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THE ART OF QUESTIONING OF SCIENCE TEACHERS IN DEVELOPING THE STUDENTS' HIGHER ORDER THINKING SKILLS AT NAVAL STATE UNIVERSITY, NAVAL, BILIRAN PHILIPPINES

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ABSTRACT

The study generally aimed to find out the science teachers of Naval State University of the different programs compare in the questions they raised during their discourse when categorized according to thinking process involved, type of answers required and degree of personal exploration or valuing. Documentary analysis research approach was utilized with 12 Science teachers as respondents. It was identified that low-order questions are high than high-order questions in terms of thinking process. On the other hand, for the type of answer required, convergent questions prevailed over the divergent questions and questions answerable by one word or phrase is high as well as questions which require analysis. In terms of the degree of personal exploration or valuing, questions categorized into personal exploration of choosing freely got the highest percentage than asking questions. Furthermore, questions predominantly raised by the Science teachers of the different programs were mostly on knowledge level in Bloom's taxonomy.

KEYWORDS: Art of questioning, Science teachers, higher order thinking skills, convergent questions, divergent questions.

INTRODUCTION

One of the most common goals of teaching is to develop critical thinking skills in students (Halpem, 1999). This higher level thinking is what allows students to excel and achieve intellectual freedom. Thinking is the cognitive process used to make sense of the world; questioning everyday assumptions will direct students to new solutions that can positively impact the quality of their lives.

On the other hand, Elder and Paul (1997) proposed that the art of questioning is essential to the art of learning and that, to the extent that they fail to ask genuine questions and seek answers to those questions; students are not likely taking the content seriously. Teacher can and should use questioning techniques to inspire higher level thinking in the classroom.

Research on the questions raised by the teachers and their techniques in questioning indicated that seventy to ninety percent of the questions raised by teachers were from the lower order category. This means that teachers concentrate on the "who, when, what, and where" questions answerable only by one word or phrase. Teachers raised lower order questions mostly on the knowledge and comprehension levels, and did a lot of lecturing, sometimes interlaced with questions or with demonstrations (Simbulan, 1993)

Ornstein (1990) pointed out that good teaching involves good questioning which can aroused the curiosity of students, stimulate their imaginations and motivate them to search new knowledge.

Instructors in the undergraduate and graduate school need to strike a balance between factual and thought-provoking questions and in selecting questions to emphasize major points to stimulate lively discussions. Accordingly, the questions raised by instructors in their classes can have a variety of classification or categorization. This could be

categorized into: (1) the thinking process involved, from the low to the high cognitive level; (2) type of answer required, that is, convergent or divergent; and (3) degree of personal exploration or valuing.

Questioning is a vital part of the teaching and learning process. The art of questioning begins with establishing what is known and allows the teacher to extend beyond to develop new ideas and understanding. Clasen and Bonk (1990) posited that although many strategies exist that can impact student thinking, teacher questions have the greatest impact. They went on to indicate that the level of student thinking is directly proportional to the level of questions asked.

It is therefore the purpose of this study to investigate the questions raised by the Science teachers in the different colleges of Naval State University and to ascertain if their art of questioning enhances or develops students' higher order thinking skills.

THEORETICAL AND CONCEPTUAL FRAMEWORK

This study is propounded by Benjamin Bloom's theories of learning based on the cognitive, psychomotor, and affective domains of human behaviour and interaction. Cognitive learning is by knowledge recall and the intellectual skills, comprehending information, organization ideas, analysing and synthesizing data, applying knowledge, choosing among alternatives in problems in problem-solving, and evaluating ideas or actions.

Bloom theorized six levels within the cognitive domain. The levels range from simple recall or recognition of facts, the lowest level, through increasingly complex and abstract mental levels, to the highest order, classified as evaluation.

The cognitive category on knowledge can include knowledge of specifics, knowledge on ways and means of dealing with specifics, and knowledge of universals and abstractions in a field. The cognitive category on comprehension can include transition, interpretation and extrapolation. The cognitive category on application is concerned on how one applies what are learned. These 3 cognitive skills are classified as low-level knowledge.

The high level knowledge includes analysis broken down to analysis of elements, relationships, organizational principles. It also includes synthesis which requires the production of unique communication, production of plan, and derivation of a set of abstract relations. The cognitive skills on evaluation are also a high level questions. This includes judgment in terms of internal evidence and judgment in terms of external evidence.

Resnik and Klofer (1998) categorized questions as to convergent or divergent, which could match to the low-level type and the high-level type of question. Convergent questions tend to have one correct or best answer that they are oftentimes mistaken to be low-level type. They usually start with what, who, when or where yet these questions can be formulated to demand the selecting of relevant concepts and the working out or problems dealing with complex data, abstract ideas, analogies and multiple relationships (Ornstein, 1990).

Divergent questions are often open-ended and usually have many appropriate different answers. They usually start with the how and the why and are associated with the high level thinking processes that can encourage creative thinking and discovery learning.

The art of asking questions is one of the basic skills of the basic skills of good teaching. Socrates believed that knowledge and awareness were an intrinsic part of each learner. Thus, in exercising the craft of good teaching an educator must reach into the learner's hidden levels of knowing and awareness in order to help the learner reach new levels of thinking (Lindley, 1993).

The main concept of the study highlighted the dependent and independent variables which would evolve an output. As illustrated in the diagram, the art of questioning served as the main independent variable, vis-à-vis students' higher-order-thinking skills as dependent variable. The interplay of these variables would yield an output on improving student's academic performance.

Figure 1 illustrates the schematic diagram of the conceptual framework of the study.
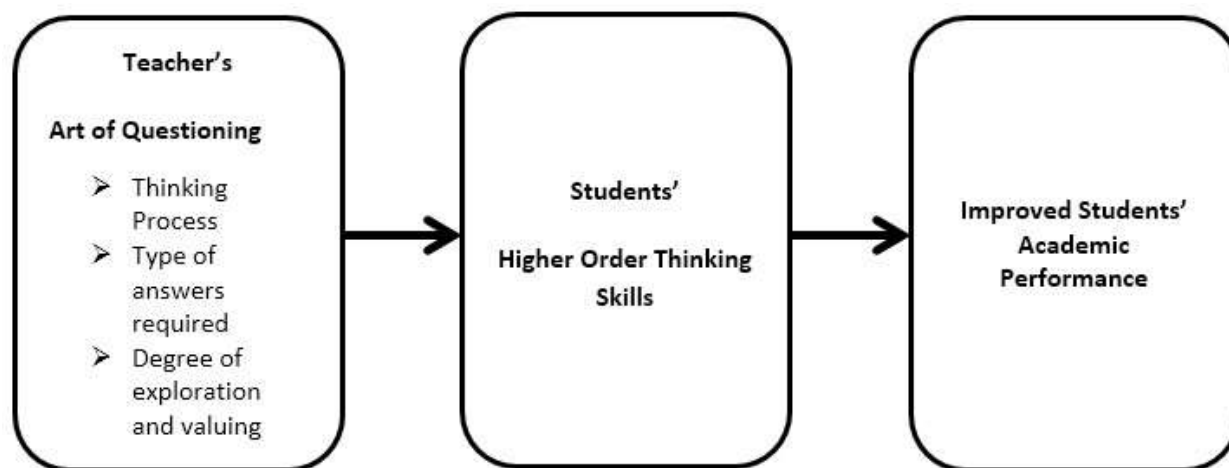
Figure 1: Conceptual Schema of the Study

METHODOLOGY

The documentary analysis design was used in this study with actual classroom. Observation and recording of transcripts of the questions were also done. Field notes were taken in the course of the classroom observation and unstructured interviews with the students were also undertaken.

The study was conducted exclusively within Naval State University, Naval, Biliran. The Science teachers of the different programs were the subjects of this study.

All the gathered data used the prescribed mode for coding qualitative outputs. Questions were transcribed from the audio-video recorder and questions were coded according to thinking process, types of answers required and to personal exploration or valuing. The data gathered during the observation were coded, analyzed and presented in tabular form using descriptive statistics such as mean, relative frequency and percentage.

RESULTS AND DISCUSSION

This part presents the survey conducted among the Science teachers of the different programs compare in the questions they raised during their discourse when categorized according to: (a) thinking process involved; (b) type of answer required and (c) degree of personal exploration or valuing as well as to determine the questions predominantly raised by Science teachers of the undergraduate and graduate classes in teaching.

Table 1 reveals that the Science Teachers raised more lower-order category questions as indicated by the percentage of 78.42 while the higher-order questions were only 21.57. It tells that the Science teacher raised more low-order questions when the skills to be developed should be the higher order level. In the lower-order skills, the cognitive skills in *knowledge* occupied the most number of occurrences while in the higher-order level the *analysis* had the most number of occurrences. This finding implies that Science teachers make good use of lower order thinking process among the students. On the other hand, the analytical skills ranked second with 18.67 percent of the questions raised, indicating higher level category and that this skill is mostly utilized by the Science teachers.

Table 1. Thinking Process

Thinking Process Involved	Frequency (f)	Percentage (%)
A. Lower Order Questions		
Knowledge	136	71.96
Comprehension	43	22.75
Application	10	5.29
Total	189	100
B. Higher – Order Questions		
Analysis	45	86.54
Synthesis	4	7.69
Evaluation	3	5.77
Total	52	100

As depicted in Table2, the Science teachers predominantly raised convergent questions. Out of 241 questions, 185 were categorized as convergent.

The most predominantly used convergent questions fell under the subcategory on question answerable by one word or phrase where 48 out of 185 convergent questions raised. This is followed by the questions answerable by alternative response like yes/no; true/ false and questions where students just fill in the answer. This implies that the Science teachers raised questions which are answerable by one word or phrase. This type of answer doesn't need any explanation or discussion since it needs only a direct and appropriate answer in response to the question being raised; whereas, rhetoric questions – those answered by the teachers themselves got the lowest percentage of .54 percentage occurrences during the study. This type of question is rarely raised by the Science teachers since it does not develop the thinking skills of the students.

Table 2. Type of Answer Required (Convergent Questions

Convergent Questions	Frequency (f)	Percentage (%)
Question answerable by one word or phrase	48	25.95
Recall questions	15	8.11
Questions answerable by alternative response like yes/no; true/ false	35	18.92
Procedural questions	10	5.41
Rhetoric questions- those answered by the teachers themselves	1	.54
Questions where students just fill in the answer	21	11.35
Short-answer opinion questions	18	9.73
Lower-order category question on knowledge, comprehension and application	20	10.81
Closure question like "Did you understand?"	4	2.16
Unfinished statements ending as questions	13	7.03
Total	185	100

Table 3 shows the divergent questions raised by the Science teachers. Out of 241 total questions, 56 were categorized as divergent questions. Questions that require analysis is the most predominant with 20 tallies equivalent to 35.71percent. Questions that make students explain/discuss ranked second with a percentage of 19.64, followed by questions that require students to prove with 10.71 percent. This implies that the Science teachers require answer that

needs analytical skills of the students. Likewise, it would further imply that the teachers place strong preference in developing the analytical thinking skills of the learners.

Table 3. Type of Answer Required (Divergent Questions)

Convergent Questions	Frequency (f)	Percentage (%)
Questions requiring long responses	5	8.93
Questions that make students explain/ discuss	11	19.64
Questions that require analysis	20	35.71
Questions that require synthesizing/ summarizing	4	7.14
Questions that call for decision making	1	1.79
Opinion questions that needs further explanation	4	7.14
Questions that lead to critiquing	3	5.36
Questions that require students to prove	6	10.71
Questions that allow students to report	2	3.57
Higher-order questions	0	0
Total	56	100

As shown in Table 4, questions requiring students to choose freely ranked first at 30.29 percent. Questions that require students to choose thoughtfully and reflectively ranked second with a percentage of 20.33 and this type of question is required in divergent and higher-order skills. The prizing and perishing questions ranked ninth with .41percent. It implies that in terms of questions raised on the degree of personal exploration or valuing, students were given questions which afforded them to choose their answer or idea as long as it relates to the question raised by the Science teacher. In science subjects, answers must be factual and relevant and must follow the different principles of science, since science is all about facts. The data discloses that the Science teachers focused more on the convergent type of questions which is a low order question and should not be their art of questioning.

Table 4. Degree of Personal Exploration or Valuing

Questions Categorized into Personal Exploration or Valuing	Frequency (f)	Percentage (%)
Choosing freely	73	30.29
Choosing from alternatives	35	14.52
Choosing thoughtfully and reflectively	49	20.33
Prizing and cherishing	9	3.73
Affirming	15	6.22
Acting upon choices	20	8.30
Repeating	12	4.98
Acting upon teachers' prompting	27	11.20
Asking questions	1	.41
Total	241	100

Table 5 shows the questions predominantly raised by the science teachers of the different programs. The data shows that most of the programs raised more questions on knowledge with 136 total number of questions given during the Science teachers' discussions. On the other hand, evaluation got only 3 questions and theses type of questions have few occurrences in most of the programs. It indicates that the Science teachers of the different programs focused more on asking questions which require simple and direct answers or simple recalling of facts. Furthermore, it also showcases that the teachers commonly develop low order thinking skills of the students than high order thinking skills.

Table 5. Questions Predominantly Raised by the Science Teachers

Art of Questioning	COEd	COME	COE	CAS	CIICT	Total
Thinking Process						
Knowledge Comprehension	67	25	5	20	19	136
Application	12	8	6	10	7	43
Analysis	3	2	1	2	2	10
Synthesis	19	9	4	6	7	45
Evaluation	2	1	0	0	1	4
	1	1	1	0	0	3

Table 6 indicates the art of questioning of the Science teachers and the student's academic performance in science. In accepting or rejecting the hypotheses of this study, the researcher used the alpha level of .05 and degree of freedom (df) of 3. The co-efficient of correlation is equivalent to 0.19 and the computed value is 1.7640 while table value is 0.8783. Therefore, based on the data and computation, the hypothesis is being rejected. There is a significant relationship between the art of questioning of the Science teachers and the students' academic performance in Science through the students' midterm grades.

This simply suggests that the academic performance of the students are greatly affected by their thinking skills which, in turn, is influenced by the manner of questioning of the Science teachers. Likewise, this implies the need for Science teachers to learn appropriate and sensible way of questioning so that students' higher order thinking skills will improve and contribute to their increased academic performance.

Table 6. The Art of Questioning of the Science Teachers and the Student's Academic Performance in Science

Variables	r	CV	TV	D
Art of Questioning of the Science Teachers and Students Academic Performance	0.19	1.7640	0.8783	rejected

CONCLUSION

Majority of the questions were lower order (i.e. Knowledge, comprehension, and application-based) as these levels are considered low under Bloom's hierarchy of cognitive domain. The higher-order questions which consist of analysis, synthesis and evaluation were seldom asked. The Science teachers have varied styles of questioning in terms of thinking process involved, types of answer required and personal exploration and valuing required. In the thinking process, teachers raised questions more common on knowledge. While in the type of answer required, the teachers relied mostly in convergent type of questions rather than the divergent. In personal exploration or valuing, the students were given freedom to choose freely on the ideas they wanted to answer. The Science teachers in the different programs raised more questions on knowledge based on Bloom's taxonomy of learning; they focused more on questions which have direct answers and common on basic facts and ideas. There is a significant relationship between the art of questioning of the Science teachers and the student's academic performance in Science. Thus, the art of questioning of the Science teachers has a great impact to the academic performance of students.

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