

Promoting Learning Achievement, Problem Solving, and Learning Curiosity of High School Students: Empirical Thai Study of Self-directed Learning in Physics Course

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Abstract

Three phases of this research were employed to study learning achievement, problem solving, and learning curiosity among 43 students in the 11th grade through self-directed learning in a Physics course. Research instruments included: a learning achievement test, a test of curiosity, observations using anecdotal evidence of curiosity, and a test of problem solving ability. The findings show that six components of self-directed learning were evident, i.e. principles and basic concepts, syntax, social system, principle of reaction, and support system. It was found that five main procedures of self-directed learning were applicable in a management model: diagnosis, strategies, growth in habit, taking action, and summarizing and assessing. Students gained in their learning achievement ; furthermore, their posttest scores in problem solving were greater than their pretest scores at .05 level of statistical significance.

Keywords: 21st century learning, science teaching, science education, physics, curiosity, thinking, autonomous, secondary

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Introduction

The Thai National Education Act of 1999 (Revised, 2002), in Unit 4 entitled “Educational Management Guideline” has two sections, Sections 6 and 7, in which the educational objectives are specified with reference to the inculcation in Thai people to have such desirable characteristics as being good, intelligent and happy people. They should also be curious to learn and be engaged in continuous self study (Office of National Education Commission, 2002). Global trends have been changed rapidly, as have the changes in society and technology. The content material for teaching was traditionally implemented for memorization. These changes in school and society had to be adjusted from knowledge to process skill. Therefore, the notion of self-directed learning has been proposed as another way of learning. When students grow up with more freedom or independence, they will be able to live by themselves and be self regulated. Self-directed learning (SDL) would become more prominent as they become adults (Merriam, 2001 ; Knowles *et al.*, 2014). Teachers would be expected to stimulate their students to search for knowledge by themselves by using different situations aimed to develop habitual actions until it becomes a sustainable characteristic of learning. Teachers need to be role models of self-directed learning so that the students would be able to solve social problems that occur. The management of the learning process needs to integrate different aspects of knowledge by combining the knowledge material proportionally and equally. The standards of ethics, morality, and good values have to be inculcated in every subject. The schools have to assess students by considering the students’ development, conduct, observations of learning behavior, activity participation and testing being in alignment with the instructional process based on appropriateness of each level and educational model (Office of Basic Education Commission, 2011).

The students’ curiosity was the major characteristic that the researchers sought to promote for learning, studying preferences, and being alert for new and challenging things around themselves. They would be curious, seek out knowledge, be critical, selective for decision making, and demonstrate analytical thinking, synthetic thinking, logical thinking, and imagination. The skills would include being able to evaluate different situations, be persistent in those situations, know how to ask others as well as search for solutions, be energetic in the face of such changes, use a variety of learning various styles, and demonstrate a good attitude towards education. The concept of self-directed learning is rooted in European Humanism, with its belief in the importance of human freedom and independence, as in the statement that every one was born with goodness, freedom, and independence. One could be able to find one’s own alternative without limitation, be responsible for oneself and other persons (Hiemstra, 1994). In the 21st century, human development means to be competent human beings, for instance,

competency in working with others, careful decision making, initiation, problem solving abilities with difficult problems, self-management, efficient communication, learning and innovation skills. If students could regulate themselves, they would be responsible for their own studying. They could control their learning behavior as well as search for their own knowledge. They would have strategies to be used in learning, with both self-motivation and self-control in behavior leading to goal accomplishment (Trilling & Fadel, 2009).

Self-directed learning is an important skill in both school-based learning and self-development after graduation. The students would have skills in self-regulation, display curiosity, and be able to manage different things by using intellectual strategies and thoughtfulness in order to achieve their specified goals effectively. Consequently, an educational management model for students to believe that they had the ability to learn or behave purposefully, is very important for students. According to the above reasons and approaches, the researcher was interested in developing such a self-directed model in order to provide learning for high school students in physics which would promote their abilities as self-directed learners, and be guidelines for students' learning development. As a result, they would have necessary skills for a 21st century livelihood further down. The study aims to develop self-directed learning management in physics for high school students. Data will be compared between the scores of pretest and posttest assessments in learning achievement and problem solving. Learning curiosity is also studied to confirm that self-directed learning is suitable for the 21st century physics classroom.

Methodology

This study proceeded in three phases. Phase 1 examined the context, social need and current situation, considered theoretical approaches and related research literature on the issue of self-directed learning, with a particular focus on physics at the high school level. The target group was identified and consisted of seven people in the area of self-directed learning to provide instructional activities in physics. Data collection method included interviewing them. When data from interviews were obtained, they were analyzed and presented to the thesis committee for considering the appropriateness, accuracy, and recommendations. Phase 2 consisted of the development of self-directed learning activities. Data were analyzed and synthesized by various rationales and theories. The tentative outline of self-directed learning was validated and certified by five experts. In addition, the appropriateness and feasibility were checked through the implementation of a pilot study conducted in one grade 11 classroom for 20 periods over the course of seven weeks. The pilot group was selected by purposive sampling to examine

the quality of the proposed learning management model with similar situation of the experimental group. Phase 3 was the implementation phase, in which the self-directed learning management model was used.

The experimental design was conceived as follows: The researchers administered a pretest and a posttest with the participants by using the results of the experimental research. Quantitative data was analyzed, then combined with the results of qualitative research, including interviewing, and teacher and researcher observations of student learning behavior. The researcher provided learning activities that provided the observed student behavior.

Teaching based on the development of self-directed learning employs five phases of instruction: *Diagnosis* was the step for diagnosing the students' ideas by demonstration or action (experimentation) to be observed by students. The teachers asked the students to explain based on their thinking framework. *Strategies* referred to the promotion of students' necessary skills in searching for knowledge by reading, analytical thinking, and participation in learning. *Growing in habit* referred to the practice for students to initiate learning by diagnosing and determining the learning objective and a topic to be learned, planning for learning, finding an appropriately scholarly source for learning, and knowing how to evaluate these sources. *Taking action*, was a learning management process providing the opportunity for students to learn from practice as well as be able to construct a body of knowledge by themselves through data checking and guidelines for improvement, selecting the improvement guidelines, planning for improvement and practice based on specified guidelines by organizing and arranging the practice list carefully and clearly for convenience. Finally, *Summarizing and Assessing*, was the process in which the students concluded and assessed their own obstacles in order to enhance the students' esteem and maintain a sustainable practice level. The teachers provided positive reinforcement, and encouraged them to obtain self-reward without considering whether their performance would be successful or not. The researcher administered a post-test for this experimental group of students with the following instruments: learning achievement test, learning curiosity test, and problem solving test. Then, the findings were analyzed statistically.

Results

Self-directed learning: qualitative study

The self-directed learning research findings began with a study of the context, social need and current situation, related approaches and literature review. Some of the interviews produced the following statements:

“...For learning activities, teachers had to encourage their students to conduct their own experiment in physics so that they would be able to initiate the process for collecting the evidence or develop the scientific explanation by themselves, search for existing facts or truth from investigation and experimentation...” (Teacher E)

“...physics had to be learned from a constructivist process in that the students had to search for, discover, investigate, check, and find out from different techniques until the students could understand and perceive meaningfully...” (Teacher D)

“...students should initiate learning by themselves by analyzing the need of what had to be learned from the technique of selecting and searching for knowledge, learning processes such as determination of learning objectives, planning for learning, searching and selecting the learning sources including the scholars as well as technologies and media, skills in working with others...” (Teacher A)

The technique for using the instructional media in physics was the key of teaching which would help the students to be self-directed as revealed in the following interviews:

“.... teachers had to prepare various kinds of media, material, and equipment to be used by students for data and evidence collection, and presentation of consistent explanations from collected evidence by teaching guidelines of science. Teachers did not need to explain what had to occur in the laboratory. It would depend on learning media and action...” (Teacher D)

“..... teachers had to provide the instructional media, material, and equipment to be ready throughout the time for students’ convenience in studying. There should be hands-on media in each locality...” (Teacher C)

Physics teachers’ role should be to be able to help their students’ self-directed learning, adjust the learning climate and environmental situation, and use psychological principles in learning and teaching such as expressed in the following interviews:

“... teachers had to trust their students. Most of students would learn fully and dedicate themselves in learning for quality. Teachers should believe that the students had potentiality to learn. They had to encourage their students, advise, suggest guidelines for learning with the goal of students’ learning development ...” (Teacher F)

“..... to be facilitators in learning management with responsibility in advising, suggesting, facilitating, providing different kinds of media, counseling the students, and stimulating them to learn throughout the time....” (Teacher G)

The students' role in learning physics was to study, be skeptical and curious to solve the problem, and be persistent in learning things such as following interview:

“..... to be able to learn by themselves, have high internal motivation to be successful, initiate to learn by themselves and try to learn more and better to be informed by the other people. They had to learn attentively and purposefully with high internal motivation. Besides, they could utilize their learning very well. They had freedom to solve the problem whether it would have occurred in democratic environment only.” (Teacher F)

“.... to obtain motivation to participate in activities leading to new experiences, and be willing to be changed in learning objective or learning method. In addition, they used problem system by using the surveying skill, trial and error without stopping their learning intention. To be able to develop the ability with good interpersonal relations with friends so that those persons would reflect the learning need, planning for learning, helping the others, and obtaining support from those persons...” (Teacher B)

The measurement and evaluation in physics, was emphasized with the use of authentic assessment. What is to be learned by students was the objective of assessment. As a result, there was not only a knowledge assessment. What needed to be expressed by students was that they could think, make decisions, and direct themselves, which can be evaluated such as the following interview statement:

“.... activities or situations should be provided for students to evaluate the process in surveying, investigating, checking, and assessing the findings of survey or investigation, or their own new body of knowledge or their classmates' by analyzing, critiquing, discussion, asking, or sharing their body of knowledge with each others for comparing the good point or weakness, improvement, or revision....” (Teacher E)

“...the measurement should be provided continuously. The authentic assessment should be administered by process for judging the students' abilities and skills being relevant to real life by using the stories, incidents, real or similar situations in daily life as the stimuli to be responded by students from expression, action, or product from the expected working process...” (Teacher C)

For individual and group learning assessment, the authentic assessment was administered including the process of judging the students' knowledge, competencies, and skills being relevant to real life. According to the study of social needs and current situation, related approaches and theoretical research literatures with self-directed learning in physics, it was found that in order to implement the instructional activity management model in physics, teachers had to support their students to conduct experiments so that they would be able to initiate the process for collecting evidence and developing scientific explanations based on prior knowledge or experience as well as each other's social context. The media used for their instructional activity management should be prepared in advance and be sufficient for use with students.

Self-directed learning: quantitative study

The comparative findings of learning achievement of students studied were shown in Table 1.

Table 1: Comparison of pretest and posttest in learning achievement.

Learning Achievement	N	\bar{X}	S.D.	Z	P
Pretest	43	10.25	3.38	5.720*	.000
Posttest	43	17.79	3.25		

*Statistical significance at .05 level.

According to Table 1, it was found that 43 students studying by the self-directed learning model obtained significantly higher posttest scores in a learning achievement test than the pretest scores at a level of significance of .05 level.

Table 2: Comparison of pretest and posttest in problem solving.

Problem Solving	N	\bar{X}	S.D.	Z	P
Pretest	43	47.56	12.26	5.634*	.000
Posttest	43	71.88	15.14		

*Statistical significant at .05 level.

According to Table 2, students had posttest scores in problem solving higher than the pretest score at a level of significance at the .05 level. The mean score rose from 47.56 to a posttest mean score of 71.88.

Table 3: Curiosity in physics learning (n=43).

Obs. I	Obs. II	Obs. III	Mean	S.D.	%
1.72	2.59	2.79	2.37	0.59	78.88

Table 3, to assess the personal characteristics required in self-directed learning, researchers reported the exploration of curiosity in physics learning through observation. They had a mean score 2.37 from 3.00, which is calculated to 78.88 of curiosity behavior. The recorded score from observation I to observation III tend to be positively developed.

Discussion

The researcher studied various aspects of self-directed learning, including the approaches and theories to be able to use as the guidelines for determining the effectiveness of self-directed learning. These included six factors: 1) the basic approaches and theories, 2) objective, 3) teaching steps or syntax, 4) social system, 5) principle of reaction, and 6) support system. The tested model consisted of five steps as follows: 1) diagnosis, 2) enhancement of strategies, 3) growing in habit, 4) taking action, and 5) summarizing and assessing. Let us look at these one at a time.

Diagnosis, in which the students' viewpoints or ideas were diagnosed by using the demonstration or taking action (experimentation). The students would observe and were asked by the teacher based on the students' framework. This is supported by Knowles *et al.* (2014), who said that the teachers had to consider the individual differences as well as respond the students' interpersonal need by providing flexible instructional management based on the students' ability, using various kinds of instruments and techniques, assigning the students' tasks or teaching according to the materials in time, class size, different competencies, and students' background. The students had to check themselves whether they understood the content, how did they understand it, whether they could solve the problem. If they did not understand, in what part was it that they didn't. They had to know how to study by themselves (Daniels, 2011). It could be seen that both teachers and students had to diagnose the need for content to be learned, students'

readiness in required learning skill, the goal setting, learning plan, scholarly sources, and evaluation. The teachers were trainers, motivators, advisors, facilitators, and counselors. The students were curious, attentive, and responsible. They practiced continuously by themselves, and learned cooperatively. Consequently, they were self-directed learners.

Enhancement of strategies referred to the development of necessary skills in knowledge searching for students by the use of practice in reading, analytical thinking, writing, and participation in studying. Carpenter (2011) stated that it was necessary for learning to include the classroom management, time management, and selection of various learning sources, and physical conditions. It was important to consider the related contexts of classroom situation, class size and conditions, class light, ventilation, students' warm or cold being in class, desk, feasibility in desk management, and disturbances during instruction. Several scholarly sources were suggested.

Growing in habit referred to the practice of students learning to initiate the learning process by diagnosing and determining the content to be studied, setting the learning objectives, planning the learning implementation, searching for appropriate scholarly sources in learning, and knowing how to assess the measurement and evaluation. The students could acquire the learning methods based on objective of learning model by determining the objective. They presumably know their own learning styles, how to search for knowledge from various sources, collect the knowledge and incorporate it into new knowledge as the self-studying of life long learning. They could practice and find knowledge based on their own need, and be stimulated by problem situation.

Taking action was a learning management process providing the students' opportunity in learning by practicing and being able to construct the body of knowledge by themselves through information checking and selection of correction guidelines, planning for correction guidelines and practice based on specified guidelines. The comprehension of higher education students' experience to be able to develop the strategies for good future learning plan, planning for individual responsibility in self-directed learning (Hall, 2011) supports that.

Summarizing and assessing was a learning management process in which students summarized and evaluated their problem or obstacle in order to enhance their esteem as well as maintain more sustainable practice level. So, the teacher provided positive reinforcement and encouraged students' motivation without considering whether their performance would be successful or not.

The students' posttest learning achievement in physics was significantly higher than the pretest at .05 level. This result supports the specified hypothesis. Their learning achievement in physics was at the good level. However, the mean score was in the low level. It indicated that the learning and teaching did not help students to sufficiently develop. It might be due to the amount of content. In each topic of the physics syllabus, the content was very important. But, there was time limitation. The teachers were not able to provide intensive details so that the students would completely understand. As a result, it was necessary for students to have supplementary reading as well as review their lesson regularly, and know how to associate the content. The students' learning skill would be quick. Their learning skill would affect the necessary competency and motivation for life long learning. The learning skill was an instrument for students to accomplish their learning goal. In addition, it was important for developing good basics in the subject for students (Knapper and Cropley, 2000: 134 -137).

Students had overall curiosity after studying at the high level. This conclusion was supported by research findings of Carpenter (2011: 118-127), who found that the students' self-directed learning was significantly higher when they obtained both techniques. In the context of online learning, the students had higher levels of self-directed learning than only by individual learning. In the meanwhile, during individual learning, the teachers still played an important role. Students are inspired when they see, touch, understand, and enjoy the activities based on teachers' learning design. The teacher was the students' inspiration to be or want to be curious people although information is widely available via the Internet. Consequently, the students could access knowledge any time and place. They learned to obtain useful information including the higher order of thinking, analytical thinking, critiquing the information, and applying it.

The test of problem solving skills of students was significantly higher in the posttest than the pretest at a level of significance at the .05 level. This shows support for the specified hypothesis and research findings of Daniels (2011: 105-127), who obtained significantly higher self-directed learning at the .05 level. One explanation might be because the activities developed by the researcher in various learning patterns, were various and focused on students' practice from experimentation, calculation for problem solving by using the problem solving process at the end of each activity. The students had an opportunity to present the experimental findings, conclusions, and were able to discuss these in classroom. They shared their opinion with their classmates, and were therefore better informed, leading to class discussion in order to obtain the ideas that there were many techniques of problem solving in each situation (Aliponga *et.al.*, 2015).

According to the above reasons, the students were able to learn and understand the content, and practice the process. As a result, they had higher

learning achievement scores. The teachers provided opportunity for students to express their competencies and skills through group activities, imagination, experimentation, practice, discussion, and reflection. These things would help students to know and remember in the long run. They would learn science in order to solve the problem in more democratic way. The first thing is that teachers need to provide activities for their students' rationale development. They should introduce students to understand what a rationale would be by explanation, and example. Then, they need to design activities for students to discover different rationales by themselves. The more the students utilized various thinking processes, the better understanding in learning content would be received (Tullett, 1996). Moreover, the students' problem solving thinking would be different. Whether each student would have sufficient competency in problem solving would depend on how well their knowledge, experience, intelligence, and motivation are applicable. These factors would affect one's problem solving thinking (Guglielmino and Guglielmino, 1994).

When the students had an interest in the subject and were able to establish their challenging goals, they would be more interested in the behaviors. The people would judge or evaluate their own behavior accurately, effectively, and conveniently for decision making (Bandura, 2002). Thai society has recently become a new age society to provide education thoroughly and equally with quality for all so that Thai people would be good, intelligent, happy, and sustainably develop their competency. Teachers were the most important factor for achieving this possible dream. They had to change their traditional teaching behavior into the role of facilitators in order to be called "New Age teachers". Future education would be the education for people, community, and society. The goal of education would be the development of balance for society so that the Thai people would obtain an appropriate balance between the search and development of many things in livelihood for peaceful and sustainable society (Nuangchalerm, 2014).

Thai people and society need to focus on firm steppingstones to achieve global knowledge and be ready to enter into the intellectual as well as educational global society. Therefore, the instructional management for students' continuous life long learning, and competency in developing body of knowledge and increasing learning skill by themselves endlessly in their physical, emotional, and intellectual aspects (Driver, 1989). The opportunity for self-discovery had to be provided for students to practice the activities by themselves. The students could participate in instructional activities and be curious in ways which would be congruent with curriculum objectives focusing on perfect, good, intelligent and happy people (Jacobs, 2010). The students' learning habits should be considered, and they also should be persistent, attentive, curious in learning, and strive for self-development. The knowledge content to be studied by students, should not

be too difficult for students' ability so that the students would not be discouraged. Difficult sections of the curriculum should be initially introduced by teachers. Later on, the higher level of knowledge should be associated in some topics.

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