# Assessing Science Students' Perceptions in Learning Activities Achievements in Physics Laboratory Classrooms in Udon Thani Rajabhat University

Toansakul Santiboon, Somchai Chumpolkulwong, Piyawadee Yabosdee, and Jutharatana Klinkaewnarong, *Member, IACSIT*

***Abstract*—This research describes science student programs' perceptions of their physics laboratory classroom learning environments in Udon Thani Rajabhat University, Thailand. Associations and relationships between these perceptions and students' attitudes toward physics laboratory were also determined. The physics laboratory learning environment perceptions were obtained in 5 scales for using the 35-item Physics Laboratory Environment Inventory (PLEI), which was a modified from the original Science Laboratory Environment Inventory (SLEI) (Fraser, McRobbie, and Giddings, 1993) [1]. This questionnaire has the 2-Actual and a Preferred Forms. Students' attitudes were assessed with the Test Of Physics-Related Attitude (TOPRA) modified from the Test of Science-Related Attitude (TOSRA) (Fraser, 1981) [2]. The questionnaires administered to a sample of 577 students in 13 science and technological program classes. Using the actual-1, actual-2 and preferred forms associated students' perceptions of their physics laboratory attitudes were also administered with the TOPRA. Statistically significant differences were found (ρ<0.001). The factor structures were found to have factor loading over than 0.30 of the PLEI. The preferred perceptions were more favorable than actual perceptions on all scales of the PLEI. The multiple correlations R are significant and show that when the scales are considered the significant associations with the TOPRA (ρ<0.001). The R2 values indicate that 3.35%, 43.82%, and 57.91% of the variances in students' attitudes to their physics laboratory classes were attributable to their perceptions of the actual-1, actual-2, and preferred physics laboratory classroom environments. Based on the finding, suggestions for improving the physics laboratory classroom environments with students' perceptions are provided.**

***Index Terms*—Science students' perceptions, learning activities achievements, actual and preferred forms, physics laboratory classrooms.**

## I. Introduction

There has been continuous concern about the situation in educational laboratories (particularly, primary, secondary schools, and universities) among educators in Thailand (Kijkosol and Fisher, 2005 [3]; Santiboon, 2010[4], 2011[5]; Santiboon and Fisher, 2004[6]; Sitthikosol and Malone, 2008[7]; Wanpen and Fisher, 2005)[8]. They reported that laboratory activities are not effectively conducted in schools, which was against the recommendations from curriculum. It was also pointed that the situation in primary, secondary, and higher education systems were worst, which meant the least likely conducted laboratory lessons.

They also found that science (physics, biology and chemistry) teachers normally experience the clash between their ideal image about science lessons and the real situation in their own science lessons. According to those teachers, they accept the fact that understanding of basic concepts and applying them in explaining natural phenomena are the most important objectives in science education, however, almost all teachers run laboratory lessons involving students' experiments only once or twice in a semester.

Education in Thailand is provided mainly by the Thai government through the Ministry of Education from pre-school to higher education level. Formal education consists of at least twelve years of basic education, and higher education. Basic education is divided into six years of primary education and six years of secondary education, the latter being further divided into three years of lower- and upper-secondary levels. Non-formal education is also supported by the state. Independent schools contribute significantly to the general education infrastructure. Administration and control of public and private universities are carried out by the Office of Higher Education Commission, a department of the Ministry of Education.

Udon Thani Rajabhat University is one of the oldest community universities in the northeast of Thailand. It was established on November 1, 1923 and offers various programs of study for all levels. Among these are associate, bachelor, master, and doctorate degrees as well as post-graduate diplomas in three major areas: education, science and arts. UDRU is a university where international and local knowledge meet to empower the community and the region. From its origin as a teacher education institute, UDRU has participated in the Public Sector Management Quality Award (PMQA) since the program was initiated in 2005 and has been ranked among top ten higher education institutes of Thailand for four years and has offered a variety of programs of study within each faculty and the overall fees vary depending on the programs of study.

Faculty of Science continues to provide education in order to produce human resources in the field of science and applied science to serve the needs of the community. It has advanced the knowledge through scientific research where integrations and adaptations of local knowledge are also in reach. There are too many programs for study in Bachelor's Degree Programs; Mathematics, Biology, Physics, Computer Science, Sports Science, Environmental Science, Applied Statistics, Public Health, Chemistry, and Information Technology. Founded in 2005, Faculty of Technology is the newest and continuously growing faculty, to offer Bachelor of Science, Technology and Engineering

Manuscript received March 28, 2012; revised April 5, 2012.

Authors are with the Physics Department, Faculty of Science; Udon Thani, Rajabhat University, Thailand. 41000(e-mail: toansakul35@yahoo.com.au; somchai.li@gmail.com; wade_yabosdee@yahoo.com; jutharatana@gmail.com).

through a wide range of programs; such as, Industrial Management, Agribusiness, Food Science and Technology, Veterinary Technology, Plant Production Technology, Animal Production Technology, Biotechnology, Electronics Technology, Mechanical Technology, Construction Technology, Food and Services, Industrial Design, Electronics Engineering, and Mechanical Engineering programs.

This study intended to extend this notion in order to obtain more comprehensive picture of physics laboratories within higher educational level for the foundational science curriculum of the Science Bachelor's Degree Programs, particularly at the science and technology students, by focusing on science students' perceptions about their own laboratories in Foundational Physics Laboratory Course, which is offered Bachelor of Science in the same management acknowledgement programs by Physics Department's administration. Its courses were designed carefully based on physics disciplines themselves and results of the studies on economic, social and cultural changes in order to promise quality graduates to the society. The frequency and quality of physics laboratory activities also depend on science and technological students have changed to experience laboratory classes are expected to get more improvement to be in physics laboratory classes, and supposed to get many more chances to experience laboratory classes with better facilities.

## II. Procedure for Paper Submission

### A. Review Stage

There are many aspects to determine the success of learning process. One of the aspects is learning environments. Many research studies show that learning environments not only have the positive correlation with the students' outcomes, motivation, and attitudes, but also teachers' motivation (Fraser, 2002)[16]. Furthermore, there are some research studies on learning environments which focus on student outcomes, students' and teachers' perceptions, and evaluation of the strategies. Moreover, because of the importance of learning environments, many instruments are developed to assess learning environments. Since the laboratory classroom learning instruments were applied and adapted version (Kijgosol and Fisher, 2005[3]; Santiboon and Fisher, 2004[6]) from the Science Laboratory Environment Inventory (SLEI) that it was developed by Fraser and his colleagues (1993)[9], Koul and Fisher (2005)[10] with an awareness of the importance of laboratory lessons in science learning, aspects of laboratory classroom environments have been widely investigated in various settings. Initially, the SLEI was developed by involving Australian secondary school students (Fraser, 1991)[11] and was extensively validated in diverse settings such as USA, Australia, Canada, England, Israel, Nigeria, Brunei, Singapore and countries in South Pacific Islands (Fraser, Giddings and McRobbie, 1995[12]; Giddings and Waldrip, 1996[13]; Wong and Fraser, 1996)[14]. It is noteworthy that the development of the SLEI involved the creation of a new format for learning environment instruments, which was based on the realization that a student can have his/her own perceptions about the classroom which can vary for different students in the same class.

### B. Learning Environments

Learning environment is an important aspect in education. According to the learning environment should be managed so that students are encouraged to set personal goals, actively gather meaningful information, monitor and evaluate their own learning and reflect personal learning experiences in different authentic environments and social contexts. As a result, teachers play important role to create the constructive learning environments which could help students to achieve best performances and meaningful learning experiences. Furthermore, the positive classroom climate can motivate both students and teacher to learn and teach effectively. Teacher who creates the positive classroom climate such as having a good relationship with students will help students to achieve their learning outcomes (Fisher, Rickards, and Fraser, 1996)[15]. The students will enjoy their learning and express their ideas and opinions. Therefore, most studies in learning environment show that the learning environment influences the students' outcomes (Fraser, 2002)[16]. According to students' perceptions of a learning environment would be determined how much they will learn and how effective a learning environment. As a result, it is important for the teachers to develop their knowledge and skills to create the positive learning environment (Yarrow, Millwater, and Fraser, 1997)[17].

### C. Learning Environment Instruments

Most learning environment questionnaires provide information on the measure of students' learning outcomes, and students' perceptions of their learning environment. Learning environments instruments essentially, measures the meaningful environments for students to a given classroom Moreover, there are many instruments to assess learning environments. Some of those instruments are Learning Environment Inventory (LEI), Classroom Environment Scale (CES), Individualised Classroom Environment Questionnaire (ICEQ), My Class Inventory (MCI), College University Classroom Environment Inventory (CUCEI), Questionnaire on Teacher Interaction (QTI), Science Laboratory Environment Inventory (SLEI), Constructivist Learning Environment survey (CLES), What Is Happening In this Class? (WIHIC), and Cultural Learning Environment Questionnaire (CLEQ).

### D. Learning Environments Assessments

The majority of learning environments assessments is based on students' perceptions. Therefore, student characteristics will have an effect on how students evaluate and perceive their learning environments. Furthermore, students' and teacher perceptions of the learning environment can give valuable information to improve the quality of learning environment (Fraser, 1998)[18]. It also can evaluate the innovation in education. As a result, the learning environment assessments can measure the aspects in the classrooms such as teacher, students, teaching, and learning processes.

### *E. Science Laboratory Classroom Learning Environments*

The laboratory experiment is an important part of science teaching. Many studies show that experiments in laboratory influence students to have better attitudes toward science and learning outcomes. Furthermore, laboratory experiments can help students to understand abstract concepts in science. Practical work is also fun and interesting for the students. As a result, they are motivated to explore the material which related to the topics in the classroom. There are four aims of practical work in the laboratory which is encouraging students to (1) practice seeing problems and solve it, (2) find the facts and new principles, (3) develop ability to co-operate, (4) develop critical attitude. The positive learning environments in the laboratory will help teacher and students to achieve the best performances in learning process. Therefore, it is important to evaluate the learning environments in laboratory. It is not only to assess students' perceptions, but also to help teacher do several improvement related to the result of learning environment assessment. However, there are only a few research studies on laboratory learning environments compared to other fields of learning environments. Therefore, exploring this field of learning environments will be useful for the professional development as a science educator.

### *F. Science Laboratory Environment Inventory (SLEI)*

One instrument which has already been developed is Science Laboratory Environment Inventory (SLEI). The development of the SLEI was initiated with an awareness of the importance of laboratory lessons in science education. The initial version of the SLEI contained eight scales, with nine items in each scale. The SLEI was developed to assess students' perceptions on learning environments in the laboratory classes (Fraser, McRobbie, Giddings 1993)[1]. This instrument is appropriate for the secondary and tertiary education which contains 35 items and five scales which are Student Cohesiveness (SC), Open-Endness (OE), Integration (I), Rule Clarity (RC), and Material Environment (ME). The preliminary version of SLEI was field tested in six countries, namely, Australia, Canada, England, Israel, Nigeria and USA. The SLEI first was developed in a Class form, which assesses a student's perceptions of the class as a whole (Fraser, McRobbie and Giddings, 1993)[1]. According to Henderson, Fisher, and Fraser (2000)[19] "the use of these scales provides coverage of the three dimensions identified by Moo's work (1974)[20] for conceptualizing all human environments" (p.29). The SLEI has five responses which are Almost Never, Seldom, Sometimes, Often, and Very Often which have scores 1,2,3, 4, and 5, respectively for positive items and revised scores for the negative items. Furthermore, this instrument is designed with economical cost which is only one page and easy for teacher to hand scoring. McRobbie and Giddings, 1993)[1]. According to Henderson, Fisher, and Fraser (2000)[19] "the use of these scales provides coverage of the three dimensions identified by Moo's work (1974)[20] for conceptualizing all human environments" (p.29). The SLEI has five responses which are Almost Never, Seldom, Sometimes, Often, and Very Often which have scores 1,2,3, 4, and 5, respectively for positive items and revised scores for the negative items. Furthermore, this instrument is designed with economical cost which is only one page and easy for teacher to hand scoring.

### *G. Actual and Preferred Forms of the SLEI*

The SLEI instrument uses the actual and preferred form which is different from other instruments which compare the personal and class version. The actual and preferred form as a personal version of students will give "meaningful and sensitive investigations of the environments existing within a class for different subgroups of students" (Fraser, McRobbie, Giddings 1992, p.7)[21]. Students choose the actual and the preferred learning environments in their laboratory. The result could be different or similar, but the teacher could have valuable information of their students' perceptions on actual and the preferred. The difference between the actual and the preferred learning environment could be used as information for teachers to choose the appropriate strategies to minimize the differences. Therefore, the using of SLEI could be used for school-based professional development and guiding to improve the effectiveness of science laboratory teaching (Fraser, McRobbie, Giddings, 1992)[21].

### *H. Validity and Reliability of the SLEI*

The SLEI is developed through the several process which are reviewing the literature, identifying the dimensions, and interviewing teachers and students. The SLEI originally was validated with a sample of 3.727 senior high school students in 198 science laboratory classes and 1,720 students in 91 university science laboratory classes in six countries (Australia, United States, Canada, England, Israel and Nigeria) (Fraser, Giddings, and McRobbie, 1992)[21]. Furthermore, there are some research studies which used SLEI instrument.

### *I. The Test of Science-Related Attitude (TOSRA)*

Original of the Test of Science-Related Attitude (TOSRA) (Fraser, 1981)[2] was designed to measure and assess science-related attitudes along seven dimensions: social implications of science, normality of scientists, attitude toward scientific inquiry, adoption of scientific attitudes, enjoyment of science lessons, leisure interest in science, and career interest in science scales for associations with students' cognitive and affective outcomes.

### *J. Previous Research Using the SLEI and the TOSRA*

The SLEI has been used in various contexts, including non-English speaking countries and English speaking countries across most high schools throughout the USA, Australia, Asian and South Pacific teachers and students (Giddins and Waldrip, 1996)[13]. Fraser and his colleagues attempted to advance science's educators' understanding of practical work from classroom learning environment perspectives (Fraser, Giddings, and McRobbie, 1992, 1993, 1995; Fraser, McRobbie, 1995)[22]. The SLEI was an instrument devised to investigate science laboratory learning environments (McRobbie and Fraser, 1993)[23]. Harrison, Fisher and Hendeson (1997)[24] investigated student perceptions of practical tasks in senior biology, chemistry and physics classes to draw data from student responses to the SLEI and curriculum analysis of the implemented laboratory tasks with a sample of 387 students in 20 classes in Tasmania and Australia. Pohl (1999)[25] used the SLEI to evaluate the learning outcomes in environmental science in Malaysia. Wong and Fraser (1996)[14] used the SLEI with a sample of 1,592 high school chemistry students in 56 classes in Singapore. Lee and Fraser (2001)[26] investigated Korean high school students' perceptions of their classroom by the items in the SLEI. Quek, Wong and Fraser (2002)[27] investigated the impact of chemistry laboratory environment on student attitude toward chemistry for 200 gifted secondary school students in Singapore. Newby and Fisher (1998)[28] studied focuses on the computer laboratory class as a learning environment in university course to a sample of 208 students at Curtin University of Technology in Australia.

Using the SLEI, and adapted the Test Of Science-Related Attitudes (TOSRA) were associated with students' cognitive and affective outcomes were found for a sample of 489 senior high school biology students in Australia (Fisher, Henderson and Fraser, 1997)[29] and 1,592 grade 10 chemistry students in Singapore (Wong and Fraser, 1996)[14]. Furthermore, several recent studies conducted in Asian countries have contributed to improve the field of learning environment research (Goh and Fraser, 1996, 1998[30]; Riah and Fraser, 1998[31]). Recently, more studies have been done in some Asian countries, revealing important learning environment features. Among those studies conducted in Asia, the following are noteworthy. Riah and Fraser (1998)[31] explored the environmental perceptions of chemistry theory classrooms and laboratory classrooms in Brunei secondary schools by using the adapted QTI, SLEI and WIHIC. Differences in perceptions between genders were also reported by other researchers (Fraser, Giddings and McRobbie, 1995[32]; Henderson, Fisher and Fraser, 2000)[33]. Fraser, Giddings and McRobbie (1995)[12] also found that associations existed between classroom environment perceptions of students and their attitudes towards science laboratories. Fisher, Henderson and Fraser (1997)[29] extended research regarding associations between students' outcomes and their perceptions of their laboratory lessons by including practical performance and cognitive achievement as student outcomes in biology classes. They reported that each outcome was associated with environmental perceptions. Santiboon and Fisher (2004)[6] described the environmental perceptions of physics theory classrooms and laboratory classrooms in Thailand upper secondary schools by using the adapted QTI, PLEI and TOPRA. Kijkosol and Fisher (2005)[3] also found that associations existed between classroom environment perceptions of students and their attitudes towards biology laboratories in Thailand.

## III. Research Aims

To describe science student programs' perceptions of their actual 1, actual 2, and preferred classroom laboratory environments in physics classes in Udon Thani Rajabhat University.

To investigate relationships between the science student programs' perceptions of their actual 1, actual 2, and preferred classroom laboratory environments in physics classes in Udon Thani Rajabhat University.

To associate correlations between science student programs' perceptions of their actual 1, actual 2, and preferred classroom laboratory environments and their attitudes towards physics in Udon Thani Rajabhat University.

To analyze the Physics Laboratory Environment Inventory (PLEI) and the Test of Science-Related Attitude (TOSRA) a valid and reliable instruments for use in this study.

To develop and improve learning activities of science student programs' achievement in physics laboratory classrooms in Udon Thani Rajabhat University.

## IV. Research Methodology

The purpose of this research was to describe effects of science student programs' perceptions of physics laboratory classroom learning environments in Udon Thani Rajabhat University classes, in order to improve the performance of students in Foundation Laboratory Physics course. Quantitative data were gathered with the two instruments, namely, Physics Laboratory Environment Inventory (PLEI) and The Test of Physics-Related Attitude (TOPRA).

### *A. Sample*

The main study involved science and technology programs' students who were freshly enrolled at the Foundational Physics Laboratory course in the first semester in the academic year 2011, Udon Thani Rajabhat University, Thailand. Overall, data were collected using the Thai version of the PLEI and the TOPRA from a sample of 577 students in 13 classes from 5 physics' lecturers, such as; Biology, Chemistry (2 groups), Mathematics, Sport Science, Applied Statistics, Environment Science, Computer Science, Health Science, and Microbiology programs from the Faculty of Science and Mechanics Technology (2 groups), and Veterinary Technology programs from Faculty of Technology. The setting up of the sample and the consequent collection of data were then able to proceed.

### *B. Research Instruments Physics Laboratory Environment Inventory (PLEI)*

The PLEI was adapted from the Personal form of the Science Laboratory Environment Inventory (SLEI) developed by Fraser, Giddings and McRobbie (1995) for measuring the science laboratory classroom environment. Because one of the purposes of this study is to investigate differences in student's perceptions of their physics laboratory classroom environments on the actual and the preferred versions for use in the present study. All items of the SLEI were selected for including version. The adapted version was to ensure renamed as Physics Laboratory Environment Inventory (PLEI), the word *science* was replace with *physics*. Thus, the final version of the PLEI contained 35 items and five scales which are Student Cohesiveness (SC), Open-Endness (OE), Integration (I), Rule Clarity (RC) and Material Environment (ME). The instrument uses a five-point response format (Almost Never, Seldom, Sometimes, Often and Very Often). Students are required to circle their response alternative on the questionnaire itself. The instrument was statistically validated before it was used to measure the classroom environment of physics laboratory classes in Thailand in the present study.

### C. Test of Physics-Related Attitude (TOPRA)

This study investigated associations between students' perceptions of their physics laboratory classroom learning environments and their attitudes toward physics in science students' program classes in Udon Thani Rajabhat University in Thailand. The 8-item of Test of Physics-Related Attitude (TOPRA) scale previously validated by Fraser (1981) was selected for this research. Because the scale was intended to measure students' attitudes in all subjects, the wording of the items was modified by replacing the word *This Subject* with *Physics*.

### D. Steps on Assessing Students' Perceptions with the PLEI and TOPRA Questionnaires

Using the PLEI for assessing students' perceptions of their actual 1 form on the 3rd - 14th week, actual 2 form on the 13th - 14th week, and preferred form on the 8th - 9th week and the TOPRA on the 12th week for associating classroom laboratory environments in physics classes in Udon Thani Rajabhat University.

### E. Data Analysis

Quantitative data were obtained using the two questionnaires (PLEI and TOPRA). Appropriate statistical procedures were selected to determine whether the Thai versions of the PLEI and the TOPRA questionnaires are valid and reliable. These were those tests traditionally used with learning environment questionnaire: factor analysis, internal consistency reliability, and ability to differentiate between students in different classrooms. Simple and multiple correlation analyses were used with the actual and preferred versions. A *t*-test for correlated samples was used for each individual PLEI scale to investigate whether students have significant different perceptions of their actual and preferred classrooms. All data collected remained confidential and all respondents were volunteers and had given signed permission.

## V. Results

### A. Validation of the PLEI

Description of quantitative data of analyzing responses for science students' assessments is reported in Table I.

Internal consistency (Cronbach alpha coefficient) and the mean correlation of each scale with the other scales were obtained for the sample in this present study as indices of scale reliability and descriminant validity for the Actual 1, Actual 2 and Preferred Forms of the PLEI is report in Table II.

In Table II, the scale means ranged from 24.50 to 27.83 on the Actual 1 Form, from 26.02 to 28.51 on the actual 2 Form, and from 29.87 to 30.52 on the Preferred Form. Standard deviations for the Actual 1, Actual 2 and Preferred Forms ranged from 3.97 to 5.05, from 4.22 to 5.06 and from 3.43 to 3.53. Table 3 reveals that the differences between the Actual 1, Actual 2 and Preferred Forms of the PLEI scales were statistically significant at the 0.01 level for all of the five scales.

TABLE I: Scale Means' Score, Means, Varience, and Standard Deviations for Actual 1, Actual 2 and Preferred Forms of the PLEI

| Scale | Form | Means' score | Mean (μ) | Variance | Std.(σ) |
|---|---|---|---|---|---|
| Student Cohesiveness | Actual 1 | 27.83 | 3.98 | 17.24 | 4.45 |
| | Actual 2 | 28.51 | 4.07 | 18.97 | 4.36 |
| | Preferred | 30.52 | 4.36 | 12.29 | 3.51 |
| Open-Endedness | Actual 1 | 27.13 | 3.88 | 16.21 | 4.03 |
| | Actual 2 | 28.05 | 4.01 | 17.81 | 4.22 |
| | Preferred | 29.87 | 4.27 | 12.10 | 3.49 |
| Integration | Actual 1 | 26.89 | 3.84 | 25.29 | 5.03 |
| | Actual 2 | 28.18 | 4.03 | 25.50 | 5.05 |
| | Preferred | 30.65 | 4.38 | 12.43 | 3.53 |
| Rule Clarity | Actual 1 | 26.71 | 3.82 | 15.78 | 3.97 |
| | Actual 2 | 27.69 | 3.96 | 17.68 | 4.21 |
| | Preferred | 29.98 | 4.28 | 11.80 | 3.43 |
| Material Environment | Actual 1 | 24.50 | 3.50 | 20.96 | 4.58 |
| | Actual 2 | 26.02 | 3.72 | 25.61 | 5.06 |
| | Preferred | 30.07 | 4.30 | 12.14 | 3.48 |

TABLE II: Scale Internal Consistency (Cronback Alpha Reliability) and Ability to Differentiate between Classroom (Anova) for the PLEI

| Scale | Form | Cronbach's alpha reliability | Discriminant validity | *F*-test | Sig. |
|---|---|---|---|---|---|
| SC | Actual 1 | 0.75 | 0.72 | 30.54 | .000*** |
| | Actual 2 | 0.79 | 0.79 | 22.68 | .000*** |
| | Preferred | 0.84 | 0.82 | 7.30 | .000*** |
| OE | Actual 1 | 0.74 | 0.72 | 24.87 | .000*** |
| | Actual 2 | 0.80 | 0.79 | 24.22 | .000*** |
| | Preferred | 0.82 | 0.83 | 26.14 | .000*** |
| I | Actual 1 | 0.79 | 0.71 | 27.70 | .000*** |
| | Actual 2 | 0.82 | 0.78 | 13.53 | .000*** |
| | Preferred | 0.83 | 0.82 | 1.40 | .021** |
| RC | Actual 1 | 0.69 | 0.74 | 31.12 | .000*** |
| | Actual 2 | 0.77 | 0.80 | 19.33 | .000*** |
| | Preferred | 0.82 | 0.83 | 9.37 | .000*** |
| ME | Actual 1 | 0.66 | 0.74 | 38.50 | .000*** |
| | Actual 2 | 0.77 | 0.80 | 31.98 | .000*** |
| | Preferred | 0.81 | 0.83 | 12.99 | .000*** |

** Correlation is significant at the 0.05 level (2-tailed)*
*** Correlation is significant at the 0.01 level (2-tailed)*
**** Correlation is significant at the 0.001 level (2-tailed)*

### B. The Circumplex Nature of the PLEI:

To investigate the circumplex nature of the PLEI, correlations between the scales were calculated. The sample in Table III, IV, and V are presented the results show that the correlation between a scale and the next scale.

### C. Factor Loading Analysis of the PLEI

The Actual and Preferred Forms of the PLEI were subjected to separate principal components factor analyses (with varimax rotation) involving the individual students' score. Table VI, VII and VIII are reported previously the factor structure and found to have factor loading than 0.30 (which is the minimum value conventionally accepted as meaningful in factor analysis) for the PLEI. On the whole, it appears that the items had factor loadings greater than 0.30 with their a priori scales, and hence, the results lend support to the factorial validity of the PLEI.

TABLE III: SCALE INTERCORELATIONS FOR THE PLEI USING THE ACTUAL 1 FORM

| Scales | SC | OE | I | RC | ME |
|---|---|---|---|---|---|
| SC | | 0.768*** | 0.748*** | 0.774*** | 0.635*** |
| OE | | | 0.638*** | 0.741*** | 0.557*** |
| I | | | | 0.718*** | 0.676*** |
| RC | | | | | 0.776*** |
| ME | | | | | |

TABLE IV: SCALE INTERCORELATIONS FOR THE PLEI USING THE ACTUAL 2 FORM

| Scales | SC | OE | I | RC | ME |
|---|---|---|---|---|---|
| SC | | 0.826*** | 0.810*** | 0.811*** | 0.705*** |
| OE | | | 0.712*** | 0.765*** | 0.605*** |
| I | | | | 0.792*** | 0.770*** |
| RC | | | | | 0.748*** |
| ME | | | | | |

TABLE V: SCALE INTERCORELATIONS FOR THE PLEI USING THE PREFERRED FORM

| Scales | SC | OE | I | RC | ME |
|---|---|---|---|---|---|
| SC | | 0.834*** | 0.806*** | 0.807*** | 0.711*** |
| OE | | | 0.787*** | 0.823*** | 0.707*** |
| I | | | | 0.827*** | 0.757*** |
| RC | | | | | 0.788*** |
| ME | | | | | |

TABLE VI: FACTOR LOADING FOR ITEMS IN THE ACTUAL 1 FORM OF THE PLEI

| | | Factor Loading | | | |
|---|---|---|---|---|---|
| Item No. | SC | OE | I | RC | ME |
| 31 | 0.75 | | | | |
| 16 | 0.73 | | | | |
| 11 | 0.72 | | | | |
| 21 | 0.71 | | | | |
| 1 | 0.71 | | | | |
| 26 | 0.52 | | | | |
| 6 | 0.37 | | | | |
| 12 | | 0.77 | | | |
| 32 | | 0.74 | | | |
| 17 | | 0.68 | | | |
| 7 | | 0.66 | | | |
| 22 | | 0.64 | | | |
| 2 | | 0.61 | | | |
| 27 | | 0.38 | | | |
| 23 | | | 0.77 | | |
| 33 | | | 0.76 | | |
| 8 | | | 0.71 | | |
| 3 | | | 0.64 | | |
| 28 | | | 0.60 | | |
| 18 | | | 0.59 | | |
| 13 | | | 0.58 | | |
| 29 | | | | 0.71 | |
| 14 | | | | 0.70 | |
| 19 | | | | 0.66 | |
| 4 | | | | 0.65 | |
| 24 | | | | 0.55 | |
| 34 | | | | 0.48 | |
| 9 | | | | 0.48 | |
| 25 | | | | | 0.77 |
| 20 | | | | | 0.74 |
| 5 | | | | | 0.71 |
| 15 | | | | | 0.66 |
| 35 | | | | | 0.40 |
| 10 | | | | | 0.38 |
| 30 | | | | | 0.31 |
| %of variance | 430.4 | 42.17 | 44.74 | 36.49 | 35.45 |
| Eigenvalue | 3.01 | 2.95 | 3.13 | 2.56 | 2.48 |

**Loading smaller than .3 omitted. The sample consisted of 577 students in 13 groups.*

TABLE VII: FACTOR LOADING FOR ITEMS IN THE ACTUAL 2 FORM OF THE PLEI

| | | Factor Loading | | | |
|---|---|---|---|---|---|
| Item No. | SC | OE | I | RC | ME |
| 31 | 0.76 | | | | |
| 16 | 0.73 | | | | |
| 11 | 0.73 | | | | |
| 21 | 0.73 | | | | |
| 1 | 0.70 | | | | |
| 26 | 0.56 | | | | |
| 6 | 0.54 | | | | |
| 12 | | 0.74 | | | |
| 32 | | 0.73 | | | |
| 17 | | 0.72 | | | |
| 7 | | 0.71 | | | |
| 22 | | 0.66 | | | |
| 2 | | 0.66 | | | |
| 27 | | 0.56 | | | |
| 8 | | | 0.79 | | |
| 33 | | | 0.77 | | |
| 23 | | | 0.75 | | |
| 3 | | | 0.67 | | |
| 13 | | | 0.66 | | |
| 28 | | | 0.62 | | |
| 18 | | | 0.61 | | |
| 29 | | | | 0.73 | |
| 24 | | | | 0.70 | |
| 19 | | | | 0.69 | |
| 4 | | | | 0.63 | |
| 24 | | | | 0.61 | |
| 34 | | | | 0.60 | |
| 9 | | | | 0.60 | |
| 25 | | | | | 0.80 |
| 15 | | | | | 0.78 |
| 20 | | | | | 0.77 |
| 5 | | | | | 0.75 |
| 35 | | | | | 0.48 |
| 10 | | | | | 0.46 |
| 30 | | | | | 0.43 |
| %of variance | 46.32 | 46.79 | 48.78 | 42.57 | 43.11 |
| Eigenvalue | 3.26 | 3.26 | 3.42 | 2.98 | 3.02 |

**Loading smaller than .3 omitted. The sample consisted of 577 students in 13 groups.*

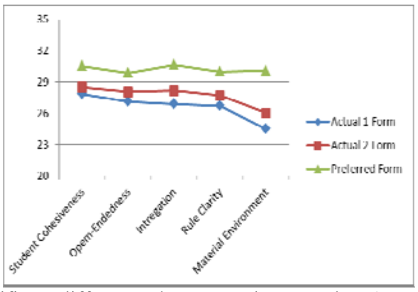
### *D. Comparisons between Science Students' Perceptions of Their Actual 1, Actual 2 and Preferred Forms in Physics Laboratory Classroom Environment*

The results of this study also indicate that using the PLEI helps physics lecturers to gain better picture of learning environment and the perceived learning needs of their students. It also provides support for the idea that lecturers needed to take differences into consideration when planning and designing the physics curriculum for the science students in the physics laboratory environments. Fig. 1 illustrates the differences between the Actual 1, Actual 2 and Preferred Forms and indicates that students would prefer more than actual and enhanced in all of scales in the laboratories.

TABLE VIII: FACTOR LOADING FOR ITEMS IN THE PREFERRED FORM OF THE PLEI

| | | Factor Loading | | | |
|---|---|---|---|---|---|
| Item No. | SC | OE | I | RC | ME |
| 21 | 0.75 | | | | |
| 11 | 0.74 | | | | |
| 16 | 0.74 | | | | |
| 31 | 0.72 | | | | |
| 6 | 0.69 | | | | |
| 1 | 0.68 | | | | |
| 26 | 0.65 | | | | |
| 12 | | 0.74 | | | |
| 17 | | 0.74 | | | |
| 32 | | 0.73 | | | |
| 22 | | 0.71 | | | |
| 7 | | 0.70 | | | |
| 2 | | 0.67 | | | |
| 27 | | 0.59 | | | |
| 8 | | | 0.78 | | |
| 33 | | | 0.74 | | |
| 23 | | | 0.73 | | |
| 3 | | | 0.70 | | |
| 13 | | | 0.69 | | |
| 28 | | | 0.67 | | |
| 18 | | | 0.65 | | |
| 29 | | | | 0.75 | |
| 24 | | | | 0.70 | |
| 9 | | | | 0.69 | |
| 19 | | | | 0.69 | |
| 4 | | | | 0.69 | |
| 14 | | | | 0.66 | |
| 34 | | | | 0.65 | |
| 30 | | | | | 0.73 |
| 20 | | | | | 0.72 |
| 25 | | | | | 0.70 |
| 15 | | | | | 0.68 |
| 5 | | | | | 0.66 |
| 10 | | | | | 0.66 |
| 35 | | | | | 0.63 |
| %of variance | 50.65 | 48.52 | 50.21 | 47.84 | 46.77 |
| Eigenvalue | 3.55 | 3.43 | 3.52 | 3.35 | 3.27 |

**Loading smaller than .3 omitted. The sample consisted of 577 students in 13 groups.*




Fi. 1. Significant differences between science students' perceptions of their actual 1, actual 2 and preferred scores on the PLEI.

The actual and preferred perceptions of 577 science program students of their physics laboratory classroom environments were measured using the PLEI. The PLEI data for the 13 groups for statistical significant with *t*-test analysis is reported in Table IX.

As reported in Table IX, the reliability coefficients for different PLEI scales, these figured suggest that the scales of the PLEI measure district although somewhat overlapping aspects of the physics laboratory environment. The distinct of the scales also was checked with a factor analysis described in Table VI - VIII.

The 35-item PLEI was also subjected to a series of one-way analyses of variance. As show in Table IX, the *eta*$^2$ statistic ranged from 0.06 to 0.84 for different between actual 2 and actual 1 forms, ranged from 0.04 to 1.03 for different between preferred and actual 1 forms, and ranged from 0.06 to 0.84 for different between preferred and actual 2 forms. They were confirmed that each scale differentiated significantly ($\rho$ <0.05) between perceptions of science students in different classrooms.

TABLE IX: MEAM SQUARE, ABILITY TO DIFFERENCES BETWEEN CLASSROOMS (ANOVA) FOR PAIR SAMPLE OF ACTUAL AND PREFERRED FORMS OF THE PLEI

| Scale | Pair Sample | Mean Square | ANOVA (eta2) | t-test | Sig. |
|---|---|---|---|---|---|
| SC | Actual 2-Actual 1 | 0.61 | 0.06 | 2.96 | .000*** |
| | Pref.-Actual 1 | 0.73 | 0.07 | 12.03 | .005** |
| | Pref.-Actual 2 | 7.84 | 0.63 | 16.63 | .000*** |
| OE | Actual 2-Actual 1 | 0.67 | 0.07 | 4.14 | .000*** |
| | Pref.-Actual 1 | 0.42 | 0.04 | 12.67 | .046* |
| | Pref.-Actual 2 | 6.69 | 0.56 | 14.81 | .000*** |
| I | Actual 2-Actual 1 | 1.03 | 0.07 | 4.75 | .002** |
| | Pref.-Actual 1 | 0.92 | 0.05 | 15.38 | .000*** |
| | Pref.-Actual 2 | 10.44 | 0.57 | 17.1 | .000*** |
| RC | Actual 2-Actual 1 | 0.84 | 0.09 | 4.44 | .023* |
| | Pref.-Actual 1 | 0.49 | 0.04 | 15.49 | .000*** |
| | Pref.-Actual 2 | 7.13 | 0.53 | 18.29 | .000*** |
| ME | Actual 2-Actual 1 | 0.72 | 0.06 | 5.58 | .000*** |
| | Pref.-Actual 1 | 0.64 | 0.04 | 22.85 | .009** |
| | Pref.-Actual 2 | 8.57 | 0.44 | 24.06 | .000*** |

** Correlation is significant at the 0.05 level (2-tailed)*
*** Correlation is significant at the 0.01 level (2-tailed)*
**** Correlation is significant at the 0.001 level (2-tailed)*

### *E. Validation of the TOPRA*

To measure science program students' attitudes towards physics laboratory studies, the present study adapted the eight-item Test Of Physics-Related Attitude (TOPRA) (Fisher, Rickards, Goh, and Wong, 1997[33]; Kijkosol and Fisher, 2005[3], Santiboon and Fisher, 2004[6]; Sittikosol and Malone[7], 2008), which was based on the Test Of Physics-Related Attitude (TOPRA) (Fraser, 1981). Using internal consistency reliability the TOPRA had a value of 0.83 which was considered satisfactory for further use in this study.

### *F. Associations between Science students' Perceptions of Physics Laboratory Learning Environment with the TOPRA*

In this study, it was also considered important to investigate associations between science students' perceptions of their physics laboratory classroom learning environment with their attitude toward physics. The cronbach alpha reliability of the selected TOPRA was 0.83, when using individual student as the unit of analysis. This suggests that the scale is reliable for measuring students' attitudes in physics laboratory classes. These involved: simple correlational and multiple regression analyses of relationships between the set of actual and preferred environment scales as a whole and the TOPRA that it's reported in Table X.

In Table X, two main methods of data analysis were used to investigate this environment-attitude relationship. The sample correlation values (r) are reported which show statistically significant correlations ($p<0.05$) between students attitudinal outcomes and their physics laboratory classroom environment on all scales. These associations are positive for all scales of the Actual 2 and Preferred Forms in their classes where the students perceived greater student cohesiveness, open-endness, integration, clear rules and a satisfactory material environment there was a more favourable attitude towards their physics laboratory classes. In the other hand, the sample correlation values (r) are reported which does not show statistically significant correlations between students' attitudinal outcomes and their physics laboratory classroom environment on all scales of the Actual 1 Form.

TABLE X: ASSOCIATIONS BETWEEN PLEI SCALES AND ATTITUDES TO PHYSICS LABORATORY CLASSES IN TERM OF SIMPLE AND MULTIPLE CORRELATIONS (R) AND STANDARDIZED REGRESSION COEFFICIENT(B)

| Scale | Actual 1 Form | | Actual 2 Form | | Preferred Form | |
|---|---|---|---|---|---|---|
| | Simple Correlat. Attitude (r ) | Std. Regres. Weight Attitude (β) | Simple Correlat. Attitude (r ) | Std. Regres. Weight Attitude (β) | Simple Correlat.Attitude (r) | Std. Regres. Weight Attitude (β) |
| SC | 0.06 | 0.07 | 0.18** | 0.21*** | 0.22*** | 0.22*** |
| OE | 0.03 | 0.04 | 0.16** | 0.18** | 0.20** | 0.19** |
| I | 0.01 | 0.02 | 0.11* | 0.15** | 0.24*** | 0.23*** |
| RC | 0.05 | 0.06 | 0.16** | 0.18** | 0.35*** | 0.33*** |
| ME | 0.02 | 0.02 | 0.10* | 0.12** | 0.11* | 0.14* |
| Multiple Correlation (R) | | 0.183 | | 0.662** | | 0.761*** |
| R2 | | 0.0335 | | 0.4382 | | 0.5791 |

*N = 557, *ρ < .05, **ρ < .01, ***ρ < .001*

### *G. Improvement and Development on Science Students' Learning Achievements with the PLEI*

Table X is compared to investigate associations between science students' perceptions of their physics classroom environments with their attitude toward physics laboratory. Using the PLEI instrument in the higher education level, Udon Thani Rajabhat University, Thailand, will help lecturers to evaluate their learning environments in physics laboratory in order to improve their education process. Furthermore, the information from the PLEI could be useful as the guide to enhance the effectiveness of physics laboratory. The effectiveness in physics laboratory is very important because the practical work is high cost and time consuming. Therefore, evaluation of the physics laboratory teaching is important for improving and developing students' learning achievement successfully.

## VI. CONCLUSION

The actual and preferred perceptions of 557 science program students of their physics laboratory classroom environments were measured with the PLEI. The comparisons of the Actual Forms with the Preferred Form indicated that students would prefer more student cohesiveness, open-endness, integration, rule clarity, and an enhanced material environment in their laboratories. In general, students' perceptions of their preferred classroom laboratory environment in physics laboratory classes to be greater than what they actually perceive to be provided. The results of this study also indicate that using the PLEI helps Thai physics teachers or lecturers in their educational institutes to gain a better picture of learning environment and the perceived learning needs of their students.

An investigation of the association between students' perceptions of learning environments with their attitudes to their physics classes, with regard to the PLEI, it was found that all of five scales were positively associated with students' attitude to physics laboratory classes. The multiple correlation *R* is significant for the PLEI and shows that when the scales are considered together there are significant associations with the TOPRA. The $R^2$ values indicate that 3.35%, 43.82% and 57.91% with actual 1, actual 2 and preferred forms of the valiance in students' attitudes to their physics class was attributable to their perceptions of their physics laboratory classroom environments. The beta weights (β) show that in classes where the students perceived greater than all scales in their physics laboratory lessons.

Learning environment is an important aspect in education process. It not only influences the students' outcomes, but also teacher performances. Teacher could use the information from learning environment assessments to improve their education process. Furthermore, one instrument which could evaluate learning environments Physics Laboratory Environment Inventory (PLEI). This instrument provides the information of students' perceptions on actual and preferred laboratory learning environments. The information from this instrument could be used for improvement and effectiveness teaching in science laboratory.

## VII. DISCUSSION

As described in the results section, Udon Thani Rajabhat University's students show similar answering patterns to those from other countries as reported in previous studies when they are asked to reply to the PLEI questionnaire. Overall, Udon Thani Rajabhat University's students show relatively favourable perceptions of their laboratory lessons, with the lowest score occurring for the Material Environment scale. It seems that laboratory lessons or practical activities related to physics lessons are operated rather as supplementary to theory classes rather than being independently important in their own right. The lower score on Material Environment scale has been also reported in several previous studies (Giddings and Waldrip, 1996; Wong and Waldrip, 1996). Internationally, it is most likely that physics teachers or lecturers are not convinced about the practical value of laboratory activities. This can be also applied to the Udon Thani Rajabhat University situation, where an examination-driven curriculum is normally prescribed and delivered. In other words, Thai physics lectures or teachers usually do not place much value to laboratory activities, because laboratory lessons guarantee satisfactory student achievement.

Overall, this study replicated previous studies using the PLEI, with the findings being consistent with the situation in Udon Thani Rajabhat University in Thailand. It is also noteworthy that this study showed distinctive and more positive learning environment perceptions among students from the science program students, Faculty of Science and Faculty of Technology.

## REFERENCE


[1] B. Fraser, C. J. McRobbie, and G. J. Giddings, (1993). "Development and cross-national validation of a laboratory classroom instrument for senior high school students," *Science Education, 77*. pp. 1-24.

[2] B. J. Fraser, (1981). "Test of Science-Related Attitude (TOSRA)," Melbourne: *Australian Council for Education Research*. Hawthorn, Australia.

[3] D. Kijkosol and D. Fisher, (2005). Teacher-student interactions and laboratory learning environments in biology classes in Thailand. [Online]. GEN01-ERA02 (Available): http://espace.library.curtin.edu.au/R/?func=dbin-jump-fullandobject_

[4] T. Santiboon, (2010). "Developing learning achievement with controlled activities by the forms of learning administration plans onto students' center in geology course in Udon Thani Rajabhat University," *Proceedings of the 3rd International Conference on Education Reform (ICER2010): Education Change in the Age of Global Warming at Hoang Anh Gia Lai in Danang***.** Da Nang City, Vietnam. pp. 1-13.

[5] T. Santiboon, (2011)."My school and my dream school climate," *Proceeding at the 4th International Conference on Educational Reform 2011 (ICER 2011) 'Equity in Education'***.** Luang Prabang. Loas PDR.

[6] T. Santiboon and D. Fisher, (2004). "Actual and preferred learning environments in physics classes in Thailand," *Paper presented at the International Conference on Science and Technology of Thailand*. Bangkok, Thailand.

[7] L. Sittikosol and J. Malone, (2008). "The roles of teacher-student interpersonal behaviour in improving mathematics teaching and learning in Thailand," *Paper presented at the 5th International Conference on Science, Mathematics and Technology Education: "Science Mathematics and Technology Education: Beyond Cultural Boundaries"*, Udon Thani Rajabhat University, Udon Thani, NortheasternThailand, Thailand.

[8] S. Wanpen, (2005) "Creating a collaborative learning environment in a computer classroom in Thailand using the constructivist learning environment survey," *Paper presented at the IASCE conference 2004*. Singapore.

[9] B. J. Fraser, C. J. McRobbie, and G. J. Giddings, (1993) "Assessing the climate of science laboratory classes," *Research Implications for Science and Mathematics Teachers*, vol. 1. National Key Centre for School Science and Mathematics, Curtin University of Technology.

[10] P. Koul and D. Fisher, (2005) "Science classroom learning environments in India," International Educational Research Conference of the Australian Association for Research in Education *(AARE)*. Brisbane, Australia.

[11] B. J. Fraser, (1991). *Two Decades of Classroom Environment Research*. In B. J. Fraser and H. J. Walberg (EDs.), "Educational environments: evaluation, antecedents and consequences". pp. 141–160. Oxford. Pergamum Press.

[12] G.J. Giddings and B. Waldrip, (1996). "A comparison of science laboratory classrooms in Asia, Australia, South Pacific and USA: An international study," *Paper presented at the annual meeting of the American Educational Research Association*. New York. USA.

[13] A. F. L. Wong and J. B. Fraser, (2008). "Assessment of chemistry laboratory classroom environments," *Asia Pacific Journal of Education*, vol. 17, Issue 2, 1997. [Online]. (Available): http://www.tandfonline.com/doi/abs/10.1080/021887997 08547761?journal Code=cape20 [2008, Mar 13].

[14] D. Fisher, T. Rickards, and B. Fraser, (1999) "Assessing teacher-student interpersonal relationships in science classes," *Australian Science Teachers Journal, 42*, pp. 28-33.

[15] B. J. Fraser, (2002) "Learning environments research: yesterday, today, and tomorrow in educational learning environments," Singapore: *World Scientific Publishing***.** pp. 49-72.

[16] A. Yarrow, J. Millwater, and B. J. Fraser, (1997). "Improving university and primary school classroom environments through pre-service teachers' action research," *International Journal of Practical Experiences in Professional Education, 1*(1), pp. 68-93.

[17] B. J. Fraser, (1998) "Science learning environments: Assessment, effected and determinants". *International Handbook of Science Education*. pp. 517-564.

[18] Moos. (1974). *Classroom Environment*. [Online]. (Available): http://books.google.co.th/books?id=201968&f=false. [2011, June 12].

[19] B. J. Fraser, G. J. Giddings, and C. J. McRobbie, (1992). "Science laboratory classrooms at schools and universities: A cross-national study," *High Education, 24*. pp. 431 – 451.

[20] B. Fraser and C. J. McRobbie, (1995). "Science laboratory classroom environments at schools and universities: a cross-national study," *Educational Research and Evaluation, 1*..pp. 289-317.

[21] C. J. McRobbie and B. J. Fraser, (1993) "Associations between student outcomes and psychosocial science environment," *Journal of Educational Research, 47*. pp. 78 – 84.

[22] A. Harrison, D. Fisher, and D. Henderson, (1997). "Student perceptions of practical tasks in senior biology, chemistry and physics classes," *Proceedings Western Australian Institute for Educational Research* Forum 1997. Retrieved May 5, 2003.

[23] J. M. Pohl, (1999) "NONPF faculty practice on science laboratory survey results," *Presented at the National Organization of Nurse Practitioner Faculties Annual meeting*, San Francisco. USA.

[24] S. Lee and B. Fraser, (2001) "Laboratory classroom environments in Korean high schools," *Paper presented at the annual meeting of Australia Association for Research in Education*. Fremantle, WA.

[25] C. L. Quek, A. F. Wong, and B. J. Fraser, (2002). "Gender differences in the perceptions of chemistry laboratory classroom environments," *Queendlands Journal Education Research, 18*. pp. 23 - 32.

[26] M. Newby and D. Fisher, (1998). "The associations between computer laboratory environment and student outcomes," *Paper presented at the Australian Association for Research in Education Annual Conference*. Adelaide, Australia.

[27] D. L. Fisher, D. Henderson, and B. Fraser, (1997) "Laboratory environment and student outcomes in senior high school biology classes," *American Biology Teacher, 59*. pp. 214-219.

[28] S. C. Goh and B. J. Fraser, (1998) "Teacher interpersonal behaviour, classroom environment and student outcomes in primary mathematics in Singapore," *Learning Environment Research, 1*, pp. 199 – 219.

[29] H. B. Riah and B. J. Fraser, (1998) "Chemistry learning environment and its association with students' achievement in chemistry," *Paper Presented at Annual Conference of Australia Association for Research in Education*. Adelaide, Australia.

[30] B. J. Fraser, G. J. Giddings, and C. J. McRobbie, (1995) "Evaluation and validation of a personal form of an instrument for assessing science laboratory classrooms," *Journal of Research in Science Teaching. 32*. pp. 399 – 422.

[31] D. L. Fisher, T. W. Rickards, S. C. Goh, and A. F. L. Wong, (1997). "Perceptions of interpersonal behaviour in secondary science classrooms in Singapore and Australia," *Journal of Applied Research in Education, 1*. pp. 2 – 13.



**Toansakul Santiboon:** A Member of IAENG: M10079, was born in Bangkok, Thailand on 4 June 1952 and Education background is Doctor of Science Education (Sc.Ed.D.) form Curtin University of Technology, Perth; Western Australia: Australia in 2006.

To use the pronoun as Assistant Professor Dr. Military and work experience have been lectured at Physics Department, Faculty of Science; Udon Thani Rajabhat University for 33 years ago and field of researches are physics, geology, meteorology, and education.

Santiboon, T. (2011). "My school and my dream school climate". *Proceeding at the 4th International Conference* on *Educational Reform 2011 (ICER 2011) 'Equity in Education'***.** Luang Prabang. Loas PDR.

Santiboon, T. (2010). "Dendrochronology and sunspot cycle: Determining effects of global warming on climate change in Udon Thani Province in period of 30 surrounding years (A.D.1979-2008)".

*Proceedings of the 1st Climate Thailand Conference 2010: National Risks and Opportunities in Global Climate Changes***.** Impact Muang Thong Thani, Bangkok. Thailand.

Santiboon, T. (2010). "Developing learning achievement with controlled activities by the forms of learning administration plans onto students' center in geology course in Udon Thani Rajabhat University". *Proceedings of the 3rd International Conference on Education Reform (ICER2010): Education Change in the Age of Global Warming***.** Hoang Anh Gia Lai in Danang**.** Vietnam. pp. 1-13.

Assist. Prof. Dr. Santiboon was 25 researches titles in 10 years ago and congratulated the merit awards; the Certificate of merit: Presented with the best teaching paper award from the 16 Universities central of Michigan state, USA in 2011.

**Somchai Chumpolkulwong**: Place of birth was in Bangkok, Thailand. Date of birth was on 19 February 1973 and Education background is Ph.D. (Physics-Solid State) from Suranaree University of Technology, Nakhon Ratchasima: Thailand.

To use the pronoun as Dr., military and work experience have been lectured at Physics Department, and Vice Dean of the Faculty of Science; Udon Thani Rajabhat University for 6 years ago and field of research is physics;

Dr. Chumpolkulwong was administrated the research titles followed as:

Nakajima, H., Buddhakala, M., Chumpolkulwong, S., Songsiriritthigul, P. and Kakizaki, A. (2009). "Final state interaction observed in M2, 3VV Auger profile of Cu (110)". *Journal of Physics: Condensed Matter , Vol. 21 No. 5 (055007). Issue 5* (4 February 2009)

Chumpolkulwong S, Nakajima H, Buddhakala M, Sabrueangnet, R., Songsiriritthigul, P., and Kakizaki, A. (2007). "Angle-Resolved Photoemission Study of Electronic States in Ni(111) Surface with Oxygen Adsorption***". Journal of the Physical Society of Japan, Vol. 76 No. 11***, pp. 114-202.

Nakajima H, Buddhakala M, Chumpolkulwong, S., Sabrueangnet R, Kakizaki A and Songsiriritthigul P. (2007). "Performance of the BL4 Beam line for Surface and Interface Research at the Siam Photon Laboratory" *9th International Conference on Synchrotron Radiation Instrumentation, AIP Conference Proceedings Volume 879*: pp. 543-546. Daego, Korea.

**Piyawadee Yabosdee** was born in Loei, Thailand and education background is Ph.D. (Physics- Fiber Optics and Sensor) from King Mongkut's Institute of Technology Ladkrabang; Bangkok: Thailand.

To use the pronoun as Dr., A. F. L. military and work experience have been lectured at Physics Department, Faculty of Science, and Vice Administrator at the Office of Research and Institute, Udon Thani Rajabhat University for 5 years ago and field of research is physics;

Dr. Yabosdee was administrated the researcher titles followed as:

Yabosdee, P.. Srinuanjan, K., and Yupapin, P.P. (2010). "Proposal of the nano-sensing device and system using a nano-waveguide transducer for distributed sensors". *Optik - International Journal for Light and Electron Optics, Volume 121, Issue 23, December 2010*, pp. 2117-2121.

Yabosdee, P., Phiphithirankan, P., and Yupapin, P.P. (2010). "A new concept of nano-strain monitoring using μ -strain perturbation". *Optik - International Journal for Light and Electron Optics, Volume 121, Issue 5, March 2010,*. pp. 442-445.

**Jutharatana Klinkaewnarong** was born in Udon Thani, Thailand on 22 June 1978 and Education background is Ph.D. (Physics) from Khon Kaen University, Khon Kaen: Thailand in 2010.

To use the pronoun as Dr., military and work experience have been lectured at Physics Department, Faculty of Science; Udon Thani Rajabhat University for 2 years ago and field of research is physics;

Dr. Klinkaewnarong was selected of her research that it is the best research from the National Research Institute of Thailand in 2011.

Klinkaewnarong, J**.,** Sritonwong, P., Swatsitang, E. (2012). "Magnesium substitution in hydroxyapatite synthesized by sol-gel method". *Advanced Materials Research Accepted.*

Klinkaewnarong, J**.,** Swatsitang, E., Maensiri, S. (2011). "Synthesis and characterization of high purity hydroxyapatite nanorods by hydrothermal technique". *Journal of Nanoscience and Nanotechnology* 2011; 11: 1-4.

Klinkaewnarong, J., Maensiri, S. Nanocrystalline hydroxyapatite powders by a polymerized complex method. *Chiang Mai Journal of Science* 2010; 37 (2): pp. 243-251.