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TRIZ Internet Learning Platform Applied to University Factory Practical Training Course

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Abstract: The purpose of this study is to explore the influence of applying the Internet learning platform based on TRIZ to factory practical training instruction at a university in Taiwan. The research subjects in this study were university students in factory practical training courses. The questionnaire method was used to analyze the influence of TRIZ Internet learning platform applied to university factory practical training instruction. The subjects were further divided into the experiment group and the control group, and Internet learning platform strategy was used for experiment processing to carry out experimental instruction. After statistical analysis, the study finds the following conclusions: 1) TRIZ Internet learning platform applied to university factory practical training instruction has significant positive evaluations; 2) Internet learning platform has no significant differences in university student factory practical training course learning effects; 3) TRIZ theory applied to university factory practical training has a significant positive influence on learning effects. Instructional suggestions are given based on results of this study, in order to enhance the innovative thinking ability of university students, in turn making the factory practical training activities more meaningful.

Keywords: TRIZ, Internet learning platform, factory practical training

1. Research Motives and Purposes

The educational objectives of technical education include enhancing related capabilities and cultivating occupational ethics, and it has also received attention for cultivating independent thought and problem-solving ability. However, the most representative part of technical education, factory practical training course instruction is still a teacher-centered instructional model, in which the teacher guides the procession of the entire instructional activity, and the process of knowledge and capability transmission, potential problem-solving ability of students is often overlooked. In 2007, the Ministry of Education promulgated the "Creativity Education White Paper," which mentioned that schools should infinitely expand accommodation and imagination, and create a diverse learning environment that respects differences and appreciates creativity. If creative thinking instruction can be applied to engineering education, it should benefit the creation of engineering knowledge, development of technology, and improvement and innovation of products; the instructional strategies, processes, and effects deserve in-depth exploration and research.

In a context of advanced information, diverse society, and rapid changes, in order to cope with the times and the needs of the current environment, education should be highly sensitive and self-conscious and work hard at reformative and innovative concepts, so instructors cannot maintain traditional instructional methods. Teachers must adapt to people, time, and location to innovate instructional methods to inspire student learning interest. Teachers can use different instructional media to stimulate student learning, realize their creativity, enhance learning motivation, and lower and dispel learning obstacles for students in the process of learning, so that they can achieve the optimal learning effects (Ringwood, Monaghan & Maloco, 2005).

Thus, this study uses TRIZ Internet learning platform to accommodate university factory practical training course instruction, which breaks through the limitations of time and space, effectively realizes the advantages of Internet learning, provides an efficient learning environment, and follows the design of instructional activities and curricular content. Students can use the different instructional strategies and tools to obtain the best learning effects, in order to achieve the educational purpose of insight. This study seeks to achieve the following two points:

(1) to explore the influence of the application of TRIZ Internet learning platform on university factory practical training instruction;

(2) to explore the of TRIZ Internet learning platform on university student learning effects in factory practical training course.

2. Literature Review

Regarding Internet learning platform, TRIZ, and factory practical training, the literature organized and summarized below:

2.1 Internet learning platform

Due to rapid development of computers, communications, and audiovisual technology, learners are no longer isolated when they are learning (Sanchez & Hueros, 2010). Through the assistance of Internet technology, then can cooperatively learn with their peers, or even communicate and interact with other participants. They can engage in real-time or asynchronous discussions that are simultaneous or otherwise, to discuss and supplement each other, so that the Internet has formed rich learning content, diverse learning resources, and personalized learning needs and open learning contexts. Compared to traditional instruction, digital instruction can provide various advantages, including lower learning costs, strengthen response abilities. It is possible to create consistent instructional material content based on needs or customize personal instructional material content, instantly update instructional material content, learn at any time, and construct community knowledge. In the cooperative learning environment with Internet support, when students interact with others, they can also reflect upon themselves. The unceasing process of response and reflection can help promote student integration of their concepts, and this is beneficial for learning (Webb, 1995; Hoadley & Linn, 2000). Many studies have proven that Internet interactive learning method is indeed beneficial to student conceptual learning and problem-solving abilities (Webb, 1995; Hoadley & Linn, 2000).

This study applies the Internet learning platform to university factory practical training course, in hopes of transcending the limitations of time and space, to provide students with diverse learning resources. The learning environment involving student interaction can enhance learning interest to enhance learning effects.

2.2 TRIZ – Theory of Inventive Problem Solving

TRIZ was invented by Soviet Russian inventor Genrich Altshuller in the 1940s; TRIZ is the acronym of the Russian term Teoriya Resheniya Izobretatelskikh Zadatch, and the English translation is Theory of Inventive Problem Solving, which means "the solution theory for inventive problems." After he analyzed over 400,000 patents, he summarized the logic of patent invention commonality, repetition, and innovative inventive thought, forming the theoretical basis for TRIZ (Rantanen & Domb, 2008).
This study uses insight from TRIZ, adopts diverse innovative instruction to elicit active student learning motivation and interest, in hopes of improving the strategy in innovative instruction to elicit student creativity and problem-solving ability.

2.3 Factory practical training course

In order to enable students to be able to practically apply the theoretical courses they have learned after graduation, the purpose of factory practical training is to connect planning of instructional courses with the practical ability in work (Krar & Check, 1997). This allows the practical training process to help students practically understand the basic principles and capabilities of various types of machinery, and at the same time become familiar with the processing and operational procedures, as well as understand correct mechanical operational capabilities and processing methods. With practical work of the work items, students can become familiar with clipping tools, measurement tools, and operation of various tool machineries, cultivating good student industrial safety and hygiene habits at their factory work sites (Krar & Check, 1997).
However, due to advancement of new technological knowledge, if student capabilities can only stay in lower-level learning such as basic processing, it would not conform to needs in the industry. Therefore, this study integrates TRIZ theory into factory practical training course instruction, and would effectively lead students learn higher-level innovative design, so students can engage in practical processing to complete real items to obtain the ability of practical work, allowing them to have deeper impressions on the theories they have learned. The learning method through Internet learning platform is used to help students establish the concept learning they should achieve, and blend into their personal learning contexts for the future, and in turn, make the whole factory practical training course more meaningful.

3. Research Design and Implementation

Based on the research purposes and literature review, the research design and implementation procedures of this study are explained as follows.

3.1 Research framework

Research design in this study is based on research objectives and literature review, applying TRIZ theory to factory practical training course for classes A and B in an engineering department at a Taiwanese university as the focus of the first part of the curriculum, in order to cultivate correct mechanical operation capabilities and processing methods for students. After the midterm exam, classes A and B (the experiment group and the control group) underwent six weeks of experimental instruction via Internet learning platform instruction and traditional classroom instruction, as shown in Figure 1. A context was set so students can express their imaginations. Through TRIZ theory, team students use their creativity to design a conceptual diagram, and apply the capabilities they have learned from factory practical training to realize the product, making students familiar with clipping tools,

measurement tools, and the operation of various tool machines, to achieve the purpose of making students fully understand basic processing abilities of machinery and cutting methods and principles.

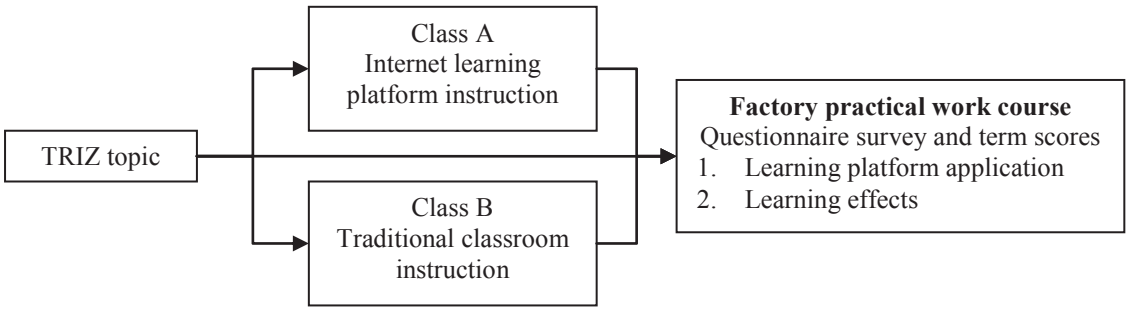

Figure 1 Research framework diagram

3.2 Research Subject and Research Method

Research subjects in this study are 107 freshman students from class A and B (55 students in Class A and 52 students in Class B) at the factory practical training course of the engineering department at the case university. The university uses normal distribution class divisions, and the course is taught by the same teacher, which can enhance the sample heterogeneity. The study uses questionnaires and the 107 students at the case school as the sample. The questionnaire is divided into the two major items of platform usage and learning effects, with a total of 20 questions, and the Likert scale is used to evaluate the extent to which the research subjects agree, in which they select one out of the five choices, which are "highly agree," "agree," "neutral," "disagree," and "highly disagree." Investigation of quantitative data relating to the effect of TRIZ Internet learning platform on university student factory practical training course is conducted through questionnaire data and statistical analysis of student term scores, in order to understand the effect of TRIZ Internet learning platform instructional model on university student factory practical training instruction.

4. Results and Discussion

Based on the research design and implementation of this study, the collected quantitative data undergoes statistical analysis is used to understand "the effect of TRIZ Internet learning platform applied to university factory practical training instruction" and "differences in learning effects caused by TRIZ Internet learning platform to university student factory practical training course learning effects," to serve as the primary basis for follow-up factory practical training course instructional design.

4.1 Analysis of TRIZ Internet learning platform instruction effects

This study uses the results of Class A questionnaires regarding the TRIZ Internet learning platform applied to university factory practical training course in a single sample t-test analysis, in order to understand the effect of integrating TRIZ Internet learning platform into university factory practical training course instruction. The results of analysis on instruction are explained in the following.

4.1.1 Statistical analysis of the effect of TRIZ Internet learning platform on factory practical training instruction

In the application of Internet learning platform, the mean values of the items were all above 3.5214, the standard deviation is under 0.76111, between agree and neutral, and when the test value is 3, it reaches a level of significance, as shown in Table 1. This shows that most students gave positive evaluation to the Internet learning platform. The Internet learning platform can be used to classify and search for knowledge, which can help students accumulate, share, and obtain knowledge. Assistance and consulting from the Internet teaching assistant can help students have in-depth exploration of knowledge relating to the topic. The team members use the discussion area for discussion, so that students can make their knowledge or thoughts more concrete and in the forms of words, and in turn complete the design and production of the topic, which can effectively enhance student learning interests and effects in the factory practical training course.

Table 1 Single sample t-test of TRIZ topic activity Internet learning platform application

NO.	Question	Mean number	Standard deviation	t (test value = 3)
1	The Internet teaching assistant is helpful for me in carrying out the "TRIZ topic activity"	3.5641	.73560	8.295***
2	The work in every task makes me explore knowledge relating to the topic more deeply	3.5385	.76043	7.659***
3	The work in every task is helpful for completing the topic design and production	3.7179	.62761	12.374***
4	Using the discussion area and discussing with team members helps me make knowledge or thoughts more concrete and in the form of words	3.7094	.71991	10.659***
5	The Internet platform helps me to accumulate knowledge	3.6325	.72633	9.419***
6	The Internet platform helps me to share knowledge	3.6667	.62972	11.451***
7	The Internet platform helps me to acquire knowledge	3.6581	.68434	10.402***
8	The various categories on the Internet platform discussion area can help me categorize and search for knowledge	3.5726	.72298	8.568***
9	Participating in the explanation meeting helps me have a quicker grasp of the techniques of operating the Internet platform	3.5214	.76111	7.410***
10	Internet platform usage explanations helps me have a quicker grasp of the techniques of operating the Internet platform	3.5556	.70030	8.581***

*** $p < .001$.

4.2 Analysis of Internet learning platform learning effects

This study applies Internet learning platform on factory practical training course for experimental instruction, and the term scores from factory practical training of the students from classes A and B undergo independent sample t-test analysis to understand differences in learning effects of Internet learning platform applied to university student factory practical training course. The analytical results are described as follows.

4.2.1 Statistical analysis of Internet learning platform on university student factory practical training course learning effects

After six weeks of experimental instruction, this study takes the term grades of research subjects in class A and B (the experiment group and the control group) to conduct an independent sample t-test analysis. Results show that the mean value of the control group (M=73.351) is higher than the mean value of the experiment group (M=72.110). The statistical analysis results show that t=-1.032, p=0.305<0.05, and that the Internet learning

platform applied to university student factory practical training course does not show a significant difference in the learning effects aspect, as shown in Table 2.

After the researcher interviewed the teacher and students, the summarized conclusions are as follows. “Factory practical training” is a practical work course, the primary purpose is to help students to work onsite and understand the basic functions and capabilities of the machinery and the processing operational procedures, thus, the semester scoring focus is also on practical operation ability. Online learning in the Internet learning platform designed by this study primarily provides students with diverse learning resources, so that when students interact, discuss, and share with others, they can also reflect on their work, which promotes student integration of self-concept, increases student learning interest, and in turn enhances the efficiency of knowledge acquisition. Thus, according to the traditional term score evaluation points, in the student learning effects in their practical work ability, statistical analysis results show that there are no differences in the practical work ability learning effects of the students in the experiment group and the control group. This shows that teachers should comprehensively plan the orientation of the Internet learning platform in curricular instruction based on course features, and reestablish evaluation standards to correspond to instructional models. This is a research and planning point that should be noted in future experiment design in this study, in order to enhance the completeness of research.

Table 2 Independent sample t-test analysis of Internet learning platform learning effects

	class	N	Mean	Std. Deviation	t	Sig (2-tailed)
Term scores	A	55	72.110	6.5872	-1.032	.305
	B	52	73.351	5.8039		

4.3 Analysis of TRIZ learning effects

This study further processes the questionnaires using single sample t-test analysis in order to understand the effect of TRIZ theory applied to university factory practical training course. The analytical results are explained as follows.

4.3.1 Statistical analysis of learning effects of TRIZ applied to factory practical training instruction

In the aspect of learning effects, the mean values of questions were all above 3.5385, the standard deviation is under 0.79935, between agree and neutral. When the test value is 3, there is a level of significance, as shown in Table 3.This shows that in the aspect of learning effects, most students gave positive evaluations. Through participating in challenging TRIZ topic learning activities, students can learn knowledge relating to the topics, integrate student capabilities in factory practical training, and enhance student ability in knowledge integration, problem-solving, data collection analysis, and practical work, in turn gain important learning experiences to verify theory and practice, which can effectively enhance student learning effects.

Table 3 Single sample t-test analysis chart of TRIZ topic activity learning effects

NO.	Question	Mean number	Standard deviation	t (test value = 3)
1	I learned something I did not know from the someone else's reports	3.6293	0.76363	8.876***
2	Completion of the "TRIZ topic activity" is challenging for me	3.9829	0.73088	14.546***
3	The practical work process can provide an opportunity to verify theory and practice	3.7179	0.65451	11.865***
4	The practical work process is a learning method that integrates knowledge	3.6838	0.67785	10.911***
5	The practical work process can enhance my problem-solving ability	3.6154	0.75254	8.845***
6	The practical work process can enhance my data collection ability	3.6923	0.72471	10.333***
7	The practical work process can enhance my learning of information ability	3.6667	0.73108	9.864***
8	The practical work process can enhance learning of technological ability	3.6325	0.77235	8.858***
9	The practical work process can enhance learning of engineering ability	3.5385	0.82565	7.054***
10	The practical work process has given me very important learning experiences	3.7094	0.79935	9.599***

*** $p < .001$.

5. Conclusions and Suggestions

Based on the research purposes, the composite analysis and discussion of this study leads to the conclusions and suggestions as follows:

5.1 Conclusions

After six weeks of applying TRIZ Internet learning platform to the factory practical training course experimental instruction at a Taiwanese university, the tested questionnaire survey data and student term scores undergo statistical analysis. Three conclusions are reached after analysis and discussion in this study:

- TRIZ Internet learning platform has a positive significant influence on the effect of factory practical training instruction

Results of this study show that in the aspect of Internet learning platform application, most students gave positive evaluations. Through Internet learning platform learning, assistance of Internet teaching assistants, and discussion with team members, students can accumulate, share, and obtain knowledge, and in turn have in-depth exploration of knowledge relating to the topics. This can help students make their knowledge or thoughts more concrete and convert them into words. This effectively enhances student learning interest and learning effects in factory practical training course.

- Internet learning platform does not show significant differences on learning effects for university student factory practical training course

This study applies Internet learning platform to factory practical training course for experimental instruction. Analysis of the student term scores shows that there are no significant differences in the learning effects. This shows that the application of Internet learning platform on factory practical training course has no significant difference on the learning effects of student practical work ability.

- TRIZ application to factory practical training course has significant positive learning effects

Results of this study show that in the aspect of learning effects, most students gave positive evaluations. Through participating in TRIZ topic activities, students can integrate the capabilities learned by students in factory practical training, enhance student knowledge integration and abilities in problem-solving and practical work, and in turn gain important

learning experiences that verify theory and practice to effectively enhance student learning effects.

5.2 Suggestions

Based on the above research results, the following suggestions are provided as a reference:

- Schools should apply TRIZ Internet learning platform to factory practical training instruction

Results of this study show that there is a significant positive effect of TRIZ Internet learning platform on factory practical training instruction effects, which shows that most students can identify with this instructional model. Since students are happy to accept diverse and lively creative instructional methods and content, so it is suggested that schools should establish a TRIZ Internet learning platform and apply it on factory practical training instruction to elicit intrinsic learning interest of students, and enhance factory practical training learning effects.

- Teachers should adequately plan the orientation of Internet learning platform in course instruction

This study finds that Internet learning platform has no significant difference on university student factory practical training course learning effects. Since factory practical training course is a practical work course, the purpose of which is help students practically understand the basic functions of various types of machinery and become familiar with various processing operational procedures. Thus, teachers should comprehensively plan the orientation of Internet learning platform in course instruction based on course characteristics. For application of factory practical training courses, this study suggests that teachers should stress transmission of knowledge of basic functions and operational method of various types of machinery, and promotion of industrial safety and hygiene. Teachers and students can all use the platform to engage in knowledge exchange and reflection sharing, in order to enhance the efficacy of the instructional activities.

- Teachers should adequately use TRIZ theory to design student-oriented instructional models

Results of this study show that when TRIZ is applied in factory practical training course, most students gave positive evaluations to the aspect of learning effects. Since TRIZ theory can help students to effectively enhance abilities in problem-solving and creative thinking, teachers should adequately use TRIZ theory to provide students with a flexible learning environment, create instructional models that meet personalized needs to incorporate future learning contexts for students, so that they can be more confident in facing their future workplace. Thus, students can learn better and be better able to apply skills to the workplace.

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