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View Variation and their Effect on Student Solution to Transformation Problems — Part 2, On the Effect of Right Side View

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Abstract. By an experimental method the authors determined in which way different view combinations influence the students' understanding of multiview projection drawings. The students had to produce an isometric projection view drawing from a set of displayed orthographic views. The effect of view variation was examined for three combinations of orthographic views: Front and Top view; Front, Top, and Right Side view; and Top and Right Side view presentation. The instrument selected for this experiment was a CAI (Computer Aided Instruction) system that the authors developed for instruction in graphic transformation problems. The means of time-on-task and the correct response rate (CRR) confirmed the apparent preference of Front and Top view pairing by students.

1 Introduction

Graphics instructors and teachers have many experiences of student response to the generation of solutions for multiview projection problems. Considering these experiences, it appears that the individuals partially observe all views of to understand a multiview projection drawing. However, this proposition has not been examined thoroughly by any experimental method. The authors have investigated this proposition by an experimental method, that is, to determine the effect of various orthographic view combination on the understanding multiview projection drawings. The effect of view pairing presentation on student solutions to transformation problems has been described in a previous paper [1]. The authors have found that

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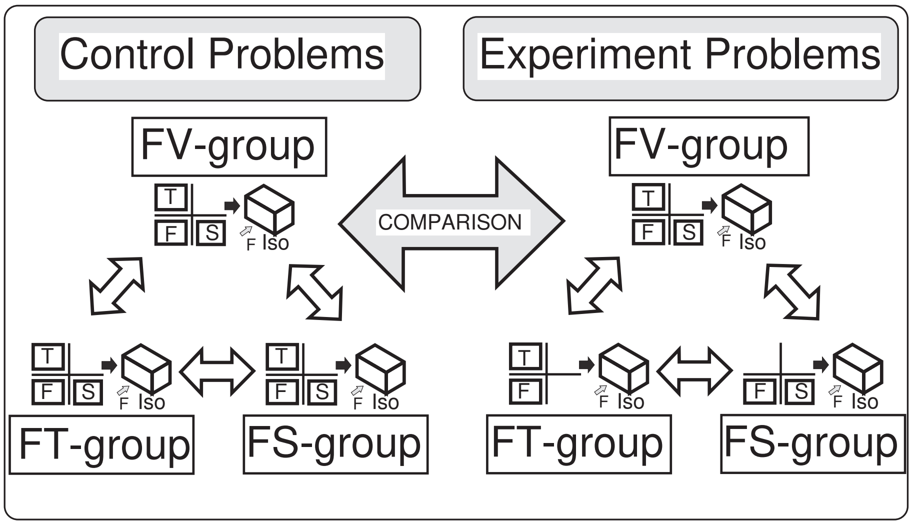

Figure 1: Outline of this experiment

student solution to problems where Front and Top view pair is presented have a shorter time-on-task (TOT) for solution than for Front and Right Side view combinations problems. This paper is continuation of that research.

Fig. 1 shows an outline of the experiment method. In this experiment, the subjects were requested to draw an isometric projection view from one of three possible sets of orthographic view representations. Considering the data of obtained on each subject's performance for a set of problems, the relative importance of each view set was determined. Two kinds of problems were prepared: control and experimental.

The control problems were used to compare the three group's ability levels using a common set of Front, Top, Right Side view problems that were displayed on the CRT in a CAI environment. The experimental problems were used for evaluation that were different for each of the three groups. Each of the experimental groups were requested to draw the same isometric view from given one of the three sets of orthographic view representations. The data of each group's performance for control and experimental problems was collected and compared. The mean of time-on-task for each solution and correct response rate for solutions were used as metrics for evaluation and comparison. Using this data, the importance of each view (Front, Top, and Right Side) was examined to determine the effect on the student's understanding of orthographic projection.

2 Methodology

The measurement system for this experiment was a CAI (Computer Aided Instruction) system that the authors have developed for the instruction of graphic transformation problems [2]. Data for each subject's performance was collected by this CAI system and stored in a database. The subjects were first year undergraduate engineering students who had received basic instruction in descriptive geometry. The subjects were divided into three groups and each group was given a different representation of a multiview projection.

Fig. 2 shows representations of the control and experimental problems that three groups had answered. The FT-group were given Front and Top view of solid shape on experimental problems, the FS-groups were given Front and Right Side view, and the FV-group were given

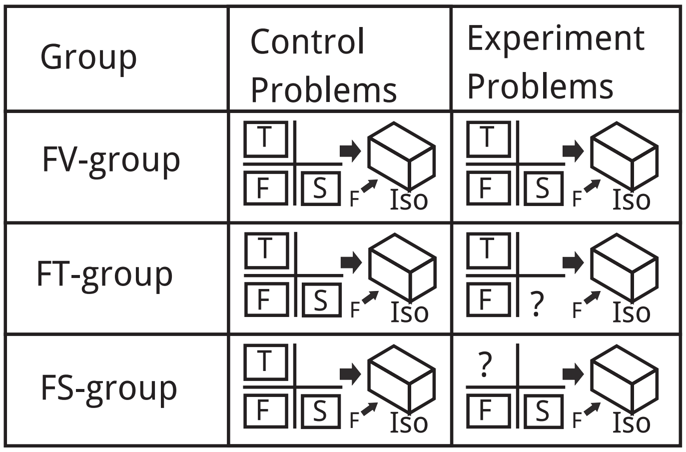

Figure 2: View representation for three groups

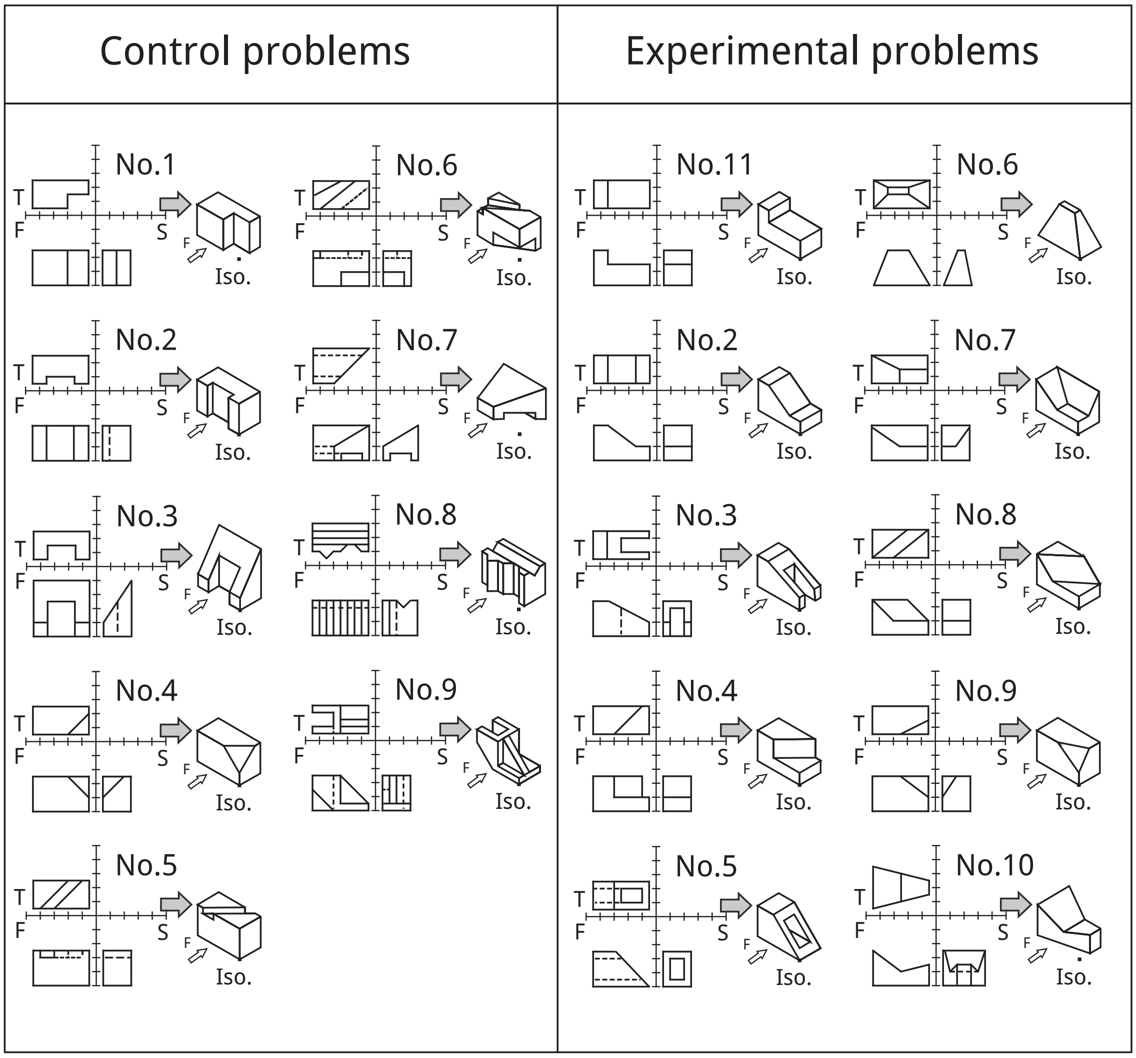

Figure 3: Control and experimental problems

three views, Front and Top and Right Side views. For the control problems the three groups were given identical common representations of a solid shape consisting of the Top, Front, and Right Side views. Fig. 3 shows examples of the control and experimental problems. The subjects were instructed on how to use CAI system before they solved the control and experimental problems and they had received identical instruction on solving transformation problems.

3 Results

3.1 Comparison on the Control Problems

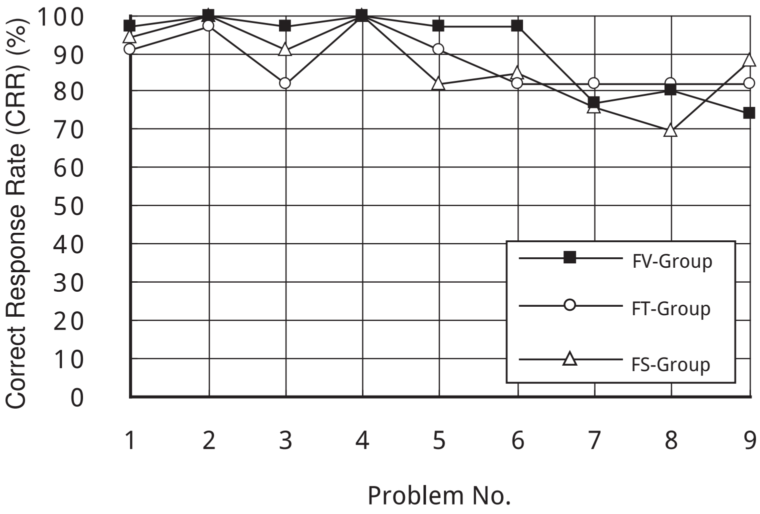

Figure 4: Correct response rate on control problems

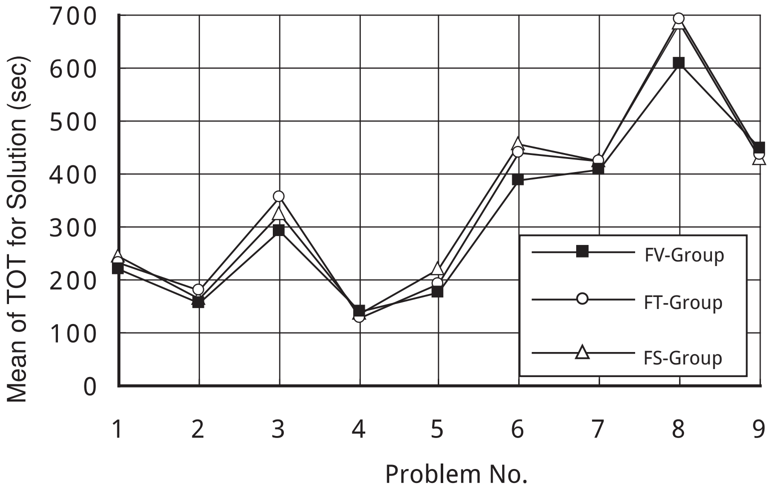

Figure 5: Mean of TOT (time on task) on control problems

Fig. 4 shows each group's correct response rate (CRR) on the control problems. Fig. 5 shows each group's mean TOT (Time-on-task) for the solution on the control problems. Considering Fig. 4, the difference between each group's correct response rate (CRR) is not clear. Considering Fig. 5, the difference between each group's mean time-on-task (TOT) for the solutions is not clear. Therefore, an average of CRR and TOT mean for all control problems were calculated and shown. Table 1 shows the average of correct response rate (CRR) and the average of mean of time-on-task(TOT) for each group. The FT-group's value is 88% and the FS-group's value is 87%. This data shows that both groups are performing at approximately the same level. FV-group's value is 91% and is somewhat higher than other two groups. For the average of mean of time-on-task for solutions, the value of FT and FS groups are 341 seconds. These values show that the FT-group's performance level is approximately the same as the FS-group's. The FV-group's value is 314 seconds and performed the faster set of solution than the other groups.

	FV-Group	FT-Group	FS-Group
CRR	91 %	88 %	87 %
TOT	314 sec	341 sec	341 sec

Table 1: Average of CRR (correct response rate) and mean of TOT on control problems

3.2 Comparison on the Experimental Problems

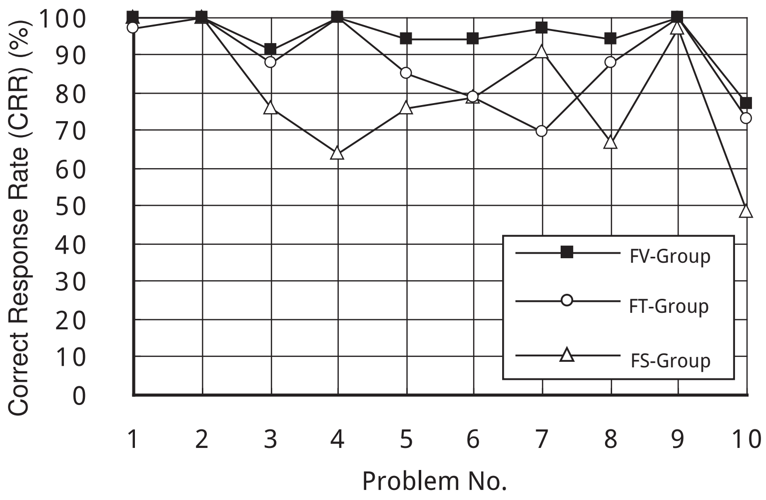

Figure 6: Correct response rate on experimental problems

Fig. 6 shows each group's the correct response rate (CRR) on the experimental problems and Fig. 7 shows each group's mean of TOT(Time-on-task) for solution on the experimental problems. For the correct response rate, FV-group's value is higher than other group's values. FT-group's value is higher than FS-group's values. The FV-group's value on the TOT mean is less than the other group's and FT-group's one is less than the FS-group's. In order to clarify this relationship, an average of CRR and TOT mean values for all experimental problems were calculated and are shown Table 2. For the average CRR value, the FV-group's value is 95%, the FT-group's value is 88%, and the FS-group's value is 80%. If the array of these three group's values is put into order, it is FV-group, FT-group and FS-group. For the average of

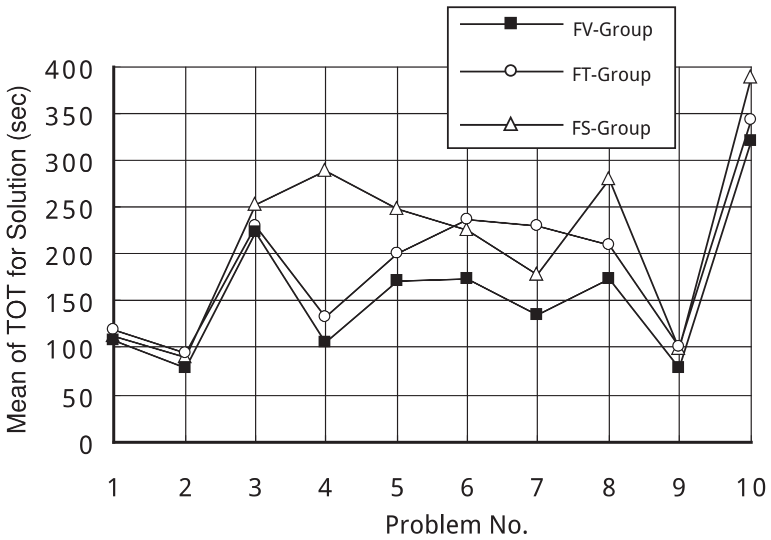

Figure 7: Mean of TOT on experimental problems

TOT mean, the FV-group's value is 157 seconds, the FT-group's value is 190 seconds, and the FS-group's value is 216 seconds. If the array of these three group's values is put into order, it is FV-group, FT-group and FS-group.

	FV-Group	FT-Group	FS-Group
CRR	95 %	88 %	80 %
TOT	157sec	190 sec	216 sec

Table 2: Average of CRR and mean of TOT on experimental problems

The authors have defined that the value of CRR and TOT mean are factors for the evaluation of the difficulty in understanding of each view. Therefore, the representation of full views is, as one would suspect, the easiest of the three kinds of representations to interpret for multiview projection and the Front and Top view pairing is more easily understood than the Front and Right Side view paring.

3.3 The Difference between Control and Experimental Problems

	FV-Group	FT-Group	FS-Group
CRR	4 %	0 %	-7 %
TOT	157 sec	151 sec	125 sec

Table 3: Difference of the averages of CRR and TOT mean between control and experimental problems

Table 3 shows the difference of CRR and TOT mean average between control and experimental problems. The difference of the CRR for the FT group's value is 0%, the FS group's value is minus 7% and FV group's value is plus 4%. FT-group's value is 7% up from the FS-group's value and the FV-group's value is 4% up from FT-group's value. On difference of TOT, FT-group's value is 151 seconds, FS-group's value is 125 seconds and FV-group's value is 157 seconds. FT-group's value is 26 seconds up from FS-group's one and FV-group's value is 6 seconds up from FT-group's one. This data shows that a difference between the FT-group and the FV-group is less than the one between the FT-group and the FS-group. From this data, the authors conclude that a representation of Front and Top views pairing is more easily understood by students than Front and Right Side views pairing.

4 Conclusions

This study was concerned with the relative importance of views (Front and Top and Right Side views) for engineering graphic problems that require students to draw an isometric projection from an object's multiview orthographic projection. This relationship was evaluated by examining the effect of three representations of view combination (Front, Top, Right Side; Front, Top; and Front, Right Side) on student solutions. The authors were able to confirm the previous paper's finding that the representation of Front and Top view pairing is more easy understood by students than Front and Right Side view pairing for solving multiview projection to isometric view problems. The representation of full views (Front and Top and Right Side views) was compared with two other view pairings.

Considering data collected in the experiment, the authors were able to conclude that the representation of full views aided in the student understanding of multiview projection and that the full views' representation did not differ significantly from the Front and Top view pairing representation. These results also support the assertion that the Right Side view is not more important for the understanding of multiview projection than the Front and Top views.

There are two additional factors related to multiview understanding: One is the effect of front direction for the object. Another is the effect of characteristic object. However there are several difficult problems for measuring to above factor. The front direction for any object is generally decided by experimental knowledge. The selection of front direction is based on that individuals can be easy understanding multiview projection. The problem sets used this experiment was well considered at removing the effect of varying front direction. Front direction and characteristic object are the themes that should be examined in the future.

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