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ABSTRACT

The purpose of this study was to reveal the prevailing instructional method utilized by inquiry-oriented science teachers using national representative teacher data. The first part of the study focuses on the measurement of teaching emphasis on inquiry science or the intended curriculum. The second part focuses on the relationship between the intended curriculum and the teachers' classroom practices or the implemented curriculum. The data for this study were taken from the Longitudinal Study of American Youth (LSAY) which included public high school students (N=3000) and middle school students (N=3000). A confirmatory factor analysis and an exploratory factor analysis were employed and identify four factors affecting teaching emphasis: (1) inquiry science; (2) affective science; (3) humanistic science; and (4) academic science. The findings also suggest that the contribution of mathematics application skills and laboratory techniques and skills to teaching emphasis is relatively small. Contains 32 references. (DDR)

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Introduction

In the area of science education, teaching hands-on science has become a socially desirable attitude. The recent recommendations for science educational reforms shifts from teaching textbook science to hands-on science and many teachers believe that science experiments will produce positive attitudinal outcomes for the student, perhaps leading to persistence in the study of science. However, previous research on science laboratory activity has not found statistical evidences that the level of laboratory activity is associated with higher levels of science achievement. Blosser (1981) pointed out that if students only follow cook-book style laboratory manuals, laboratory learning will only raises children's manipulative skills; cook-book style manuals do not guarantee the development of highly cognitive skills. In addition to frequent laboratory activities, other parts of inquiry activities, such as experimental logic and systematic observations are also important factors in facilitating authentic inquiry learning.

It is questionable whether one should expect the level of classroom laboratory experience to be positively associated with results from a knowledge-oriented standardized multiple-choice test. When science teachers see the statements favoring classroom experiments, they may tend to express their agreements, not only because they actually utilize experiments in class, but because they feel obligated to support "hands-on science". Weiss (1994) reported the results of teachers survey asking their belief in science instruction, and indicate that nearly all teachers who surveyed recognize the importance of hands-on activities and its application to the students' daily life. On the other hand, only less than seventy percent of teachers support the deeper coverage of the fewer concepts. If science teachers perceive hands-on activities as only one element of inquiry learning and recognized that the "inquiry" study proceeded by the chains of question, deeper coverage of fewer concepts is necessary. Although the development of lab skills may be a useful component of scientific learning, it is not sufficient to develop student science process skills. Students may repeat the lab procedures, following the step-by-step process outlined in a manual without really understanding the scientific process. In order to make laboratory activities more effective, other aspects of science process skills, such as identifying problems, developing experimental designs, and applying quantitative measures need to be developed by students.

The purpose of this study is to reveal, from national representative teacher data (Longitudinal Study of American Youth, 1992), the prevailing instructional method utilized by inquiry-oriented science teachers. The first part of the study focuses on the measurement of the teaching emphasis on inquiry science. In the second part of the study, the relationship between teachers' emphasis on inquiry science (intended curriculum) and their classroom practice (implemented curriculum) will be explored.

Theoretical Underpinning

Teachers emphasis and student learning

When we apply the theory to the classroom situation, teaching emphasis functions as intended curriculum. It is true that students construct their own understanding of nature, utilizing some of their prior experiences, and they do not always incorporate the materials in the way which teachers expected for them to do. However, even the constructivists would deny the contribution of teachers to the organization of student learning experience. No matter how teachers organize the learning experience, the organization itself becomes a significant source of learning opportunity for the student. It is also true that teacher organization of the learning experience may limit or expand student opportunity to learn by emphasizing certain skills and knowledge filtered through each teacher's psychological and philosophical screens. Although the reality of the students limits the feedback function of achieved curriculum, the gaps between teacher's emphasis in classroom teaching and student learning experience can be viewed as the difference between intended curriculum and achieved curriculum.

Ben-Peretz (1990) analyzed each phase of curriculum and presented the idea of curriculum potential. When a curriculum is implemented in the classroom, teacher presentation of the material may not reflect that intentions of the original curriculum developers. Ben-Peletz argued the teacher autonomy would often lead to modified curriculum implementation. Each teacher's view of children, curriculum materials, and society may influence both teachers' emphasis and implementation of intended curriculum. Some educators would argue that socio-cultural factors, such as gender, ethnicity and social economic status (SES), city size are so influential on the student learning experience that teachers can exercise only limited control of the student learning environment. However, ignoring the school effect would limit the possibility of improving student learning through alterable factors.

<u>Inquiry and laboratory learning</u>

The study identifies "the process of intelligent problem solving" as the necessary condition to use the term "inquiry". In science field, the most common technique for inquiry is laboratory activity and the common image of scientists is the scholars working in laboratory with white lab coat. However, the laboratory activities is merely one of the various technique scientists use to solve the problems. Behind the laboratory activities there are more important component of scientific inquiries, such as identifying the problem, formulating hypotheses, discussing the best way to test the hypothesis.

Some recent qualitative case studies support inquiry learning. Roth and Roychoudhury (1993) reported an example of successful open-inquiry laboratory in an eleventh-grade physics, a twelfth-grade physics class, and an eighth-grade general science class. The genenral procedure of the courses began with the introduction of the topic with which students were supposed to work. When teachers introduces the topic, they demonstrate several activities. During the demonstration, the questions from the students were marked as potential ideas for the research. Then students were allowed to to play with the material so that they got familialize with the topic. Then, driven by natural curiosity, students formulate their research question and they colaborate with other student of similar interest.

The authors admitted that there were some difficulties in the open-inquiry classes. In the beginning of the unit, students are not familiar with the material enough to formulate their own research questions. Some students, they reported four out of 46 students, did prefer the traditional teacher-directed lecture style. However, these problem were solved when students get used to this approach. Roth and Rychoudhury found in these classes that students demonstrated highly integrated science process skills in terms of: (1) identifying and defining pertinent variables; (2) interpreting, transforming, and analyzing data; (3) planning and designing an experiment; (4) formulating new hypotheses based on the result of their previous experiments; (5) definning the concepts of their own.

Palinscar, Anderson, and David (1993) described a instructional program which emphasized a context of collaborative problem solving. The authors recognized that one of the important phases of scientific literacy is collaborative skills that promote construtive social interaction. They carefully chosed a subject matter so that students can explain the phenomena from a variety of perspective and that promote the social interaction. The authors also set up four social norms in the classroom which are: 1) to contribute to the groupe's effots and help others contribute; 2) to support one's ideas by giving reasons; 3) to work to understand others' ideas: 4) and to build on one another's idea. The authors' description of their practice presented the evidence that explanation of scientific phenomena in scaffolding discourse allowed students to experience enterprise of sciences, to connect everyday experiences to scientific phenomena, and to improve their scientific concepts.

Varelas (1996) pointed out that discourse in science classroom plays the role as bridge between scientific activities and educational practices. The author contended the center of scientific enterprises are sociocultural activities in searching for the matching of theory and empirical data. No matter if theory development (deductive method) or data collection (inductive method) comes first in scientific inquiry, the discourse plays the central role of scientific activity. In terms of education, the interplay of teachers and students are conceptualized in the dichotomized form: Top-down, teacher-centered, lecture bases classroom; and bottom-up, student centerd, hands-on based classroom. In order to integrate these concept of teaching- learning process, The author identified the discourse will play central role. In both cases of scientific activity and educational practice discourse are underlied concept of science learning. Several other case studies reported that meaningful laboratory settings enhance the student higher order cognitive skills (J.S. Brown et al., 1989; Knorr-Cetina, 1981).

Type of inquiry and hands on science

In terms of openenss of laboratory, Herron (1971) suggested to categorize hands-on curricula in 4 point scales. The author began with emphasized that scientific inquiries have the interactive nature between the agent and subject matter, and introduced the Dewey's, Einstein's, Pierce's and Whewell's views of scientific inquiry. All of the example showed that the scientific methods scientist take are not pre-formatted, but are the result the scientists reflective thinging on the subject matter. Then, he examined laboratory manuals of three "New (in early 70's)" science courses, CHEM Study (CHEMs), Physical Science Study Committee (PSSC), and Biological Science Curriculum Study (BSCS). In his examination, he adopted the Schwab's idea "a sort of continuum of openness and permissiveness[1]" and added the lowest level which is "... a zero level in

1 Accoding to Herron's citation of Schwab's "The Teaching of Science as Enquiry", Schewab categorized laboratory manuals as follows:

Level 1: the manual which poses problems and describing the method to discover the relations.
Level 2: the manual which leaves methods and answers open:
Level 3: the manual which leaves problems open as well as methods and answers

which problem area, methods of solution, and correct interpretations are geiven or are immediately obvious from either statements or questions in the students laboratory manual (Herron, 1971; p.200)." In these criteria of openness, most of the laboratory activity would not meet the category which allows student to develop experimental design.

What distinguishes inquiry based laboratory from cook-book style laboratory activities? There may be several keys to distinguish these activities, such as open versus closed environment, student-centered versus teacher/textbook directing, and so on. This study will focus on the difference between inductive and deductive inquiry methods. In general, cook-book style laboratories lead to inductive methods of inquiry, which start with collecting the evidence and then generalizing results to the universal condition. The reason why students have to follow the step-by-step laboratory manual is that they cannot develop an experiment design by themselves. Since teachers or textbooks intend to show students evidence before introducing a theory, students cannot identify the significance of an experiment and consequently they cannot develop an experiment design. On the other hand, inquiry based laboratories require theory driven experiments. When inquiry is defined as an intellectual problem solving process, the laboratory activity as a part of the inquiry process requires reflective assessments of the significance of experiment. In order to assess the significance of experiment, constructing a new theory or referring to existing theories is indispensable.

In science education, there are several articles which criticized inductive inquiry method in the science classroom (Finley, 1983; Haris and Taylor, 1983; Driver, 1994; Millar, 1994). Finley (1983) criticized Gagne's inductive perspective of science which Finley perceived as over-emphasized notion. Finley asserted conceptual changes play important role in science inquiry. He also pointed out that the inductive inquiry process was not content-free, because the concepts in each discipline are different from discipline to discipline.

Harris and Taylor (1983) described the problem of the inductive view in over emphasizing science classroom as follows:

> The problem with an inductive view of science which suggests that there is an immutable chain of inferences from initial observation to final conclusion is that it rules out the possibility of alternative explanations. The complaint then would be that science teaching is indoctrination.
>
> (Harris & Taylor, 1983, p.287)

It is not uncommon that teachers provide a series of experiments which supports the concept the teacher tried to teach. In summarizing the result of student observation, teachers try to avoid alternative result, but they merely offer the complimentary statement such as "good point" without considering students alternative findings seriously. Driver (1994), from the constructivist perspective, criticized the notion "I do and I understand" which was commonly spread around the science classrooms. Although teachers or text book include each hands-on activity to present an evidence of an conventional scientific concept and theory, alternative framework of the students intrude their understanding. Therefore, guidance to the way of thinking scientifically and the presentation of theoretical models and scientific conventions are necessary. Millar (1994) does not only criticize the inductive inquiry, which he defined 'process', but also argue that inductive inquiry is not intellectual skill or characters which science education can teach uniquely.

In summary, inductive inquiry can be interpreted as Gagne described: (1) observation and the collection of facts; (2) analysis and classification of those facts; (3) inductive derivation of generalizations from the facts; and (4) further testing of generalizations. However, these are not strict rule that students in science classroom should follow. Science inquiry requires imagination, creative leaps, theory deduction before the collection of data.

<u>Other modes of scientific inquiry</u>

Koulaidis and Ogborn (1988) developed the questionnaire to address teachers' view of sciences. Their work of categorizing nature of science from philosophical perspective is informative in order to conceptualize the nature of inquiry. Their analysis represents four main philosophical positions which are: (1) inductivism, (2) Hypothetico-deductivism, (3) contextualism, and (4) relativism. The distinctions were made in terms of four criteria; science method, criteria of demarcation, pattern of scientific change, status of scientific knowledge. Since the focus of my study is scientific inquiry, I will introduce the difference in science method.

As I described in the previous section, inductivists believe that the scientific method is basically one which starts from data collection, organizes collected fact, derives the inference from data, analyzes data, makes generalizable result (observation to theory verification). When the consequences of a theory are compared with data, inductivist believe that sound conclusions can be drawn if theory and data agree.

A major influence on hypothetico-deductivist was made by Popper and Lakatos. Hypothetico-deductivists agree with the inductivist view that there is basically one scientific method. The critical difference from the inductivists is that hypothetico-deductivist use 'theory to observation falsification' in the scientific method which is to start by deducing consequences of theories, checking them against the data. When the consequences of a theory are compared with data, hypothetico-deductivists believe that a sound conclusion can be drawn only if theory and data disagree.

Both contextualists and Relativists believed that there are a variety of ways of being scientific. Contextualists believe that 'there are standards enabling a reasonable choice to be made in choosing different scientific method for a given problem'. They believe that the standard for the choices either 'are guided by a consensus of the scientific community' or 'belongs within the concept of science'. Since they put emphasize on the consensus and the concept in scientific community, they perceive the existence of various incompatible scientific method is a fruitful source in scientific progress.

Relativists, on the other hand, do not believe the frame of reference in choosing scientific method. Therefore, to them, 'the existence of various incompatible scientific methods show the pointlessness of discussions'. In the choice of the appropriate method', Relativists believe the use of their own critical criteria.

Teacher's view of scientific inquiry

Students' inquiry skill can be developed in the informal education setting. However, this study focuses on the effect of teachers emphasis on inquiry skills in relative to effect of informal science education. Lederman (1992) pointed that "if teaching is viewed as a purposeful and conscious act, a teacher must possess an adequate knowledge of what he/she is attempting to communicate to students"(p.339) . This section reviews the study on teachers' perception of scientific inquiry.

First, it has to be noted that inductive inquiry is perceived as the center of science not only by teachers, but also by public. The survey of public understanding on science and technology in 1990 and 1992 revealed that approximately twenty percent of adult population in the United states perceive science process as theory driven activities (Miller, 1996). Secondly, previous section of review merely presented several philosophical views of scientific inquiry. Most of science teachers and prospective science teachers are not expected to receive training in philosophy of science. Therefore, eclectic position can be allowed in determining philosophical position of each science teacher.

In 1960's, the necessity of the development of inquiry science curriculum drove the attention to the teachers' perception of science inquiry. Yager (1966) examined the effectiveness of "Biological Sciences Curriculum Study: Molecules to Man (BSCS-Blue version)" on students in University of Iowa Laboratory School. Eight teachers were involved in the study. Students' understanding of Nature of science and scientific enterprise were measured by Cooley's and Klopfer's Test on Understanding Science (TOUS). Curriculum effect on TOUS score was proven to be significant, but it was not sufficient factor to explain the variance in TOUS score. In the conclusion of the study, Yager noted that teachers effects were expected.

The study conducted by Kleinman (1965) provides the explanation of Yager's conclusion. Kleinman investigated the relationship between type of question and students' understanding of nature of science. When student ability are controlled, teachers who asked more critical thinking questions impart a better understanding of the nature of science.

Research on teachers' understanding of nature of science has began in the period of Post-Sputnik era. Behnke (1961) compared the understanding of nature of science between science teachers and professional scientist. The result of Behnke's study presents over fifty percent of the science teachers and twenty percent of scientist felt that scientific findings were not tentative. Kimball (1968) compared the understanding of nature of science among philosophy majors, science majors, and experienced scientists. The Kimball's model of scientific inquiry is similar to the contextualist2. Compared to philosophy majors, science majors and experienced scientists are more likely to believe the rigid model of scientific inquiry. Several other researches in 1960's and 70's present the evidence that teachers believe in inductive inquiry as a center of science (Miller, 1960; Carey and Stauss, 1968 and 1970).

Recent studies on teachers' understanding nature of science depict more sophisticated figure. Bloom (1989) assessed preservice elementary teachers' understanding of science. The author's qualitative analysis revealed that anthropocentricity in definition and purpose of science, theories and evolution is the most explicit in subjects' understanding of science.

Koulaidis and Ogborn (1989) surveyed the science teachers' view of scientific knowledge from the philosophical epistemological perspective. Sample of the survey is the young science teachers in urban schools and student teachers in science. In terms of philosophical position in scientific method, Koulaidis and Ogborn presented five positions which are; (1) inductivism, (2) hypothetico-deductivism, (3) contextualism, (4) undecided contextualists, (5) relativism. In addition to these five positions, the respondents who takes several position were categorized as "eclectic". The result showed that little over forty percent of all respondents are eclectic. Among non-eclectic positions, contextualism are

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2 Contextualist disagree that there are single method of scientific inquiry and supports there are as many scientific method as there are practitioners. Scientific methods used in real are dependent on the curiosity of scientist, sense experiences, insistence on operational definitions, etc. See for detail, Koulaidis and Jon Ogborn (1988).

most popular position in all samples. In focusing on young teachers sample, inductivism are the most popular position.

Aguirre, Haggerty, and Linder (1990) conducted case study on understanding of nature of science held by preservice secondary science teachers. The authors asked students a series of questions concerning nature of science, nature of teaching and nature of learning, and categorized the answers. In terms of students' conceptions of the nature of science, the authors generated five positions which are; (1) naive, (2) experimental-inductive, (3) experimental-falsificationist, (4) technological, and (5) three-phase process. Students with naive conception of science perceive science as a body of knowledge confirmed by observations and explanations of how and why certain phenomena functions. Students with experimental-inductive conception perceive science as a body of propositions confirmed by systematic experimentation. Experimental falsificationinst emphasize the Popper's view of experimentation which is experimentation is set out to 'disprove' scientific theories. Student with technological conceptions express that science is directed at technological advancement. Three-phase conception perceive the process of science as three step; development of theories, testing theories, and then acceptance by the scientific community. The authors concluded that although there were variety of conception, the majority of teachers surveyed in the study held either naive or experimental conception of science.

In summary, there are significant difference between the studies in 60's and the studies from late 80's to early 90's. The focus of the studies in 60's are whether or not teachers believes in inductive inquiry as center of sciences. However, recent studies are successful to depict more variety of teachers' view of science.

<u>Design</u>

<u>Model</u>

Three models will be used in this study. First, in order to understand the relationship within teaching emphases, the structure of items needs to be examined. Exploratory factor analysis of various teaching emphases revealed four factors: (1) development of inquiry skill in science; (2) development of affection for science; (3) development of awareness of the humanistic side of science; and (4) development of knowledge and understanding in science. The development of inquiry skills includes six items which are the development of: (1) experimental logic and design; (2) problem solving skills; (3) laboratory technique skills; (4) systematic observation skills; (5) applications of mathematics in science; and (6) scientific writing skills. The development of affection for science includes: (1) interest in science; (2) awareness of the importance in science; and (3) application of science to environmental issues. The development of awareness to the humanistic side of science includes: (1) biographies of scientists; and (2) women in science. The development of knowledge understanding in academic science includes: (1) science facts and principles; and (2) further study in science.

The first model addresses the confirmatory factor analysis used to investigate the relationship among teaching emphasis items with the consideration of measurement error of each item (Long, 1983). As a result of this analysis, scientific writing skills and biographies of scientists variables were dropped from the final models.

The second and third models are simple two block cause-and-effect models. The first block includes the latent variables, which are identified in the confirmatory analysis, and two latent variables on classroom problems. In the second model, the latent dependent variable is the utilization of hands-on science approaches. In the third model the latent dependent variable is the utilization of classroom discussions.

Data Resources

Data from the Longitudinal Study of American Youth (LSAY) will be used for the proposed study. Beginning in 1987, the LSAY collected data from a probability sample of 3000 public high school students (Cohort One) and 3000 public middle school students (Cohort Two) throughout the United States.

Achievement tests in mathematics and science were administered to all students each fall, and comprehensive attitude surveys were administered each fall and spring. In addition to the student data, the LSAY collected background and classroom data from all science and mathematics teachers who served any LSAY student. The classroom survey collected extensive information concerning number of students in the class, teaching strategies, teaching emphasis, classroom time use, and student demographics (Miller et. al, 1992).

Analysis

This study will use the structural equation modeling, utilizing LISREL 8. This technique permits the exploration of a wide range of models. By using "latent variables", structural equation models can improve the construct validity of measurements and reduce measurement errors (Bentler & Chou, 1988; Hayduc, 1987). In addition, compared to path analysis performed by ordinary multiple regressions, LISREL 8 permits the analyst to re-specify the cause-and-effect relationships in the model in the context of theory testing (Heating and Costner, 1985).

Findings

Confirmatory factor analysis of teaching emphasis

The confirmatory factor analysis, as well as the exploratory factor analysis, identified four factors: (1) inquiry science; (2) affective science; (3) humanistic science; and (4) academic science. The analysis also revealed that the teachers' views of inquiry science are primarily reflected by systematic observation skills and problem solving skills. The contribution of mathematics application skills and laboratory techniques and skills are relatively small. The second factor, affective science is mainly characterized by an interest in science. Awareness of environmental issues has a small contribution in explaining the teachers' views of affective science. Humanistic science is characterized by the single variable "Women in Science" in the model, the high value of polychoric correlation guarantees the association to the biography of scientists. The fourth factor "academic science" is primarily characterized by further study in sciences.

The four forms of teaching emphasis are significantly correlated with each other. Teachers who emphasize affective science also prefer humanistic science, and teachers who emphasize inquiry science also emphasize affective science and academic science. The correlation between inquiry science and humanistic science is still significant but relatively small (See Figure 1).

Structural equation models on teaching method

Teacher utilization of hands-on methods consists of reports of frequencies of: (1) requiring written reports on experiments; (2) teacher demonstration of experiments; and (3) student experiments. Among the six factors in the model, the significant factors leading to the utilization of hands on science methods are inquiry science, affective science and humanistic science. Emphasizing inquiry science is the strongest factor related to a teacher's utilization of the hands-on approach. Emphasizing humanistic science has a relatively small but significant negative effect on the hands-on approach (See Figure 2).

Classroom discussion are primarily explained by the discussion of media (science magazine and science TV programs). Reading supplementary materials and discussing science careers provide a less contribution to classroom discussions.

The significant factors leading to classroom discussions are a teaching emphasis on affective science and academic science and problems with science equipment. Among these factors, emphasizing affective science has the strongest relationship with the utilization of classroom discussions. The second strongest relationship is with "problem in science facilities and equipment" which has a positive effect on classroom discussion. This means that a paucity of science equipment, facilities, and funding causes classroom discussions3 (See Figure 3).

Discussion

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3 The programs used for all analysis presented in this paper can be obtained from the author.

The results of confirmatory factor analysis explain teachers' view of scientific inquiry. It is not surprising that each element of science inquiry skills constructs one factor. Roth (1989) has already indicated, through confirmatory factor analysis, that students science process skills are related to one underlying construct. This study focused on how teachers connect each element of science inquiry skills and what the relationship between science inquiry skills is with other teaching emphasis and teaching strategies.

Developing systematic observation skills and problem solving skills have more of a contribution to a teacher's emphasis on inquiry science than do laboratory technique and mathematics application skills. This indicates that teachers' view of scientific inquiry is inductive rather than deductive. The "objective" observation is the most critical component of inductive methods of inquiry. Although mathematics application is also one of the critical skills to make generalization from the data collected, it comes after the observations. On the other hand, in the deductive method, systematic observation comes after theory construction and there is no need to say that mathematics have taken important role in the development of scientific theories.

The results of the two structural equations model indicate that teachers' views of scientific inquiry are influenced by inductive empiricism. Although an emphasis on inquiry science is the most influential factor in the hands-on science approach, it does not have a significant effect on classroom discussions. If theory construction came before the experiment in inquiry science, classroom discussions would be as important as hands-on activities. Instead, according to the results of the model predicting classroom discussion activities, affective science and equipment problems show positive effects and academic science shows negative effects. In other words, teachers use classroom discussion merely as a strategy to motivate students who are neither oriented to academic science nor surrounded by scientific facilities. Although classroom discussion and hands on activity have to be integrated in deductive inquiry process, classroom discussions, in reality, seem to be used as a kind of replacement for scientific inquiry.

There are some criticisms to overemphasizing inductive empiricism in science education from epistomologic perspectives (Finley, 1983; Harris and Taylor, 1983; Millar, 1994). Since teachers' views of science inquiry are more influenced by inductive empiricism, an emphasis on hands-on science may lead to students obtaining only a limited view of science. Fortunately, there is also the constructivism movement which provides the opportunities for teachers and curriculum developers to re-assess the integration of theory construction and laboratory activities. Yet, paralell emphases hands-on activities and constructivism produce the situation in which teachers misunderstand the constructivist approach as a formatted teaching method without the meaningful connection between the classroom discussion and hands-on activities. Both of these teaching strategies must play equally important part in inquiry learning. Although the constructivist classroom may adopt both classroom discussion and hands-on activities, the point does not exist in such a simple format. Both activities have to be associated each other.

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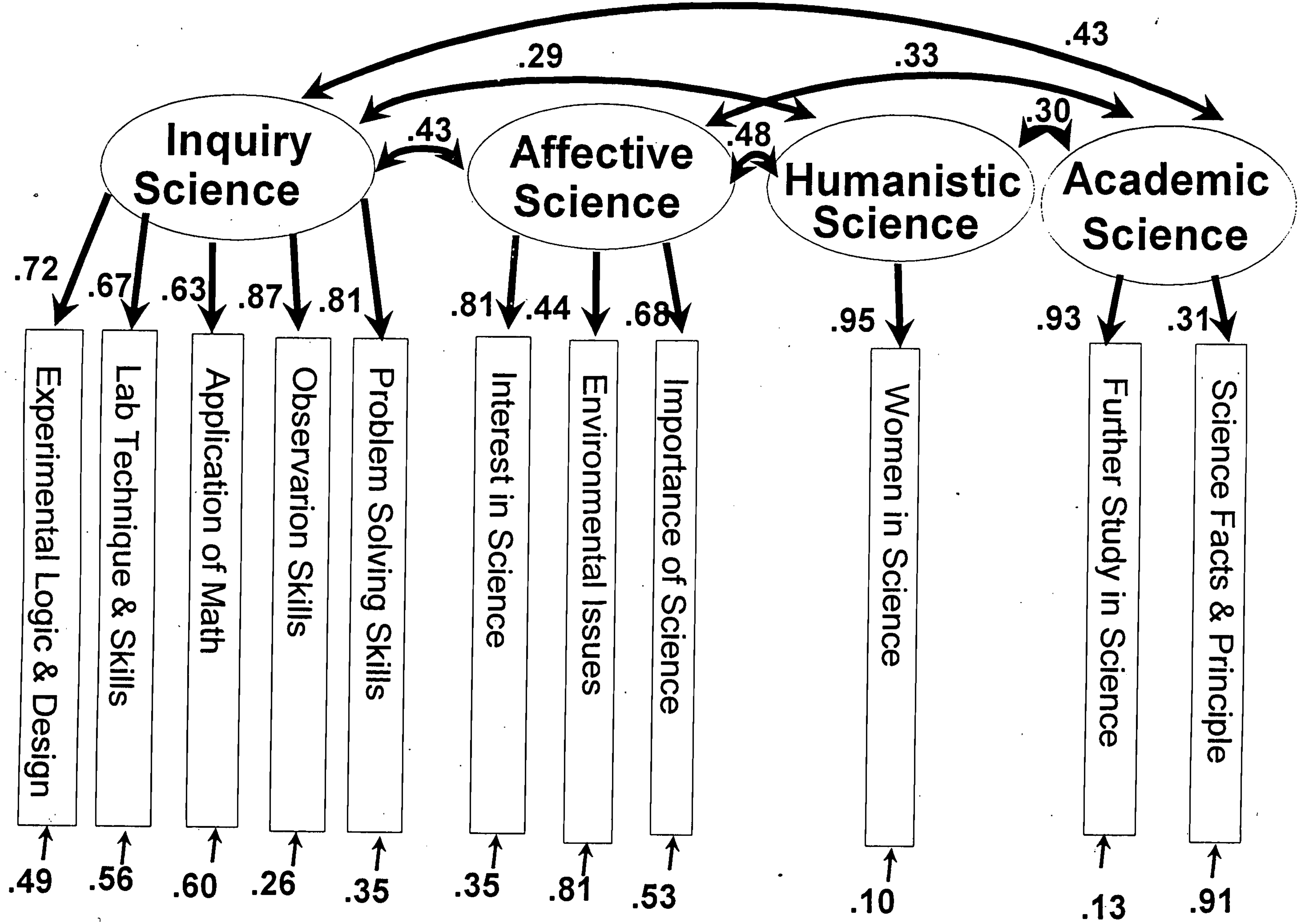

Figure 1: Teaching Emphasis in Science

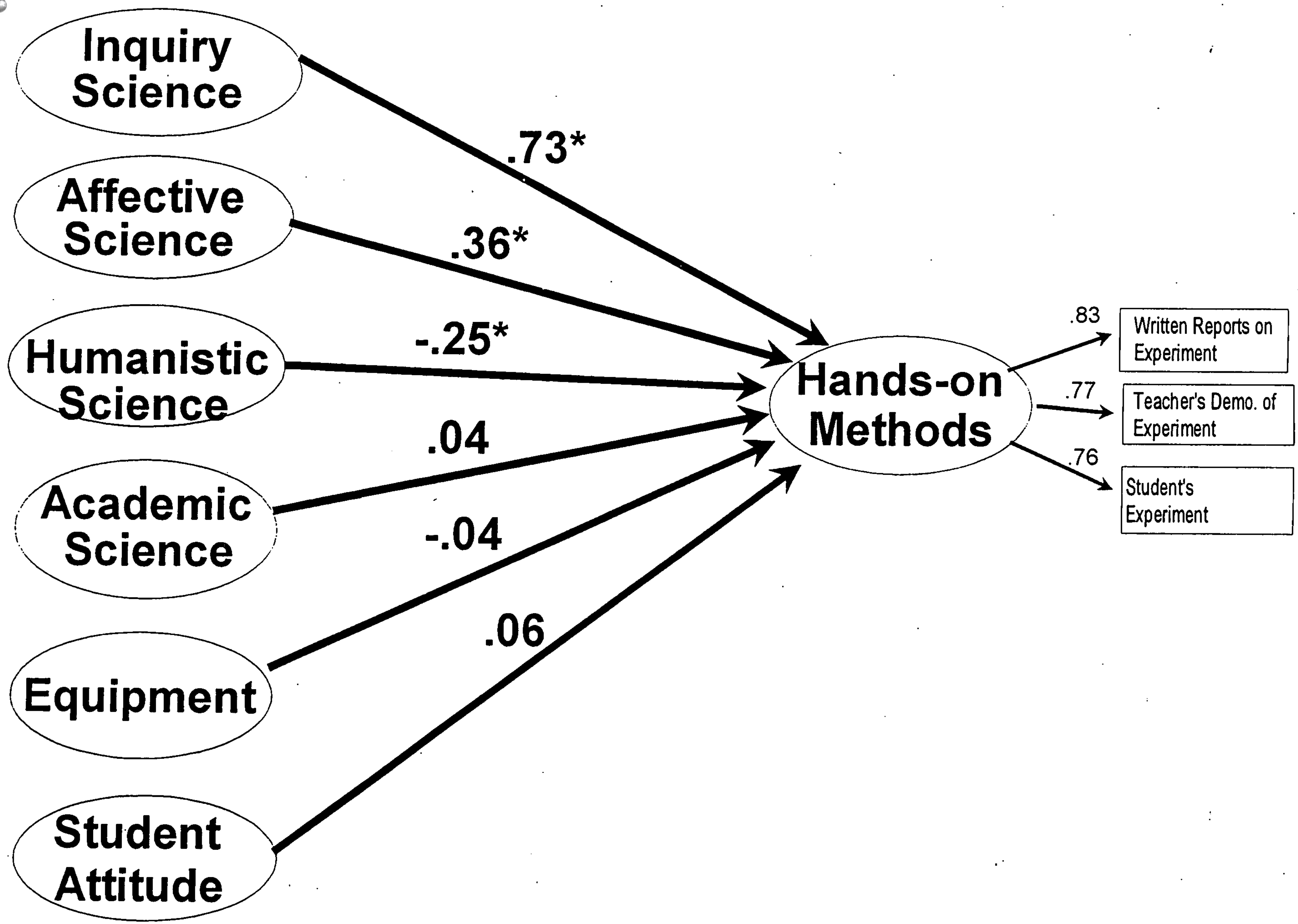

Figure 2: Teaching Emphasis & Method in Science (Hands-on)

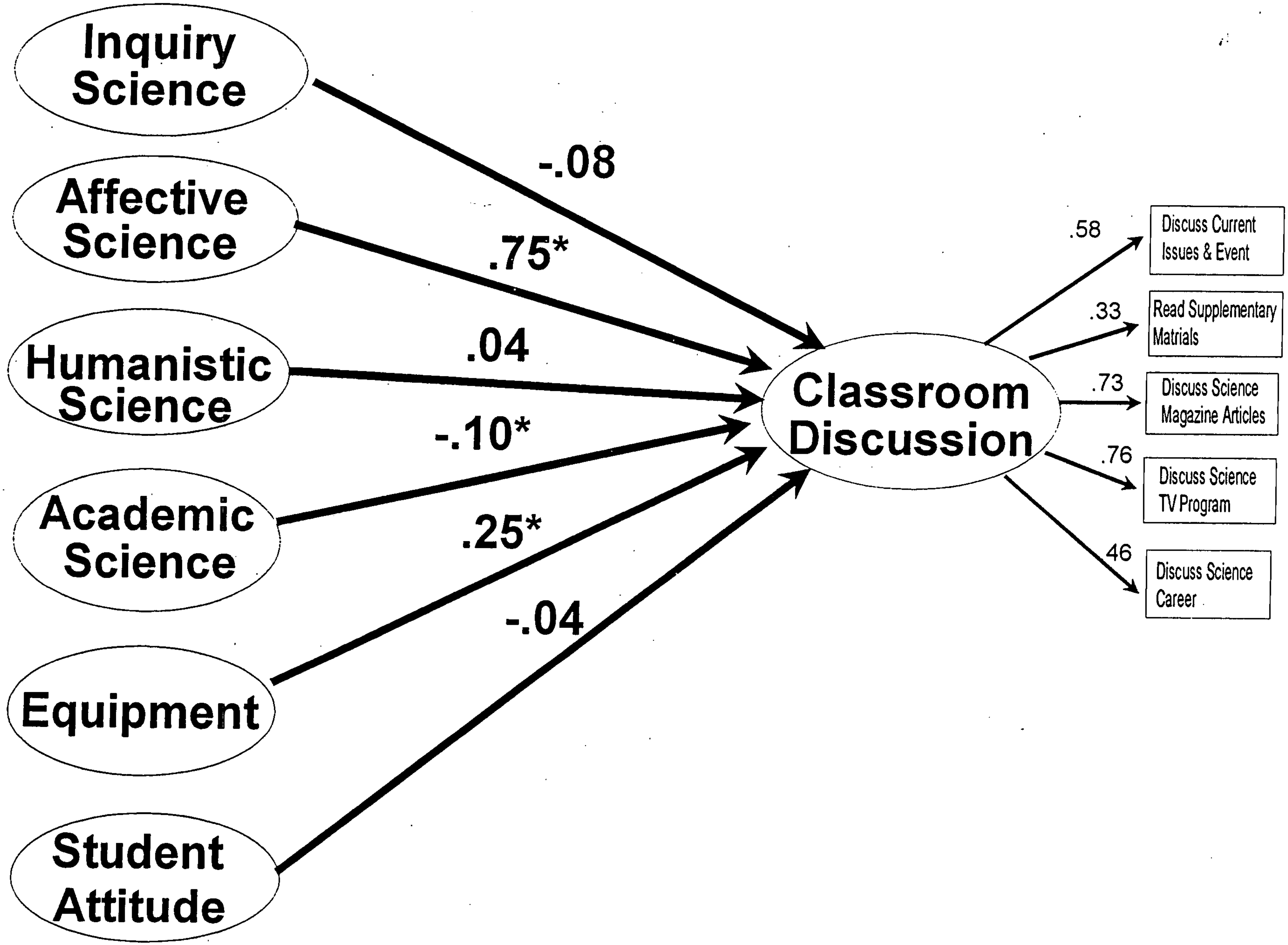

Figure3: Teaching Emphasis & Method in Science (Discussion)

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