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Colloquium

Effect of the interaction of instructional delivery model and preference of learning environment on students' attitudes

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Introduction

While previous studies and meta analyses have primarily focused on the comparative efficacy of computer-assisted instruction (CAI) versus traditional instruction (Chang, 2001a, b; Kulik & Kulik, 1986, 1991), there have been rather fewer examples of research exploring whether the effects of different instructional delivery models of CAI on tenth graders' attitudes towards science were influenced by the students' preferences of learning environment. In this research project, this issue is addressed and investigated in a senior high school in Taiwan.

Methods

The sample group was composed of 347 tenth graders (180 girls and 167 boys) attending eight Earth science classes from the fourth year of secondary education. Each of the eight groups was randomly assigned to either one of the following instructional delivery models of CAI: the teacher-centred model and the student-centred model.

The students' preferences of learning environment were measured by a Chinese version of the Constructivist Learning Environment Survey (CLES), originally developed by Taylor and Fraser (1991). The scores for every student's responses on the student-centredness scale in preferred forms of CLES were used as indicators to display their preferences of constructivist learning environments; hence, every student had different scores to show their preferences towards such environments. The students participating in this study were pretested using CLES and were categorised as either less constructivist-oriented or more constructivist-oriented, based on their average scores on the student-centredness scale.

The dependent variable, students' attitudes towards science, was acquired through the use of the *Attitudes toward Earth Science Inventory* (ATESI) (Chang & Mao, 1999), which

consists of 30 items intended to investigate student attitudes towards Earth science. The ATESI was administered to the participating students before and after the interventional experience in the present study.

A 2 × 2 (Treatment × Preference) analysis of covariance (ANCOVA) was conducted on the posttest measures, with the students' pretreatment measure as the covariate, to detect any significant differences or interactions between the groups and/or student preferences. A level of confidence was set at a 0.05 level of significance.

Findings

The F ratio for the 2 × 2 univariate ANCOVA on the posttest scores with the students' pretest scores as the covariate indicates that there were no significant main effects for the treatment or student preferences of learning environment, $F\ (1,342) = 2.490$, $p = 0.115$, $\eta^2 = 0.007$, $f = 0.08$ for the treatment and $F\ (1,342) = 1.728$, $p = 0.190$, $\eta^2 = 0.005$, $f = 0.07$ for the preferences, as shown in the third and fourth rows of Table 1. However, there was a statistically significant interaction between the treatment and student preferences of learning environment, $F\ (1,342) = 4.199$, $p = 0.041$, $\eta^2 = 0.012$, $f = 0.11$, as shown in the fifth row of Table 1. According to Cohen's rough characterisation (1988, p. 284–288), $f = 0.1$ is deemed as a small effect size.

Table 2 summarises the means and standard deviations (*SD*s) of posttest scores by the breakdown of treatment groups by student preferences. The data showed that less constructivist-oriented students receiving teacher-centred instructional delivery model (mean = 108.3, *SD* = 9.0) had a more positive attitude towards Earth science than did those with the same orientation in the student-centred model (mean = 104.6, *SD* = 8.8). It was also found that more constructivist-oriented students receiving the student-centred model (mean = 108.0, *SD* = 8.9) had better attitudes towards Earth science than did those with the same orientation taught by the teacher-centred instruc-

Table 1: Effects of instructional delivery models of computer-assisted instruction and preferences of learning environment on students' attitudes towards Earth science

	2 × 2 univariate analysis of covariance						
Source	*degrees of freedom*	*Sum of squares*	*Mean square*	*F (1,342)*	*Significance of F*	*eta square (η^2)*	*f (effect size index)*
Treatment	1	194.944	194.944	2.490	0.115	0.007	0.08
Preference	1	135.258	135.258	1.728	0.190	0.005	0.07
Interaction	1	328.698	328.698	4.199*	0.041	0.012	0.11
Within groups	342	26 770.059	78.275				
Total	347	4 051 933.000					

*$p < 0.05$

Table 2: Summary of means and standard deviations of treatment groups by student preferences of learning environment

	Treatment			
	Teacher-centred model		*Student-centred model*	
Preference	*Mean*	*SD*	*Mean*	*SD*
Less constructivist-oriented	108.3	9.0	104.6	8.8
More constructivist-oriented	107.4	8.9	108.0	8.9

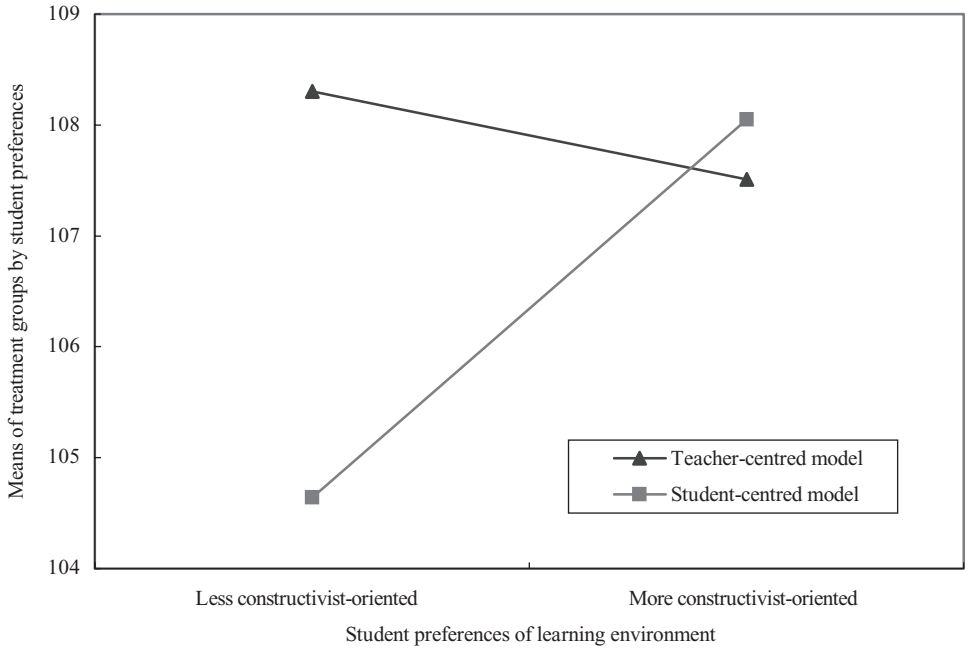

Figure 1: Relationship of the interaction of the instructional delivery model and preference of learning environment with students' attitudes towards Earth science

tional approach (mean = 107.4, *SD* = 8.9). Besides, when the treatments matched the students' preferences of learning environment, students seemed to develop better attitudes towards the subject, and the reverse was also held true in the mismatched situation.

The observed interaction between student preferences of learning environment and treatment is best illustrated in Figure 1. Clearly, the less constructivist-oriented students receiving the teacher-centred strategies appeared to increase in more positive attitudes compared with those students taught by student-centred instruction, while the more

constructivist-oriented individuals seemed to benefit more from the student-centred approach in comparison with students learning from the teacher-centred condition. Here, we also find that the differences between the treatments seem to be greater for the less constructivist-oriented individuals and lesser for the more constructivist-oriented students.

Discussion

The findings suggest that constructivist-minded students rated the subject they had studied more positively if they were in a student-centred learning experience; and non-constructivists rated the subject less favourably if they had been in a student-centred learning situation. Accordingly, expository-oriented students seemed to develop better attitudes to the subject they had studied if they were in a teacher-centred learning environment; and non-expository-oriented students judged the subject less positively if they had been in a teacher-centred learning situation. The findings of this study also revealed that more attention should be paid to the interaction of students and learning environments, be it computer-based or not, and that the mere introduction of a constructivist-oriented software/instruction does not necessarily guarantee that all students will benefit from it. Future replication studies conducted in this research area might be needed to further substantiate the findings.

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