23 item achievement test and 2) comparison of a predicted cognitive difficulty for each test item with a "found" cognitive difficulty. They made several attempts to assess the validity and reliability of the procedures for predicting and "finding" cognitive difficulty and throughout the investigation utilized classroom settings and practicing teachers as part of the design.

The pretest instruments. Seventy-one high school chemistry students took two tests measuring Piagetian level. Tests were selected according to two criteria: 1) instruments that teachers could administer and score in a reasonable amount of time, 2) instruments that would "cover the expected range of pupil (Piagetian) levels." One instrument, the Logical Reasoning Test (LRT) (Sund, 1976), sorted students into formal and concrete operational thinkers. The test items were all paper and pencil problems. The other instrument, Science Reasoning Task III (SRT) (Shayer, et al., 1980), sorted students according the substages of operational development from early concrete (below 2B) through late formal (3A). No statistics were given correlating results from the two instruments. However, the authors reported the criteria for using combined scores to assign subjects to one of four Piagetian levels (2B, 2B/3A, 3A, 3B, with 2B/3A being transitional between concrete and formal stages) and stated that only six students scored formal on one test and concrete on the other.

Four students who scored below 2B on the SRT were dropped from the study. One person (not the classroom teacher) scored the tests and assigned pupils to a Piagetian level by their scores. Since Howe and Durr were careful to point out that the test scorer had no "biases" about the students' abilities, this reader inferred that the scoring procedure involved individual judgment. No reliability of the scoring procedure was reported.

Classification of students into four Piagetian levels was needed for two purposes: 1) to predict achievement and 2) to determine the cognitive demand of each item in the achievement test. This "found" cognitive demand was then compared to a "predicted" cognitive demand obtained by the procedure described in the "Posttest Comparisons" section below.

The instructional treatment. Instructional objectives centered on achieving comprehension of the "mole concept." Each of six basic skills (calculations involving Avogadro's Number determination of the empirical formula of a compound from percentage composition, gas volume calculations, etc.) was explicitly assessed on a unit test (Kuder-Richardson 20 reliability, 0.90; average discrimination index 0.63) composed of 23 presumably valid items selected from CHEM Study Achievement tests, New York State Regents Examinations in Chemistry, and the American Chemical Society-National Science Teachers Association High School Chemistry Examination.

The posttest comparisons. In order to estimate the cognitive demand of test items, Howe and Durr adapted guidelines from the literature (Herron, 1975; Karplus, et. al., 1977) into a simple set of criteria for classifying each item as late concrete operational (seven items), or late formal operational (7 items). This classification represented the "estimated" or "predicted" cognitive demand for each item.

"Actual" or "found" cognitive demand was also calculated for each item. This level was defined as "the lowest Piagetian level (as determined by the LRT and SRT combined score) at which 60% of the pupils got the item right, provided at least 60% of pupils at each higher level also got the item right."

Findings

The investigators found that four groups of pupils differed significantly ($p < .01$: one-way analysis of variance) with respect to performance of the unit achievement test. From regression analysis, they determined that a "moderately high" association existed between Piagetian level and unit test score (multiple correlation r^2 of 0.44).

The findings in answer to their second objective--determination of the cognitive demand of the curriculum -- were more complex. On all items, pupil success increased across Piagetian levels 2B to 3B. The investigators had succeeded in scaling the items by difficulty. Prediction of cognitive demand for individual items led to mixed results, though none substantially at odds with the investigators' skill in estimating the cognitive demand of most items. In general, cognitive demands were much higher than expected for low difficulty items (there were no 2B items "found" according to the definition given above). Three logically simple problems (such as finding the weight of one mole of a substance given its atomic formula and the atomic weights of its two elements) proved more cognitively demanding than expected. In each of these instances the problems were stated in "generic" terms (i.e., "elements 'A' and 'B') rather than standard chemical symbols. Only three items were somewhat less difficult than predicted -- similar problems in a more general form were not solved successfully by transitional pupils.

Interpretations

Howe and Durr stressed two results: 1) early concrete operational students failed to master any aspect of the mole concept and 2) Piagetian instruments can provide teachers with useful information about the abilities of students to master specific topics in the science curriculum. They also acknowledged that their guidelines for assessing the cognitive demands of specific concepts and problems need refinement. Although these investigators did not test the hypothesis directly, they conclude that "it is hard to escape the conclusion that chemistry as it is taught in secondary schools today is beyond the present abilities of a large segment of the high school population."

ABSTRACTOR'S ANALYSIS

The nation has listened recently to many statements about the decline and crisis in science education and responded, in part, by adding to the science requirements for graduation from high school. Educators must also listen to research reports about the level of cognitive demand in the curriculum. If Howe and Durr are right, more chemistry for more students holds little promise of more chemistry learning.

Howe and Durr strongly imply that the reason a large proportion of students in their study did not learn the mole concept was that they were unable to learn it with the tools available at their operational level of thought. This implication is difficult to defend on the basis of their results because it is also one of their starting assumptions and one with no potential for rejection within their experimental design. They do refer to Gabel and Sherwood (1980) who have found that the mole concept is very difficult for students to learn, regardless of the instructional method used.

Important to note is that the experiment in this study is on the investigators themselves. The results bear witness to their skill in using a simple procedure to determine the cognitive demands of specific test items. There are no treatment differences to compare across pupils and no control for excluding the hypothesis that both Piagetian level and mole concept learning are different expressions of the same underlying cognitive ability -- with neither an explanation of the other. Moreover, assuming that these researchers can invent a refined procedure for estimating the cognitive demand of chemistry topics does not offer hope for proving the proposition that operational level determines performance.

Such was not their goal, however, although it permeates the research as an implied assumption. Certainly, they have demonstrated the utility of assessing the difficulty of a curriculum: by estimation and by student performance in light of known student differences.

Apparently, formal operational thinking was unavailable to many of these 67 pupils in the context of solving problems dependent upon application of the mole concept. Are formal operations unavailable to these students in other contexts? Did the students who succeeded on mole problems actually do so using formal operations? Are the most difficult problems solvable with non-formal techniques?

Some of the interesting results in this study are the exceptions to the predictions. Simple problems stated without linguistic content proved more difficult than problems of analogous logical form but with a linguistic (or semantic) content (i.e., chemical symbols). Additional research could focus on a "semantic content" and its effect on problem difficulty in chemistry.

Three items proved less difficult than anticipated. The authors speculate that students may have learned algorithms particularly appropriate to these problems but had failed to learn to recognize the problem in a more general form. This observation raises at least two interesting questions. What aspects of a problem lead students to recognize its general form? How does success in a restricted set of problems transform into success with the more general set? Phrasing questions in this style helps to point out the educative potential of the science curriculum, not the pessimistic conclusion that many students cannot learn. Perhaps learners depend upon imagery -- not mental logic levels -- in constructing a potential problem solution. If so, teaching should guide the learner in acquiring imagery rich enough to give meaning to principles that the learner may subsequently disembed from the primary image.

This speculation is intended to raise the question of what the limits to applying Piagetian stage constructs in classroom practice might be. Documenting that some students (even many students) appear impervious to instruction does not prove that instruction fails to cause cognitive change. The Howe and Durr paper admirably establishes that the demands of the chemistry curriculum too often outstrip the performances of chemistry students. The analysis of such research raises a fundamental question in science education research: do Piagetian constructs constitute an explanation of student performance?

In their last paragraph Howe and Durr advise teachers to assess student cognitive levels, use their guidelines to estimate the cognitive demands of curriculum objectives, construct test items for each objective (and balance the items for the test according to estimated cognitive demand), administer and score the test. The "found" level of cognitive demand for each item can then be used in planning instruction. Is this system superior to conventional use of item difficulty information in test construction and course objective authoring? Would a mole concept pretest do better or worse in predicting student performance than the cognitive level assessment? The investigators have completed a very careful piece of research consistent with their objectives and reported procedures and results in detail sufficient for others to replicate. Their observations and interpretations raise questions that go beyond the design of their research to the presuppositions and potential value of their research paradigm.

The problem they address -- transmitting Piagtian assertions about the relationship of operational level to performance in science -- is of primary concern to science educators and merits careful discussion on many levels. Anyone interested in pursuing this topic should read "Is it Formal if it's not Physics?" (Linn, Clement and Pulos, 1983) which includes the claim, "Evidence for content effects casts doubt on use of formal reasoning tasks to assess whether students will be able to reason formally in a particular content area (e.g., introductory chemistry)." (p. 768). Apparently, student familiarity with content influences their expectations of the effects of key variables. Expectations, in turn, effect operational reasoning performance and greatly complicate efforts to assess student cognitive level by operational stage.

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Descriptors--*Curriculum Development; Junior High Schools; Questionnaires; *Science Course Improvement Projects; *Science Curriculum; Science Education; *Science Teachers; Secondary Education; *Secondary School Science; Teacher Attitudes; Teacher Characteristics

Expanded abstract and analysis prepared especially for I.S.E. by John R. Staver, University of Illinois at Chicago.

Purpose

The goal of the study was to examine the concern profiles of junior high school teachers involved in the implementation of the ISCS curriculum. Three research questions were answered:

1. What are the concerns of junior high school teachers who are implementing ISCS?
2. How do the concern profiles for ISCS users differ from those of nonusers?
3. How do concerns differ among teachers with varying amounts of ISCS teaching experience?

Rationale

Adoption and implementation of the NSF-developed ISCS curriculum usually represents a drastic change in curriculum and instruction for students, teachers, and administrators. Unlike other junior high school science curricula, ISCS is a complete curriculum package for grades 7, 8, and 9. Its primary thrust is individualized science instruction through a self-paced text. Other aspects of ISCS are: 1) student involvement in the selection and sequencing of content; 2) remedial instruction in basic skills; 3) enrichment activities;

4) emphasis on the processes as well as the products of scientific inquiry; 5) hands-on laboratory experiences; and 6) teacher as an advisor/facilitator rather than an information giver. Taken together, these aspects provide ISCS a unique niche among curriculum projects. Implementation of such a complex, unique science program necessitates a complex role modification for students and teachers. In spite of such complexities and associated implementation difficulties, ISCS has become one of the most widely adopted NSF sponsored junior high school science programs; it is used in about 12% of the districts (Weiss, 1978).

The conceptual framework for the present examination of teacher concerns is taken from research and development work done in the Procedures for Adoption of Educational Innovation (PAEI) project at the Research and Development Center for Teacher Education, located at the Univeristy of Texas at Austin. The change process as it affects the individual teacher has been the focal point of the PAEI effort through usage of the Concerns-Based Adoption Model (CBAM) (Hall, Wallace, and Dosett, 1973).

The stages of concern about an innovation represent a critical part of the CBAM. Concern stages are an outgrowth of earlier work (Fuller, 1969), which showed that teachers' concerns progress from self concerns, to task concerns, to impact concerns as they move through their teacher education programs. Seven stages of concern, (awareness, informational, personal, management, consequence, collaboration, and refocusing) are defined within the Concerns-Based Adoption Model and assessed by means of a 35-item instrument entitled Stages of Concern Questionnaire (SoCQ).

Research using the SoCQ indicates that, initially, awareness, informational, and personal concerns are likely to be high. During early implementation, management concerns become elevated while earlier concerns gradually lessen. Later, consequence, collaboration, and refocusing concerns become more intense. Concerns tend to follow a profile of increasing and decreasing levels as implementation occurs.

Research Design and Procedures

The sample of 229 potential subjects was taken from a population of teachers who attended NSF sponsored ISCS Implementation Institutes at Kansas State University from 1972 to 1974, and all junior high science teachers from a large midwestern city. The authors do not describe the sampling procedure further. SoCQ instrument and demographic questionnaires (age, sex, years of experience, length of time teaching ISCS, self estimate of quality of use, number of classes taught be level, formal ISCS training, and their involvement in the first or second year of another major innovation) were mailed to potential subjects. One hundred thirty-nine responses were returned. The majority (58%) were from Kansas, but questionnaires were returned from 21 other states.

The Stages of Concern Questionnaire (SoCQ), mentioned earlier, is a 35-item instrument developed to assess stages of concern for innovations. Test-retest reli:'bility and validity information are reported elsewhere (Hall, George, and Rutherford, 1977).

The research design is descriptive and cross-sectional in nature.

Findings

The authors present their results in a series of three graphs. The relative intensities of each stage of concern for all ISCS users and for nonusers are shown in the first graph. The relative intensities of each stage of concern for first, second, and third year ISCS users and nonusers are compared in the second plot. Relative concern stage intensities of fourth and fifth-year ISCS users and nonusers are plotted in t third graph. Of the 129 participants, 122 were ISCS users, and 1/ were nonusers. Listed below are the principal points discussed regarding the graphs. The authors caution that readers should not interpret the findings as evidence that individuals develop across the stages of concern as predicted, due to the cross-sectional design of the study. The authors do maintain, however, that observance of expected patterns supports the validity of the model.

1. Awareness, information, and personal concern intensities were relatively high for nonusers as compared to ISCS users. This finding is congruent with the hypothesized developmental model of stages of concern.
2. The intensities of consequence and refocusing concerns for nonusers are higher than expected, possibly because most nonusers taught in a district which had adopted ISCS as its junior high school science curriculum. Their decision not to use ISCS represents a stand against school district practice and could have thereby produced higher intensities of such concerns.
3. Lower intensities of awareness, informational, and personal concerns for first, second, and third-year ISCS users relative to nonusers are consistent with the expected profiles. Within ISCS users, high intensities of management concerns for first-year users compared with high intensities for impact concerns for third-year users reflects the different needs of these groups.
4. A relatively high collaborative concern intensity for second-year users is somewhat inconsistent with the model. Further examination of this group leads the authors to conclude that the past emergence of such concern is due to the extensive experience and strong leadership qualities of group members.
5. For fourth and fifth-year users, the decline of personal concerns and increase of consequence concerns is consistent with the model. It reflects the thoughts of such teachers regarding the effects of ISCS use on student achievement and attitudes and possible adjustments in the curriculum.

Interpretations

The authors caution again that conclusions must be qualified due to the use of a cross sectional sample. Further, the conclusions are based on assumptions about the validity and truthfulness of responses to a paper-pencil questionnaire. The authors also recommend strongly that future investigators who use the SoCQ should check initial analyses through direct, informal, on-site methods with respondents and their supervisors. Listed below are three conclusions considered justifiable by the authors:

1. The concerns of ISCS users differ from those of nonusers. Users express more intense task and impact concerns (consequence, collaboration, refocusing), whereas nonusers exhibit more-intense personal concerns.
2. ISCS teacher concerns are expected to change with time according to the developmental progression proposed in the model (Hall, Wallace, and Dossett, 1973).
3. Teachers with four or more years of ISCS teaching experience may be expected to exhibit higher refocusing concerns. This indicates that such teachers are considering modifications and alternatives to innovation. Thus, a cycle of adoption, implementation, and redirection may exist within the arena of innovation.

The authors go on to make six recommendations to those who have leadership responsibilities for curriculum change in science. The recommendations are derived from the results of this and other studies cited in this paper, which utilize the model. They are summarized below.

1. Teachers approaching the adoption of an innovation will need personal support and orientation information. The support should focus on personal rather than impact concerns.
2. Inservice regarding management concerns of teachers should be provided at the time when management concerns are most prominent. Such concerns usually do not predominate in the initial implementation stages of an innovation.
3. Teachers will have a wide variety of concerns during the implementation process. Leaders should attend to the most intense of these concerns at the time of their manifestation.
4. Teachers using an innovation will exhibit a pattern of change in their concerns over time. Leaders should be sensitive to such changes.

5. The typical "one-shot" preschool workshop will not adequately support the implementation process. Rather, inservice programs should occur over an extended period, with attention to certain needs and concerns.
6. Researchers in science education should consider these results in evaluations of the outcomes of science curriculum implementations. It seems prudent to delay evaluation until teachers' personal and management concerns have been addressed.

ABSTRACTOR'S ANALYSIS

The authors would be hard pressed to find a research question more consistent with the NARST dedication--the improvement of science teaching through research. The concerns of faculty members who are responsible for the reality of classroom innovation play a critical role during classroom instructional changes. Without the enthusiasm and commitment of faculty, any innovative practice is doomed to failure. Whereas this bit of common sense, first acquired by many of us during our own years of teaching experience, seems so apparent, it is no surprise that school district administrators often fail to show similar common sense by attending to faculty concerns as well as other important variables. The "one-shot" workshop, as the authors point out, hardly begins to scratch the surface of the problem. Well-designed professional development programs, carried out over a period of years, are necessary.

The authors are commended for removing this problem from the arena of common sense, and placing it into the domain of empirical research. Such a transfer, of course, allows the potential that the knowledge derived will not necessarily look like old knowledge, which common sense requires (Ary, Jacobs, and Razavich, 1979). I found the framework of the Concerns-Based Adoption Model and the Stages of Concern Questionnaire quite excellent for answering their research questions. Whereas the conclusions and recommendations still retain some flavor of common sense, they were derived from a scientific process of empirical research.

Criticisms of the study are centered on interpretations based on the data. The authors caution that it would be inappropriate to conclude from these data that teachers progress through the stages of concern as predicted by the model. This caveat is due to the cross-sectional sample. Yet, their second conclusion appears to violate their own warning. Perhaps, it should be restated as: the relative intensities of ISCS teachers' concerns at different times are in accord with the concern intensities predicted by the model. Secondly, the presentation of the data as polygon line graphs (Ary, Jacobs, and Razavich, 1979), with the concerns connected, tempts the reader to violate the authors' caveat. Whereas the authors' graphs are a correct and meaningful way to present the data, I would prefer to see simple bar graphs showing the relative intensities of the concern stages.

The above mentioned criticisms, however, should not detract from the importance of the present research question, or the results, conclusions, and recommendations derived from it. They are meant only to reemphasize the cautions noted by the authors themselves.

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Descriptors--*Academic Achievement; Chemistry; *College Science; Conventional Instruction; Course Evaluation; *Curriculum Evaluation; Higher Education; *Individualized Instruction; Pacing; Physics; *Science Curriculum; Science Education; Science Instruction; Science Programs; *Student Attitudes; Two Year College Students

Expanded abstract and analysis prepared especially for I.S.E. by Bob VandenBranden, Drake University.

Purpose

The purpose of the study was to investigate whether or not a self-paced, individualized instruction course in basic chemistry and physics would result in (1) a greater level of mastery among academically underprepared students learning Basic Science, (2) more satisfaction with instruction, and (3) a more positive attitude toward basic science than a program of more traditional, whole class instruction.

Specifically, the following hypotheses were tested: (a) students experiencing individualized instruction would demonstrate a greater level of academic achievement than students who experience traditional instruction, (b) students would be more satisfied with individualized instruction than with traditional instruction, (c) students who experience individualized instruction would exhibit a more positive attitude toward science than students who experience traditional lecture instruction.

Rationale

Two classes of community college students having less than the usual minimal preparation required for admission were taught half of a basic science course using individualized instruction and half using traditional instruction. The course was divided into chemistry and physics segments and random halves of each class received the individualized treatment in one segment and the traditional treatment in the other.

Forty-two students in two sections of the Basic Science course at Briston Community College in Fall River, Massachusetts, participated in the study. The students were of lower to middle socio-economic level and were enrolled in a special program for educationally disadvantaged students. The two class sections were assigned by the Registrar of the College. The functional N of the study was 80 (see below).

Research Design and Procedures

The authors stated independent variables, moderator variables, and dependent variables.

The independent variables stated were individualized instruction and traditional instruction. In individualized instruction unitized instructional models were completed by students at their own pace. Behavioral objectives were followed by self-instructional learning activities, by a self-assessment test, and then by a post-assessment test. Failure to achieve 70% success on either test led to additional learning activities and retesting until success was achieved on both tests. In traditional instruction students listened to lectures and were encouraged to ask relevant questions in class.

The moderator variable stated was similar subject matter in chemistry and physics.

The dependent variables stated were student achievement and attitudinal assessments. Student achievement was measured by performance on pre-tests and post-test, constructed by the authors. Objective test items were used. The Remmers Attitude Scale and the Satisfaction Scale (Tuckman, 1978) were used for attitudinal assessment.

Test validity was insured by applying appropriateness criteria (Tuckman, 1975) and reliability of the pre-test and post-tests was determined by the Kuder Richardson Formula 21. The obtained reliability values were: (1) pretest = 0.75; (2) chemistry post-test = 0.90; and, (3) physics post-test = 0.96.

The study was conducted during one semester. In the first half of the semester, one class (Section A) was presented with individualized instruction in chemistry, the experimental condition (cell 1.1). The ohter class (Section B) was presented with traditional lecture instruction in chemistry, the control condition (cell 2.1). At mid-term, the two sections rotated for instruction in the second segment of the course:physics. Section A now experienced traditional instruction, the control condition (cell 2.2) and Section B individualized instruction, the experimental condition (cell 1.2).

At the beginning of the first segment, students in the two groups were pre-tested in both chemistry and physics. A t-test was conducted to determine the equivalency of the two groups. At mid-terms the students were given an achievement post-test in chemistry, the Remmers Attitude Scale Test, and Satisfaction Scale. At the end of the semester, the students were given the achievement post-test for physics and the attitude and satisfaction tests.

In the data analysis section, the authors' procedure was to convert all tests scores of students to standardized gain scores (post-test minus pre-test standard T scores). Then, t-tests were used for analysis, namely: (1) main affect of treatment (cells 1.1 + 1.2 vs cells 2.1 + 2.2) = test of hypotheses; (2) main affect of segment (cells 1.1 + 2.1 vs cells 1.2 + 2.2) = determination of differences in difficulty and likeability of subject matter; (3) interaction (cells 1.1 + 2.2 vs cells 1.2 + 2.1) = to see whether the treatment worked better with one subject matter than with the other.

Findings

The authors separated the "findings" into Results, Effect of Treatment, Effect of Segment, and Interaction Effect. In the Results section they reported that the groups were equivalent based upon the results of a pre-test to measure the students' reading ability, comprehension, and previous knowledge of science. A two-tailed t-test at the 0.05 level of significance failed to attain a significant result.

In the Effect of Treatment section, the main gain scores and t value of difference for the treatment effect on (a) achievement, (b) satisfaction and (c) attitude toward science were reported in a table and in text. A significant gain at the 0.001 level was recorded for the individualized treatment. A nonsignificant t value was reported for satisfaction. The experimental conditions yielded a significant mean value on attitude toward science.

In the Effect of Segment section, they reported that "on none of the three measures was the effect of segment significant." This was reported in table and text.

The report on the test for interaction of instructional treatment was that individual instruction worked best in the physics segment. The interaction effect in neither satisfaction nor altitude toward science was significant.

Interpretations

The findings of the study present strong evidence of the effectiveness of individualized instruction in teaching Basic Science to underprepared community college students. The evidence is: (1) experimental conditions produced significantly greater achievement gains and significantly more positive attitudes toward science than control conditions, although the two yielded equal satisfaction; (2) achievement gains, satisfaction and attitudes toward science were equivalent for chemistry and physics segments; (3) of the four cells, achievement gains were the greatest for the combination of individualized instruction and physics, although neither satisfaction nor attitudes toward science varied by cell.

According to the authors, the findings led to the following conclusions: (1) individualized instruction is a highly effective method for improving student achievement in science; (2) while students may not prefer individualized instruction in science, it does improve their attitude toward science.

The authors discussed reasons why the individualized approach was advantageous to these students, which included: small segments of learning and testing; individual identification of strengths and weaknesses which allowed for positive reinforcement; and the discounting of the difference in preparation and allowed for independent rate of learning.

The study also illustrated how instructional effects can be compared with a small number of classes using subjects as their own controls. The authors recognize the limitation to projected conclusions because every student did not experience all four of the condition/segment combinations. However, despite limitations, the authors state that the design works well for the evaluation of instructional conditions.

ABSTRACTOR'S ANALYSIS

The article was well written, organized, and concise. The first paragraphs of the Abstract and the concluding paragraphs were directly related and the sections of the article were clearly identified.

It addressed a sample of the community college population which must be a concern of community college teachers and administrators. Information about the course re: was it required?; was it a college transfer course?; was the same material covered as in the regular course?; etc., would have been valuable to some readers.

The brief survey of literature included in the article provided a sample of research done in the three areas of the study, but the combination of the three purposes in one study seems to be unique as is claimed.

Both the purpose of the study and the method of the study contributed to a resolution of the value of individualized instruction; however, no new concept was presented.

The methodological contribution of the study is worthy of repetition. As the authors state, the limitation of the study, namely, that all students did not experience the individualized treatment in both subject matter segments, could be eliminated. The authors, undoubtedly, have considered other ways of conducting the course so that all students experience the same method in comparable subject matter segments.

Validity and reliability are addressed by the authors and this is a definite plus. It is assumed that an appropriate evaluation authority was employed before using the Remmers Attitude Scale and the Satisfaction Scale (Tuckman, 1978). The discussion about the validity and reliability of the achievement tests raises some questions, however.

The authors based the tests upon behavioral objectives. To the abstractor this is the appropriate basis. The question is, however; At what cognition level; i.e., simple recognition and recall? Higher level objectives could not be evaluated by multiple-choice, fill-in-the-blanks, and true-false questions. Were the same objectives used for both the traditional and individualized instruction groups in each subject section? It is assumed that identical tests were used. Further, one might assume that a more complete discussion of the relationship between the objectives and the measurement items used was written by the authors and not elaborated upon in this article.

The use of T and t tests suggest a thorough study and/or knowledge by the authors. It is to be commended that, although possibly peripheral to the study, a description of how the equivalency of the two student groups was included. The only question brought to mind in the statistical descriptions was one related to determination of differences in difficulty and likeability of subject matter. This was the only mention of difficulty. One can surmise a relationship between difficulty and likeability, but are these synonymous terms for satisfaction?

The findings of this study did present evidence of the effectiveness of individualized instruction in teaching Basic Science to underprepared community college students. One might question the authors' use of the expression "strong evidence," however.

As the evidence presented by the authors indicated that experimental conditions produced significantly greater achievement and significantly more positive attitudes toward science, the case for the use of individualized instruction should be considered for course use by other community college teachers. The satisfaction element seems of minor importance if one would weigh the three results of the study.

Research should encourage using the same or a modified version of the methods of the authors by teachers of "regular" students in high schools and four year colleges; by teachers of transitional students in four and two year colleges; and possibly by teachers in classes other than science courses. An interesting modification would be the use of other methods, i.e. discussion, team-learning, combined chemistry-physics principles in a unitized science course, etc. for segments rather than only the lecture-lab or individualized modes.

The design of the study is well-worth repetition especially if the students experience both (or all) of the methods of instruction in both (or all) of the segments of the course.

Erickson, G. "Children's Viewpoints of Heat: A Second Look." Science Education, 64 (3): 323-336, 1980.

Descriptors--*Beliefs; Education; *Heat; *Junior High School Students; *Physical Sciences; Science Education; Secondary Education; Secondary School Science

Expanded abstract and analysis prepared especially for I.S.E. by Steve Tipps, Midwestern State University.

Purpose

The goal of the study was to identify and classify beliefs students have about the nature of heat. In addition, application of this knowledge to improvement of instruction was proposed.

Specifically the author states that the study had three primary objectives:

1) To provide a more extensive empirical check on a set of ideas about heat and temperature phenomena earlier hypothesized to be characteristic of 12-year-olds.
2) To determine whether children find other viewpoints of heat equally attractive.
3) To develop a suitable classroom instrument that could be used to assess patterns of beliefs held by students about heat phenomena.

Rationale

This investigation serves as a second step in an investigation of concepts of heat. The first investigation by this author involved intensive interviews with 10 children aged 12. This observation needed to be extended to a larger sample of students to support generalizability. The information from interviews also needed to be organized into an instrument which could be scored and interpreted easily--both for research and for classroom use.

Research Design and Procedures

Subjects were 76 fifth-grade, 117 seventh-grade, and 83 ninth-grade students in urban schools. Four intact classes at each level were taken from three randomly selected schools.

The development and analysis of an instrument was the primary focus of the study. The Conceptual Profile Inventory (CPI) was developed to assess ideas about heat and temperature. The instrument was organized with eight open-ended stems about demonstrations with heat. For example,

The wax melted because:

For each stem, one to three possible explanations were presented. For example, the explanations about wax were:

1. It was soft
2. The heat particles went inside and forced the wax particles apart.
3. The wax particles were moving so fast that they could not hold on to each other so well.

The explanations were taken from responses which children had made and from scientific theories about heat. They were organized to represent three different types of explanations. In the case of wax, the first explanation is representative of the intuitive, or Children's Viewpoint. The second comes from the outdated Caloric explanation of heat, and the last is a current Kinetic explanation.

Twenty different explanatory statements were developed for the eight stems. Some stems had only one explanation offered. Students rated each of the 20 explanatory statements on 6 Likert-type scales. A belief dimension included three scales on true-false, agree-disagree, and like my ideas-unlike my ideas. A second dimension was labeled familiarity with three scales on clear-confusing, easy-difficulty, and familiar-unfamiliar.

The instrument thus allowed each student to respond 6 times to each of 20 heat explanations. The resulting 120 responses could be analyzed for consistency of belief and confidence about that belief.

The study was conducted with four demonstrations for the students: heating two aluminum rods of different thicknesses with a piece of wax holding a pin, heating six small cubes of different materials, dropping ice cubes in water, and heating a flask with a liquid expansion tube attached. In each case, students observed particular results of the demonstration: which pin fell first, which cube melted or got hottest, change in water temperature, and rise in liquid in the tube.

After each experiment, possible explanations were given to the students to rate on the six scales. Each explanation was on a separate piece of paper.

Analysis was done in three stages. First, the dimensions of the scales were checked for student responses based on belief and familiarity. Factor analysis of the intercorrelations of responses was used. The second stage sought clusters of statements which relected the three different viewpoints about heat. Factor ana' is was also used for this stage. Finally, a profile analysis of students was attempted to discern models which might be useful in instruction. A profile analysis program was used.

Findings

The two dimensions from the instrument were supported in the analysis. Students were able to discriminate among the scales and respond consistently. A composite score including both belief and familiarity was calculated for further analysis.

The analysis of beliefs about heat phenomena suggest that students had consistent ways of looking at different demonstrations. One belief cluster included only the Kinetic statements. The Children's Viewpoint was the second cluster. Of the seven items in the cluster, consisting of all three statements from the first demonstration and representing one of each of the viewpoints, was not easy to classify. A possible response set, or meas rement artifact, was proposed. The fourth cluster included four of the six Caloric explanations and one from the Children's explanations.

Three model response profiles were found. The profiles were described likely responses to all the possible statements. Model Concept Profile 1 was distinguished by acceptance of the Kinetic explanation and rejection of the Children's explanations. However, students in this profile also were likely to accept many of the Caloric explanations.

Model Concept Profile 2 featured strong belief of the Children's explanations, rejection of the Kinetic viewpoint, but agreement with several of the Caloric explanations. Model Concept Profile 3 was very similar to MCP 2, differing primarily on the strength or weakness of items in the Caloric and Children's cluster. A slight decrease in the values of the Children's items and increase in the Caloric items suggest that Model 3 might be transitional.

Interpretation

A grade level analysis of membership in the profiles tended to support the suggestio that the MCP 1 (Kinetic) was the most mature explanation, while MCP 2 was the least mature explanation profile. Twenty-eight percent of the fifth graders were classified in MCP 2 and only 10 percent of ninth graders were. The percentages for MCP 1 were reversed. The role of MCP 3 as transitional requires further study.

The educational implications of the proposed profiles is seen as a practical way of assessing student understanding and adjusting instruction. The instrument could be administered and profiles plotted. Teaching strategies would then be employed to set up activities to challenge and direct their thinking about heat.

One conclusion is that the intuitive beliefs about heat are widespread. These beliefs do not appear to be the result of interview techniques or to be limited to a small sample of twelve year olds. Many children were able to accept several explanations of heat phenomena at the same time. Caloric explanations seemed particularly likely to appear with both the Children's and the Kinetic viewpoints.

ABSTRACTOR'S ANALYSIS

This study is a thorough and worthwhile continuation of previous research done by this author. It parallels studies in other areas which are looking at "misconceptions" in science as a basis for understanding how people think. This effort owes some debt to Piaget's interview methods, particularly the request for "why" rather than a simple inventory of right and wrong answers. The other debt is to modern analytical methods and techniques.

The report is readable and understandable even to someone unfamiliar with the statistics. Both the charts and the narrative make the profiles easy to follow. Fifty-sixty percent of the students at each grade level were classified into the three profiles. The nature of the other forty percent of students was not addressed. The lack of profiles for a plurality of the students seemed to be worth some mention in the article. Were there students who rejected all explanations or who accepted them all indiscriminately?

The reasoning and methods of the instrument and analysis take into consideration many of the issues which invalidate other instruments. Consistency of response is too often assumed rather than validated. The clustering of responses are extremely interesting because they resemble the a priori clusters. The profiles are interesting to ponder. Looking at what people understand and misunderstand about heat is fascinating to science educators. The fact that many students hold alternative explanations simultaneously is puzzling, but not surprising. However, what should be done about the condition is not clear.

The author's suggestion that teachers would plot a profile and go to a set of activities keyed to the profile sounds good. But, what are the activities and how are they different from the activities which are now standard in elementary, intermediate, and advanced physics texts and programs? Is the profile so specific that it would say Student A needs to do the melting with salt experiment and Student B does not? Or does one simple experiment have many possible learnings for students with different profiles?

An even worse outcome is that someone would take the instrument and use it as a mastery test for a heat chapter. If students discard all the intuitive beliefs and adopt all the scientific beliefs, they get an A. Seventy-five percent change would be a C. Then the four demonstrations would be used as the instruction.

Understanding what people know about things as a basis of teaching is a truism with which no one disagrees, but upon which practically no one takes action. This observation does not discount the work done here at all. It simply points out that the harder job may be ahead if instruction is to improve based on our understanding of students' understandings. Delineation of thinking models seems to have much to tell a teacher about organizing instruction. The question is still "What?"

Looking for further developmental indications might be one way to extend research in this area. A longitudinal study would be worthwhile. The transitional area of conceptual development seems to be very fruitful, but difficult to assess. A more practical use of the instrument might be pre-post with a unit on heat. This would not be an achievement score, but might focus on conceptual changes and trends. Specific teaching strategies and materials could be tried with an experimental design. The demonstrations might even serve as an organizer or probe for a unit.