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Learning Style and Problem Solving in Technology Education (I)

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The present study examines the situation on fostering problem solving ability to clarify how students' learning styles affect it in Technology Education. Leaning styles are classified into three categories: "Versatile and Deep Holist Type," "Deep Serialist Type," and "Surface Type." Problem solving abilities are also classified into three structures: "Thinking Ability," "Affective Domain," and "Skills." As a result, characteristic tendency is found regarding the relation between students' learning style and their problem solving ability.
Key words : Learning Style, Problem Solving, Technology Education

1. Introduction

Technology Education is known for having great possibilities. Among them, it is shown in the previous studies that Technology Education fosters students' various abilities including creativity[1], self-educability[2], and problem solving ability[3]. It is also known that there are differences in the situation for fostering such abilities according to individual student. The differences can be considered as a result of different learning styles that students have.

The aim of this study is to clarify how students' learning styles would affect their fostering abilities, focusing on problem solving ability in Technology Education.

2. Study Method

2.1 Practicing Class

The participants of this study were 20 male and 20 female students in the third grade of a junior high school in Nagoya City. The content of the class was "Production of a Robot with Lever Crank Mechanism" in "Machines" area.

2.2 Teaching Plan

Table 1 shows the teaching plan for the total 16 class hours; the first through fourth hour: Wiring, the fifth through seventh hour: The Base of Leg Mechanism, the eighth through 12th hour: Leg Production, and the 13th to 16th hour: Modification.

Table 1 Teaching Plan in "Machines" Area.

Unit	Contents
① Let's do wiring. (1st ~ 4th) [Wiring]	·Make students work on parts arrangement and shape of a robot. ·Catch students' attention to the direction of rotation of a motor and make them decide the direction of a switch. ·Make students wire from a gear box to switch by soldering.
② Let's think about leg mechanism. (5th ~ 7th) [The Base of Leg Mechanism]	·Make students understand the movement of legs of a robot with lever crank mechanism. ·Make students understand the movement of legs using the teaching materials. ·Make students observe the relation among the length, balance, and movement of the link by demonstrating the movement of production models with various length of legs.
③ Let's make legs of a robot. (8th ~ 12th) [Leg Production]	·Decide the length of legs and the link. ·Make students cut parts off the material and machine the parts. ·Make students think about the combination of the link referring to models and handouts and make them assemble the legs. ·Explain the method of double-nuts and make students utilize them. ·Make students work on tools including a mini-wrench.
④ Let's improve the robot. (13th ~ 16th) [Modification]	·Make students find problems and modify them. ·Make students review what they learned in "Machines" area and summarize it.

2.3 Classification and Definitions of Learning Styles

According to the study of Noel. J. Entwistle[4], there are four kinds of learning styles: "Versatile Type," "Deep Holist Type," "Deep Serialist Type," and "Surface Type." These four types are defined as follows. First, "Versatile Type" learners tend to choose proper skills based on a general plan and systematize them. Second, "Deep Holist Type" learners tend to utilize general and field-dependant thinking and make the most of specific examples from their own experiences. Third, "Deep Serialis Type" learners tend to infer in an analytical and unified way, and utilize clear and field-independent thinking. Lastly, "Surface Type" learners tend to repeat the learning content mechanically.

In this study, "Versatile Type" and "Deep Holist Type" are integrated and called "Versatile and Deep Holist Type." Therefore, learning styles are classified into three types for our study: "Versatile and Deep Holist Type," "Deep Serialist Type," and "Surface Type." The summary of the definition of each learning style is shown in Table 2.

2.4 Selecting Students for Three Learning Styles

In order to select students whose learning styles are regarded as these three, the survey was carried out on their learning style before the whole class started with the same questionnaire used in the previous study[3]. In addition to that, students were selected based on the two-year observation on 40 students at the third year classroom by the technology teacher who had 15-year teaching experience. Consequently, six students were considered "Versatile and Deep Holist Type"; five students were considered "Deep Serialist Type"; nine students were considered "Surface Type."

2.5 Structure of Problem Solving Ability and Definition of Each Component

Based on the previous study[3], the structure of problem solving ability is classified into three categories: "Thinking Ability," "Affective Domain," and "Skills," and it has 10 components as the subordinate structure. As the components of "Thinking Ability," "Knowledge and Understanding," "Imagination," "Judgment," and "Analysis" are established. As the components of "Affective Domain," "Independence," "Ambition," and "Curiosity" are established. As the components of "Skills," "Planning," "Information Collection," and" Manipulation of Teaching Aids and Tools" are established.

2.6 Measurement of Problem Solving Ability

In order to measure students' problem solving ability, the questionnaire for evaluating Problem Solving Ability, which was used in the previous study[3], was utilized. It consisted of nine questions, one for each nine components mentioned above excluding one component, "Knowledge and Understanding," because it is considered difficult for the students to do self-evaluation on the component.

After every class hour, the students were asked to choose one out of four choices for each question; A: It holds sufficiently true, which is counted as 4 points; B: It holds rather true, which is counted as 3 points; C: It does not hold true to some extent, which is counted as 2 points; and D: It does not hold true completely, which is counted as 1 point. The result of the questionnaire was calculated to seek the score of problem solving ability.

The definition of each component can be referred in the previous study[3].

Table 2 Definition of Learning Style.

Type	Definition
Versatile and Deep Holist Type	·Learners have characteristics of both Versatile Type and Deep Holist Type. Versatile Type learners choose proper skills based on a general plan and systematize them. Deep Holist Type learners utilize general and field-dependant thinking and make the most of specific examples from their own experiences.
Deep Serialist Type	·Learners infer in an analytic and unified way, and utilize clear and field-independent thinking.
Surface Type	·Learners repeat the learning content mechanically.

3. Results and Considerations

3.1 Variation of Average Scores of Problem Solving Ability as a Whole

Figure 1 shows the variation of average scores of problem solving ability of three learning styles from the first through the last 16th class hour. As shown here, the average score of problem solving ability as a whole increases little by little as the class hour advances, though there is some increase and decrease depending on the content of the class.

Statistical analysis was carried out to examine if the difference of the average scores of problem solving ability between the first through the 16th class hour was statistically significant. Analysis of variance was calculated with three factors. The first factor is a leaning style, which has three levels: "Versatile and Deep Holist Type," "Deep Serialist Type," or "Surface Type." The second factor is a structure of problem solving ability, which has three levels: "Thinking Ability," "Affective Domain, " or "Skills." The third factor is time, which has 16 levels: from the first through the 16th class hour. It is a three factor mixed design. The result of the three-factor analysis of variance shows that the simple main effect of problem solving ability as a whole was significant at 1% level ($F = (2,36)\ 5.87$) and main effect of time was significant at 5% level ($F = (15, 270)\ 1.89$) . The multiple comparisons were also carried out by using LSD Method on the main effect of time.

According to this result, as one of the viewpoints, the average score of problem solving ability as a whole at the first class hour was compared with the 16th class hour according to the learning styles. The average score of the students who are "Versatile and Deep Holist Type" varies from 3.43 to 3.78; the average score of the students who are "Deep Serialist Type" varies from 3.47 to 3.56; the average score of "Surface Type" varies from 3.04 to 3.33. In short, "Versatile and Deep Holist Type," "Surface Type," and "Deep Serialist Type" are the order of higher increasing ratio.

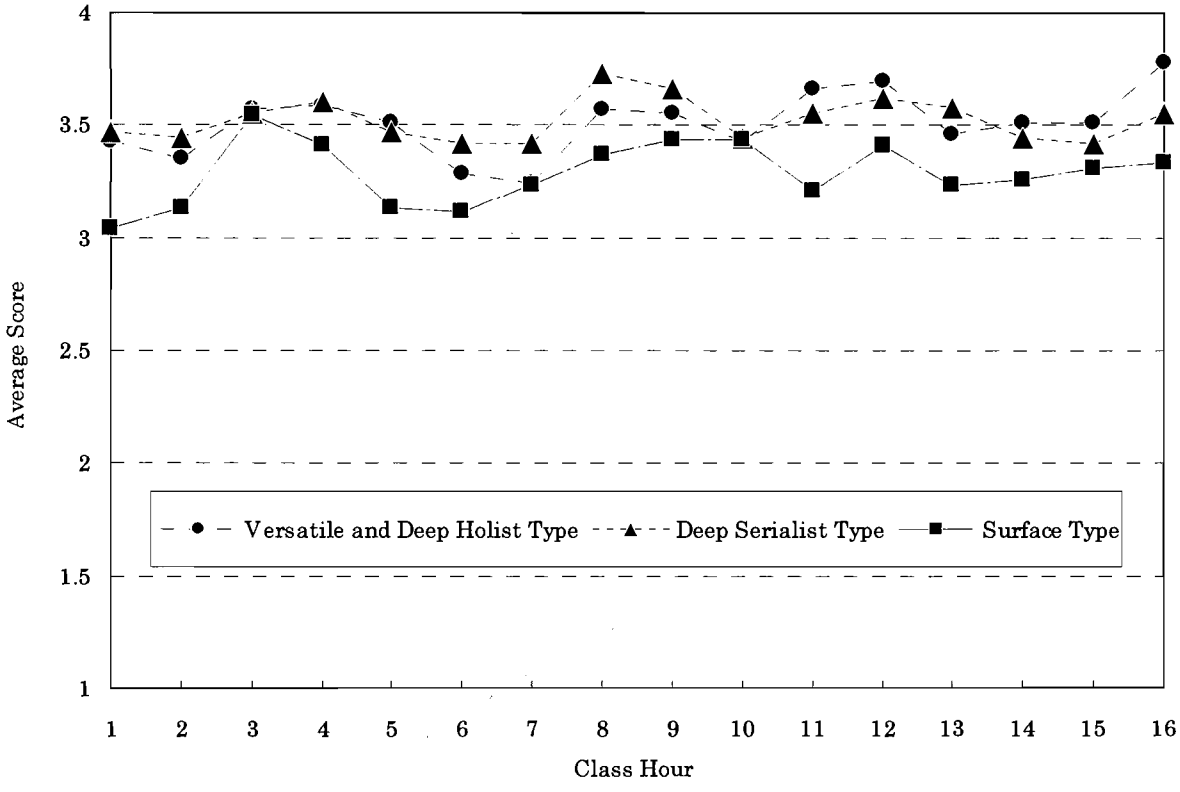

Figure 1 Variation of Average Scores of Problem Solving Ability as a Whole.

3.2 Variation of Average Scores of "Thinking Abilities"

Next, the variation of the average scores of three structures of problem solving ability was examined in order to clarify the situation for fostering it. Figure 2 shows the variation of average scores of "Thinking Ability." The average score of "Thinking Ability" at the first class hour is compared with that at the 16th class hour according to each learning style. The average score of students who are "Versatile and Deep Holist Type" increases from 3.29 to 3.78. The average score of students who are "Deep Serialist Type" is 3.33 at the both class hour. The average score of students who are "Surface Type" increases from 2.92 to 3.33. It shows that "Versatile and Deep Holist Type," "Surface Type," and "Deep Serialist Type" are the order of the higher increasing ratio. One-factor analysis of variance was carried out to examine if the difference of the average scores of "Thinking Skills" was statistically significant. The first factor is a leaning style, which has three levels: "Versatile and Deep Holist Type," "Deep Serialist Type," or "Surface Type." The second factor is time, which has two levels: the first and the 16th class hour. The result shows that the increase of "Versatile and Deep Holist Type" is significant at 1% level ($F= (1, 5)\ 8.93$) , and the increase of "Surface Type" is also significant at 5% level ($F= (1, 8)\ 19.36$) . It suggests that students' "Thinking Ability" whose learning styles are "Versatile and Deep Holist Type" or "Surface Type" is developed in the class of Technology Education.

3.3 Variation of Average Scores of "Affective Domain"

The variation of average scores of "Affective Domain" is shown in Figure 3. The average score of "Affective Domain" at the first class hour was compared with the 16th class hour according to each learning style. The average score of students who are

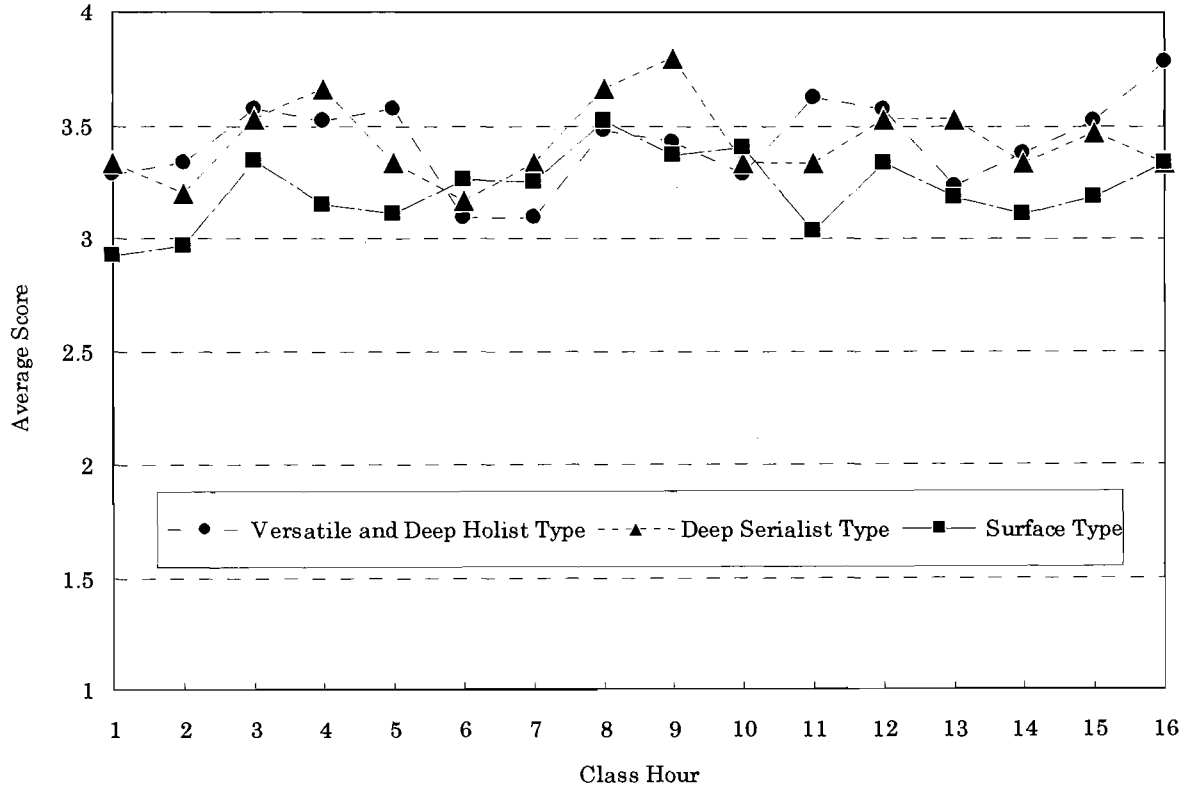

Figure 2 Variation of Average Scores of "Thinking Ability."

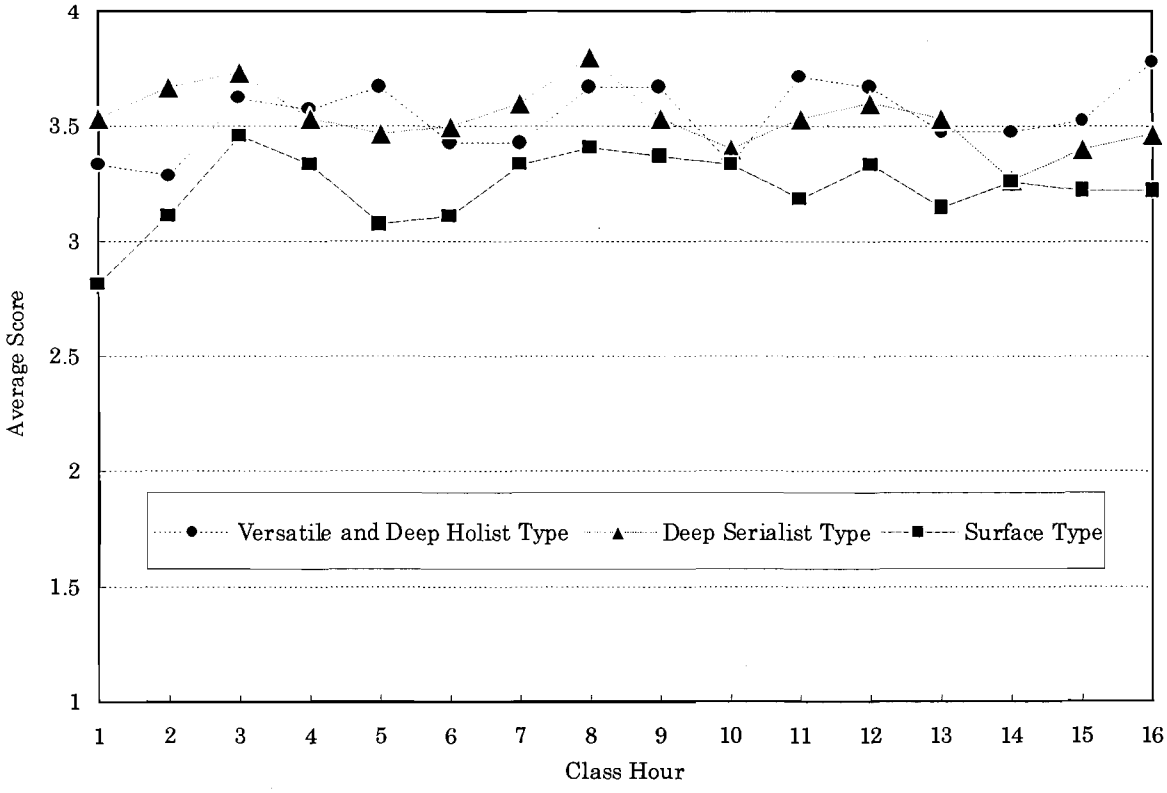

Figure 3 Variation of Average Scores of "Affective Domain."

"Versatile and Deep Holist Type" increases from 3.33 to 3.78. The average score of students who are "Deep Serialist Type" decreases from 3.53 to 3.47. The average score of students who are "Surface Type" increases from 2.82 to 3.22. It indicates that "Versatile and Deep Holist Type," "Surface Type," and "Deep Serialist Type" are the order of the higher increasing ratio. One-factor analysis of variance was conducted again to examine if the difference of the average scores of "Affective Domain" was statistically significant. The first factor and the second factors are as same as "Thinking Ability" mentioned above. The result shows that the differences of average scores of all three learning styles are not significant for "Affective Domain."

3.4 Variation of Average Scores of "Skills"

The variation of average scores of "Skills" is shown in Figure 4. The average score of "Skills" at the first class hour was compared with 16th class hour according to each learning style. The average score of students who are "Versatile and Deep Holist Type" increases from 3.67 to 3.78. The average score of students who are "Deep Serialist Type" increases from 3.53 to 3.87. The average score of students who are "Surface Type" increases from 3.37 to 3.44. It indicates that "Deep Serialist Type," "Versatile and Deep Holist Type," and "Surface Type" are the order of the higher increasing ratio. One-factor analysis of variance was also conducted to examine if the difference of the average scores of "Skills" was statistically significant. The first and the second factors are as same as "Thinking Ability" mentioned above. The result shows that the increase of "Deep Serialist Type" was significant at 5% level ($F=(1,4)$ 9.99). It suggests that students' "Skills" whose learning styles are "Deep Serialist Type" is developed in the class of Technology Education.

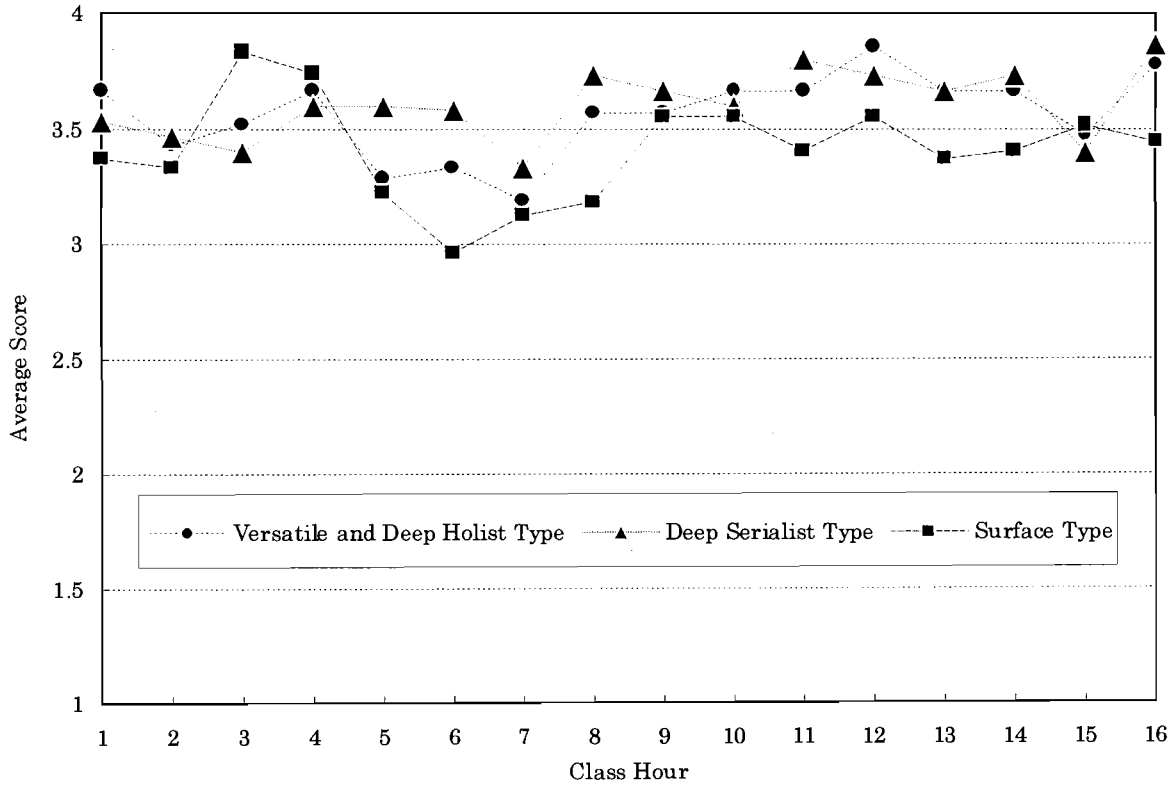

Figure 4 Variation of Average Scores of "Skills."

4. Conclusion

The situation for fostering problem solving ability as a whole and its three structures were examined in order to clarify how students' learning styles affect fostering problem solving ability in the class of Technology Education. The result shows no characteristic regarding fostering problem solving ability as a whole according to students' learning styles. However, it is found that each learning style develops the specific structure of problem solving ability. "Thinking Ability" of the students whose learning styles are "Versatile and Deep Holist Type" or "Surface Type" is developed, while "Skills" of the students whose learning styles are "Deep Serialist Type" is developed.

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