A Case Study on the Learning Assessment of a Sandwich Program Based on Constructivism

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***Abstract* – This case study paper investigates the learning assessment of a sandwich program adopted by a private university of technology in Taiwan. In the program, all the junior students of the university take one year in cooperative companies for practical training. However, it is difficult to evaluate the learning achievements of the students practiced in different factories or companies. For evaluating the intellectual skills of the students, four abilities defined by the Florida assessment project system, concept, rules, problem solving and cognitive strategy, are used, and then five examination papers based on constructivism are developed. Through five stage examinations, the performance of the students can be assessed. From the score results, it can be found that the students' performance is directly related to the factories or companies they practice. Therefore, the students' scores of the five-stage examinations can be regarded as an important index. Namely, the five stage examinations developed in this project can be used to supervise the implementation of the sandwich program and choose the cooperative companies.**

Index Terms - Sandwich Program, Constructivism, Learning Assessment

INTRODUCTION

It is well known that practical training is very important for the students of studying in technology universities, and many schools have been adopting sandwich programs to help their students to learn know-how. Obviously, sandwich programs are profitable for minimizing the gap between theories and practices [1-2]. The implementation of sandwich programs may be diverse. It may be a half year in school and a half year in factory. Or, it may be a year in school and a year in factory. Basically, learning alternates between school and factory. No matter how the diverse of sandwich programs, seeking an instructive company for students is the most important. It should be stressed that not all sandwich programs can be naturally successful. Intrinsically, factory practice is a process of "learning by doing". If cooperative companies cannot provide instructive working environments, the practiced students maybe become low-cost labors. Therefore, "how to grade the student's achievements and discriminate the qualification of factories" is the principal concern of the faculty administering the sandwich program.

In Taiwan, Mingchi University of Technology has been administering her sandwich program more than forty years. The students graduated from the school must complete a one-year factory practice. During the year, the faculty guide and grade the students by students' reports. However, it is not easy to assess the students' achievements only by a report because the students' learning is a process based on the Constructivism [3-4]. Next, due to the change of industrial structure, the sandwich program of the university needs to revise for adapting the change of society. Moreover, as a part of engineering education accreditation, the faculty also needs a standardized procedure to supervise the implementation of sandwich program and assess the learning achievement of students. Accordingly, the mechanical engineering department of the university conducts a project to build a standard procedure for assessing the students' performance and evaluating the cooperative companies. Based on the Constructivism, the construction process of intellectual skills is the main concern. Therefore, the student's growth in problem solving and cognitive strategy, before and after the sandwich program, is observed and analyzed. This article summarized the test results of the students in mechanical engineering.

PROCEDURES

In this problem-oriented project, all junior students practiced in companies and factories, thirty-eight persons, are tested and observed. Figure 1 illustrates the procedures of the project. The procedures are briefly depicted as follows. Firstly, an initial reference survey is conducted. The reference survey includes the curriculum standard and the core abilities of the student in the field of mechanical engineering. The following Delphi investigation is indeed a consultative process. Some scholars and experts in the fields of industrial education and mechanical engineering are consulted to clarify the education targets and administration procedures of the project. As the investigation is completed, the learning goals and contents in the field of mechanical engineering are analyzed and drafted. While the curriculum committee of the department passes the draft of the learning goals and contents, a more detailed instruction objectives and contents are listed in a bidirectional table. As shown in Table I, the items of instruction objectives are arranged in

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columns and the items of learning assessment are listed in rows.

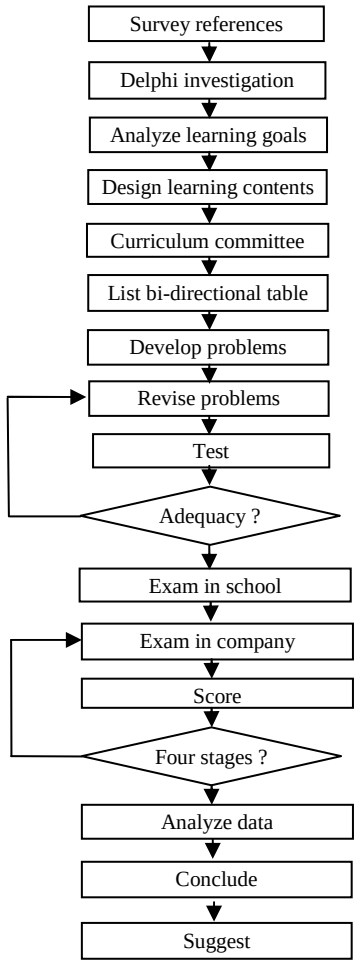


FIGURE 1
THE FLOW CHART OF THE PROJECT

To assess the students' intellectual skills, the Florida assessment project system is adopted [5]. The Florida assessment system includes eight intellectual skills, motor chain, verbal chain, discriminates, concepts, rules, problem solving, cognitive strategy, and attitude. Table II shows the Florida assessment system and illustrates the corresponding learning outcomes, human performance, and assessment example. In this project, only four intellectual skills are selected from the Florida assessment system and used to evaluate the students' learning achievements. The four items selected are concept, rules, problem solving and cognitive strategy, as listed in Table I. Based on the Constructivism, the students practiced in factories and companies should be able to actively learn and construct their knowledge with his formerly experiences. Basically, the four assessment items are stratified. First, the concept can be regarded as a basic knowledge requirement in the works. Second, be able to apply the rules learned from school to works is viewed as a higher performance level. Third, if the students can apply their knowledge and rules to solve the problems they encountered, it is seen as a promotion from the second grade, rules.

TABLE I
BIDIRECTIONAL TABLE

Field	Items	Concept	Rules	Problem solving	Cognitive strategy	Total
Materials	Objective 1	2	1	1	1	5
	Objective 2	1	1	0	1	3
	□					
Dynamics	Objective 1	1	1	0	1	3
	Objective 2	2	0	1	1	4
	□					
Manufacturing	Objective 1	3	0	1	1	5
	Objective 2	0	2	2	1	5
	□					
Mechanical Design	Objective 1	2	1	1	1	5
	Objective 2	2	1	1	1	5
	□					

TABLE II
THE FLORIDA ASSESSMENT PROJECT SYSTEM [5]

Intellectual Skills	Learning Outcome (Action Word)	Human Performance	Assessment Example
Motor chain	Manipulates	Executes a skilled motor performance	Weighs substance on a balance
Verbal chain	Recalls	States fact, generalization or descriptions	Lists minerals in Moh's scale of hardness
Discriminates	Discriminates	Distinguished objects or object features as same or different	Tells whether photographs of galaxies are same or different
Concept	Identifies or classifies	Classifies an object or situation in accordance with a definition	Classifies granite as an igneous rock
Rules	Demonstrates	Applies a rule, law, or concept to specific example	Determines density of a mineral
Problem solving	Generates	Generates a solution to a novel problem	Determines effect of velocity on erosion in stream
Cognitive strategy	Originates	Originates a novel problem and solution	Gets an answer to "I wonder what would happen if..."
Attitude	Chooses	Chooses a course of action, expresses a feeling toward a person, object, or event	Writes a letter to congressional representative supporting air quality standards

Finally, if there are several methods that may solve the problems encountered and the students can choose an adequate method, then the learning objectives of incubating the ability of cognitive strategy are achieved. According to the selected four assessment items, many problems in mechanical engineering are designed and categorized into five examination papers. To test the growth of the intellectual skills of the students practiced in the cooperative factories and companies, all five examination papers are designed as having equivalent difficulty and assessment effects. Each examination paper contains fifty choice problems and five answer questions. Selected problems and questions both include the four assessment items, concept, rules, problem solving, and cognitive strategy. The numbers shown in the bi-directional Table-I are just examples. The numbers in rows show the problem quantities designed in the four assessment items.

In Figure 1, the procedure of the problem design is a three-step loop consisting of revision, test and accreditation. In the loop, the problems are tested by junior student samples. The circulating loop runs continuously until the developed problems behave adequate difficulty. After finishing the problem design, a guidebook for learning assessment is prepared. The guidebook is used to help the faculty to conduct the stage examinations as they visit their students in factories and companies. While the five examination papers are prepared, the first examination is held in school, and the other four examinations are held in companies and factories every three month. In the sandwich program adopted by the university, the students' learning process in companies is divided into four stages. Each stage lasts for a quarter or three months. While each stage ends, the faculty holds a stage examination to assess the student's performance. According to the students' examination results, the faculty can objectively improve their instruction strategies and select more instructive factories and companies for students.

In the project, there are thirteen companies cooperated with the department of mechanical engineering. Here, the cooperative companies, factories or institutes are designated as A to M. The main features of the thirteen companies cooperated with the university are briefly described as follows:

Company A is an enterprise produced plastic products.

Company B is a metal-sheet folding and pressing factory.

Company C is a company for mockup manufacturing.

Company D is a metal-sheet folding factory.

Company E is a trading company for importing high class and accurate measuring instruments.

Company F is an industrial technology research institute focused on the development of energy and resource.

Company G is an enterprise produced PC chassis, server chassis, power supply cases and server barebones.

Company H is a company mastered in the technique of mechanical and electrical system integration.

Company I is a private university of technology.

Company J is a machine design company mastered in reverse engineering, CAD/CAM, CNC, RP and prototype.

Company K is the management department of a plastic enterprise.

Company L and M are the branch companies belonging to the same plastic enterprise.

TEST RESULTS

The students' scores are analyzed after the five-stage examinations are completed. For clarity, the students' scores in the thirteen companies are divided into two groups and shown in respective charts. The first group consisting of the company A B C D E L and M is designated as group I, as shown in Figure 2. The second group contains the company F G H I J K, as shown in Figure 3. In the two charts, the score line of each company is compared to the black average line. The average line shows the average score of the thirty-eight students. All the scores of the students are normalized. The first-stage score is the score tested in school and the next four-stage scores are the scores tested in companies. As shown in Figure 2 and 3, the overall score trend on choice problems is descending. On the contrary, the score trend on answer question is ascending as shown in Figure 4 and 5.

Figure 4 and 5 show the score trend on answer questions. Because the first stage examination hold in school has no answer question, there are only four stages in the two figures.

Figure 6 to 8 are the typical test results that illustrate the individual differences of the students practiced in the company B C and G, respectively. Since each company may have more than two students, the individual differences on the mental growth are deserved to care.

Figure 6 depicts the different intellectual skill growth of the four students in company B. They have the same descending trend on choice problems, but three students grow in answer questions.

Figure 7 shows the trend of company C. It is similar to Figure 6. The trend on choice problems is descending but is ascending on answer questions. Moreover, even though the overall trend on answer questions is ascending, it still has a student drops.

Compared to Figure 6 and 7, Figure 8 is a better case. Figure 8 illustrates the individual differences in company G are little. The students practiced in company G have a better performance.

FINDINGS

Obviously, the group-II has better performance than group-I. This phenomenon can be regarded as a normal situation, because the group-II has more design and study works than group-I. Therefore, the students practiced at the companies of group-II can naturally get more learning achievements and such a result coincides with the anticipation of the faculty.

Accordingly, the faculty of the university may check the students' scores to improve the administrations of the sandwich program. That is, the scores may help the faculty to accredit the cooperative companies whether the companies are qualified or not.

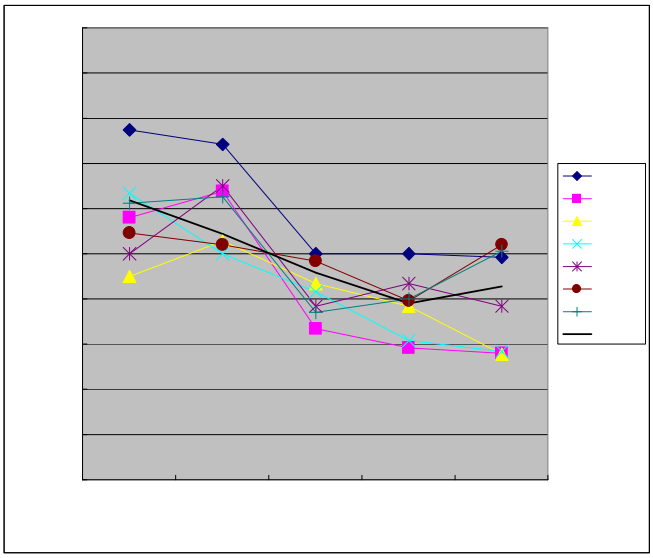


FIGURE 2
THE TREND OF GROUP I ON CHOICE PROBLEMS

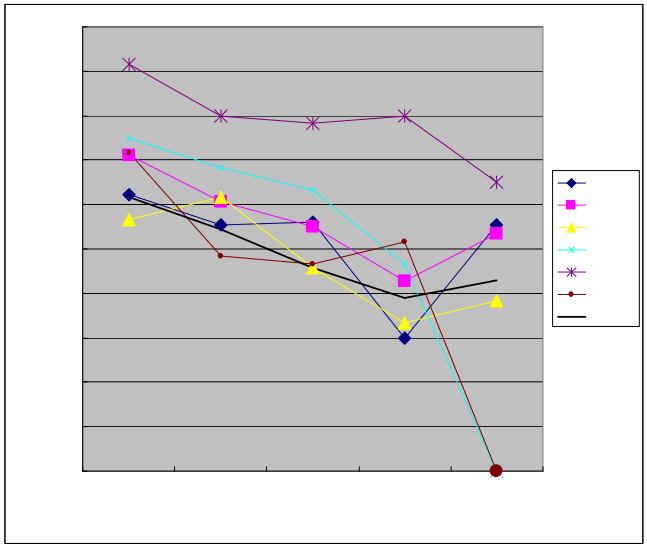


FIGURE 3
THE TREND OF GROUP II ON CHOICE PROBLEMS

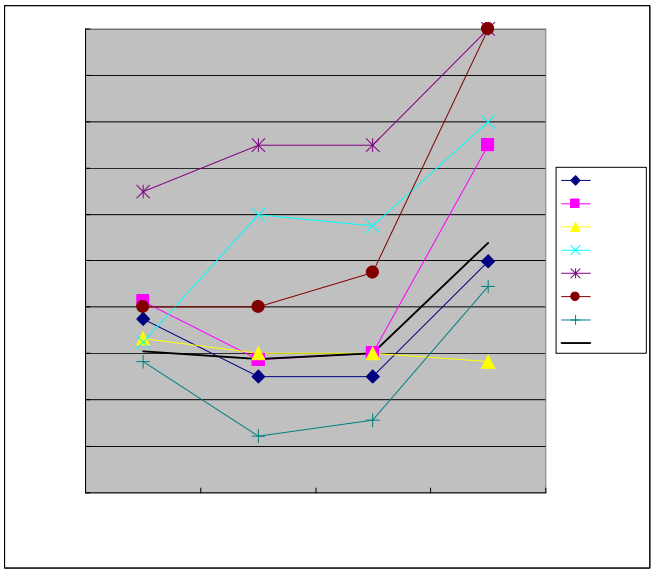


FIGURE 4
THE TREND OF GROUP I ON ANSWER QUESTIONS

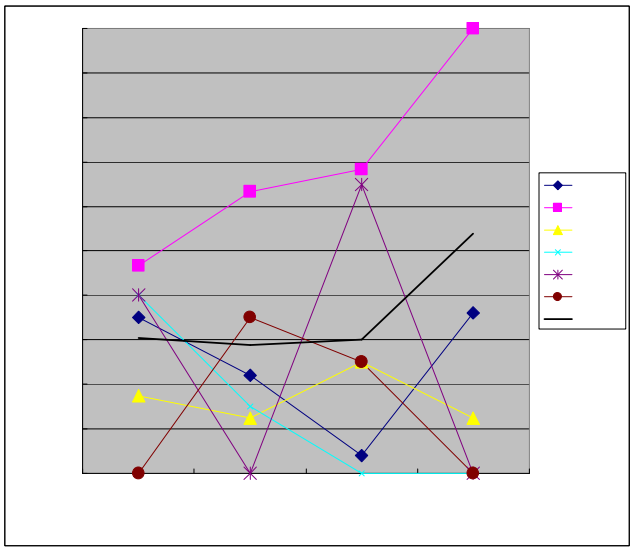
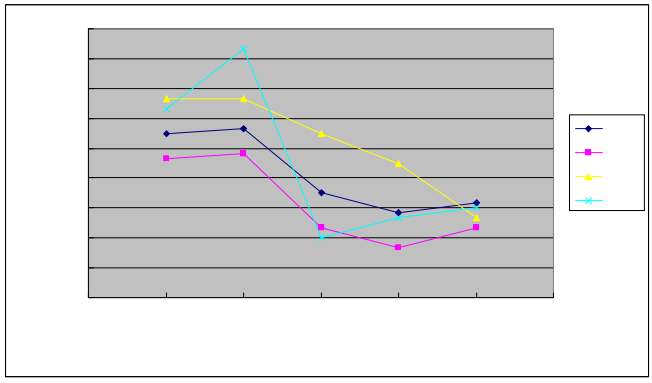


FIGURE 5
THE TREND OF GROUP II ON ANSWER QUESTIONS



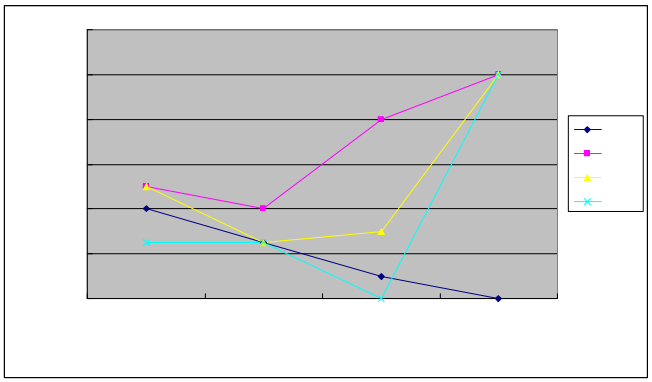
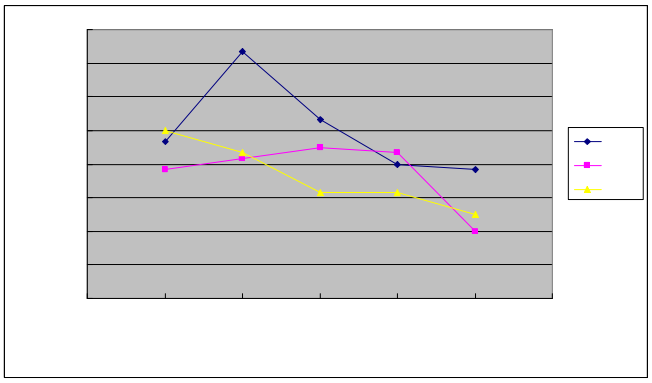


FIGURE 6
THE TREND OF COMPANY B



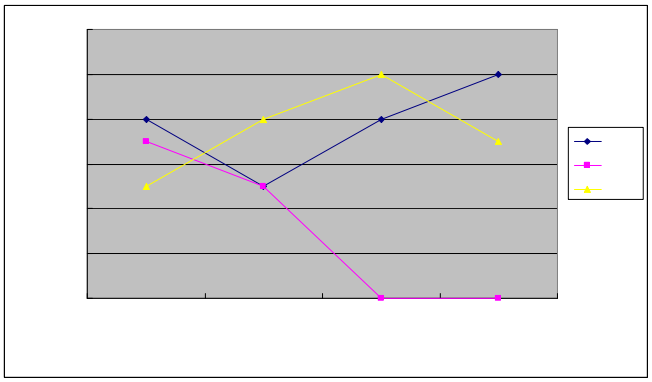
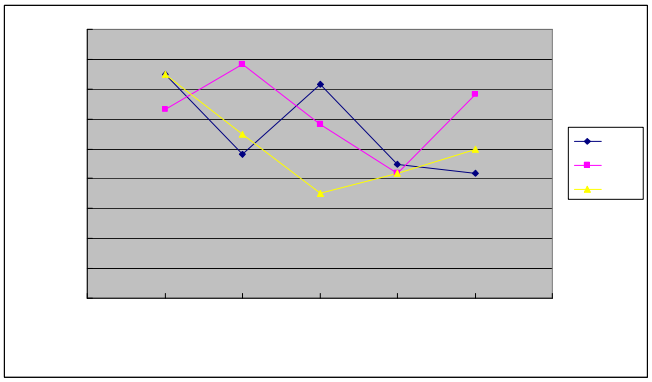


FIGURE 7
THE TREND ON COMPANY C



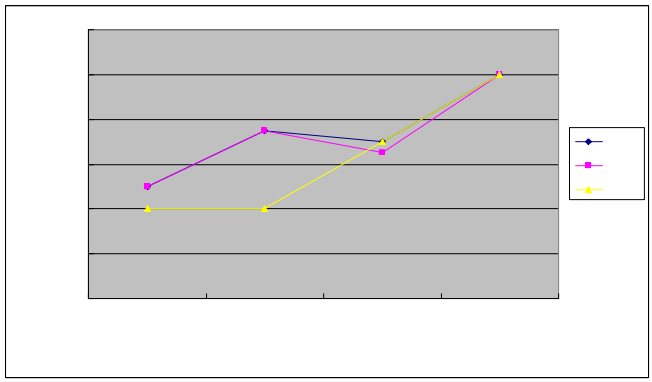


FIGURE 8
THE TREND ON COMPANY G

CONCLUSIONS

This paper provides a case study of learning assessment to improve the administration of a sandwich program. The test results of the five-stage assessment show that the intellectual skill growth of students is mostly related to the factories or companies. The growth of problem solving ability is an important index while the learning of a sandwich program is assessed. For the purpose of evaluating the students' learning achievement, the designed examination problems may base on the intellectual skills defined by the Florida assessment project system. In this article, concept, rules, problem solving, and cognitive strategy are chosen as learning assessment items. The test results coincide with the authors' anticipation.

ACKNOWLEDGEMENT

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