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A Study on Modification of Knowledge, Attitude and Practice on Vocational High School Electronics Courses Integrated with Nanotechnology Concept

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Abstract

The purpose of this study is trying to explore the discrepancy of knowledge (K), attitude (A), and practice (P) before and after the experimental teaching on nanotechnology infused into electronic course in vocational high school. Valid 116 samples were selected from department of electronic of one vocational high school in Taiwan via judgmental sampling. The research result shows that students who received nanotechnology are rise their knowledge test scores dramatically that post-test (M=24.03、SD=2.48) higher than pre-test (M=13.71、SD=3.14); meanwhile, the growth rate around 30%. The analysis result of attitude as 1. The designed materials were suite for students in nanotechnology learning and it will not cause their learning loading rise, hence, students tended to participant nanotechnology related studies and activities initiatively. 2. It is agreed by students that appropriate nano-product can facilitate the convenience of our life. The analysis result of practice as 1. Students either can describe functions at nano-scale within natural world or can identify material physical characteristic at nano-scale. 2. Students learned to search nanotechnology related information and know how to analyze the special function of nano-product.

Keywords: *nanotechnology, KAP, vocational high schools electronics courses*

1. Introduction

1.1. General Background Information

Nanotechnology is emerging rapidly in recent years, becoming a strong new trend in global technology (Islam & Miyazaki, 2009). With the advancement of nanotechnology, nano-materials are found in wide applications that bring the character manifested under the nano scale by atoms and molecules under control in the development of new materials, components, processes and systems (Zheng, Lin & Lei, 2006), and that the manufactured nanotechnology products are developed with the goal of being slim and light. Understanding nanotechnology and its applications has definitely become the new research area that every industry is actively participating in (Xu, Li & Li, 2009).

This study is based on the KAP theory model, first investigating whether students have taken courses in nanotechnology concept, and then exploring the differences in their knowledge, attitude and practice. Cai (2007) thinks individual knowledge affects one's learning attitude. Once the attitude is set, it will further affect learner's performance. KAP concept is also applied in various aspects of teaching strategies, such as ecological teaching and research, environmental teaching, medical education (Chien & Tsay, 2001; Feng & Li, 2004; Lee, 2006; Liao et al., 2006; Luo, Zheng, & Zhou, 2010). Summarizing the reasons above, this study aims to understand the changes in students' knowledge, attitude and practice after incorporating the concept of nanotechnology into the curriculum of electronics courses in the vocational high schools experimental teaching.

1.2. Purpose

This study utilizes KAP Scale as a research tool to explore the differences in students' knowledge, attitude and practice after participating in the experimental teaching which incorporates the concept of nanotechnology into the curriculum of electronics courses in vocational high schools.

2. Literature Review

2.1. Nanotechnology

Nanotechnology is regarded as a new economic opportunity and a technological revolution in the twenty-first century, and is also regarded as, the most significant in the industries, the fourth wave of technological revolution (Ma, 2002). The so-

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called nano is a very tiny unit in length. A Nobel Laureate, American physicist Richard P. Feynman, in 1959, proposed an idea to reduce the content of the Encyclopedia Britannica to a finger tip. The idea was later manifested into the concept of being slim and light and found popular applications in various fields (He, Chen & Liao, 2004; Liao et al., 2004). Today the applications of nanotechnology cross many fields, such as applied physics, materials science, chemistry, biology, robotic science, engineering, electrical engineering and biomedical engineering. It is included in, and is considered a very important part of, technological fields, sciences and engineering research fields. Discoveries and breakthroughs in nanotechnology are spreading rapidly in advanced countries. It is expected that this new technology will bring more benefits to mankind (Ahmed & Jackson, 2009; Kumiko & Nazrul, 2007; Romig, Baker, Johannes, Zipperian, Eijkel & Kirchhoff, 2007; Zitt & Bassecoulard, 2006). Therefore, allowing vocational high school students to learn the knowledge and the applications of the nanotechnology concept early: this research studies nanotechnology-related course materials and classroom digital media, and investigates students learning effectiveness through experimental teaching, hoping to achieve the goal of pursuing practical applications in vocational education and to accomplish the task of nurturing talents with the basic knowledge of emerging technology.

2.2. "Knowledge, Attitude, Practice", KAP Model

Rogers proposed DOI theory (Diffusion of Innovations) in 1962. This theory tries to describe the process that new ideas, or new methods, spread over time. The theory consists of features such as, that the spreading occurs because of the passing of time, and that most people will experience the usage, but not the adoption, of an innovation. In recent years, scholars have been conducting empirical research on innovation diffusion theory, and have integrated the innovation adoptions into three stages: knowledge, attitude and practice (Hubbard & Hayashi, 2003). The learning knowledge of the learner affects his learning attitude, while learning attitude affects, and is shown through, the learner's (learning) behavior (Wang, Huang, Tang, Ye & Zeng, 2009). On one hand, KAP model had been employed in the hygiene education field from 1960's to teaching patients how to correct their health behavior in practice, the cognitive learning was focus on the knowledge and the ability of realization; the affective learning means to change subject's intention, attitude or norms to adjust themselves through hygiene education, the psychomotor learning was focus on cultivating learner's health behavior (Lothian, Ferrence & Kaiserman, 1996). On the other hand, educational field focus on cultivating student's cognitive, affective, and psychomotor (Bloom, Engelhart, Furst, Hill & Krathwohl, 1956), against KAP model in hygiene education field, K (knowledge) to cognitive, A (attitude) to affective, and P (practice) to psychomotor in educational field, the difference is psychomotor require students learned some skills, compared with P (practice) was require the changing of behavior as target. Concerning the nanotechnology teaching in high school level was focus on tracing students' change of behavior instead of skill learning, therefore, KAP model had been utilized as research model to explore students' learning performance in this study.

Conventional thinking in the field of education is that knowledge affects the learner's attitude directly, and the attitude is transformed into behavior. Figure 1 in the Appendix shows the mode of operation. Xie (2003) discovers in her research that if the student has a higher level of knowledge, his learning attitude is relatively more positive. Other related studies find that knowledge will directly affect the attitude and practice, and that attitude will directly affect practice or intentions, except that the degree of impacts that knowledge affects practice through attitude is better than that of knowledge affects practice directly (Li, 2002; Lin, 2001; Lai, 2006; Lee, 2006). Therefore, this article uses KAP framework as the base to develop the required assessment tool.

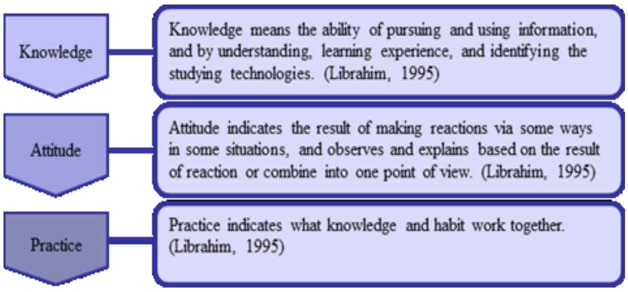

Fig. 1 The influence diagram of knowledge, attitude and practice

2.3. New Vocational High School Curriculum

The future of vocational education needs to work towards cultivating innovative technology, fostering international talents, and enhancing international competitiveness (Hsu, 2007). As far as balancing the theory and the practice in vocational high school curriculum, from the viewpoint of the entire vocational education system, the curriculum must be reformed without delay. As the conventional industries are impacted by vary factors, such as: high-tech industries, knowledge-based economy and globalization, the tasks of nurturing intellectual technical professionals, assisting in industrial professionalization upgrading and restructuring, and setting foundations for knowledge-based technical professionals, as required by technological industries, are the new missions in the new era of vocational education (Yang, 2001). Vocational education is the cradle of training technical talents in our country, and is also an important foundation in strengthening national competitiveness. The effect directly impacts national economical development. The revision of the vocational school curriculum should take into account the manpower structures and qualifications required by the knowledge-intensive industry (Tien, 2005).

3. Research Design

3.1. Research Framework

This study utilizes the KAP scale of teaching nanotechnology concept as a research tool. While taking the experiment group, which implementing nanotechnology courses, along with control group (only provides course handouts) as independent variables, and taking the questionnaire that contains three aspects: knowledge, attitude and practice as the dependent variable, after excluding the interference variables, such as student quality, teaching time, teaching contents, and teaching locations, obtains research data through experimental teaching and questionnaire survey. The data is tested with paired t-test to understand the differences in the knowledge scale of nanotechnology concept teaching under different teaching methods, and lastly, the data is further tested with independent t-test to analyze the differences in students' attitudes and practices after implementing the teaching of vocational high school electronics courses with integrated nanotechnology concepts. Figure 2 shows the research framework.

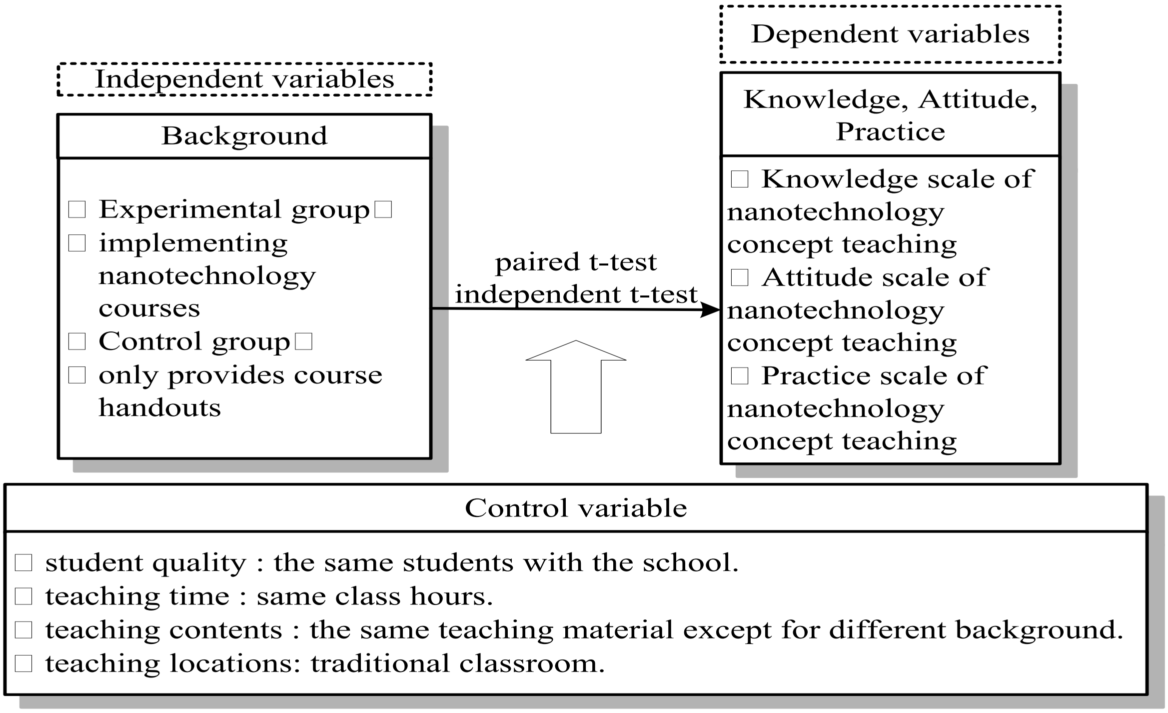

Fig. 2 Research Framework

3.2. Methodology

This study is based on vocational high school courses developed by the Ministry of Education, using expert conference to proceed with the preparation of research tool and using quasi-experimental research method to implement experimental teaching and to assess learning achievement. Below is the explanation of each step.

3.2.1 Expert Conference

The team invited experts and scholars in the field of nanotechnology, experts in the electronic related industries, experts of technical and vocational education, teachers in the electronics division and specialists in the media to examine the appropriateness of the related course contents and materials. For the questionnaire validity, the team also invited the Psychology and Assessment Center director from National Taiwan Normal University, professors of the applied electronics department from National Taiwan Normal University and faculty teachers from national vocational high schools, totaling eight people, participating in six expert conferences, to review and revise the content of the questionnaire. The research team constructed the developed the Vocational High School Learning Nanotechnology Knowledge, Attitude and Practice (KAP) Assessment Scale to assess the effectiveness of student learning.

3.2.2 Quasi-Experimental Research Method

Table 1 explains the experimental design framework.

Table 1 Experiment design

Group	Pre-test	Treatment	Post-test
EG	Y1	X1	Y3
CG	Y2		Y4

Annotation: X1 indicates to experimental treatment； Y1, Y2 indicate to pre-test ;Y3, Y4 indicate to post-test; EG= experimental group; CG= control group

Because of field teaching restrictions, the experimental designed method of randomly assigning subjects to an experiment group and a control group was not possible, we adopted non-equivalent control group pre-test—post-test from the quasi-experimental research method.

Longitudinal research has been treated as temporal order, measuring change, and making stronger causal interpretations, particularly when the temporal order variables such as gender, race, and age, meanwhile, a longitudinal data are certainly not a cure for weak research design and data analysis (Menard, 2002). Due to this is an exploring research to discover the possibility of nanotechnology teaching in high school level and for some research limitation reasons, therefore, we use the quasi-experimental research method instead of longitudinal research.

3.2.2.1 Independent Variable: implementing the teaching of nanotechnology concept.

a) Experiment Group (Electronic Engineering A) implemented with digital multimedia teaching and written learning materials teaching program, and labeled as X1.
b) Control Group (Electronic Engineering B) implemented with traditional teaching method, followed normal teaching process.

3.2.2.2 Dependent Variable: testing students, who received professional electronics courses with integrated nanotechnology concepts education, with KAP scale.

3.3. Research Subjects

This study selected students from the electronic engineering division of a vocational school in Taiwan with judgmental sampling, and obtained 116 valid samples. Table 2 in the appendix shows the detail.

Table 2 Distribution of the number of research object

Group	Sample(n)	Percentage(%)
Experimental group (Nanotechnology concept teaching)	77	66.4
Control group (Standard teaching)	39	33.6
Total	116	100

3.4. Research Process

For the experimental teaching courses of this study, we selected seven units of four chapters from the electronics course, a total of 12 sections, as the experimental teaching theme unit, and then conducted general teaching experiments. Teachers, when conducting the experimental teaching, may chose the appropriate teaching resources according to the programmed schedule, and may have the flexibility to adjust teaching methods. The process of the experiment is that the pre-test was conducted to the experiment group and control group. The content of the pre-test was obtained by blending nanotechnology into professional subject knowledge scale, and then the teaching was performed to the experiment group the following week. The teaching process was conducted by giving multimedia presentations and providing students with student version written materials for their reading and reference; while providing handouts for reading and reference of the same content to the students in the control group, without performing teaching. Post- test was conducted after students of the experiment group and control group went through the entire experimental teaching. The content of the post-test was obtained by integrating nanotechnology into professional subjects with knowledge, attitude, and practice. Figure 3 shows the flow of research process.

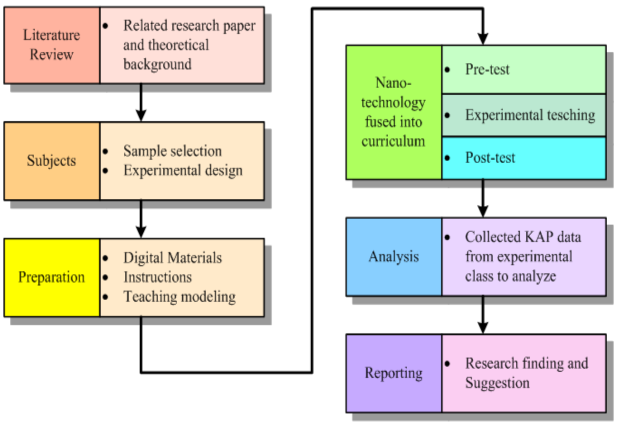

Fig. 3 Procedure

The learning activity was designed as "fused into curriculum in professional units", we first review the chapters to decide the appropriated sections shall be add nanotechnology contents and then we developed additional digital materials and instructions. The courses were conducted following semester schedule then an extra introduction in nanotechnology around 10 to 15 minutes in particular units or sections. The digital materials were utilized to let students realized the structures, patterns or characteristics of the material in nano-scale. Prior to teaching nanotechnology knowledge, we conduct a pre-test to control the knowledge basis of students and then a post-test was conducted for comparison.

3.5. Reliability and Validity of Research Tool

Below is the description of the reliability and validity of the research tool KAP scale used in this study.

3.5.1 Reliability

KAP reliability coefficients are, respectively, "knowledge" is .903; "attitude" is .914; "practice" is .943. Each is greater than 0.70. Therefore, the knowledge, attitude, and practice scales of teaching nanotechnology concept have good reliability (as shown in Table 3). (Nunnally, 1978; George & Mallery, 2003)

Table 3 Reliability analysis abstract of Knowledge, attitude, practice of Nanotechnology concept teaching

Project	Numbers of questions	Reliability analysis
Knowledge scale of nanotechnology concept teaching	30	.903 (K-R 20)
Attitude scale of nanotechnology concept teaching	25	.914 (Cronbach's α)
Practice scale of nanotechnology concept teaching	25	.943 (Cronbach's α)

3.5.2 Validity

The meaning and the content of each question in the scale were discussed six times in the expert conference and were revised many times. So the scale has expert validity.

4. Analysis Results

4.1. Analysis of the variance in the knowledge scale of teaching nanotechnology concept

Table 4 shows the summary table of the mean, standard deviation and paired t test, obtained from the pre- and post-test of the knowledge scale of vocational high school electronic curriculum with integrated nanotechnology concept teaching.

Table 4. Analysis abstract of mean, standard deviation and t-test of pre-test and post-test on knowledge scale of nanotechnology concept teaching infused into electronic course in vocational high schools.

Group	Pre-test		Post-test		t value
	M	SD	M	SD	
experimental group	13.71	3.14	24.03	2.48	-24.621***
Control group	9.90	5.89	11.85	3.83	-1.717

***p<.001

In the experiment group (t = -24.621; p <.001), reaching a significant level, rejecting null hypothesis. This proves that students in the experiment group, after the experimental teaching is performed, show significant differences in learning the knowledge of nanotechnology concept. Therefore, through the mean value from the pre-test and post-test, we find that students receiving the integrated nanotechnology concept teaching have a higher post-test value than the pre-test value. In the control group, t value equals -1.717 (p>.05), not reaching a significant level, accepting null hypothesis. This proves that students in the control group, without the experimental teaching, show little learning in the knowledge of nanotechnology concept.

4.2. Analysis of the variance in the attitude scale of teaching nanotechnology concept

The result of independent sample t-test, we understand the differences between the two groups in the attitude scale of teaching nanotechnology concept. The analysis result shows whether the teaching is conducted contributes to the students' learning attitude, where "Question 1: I think that integrating nanotechnology into the professional subject will not cause a burden in my learning" and "Question 15: I think that choosing appropriate nano products may enhance the quality of life." Both reach a significant level of difference, as shown in Table 5; while the rest of the questions fall below the significant level.

Table 5 Analysis abstract of mean, standard deviation and t-test of pre-test and post-test on attitude scale of nanotechnology concept teaching infused into electronic course in vocational high schools.

Item	Group	Mean	S.D.	t value
1	EG	3.60	0.92	2.112*
	CG	3.18	1.20	
5	EG	3.56	0.88	2.594*
	CG	3.16	1.22	
15	EG	4.31	0.71	5.474*
	CG	3.92	1.08	

EG=Experimental Group; CG= Control Group; * p<.05

We check the variance equal test through Welch (value=301.514, p<.001) and Brown-Forsythe (value=301.514, p<.001), and the result shows that the Levene is 10.781 (df=1/78, p<.01) reached the significant level. "Question 1" ANOVA test result reaches significant level (t = 2.112; p <.05), of which the experiment group (M = 3.60; SD = 0.92) is higher than the control group (M = 3.18; SD = 1.20). "Question 5" ANOVA test result reaches significant level (t = 2.594; p <.05), of which the experiment group (M = 3.56; SD = 0.88) is higher than the control group (M = 3.16; SD = 1.22). "Question 15" ANOVA test result reaches significant level (t = 5.474; p<.05), of which the experiment group (M = 4.31; SD = 0.71) is higher than the control group (M = 3.92; SD = 1.08).

4.3. Analysis of the variance in the practice scale of teaching nanotechnology concept

Tested with independent sample t, the analysis result shows whether the teaching conducted contributes to the students' learning practice, where "Question 2: I can give examples of nano-functions in the natural world." , "Question 8: I can describe the physical characteristics of nano-scale.", and "Question 12: I can analyze the related information or the characteristics of nano products." reach a significant level of difference, as shown in Table 6; while the rest of the questions fall below the significant level.

We check the variance equal test through Welch (value=9.996, p<.001) and Brown-Forsythe (value=9.996, p<.001), and the result shows that the Levene is 7.138 (df=1/78, p<.01) reached the significant level. "Question 2" ANOVA test result reaches significant level (t = 0.508; p<.001), of which the experiment group (M = 3.57; SD = 0.80) is higher than the control group (M = 2.68; SD = 0.93). "Question 8" ANOVA test result reaches significant level (t = 4.656; p <.05), of which the experiment group (M = 3.04; SD = 0.75) is higher than the control group (M = 2.66; SD = 0.97). "Question 12" ANOVA test result reaches significant level (t = 6.977; p<.001), of which the experiment group (M = 3.03; SD = 0.73) is higher than the control group (M = 2.55; SD = 0.89).

Table 6. Analysis abstract of mean, standard deviation and t-test of pre-test and post-test on practice scale of nanotechnology concept teaching infused into electronic course in vocational high schools.

Item	Group	Mean	Standard Deviation	t value
2.	EG	3.57	0.80	0.508***
	CG	2.68	0.93	
8.	EG	3.04	0.75	4.656*
	CG	2.66	0.97	
12.	EG	3.03	0.73	6.977**
	CG	2.55	0.89	

EG=Experimental Group; CG= Control Group; * p<.05; ** p<.01; *** p<.001

5. Conclusions and Recommendations

After the experimental teaching, we found that students from the experiment group and the control group show significant differences in the learning of the nanotechnology conceptual knowledge and in their attitude and practice when dealing with nanotechnology. The following description illustrates the conclusions of this research in all aspects.

5.1. Conclusions

5.1.1 Knowledge

1. Receiving nanotechnology integrated concept education helps students build conceptual nanotechnology knowledge effectively.
2. Not receiving nanotechnology integrated concept education does not help students absorb conceptual nanotechnology knowledge.

With the arrival of the information technology era, the rapid social changes, and the constant changes in industries demands, students are facing the task of learning new knowledge. We know from this research result that receiving nanotechnology concept curriculum helps students to have a positive attitude in the learning of the integrated courses and can enhance building nanotechnology knowledge.

5.1.2 Attitude

1. Students receiving nanotechnology integrated concept education, in general, think that the teaching materials prepared by this research is suitable for student learning, that it will not cause a burden in learning, and that students are motivated to actively participate nanotechnology related studies and activities.
2. Students receiving nanotechnology integrated concept education agree that appropriate nanotechnology products may improve the convenience of human life.

Learning attitude refers to the psychological reaction to the teachers, the curriculum, the teaching materials, or the evaluations of the learning activities (Ji, 1965), and it also affects the behavior choices of an individual to a particular object (Zhang, 2000). The study results show that students receiving nanotechnology integrated concept education all respond, in their learning attitude, that the study is meaningful and that the guidance from the teachers of the experimental courses, the portion of the course units and the arrangement of the living examples are appropriate. In addition, they are also highly motivated, during the course of study, to participate in activities of the related topics to extend their breadth of knowledge.

5.1.3 Practice

1. Students receiving nanotechnology integrated concept education can clearly describe and draw inferences concerning the clarification of nano-scale physical properties, and give examples of nanotechnology-enabled applications in nature.
2. Students receiving nanotechnology integrated concept education can search for nanotechnology related information online and can analyze the relevant characteristics of nano products.

Students receiving nanotechnology integrated concept education, in their practice, not only can clearly describe the course content and have the ability to analyze and compare the characteristics of nano-related products, and they can also search relevant information about new technologies on internet.

In summary, we know from the teaching of the nanotechnology concept that high willingness in personal learning impacts the learning of the knowledge, and that the changes in learning attitude reflect in the reaction of the ability in practice (Wang, Huang, Tang, Yei, & Seng, 2009). Because attitude is a behavior that has a reactionary tendency of being implicit and sustaining (Lin, 1998), this study also discovers that, through teaching the curriculum of the integrated nanotechnology concept, students are encouraged to learn new technologies, then, in turn, change their attitude in learning and the performance in practice capacity about new technologies.

5.2. Recommendations

1. Students, while learning new knowledge of nanotechnology, still have to focus on cultivating basic professional knowledge. This is helpful in the early stage of learning. In learning the abstract concept about the new technology, the research result shows that adding digital media presentation technique to the applications of the course materials as teaching aid may enhance learning interest and attention. In designing the content of the digital course materials, one should favor examples of daily life applications to better motivate students to learn, and to encourage students in learning the knowledge of nanotechnology concept.
2. In teaching students about the new knowledge of nanotechnology, teachers may provide instructions through multimedia, especially where the knowledge cannot be conveyed through words in the written materials. Lively use of the interactive course materials may promote students to link knowledge towards positive performance in attitude.
3. Teachers encourage students to search nanotechnology related information through a variety of search engines during after-school hours, to understand the latest nanotechnology development trend. This is very helpful in promoting the students' ability in practice about learning nanotechnology concept.

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