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**Profiling Secondary School Teachers' Attitudes Towards Learning Physics**

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**Abstract**

The study describes the attitudes towards Physics and learning Physics of secondary school teachers who underwent a six-week in-service training program at the De La Salle University – Manila during the months of April and May, 2007. Since the background of the teachers was neither in Physics nor in Physics education, the training program was designed to upgrade their conceptual understanding of Physics and their skills and competencies in teaching Physics. Using the data obtained from the Colorado Learning Attitudes about Science Survey (CLASS), this study presents a profile of the attitudes and beliefs held by the secondary school teachers.

**Introduction**

Strides in human development and the progress made by human society over the past half century highlight the role that science and technology plays in meeting the challenges of an ever-transforming society. Nations that have set global economic standards have invested, and continue to invest, a substantial portion of their human and financial resources into science and technology, including education and training, research and development, technology acquisition and adaptation, and the development of physical infrastructures to support science and technology. The experience of industrialized nations has shown that a critical mass of scientists, researchers, engineers, and technicians will propel a country towards the next stage of modernization. By nurturing a "culture of science", this socio-economic breakthrough could be achieved with a citizenry equipped with the knowledge, skills, values, and attitudes made keener by quality education in science and technology.

An understanding of the nature of science is an important objective in a science education curriculum that intends to promote scientific literacy. Lederman (1992) noted that the development of an adequate understanding of the nature of science and an understanding of science as a way of knowing is a desired outcome of science teaching.

If we regard students' sound understanding of the nature of science as something important in our science classrooms, it becomes important to examine the conceptual position of science teachers with regard to how they view science. Clark and Peterson (1986) reported that research in math and science education suggests that teacher beliefs about what mathematics and science is and what it means to know the content, do mathematical and scientific activities, and teach mathematics and the sciences may be driving forces in the instruction of science and math ideas.

Working with pre-service and in-service science teachers, Tairab (1999) noted that the teachers' conceptual position often influenced what transpires in the classroom more than what is planned in the curriculum. Haney, Czerniak, and Lumpe (1996) reported that teacher beliefs were a strong predictor of their intentions to implement reform-based strategies. Using a quantitative approach, they determined that the following four beliefs were most salient to a teacher's intention to initiate inquiry:

(1) increase student enjoyment and interest in science,
(2) foster positive scientific attitudes and habits of mind,
(3) help students learn to think independently, and
(4) make science relevant to the students' everyday lives.

There is a complex interaction between teacher beliefs, which are mental, and teacher actions, which take place in the social arena. Wallace and King (2004) view teacher actions as “representing one aspect of a teacher’s beliefs and thus, should not be perceived as separate entity from the belief system as a whole”. Furthermore, they stated that what a teacher does in the classroom is representative of the teacher’s belief system.

Villena (2004), documenting the beliefs and practices of elementary teachers of high- and low-performing schools in Metro Manila (Philippines), recommended that in-service training be conducted that would deliberately include opportunities for teachers to reflect on their beliefs and practices, as some teachers are not fully aware of the tradition they adhere to when teaching.

Teacher attitudes and beliefs are important considerations in understanding classroom practices and conducting teacher education programs that are designed to help prospective and in-service teachers towards developing their thinking skills and classroom practices.

**The Colorado Learning Attitudes about Science Survey (CLASS)**

The Colorado Learning Attitudes about Science Survey [CLASS] (Adams, et al., 2006) builds on the work done by existing surveys that looks at beliefs and attitudes. There are three well-known surveys for probing student attitudes and beliefs about the physical sciences: (a) the Maryland Physics Expectations Survey (Redish, et al., 1998), (b) the Views About Science Survey (Halloun and Hestenes, 1985), and (c) the Epistemological Beliefs Assessment about Physical Science (Elby, 2001). The Physics Education Research Group at the University of Colorado in Boulder developed CLASS to make the statements as clear and concise as possible. The Colorado Learning Attitudes about Science Survey probes students’ beliefs about physics and learning physics and distinguishes the beliefs of experts from those of novices.

Participants taking the CLASS inventory are asked state their view (agree or disagree) regarding 42 statements, such as the following:

“Learning physics changes my ideas of how the world works.”
“If I get stuck on a physics problem on my first try, I usually try to figure out a different way that works.”
“Reasoning skills used to understand physics can be helpful to me in my everyday life.”

Scoring of the Colorado Learning Attitudes about Science Survey is done by determining, for each survey taker, the percentage of responses for which s/he agrees with the experts’ view (tagged as “percent favorable”). The average “percent unfavorable” is determined by taking the number of responses for which the respondent disagrees with the experts’ view. Neutral responses are also noted and reported in the findings.

The survey is scored “overall” and for the following eight categories: (a) Real World Connection, (b) Personal Interest, (c) Sense Making / Effort, (d) Conceptual Connections, (e) Applied Conceptual Understanding, (f) Problem Solving [General], (g) Problem Solving [Confidence], and (h) Problem Solving [Sophistication]. Each category consists of four to eight statements that characterize a specific aspect of thinking. Together, these categories include 27 of the 42 statements. The overall score includes these 27 statements, plus an additional nine statements, all thirty-six of which passed the validity and reliability tests conducted by the University of Colorado Physics Education Research Group (Adams, et al., 2004). In the current version of the survey (ver. 3, available through http://CLASS.colorado.edu), six statements do not yet have an “expert” response.

**Experimental Design**

During the months of April and May, 2007, the Department of Education (DepED) partnered with the Department of Science and Technology (DOST) and De La Salle University – Manila (DLSU), a private tertiary institution in the Philippines, to deliver the second phase of the Diploma Program in Science / Mathematics. The diploma program aimed to improve the capability of teachers who are non-majors in science by equipping them with knowledge of content, strategies in teaching, and tools for assessing learning.

The secondary school teachers who underwent the Diploma Program in Physics have been teaching Physics and / or will be teaching Physics even if their college preparation was not in Physics teaching. About half of the participants (48%) had a background in secondary education with a major in Mathematics. The background of twenty-one percent (21%) of the respondents was in General Science. The rest of the group had a secondary education degree with a major in one of the following subject areas: Agricultural Education, Agronomy, Applied Electronics, Chemistry, Food Technology, Political Science, and Zoology.

The teachers were from the Southern Luzon region of the Philippines, comprising the provinces of Mindoro, Marinduque, Romblon, and Palawan. The average age of the participants in the Diploma Program in Physics was 40.4 years. The youngest participant was a 24-year old male teacher; the oldest was a 59-year old female teacher. About half of the number (45%) of the participants fall in the 40-49 years age range, with the number of participants in the 30-39 years age range coming in a close second, at 38%. The participants coming from the 20-29 years age group and from the 50-59 years age group composed 10% and 7% of the total, respectively.

The teacher improvement program was prompted by the report of the 2000 Philippine Commission on Educational Reform, which noted that there is a serious shortage of teachers trained in mathematics and the sciences, particularly for Physics and Chemistry. Many of the secondary school science and math courses are taught by teachers who do not have the adequate training and background in science / mathematics. The survey conducted by the PCER revealed that the total number of teachers who majored in subjects taught is low for the sciences. The report, published in the year 2000, showed that only 40% of General Science teachers have a background in General Science. Only 41% of Biology teachers, 21% of Chemistry teachers, and 18% of Physics teachers are adequately prepared to teach secondary level science courses.

The figures cited in the previous paragraph are an improvement from the percentages cited by the report of the 1991 Philippine Congressional Commission on Education, where it was given that at the secondary level, the percentage of qualified science teachers are as follows: General Science, 34%; Biology, 30.5%; Chemistry, 15.4%; and Physics, 4.4%.

## Discussion of Results

The over-all profile [table 1] of the 41 teachers surveyed reveal that they gave a favorable response (agreement with the experts' response) in an average of 65.7% of the 36 CLASS statements. An unfavorable response was reflected in 18.2% of the statements, with the remaining 16.1% being rated as neutral (neither in agreement with nor in disagreement with the experts' response).

**Table 1. Percentage Agreement / Disagreement with Experts' Response in the Categories of the Colorado Learning Attitudes about Science Survey (CLASS)**

| Dimension / Category | Favorable Response (% agreement) | Unfavorable Response (% disagreement) |
|---|---|---|
| Personal Interest | 87.63 % | 3.23 % |
| Real World Connection | 83.06 % | 9.68 % |
| Problem Solving (General) | 76.21 % | 8.06 % |
| Problem Solving (Confidence) | 70.16 % | 9.68 % |
| Problem Solving (Sophistication) | 52.69 % | 23.12 % |
| Sense Making / Effort | 78.80 % | 5.99 % |
| Conceptual Connections | 56.45 % | 23.66 % |
| Applied Conceptual Understanding | 40.09 % | 38.25 % |
| OVERALL | 65.71 % | 18.16 % |

This over-all percent favorable profile is slightly higher than the over-all percent favorable profile for non-science majors taking up their first college Physics course, surveyed by Adams, et al. (2004) who reported that during the fall of 2003, the seventy-six non-science students from an American state research university who took the Colorado Learning Attitudes about Science Survey posted a 57% favorable response profile.

During the spring of 2004, Adams, et al. (2004) surveyed 398 engineering majors taking up their first college-level Physics course. A 68% favorable (over-all) profile was reported for this specific group. A more recent survey conducted by the Physics Education Research Group at the University of Colorado (Adams, et al, 2006) on students (N = 397) taking up a calculus-based Physics 1 course in a large state research university reveal a 65% favorable (over-all) profile. The profile obtained in the present study is within the percentage favorable profile obtained by the Physics Education Research Group at the University of Colorado.

**Personal Interest category**

This category probes if the respondents feel a personal interest in or a connection to the study of Physics. The teachers surveyed in the study posted the highest average percentage favorable (87.6%) in this category [table 1]. This group profile is higher than the 74% favorable response reported by Adams, et al. (2004) for the Physics majors (N = 38) enrolled in a calculus-based Physics 1 course.

The high school teachers reported that they "think about the Physics (they) experience in everyday life" [93.5% favorable response for CLASS item # 3] and they "study Physics to learn knowledge that will be useful in (their) life outside of school" [83.9% favorable response for CLASS item # 14].

**Real World Connection category**

In the real-world connection category, the respondents are asked whether they think about their personal experiences and relate them to the topic being analyzed [CLASS item # 37]. The 90% favorable response for CLASS item # 28, "Learning Physics changes my ideas how the world works", and the 90% agreement with experts for CLASS item # 30, "Reasoning skills used to understand Physics can be helpful to me in my everyday life", reveal that the teachers surveyed believe that ideas learned in a Physics class are relevant and useful in a wide variety of real contexts.

The 83.1% favorable result for the Real World Connection category obtained in the present study [table 1] is higher than the percentage favorable responses (average of 74% agreement with experts) reported by Adams, et al. (2004) for students enrolled in a calculus-based Physics 1 class and the result of the most recent survey conducted by the Physics Education Research Group at the University of Colorado (Adams, et al., 2006) where a 72% favorable response was noted for the real-world connections category.

**Problem Solving category**

The Problem Solving cluster looks at three inter-related categories. Included in this cluster are items that ask the respondents if they enjoy solving Physics problems [CLASS item # 25] and if they can usually figure out a way to solve Physics problems [CLASS item # 34].

The teachers surveyed in the present study reported a high percentage favorable response (agreement with experts) in two of the three categories that dealt with attitudes and beliefs about problem solving in Physics [table 1]. The 87% favorable response for CLASS item # 15, "If I get stuck on a physics problem on my first try, I usually try to figure out a different way that works", and the 90% favorable response for CLASS item # 26, "In physics, mathematical formulas express meaningful relationships among measurable quantities", reveal that the teachers have a positive attitude towards problem solving as a tool in discovering patterns in nature.

The 52% favorable response for the Problem Solving (Sophistication) category, however, tells us that the group's level of sophistication when approaching problem solving in Physics is an area that can be improved further.

Two items are common to the three inter-related Problem Solving categories. For both statements, the group of teachers surveyed in the study reported a moderate percentage favorable response. Fifty-eight percent of the respondents reported that they can usually figure out a way to solve Physics problems [CLASS item # 34]. It is also noteworthy to point out that only 25% of the respondents reported that if they get stuck on a Physics problem, there is no chance they will figure it out [CLASS item # 40%].

The average rating for the Problem Solving cluster obtained in this study – Problem Solving (General), 76.2% favorable response; Problem Solving (Confidence), 70.2% favorable response; and Problem Solving (Sophistication), 52.7% favorable response [table 1] – followed the same trend noted by the Physics Education Research Group at the University of Colorado (Adams, et.al., 2006) for their students (N = 397) taking up a calculus-based Physics 1 course: Problem Solving (General), 58% favorable response; Problem Solving (Confidence), 58% favorable response; and Problem Solving (Sophistication), 46% favorable response.

**Sense Making / Effort category**

This category probes if the learner takes the effort to use available resources to make sense out of the information in learning Physics. Adams, et al. (2004) reported an average of 77% favorable response on this particular category for the calculus-based Physics class they surveyed. The Physics Education Research Group at the University of Colorado (Adams, et al., 2006) reported a 73% favorable response for students who took a reform-oriented Physics course.

In the present study, the secondary school teachers who were surveyed posted an average of 78.8% favorable response (agreement with experts) for the seven questions included in the category. The respondents reported that, "it is important (for them) to make sense out of formulas before they can be used carefully" [CLASS item # 24, 80% favorable response]. Further, they "explicitly think about which Physics ideas apply to a problem" [CLASS item # 39, 90% favorable response]. It is noteworthy to point out that none of the respondents gave an unfavorable response to CLASS item # 11, "I am not satisfied until I understand why something works the way it does".

**Conceptual Connections & Applied Conceptual Understanding category**

Life-long learners of Physics strongly feel that students should see Physics as a coherent and consistent structure (Redish, et al., 1998). Learners who emphasize that Physics is simply a collection of facts fail to see the integrity and coherence of the whole structure of Physics. The two related categories probe how deeply the respondents understand Physics as being coherent and how the respondents draw connections between the different ideas learned. The conceptual connections profile of the high school teachers surveyed show a 56.5% agreement with experts. The applied conceptual understanding profile revealed a 40.1% agreement with the experts' response.

Although 94% of the respondents gave an expert-like response to CLASS item # 42, "When studying Physics, I relate the important information to what I already know, rather than just memorizing it the way it is presented"; 77% of the respondents reported "When I solve a Physics problem, I locate an equation that uses the variables given in the problem and plug in the values" [CLASS item # 8], which is a novice-like view of the study of Physics.

Three-fifths of the total number of respondents reported that "a significant problem in learning Physics is being able to memorize all the information I need to know" [CLASS item # 1]. This reveals that a good number of the high school teachers still focus on memory work while doing Physics. Indeed, much work is yet to be done in upgrading the teachers' conceptual understanding of Physics.

A similar trend in the percentage favorable responses is seen in the work done by the Physics Education Research Group at the University of Colorado (Adams, et al., 2006). Students enrolled in a calculus-based Physics 1 course reported a 63% agreement with experts in the conceptual connections category and a 53% agreement with experts for the applied conceptual understanding category.

**Relationship Between the Different Categories of CLASS**

The study also looked at the relationship between the beliefs held by the teachers in the different categories of the Colorado Learning Attitudes about Science Survey (CLASS). As expected, the responses in the Problem Solving categories – Problem Solving (General), Problem Solving (Confidence), and Problem Solving (Sophistication) – correlate highly with each other (r ranges from 0.794 to 0.860) [table 2]. The respondents give a consistent response that support their agreement (or disagreement) with the experts' response, as their responses in the Conceptual Connections and Applied Conceptual Understanding categories correlate highly with each other (r = 0.828).

It is interesting to point out that the Conceptual Connections profile and Applied Conceptual Understanding profile correlate highly with the Problem Solving (Sophistication) category, r = 0.657 and 0.822, respectively. The Conceptual Connections profile and Applied Conceptual Understanding profile correlate moderately with the Problem Solving (General) category, r = 0.661 and 0.652; as well as with the Problem Solving (Confidence) category, r = 0.471 and 0.598. We could hypothesize that a learner's level of sophistication and confidence when approaching problem solving in Physics is dependent on the level of appreciation and understanding of the various Physics concepts.

The moderate correlation between the Personal Interest cluster and each of the following categories: Real World Connection, r = 0.586; Problem Solving (General), r = 0.484; Problem Solving (Confidence), r = 0.496; and Problem Solving (Sophistication), r = 0.557 reveal that a learner's interest in Physics is facilitated by the abovementioned factors.

**Table 2. Correlation Coefficients when Comparing the Categories of the Colorado Learning Attitudes about Science Survey (CLASS) [95% level of confidence]**

| | *Personal Interest* | *Real World Connection* | *Problem Solving General* | *Problem Solving Confidence* | *Problem Solving Sophistication* | *Sense-Making / Effort* | *Conceptual Connections* | *Applied Conceptual Understanding* | *OVERALL* |
|---|---|---|---|---|---|---|---|---|---|
| *Personal Interest* | 1.000000 | | | | | | | | |
| *Real World Connection* | 0.586122 | 1.000000 | | | | | | | |
| *Problem Solving General* | 0.484481 | 0.315872 | 1.000000 | | | | | | |
| *Problem Solving Confidence* | 0.495665 | 0.323274 | 0.859856 | 1.000000 | | | | | |
| *Problem Solving Sophistication* | 0.557406 | 0.363148 | 0.845194 | 0.793858 | 1.000000 | | | | |
| *Sense-Making / Effort* | 0.266237 | 0.281686 | 0.276556 | 0.231281 | 0.199801 | 1.000000 | | | |
| *Conceptual Connections* | 0.210335 | 0.386319 | 0.661407 | 0.471457 | 0.657050 | 0.530761 | 1.000000 | | |
| *Applied Conceptual Understanding* | 0.306145 | 0.400778 | 0.651845 | 0.597616 | 0.821556 | 0.283991 | 0.828066 | 1.000000 | |
| *OVERALL* | 0.562671 | 0.605460 | 0.736687 | 0.642637 | 0.778525 | 0.578675 | 0.819035 | 0.842355 | 1.000000 |

*High Correlation Coefficients range from 0.700 to 1.000*
*Moderate Correlation Coefficients range from 0.400 to 0.699*
*Low Correlation Coefficients range from 0.000 to 0.399*

## Conclusion and Recommendation

The secondary school teachers who underwent the six-week intensive program in Physics posted high agreement with experts' beliefs in the following categories of CLASS: personal interest [87.6%], real world connections [83.1%], sense-making / effort [78.8%], and problem solving (general) [76.2%]. A moderate agreement with experts' responses was reported for the problem solving (confidence) [70.2%], conceptual connections [56.5%], and problem solving (sophistication) [52.7%] clusters. The teachers' attitudes and beliefs in the applied conceptual understanding category [40.1% favorable responses] may be classified as novice-like thinking.

The responses in the Problem Solving clusters – Problem Solving (General), Problem Solving (Confidence), and Problem Solving (Sophistication) – correlate highly with each other. In a similar manner, the responses in the Conceptual Connections and Applied Conceptual Understanding clusters correlate highly with each other.

It was also noted that the Conceptual Connections profile and Applied Conceptual Understanding profile correlate highly with the Problem Solving (Sophistication) cluster and moderately with the Problem Solving (General) and the Problem Solving (Confidence) categories. We hypothesize that a learner's level of sophistication and confidence when doing problem solving in Physics is dependent on the level of appreciation and understanding of the various Physics concepts.

The moderate correlation between the Personal Interest cluster and each of the following clusters: Real World Connection, Problem Solving (General), Problem Solving (Confidence), and Problem Solving (Sophistication) reveal that a learner's interest in Physics is facilitated by the above mentioned factors.

Since the teachers have completed the enrichment program, it is recommended that a follow-up of this present study be conducted. The follow-up study will document the classroom practices of the teachers involved in the study, as it would be interesting to relate their attitudes and beliefs to the teaching-learning atmosphere that is present in their classrooms.

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