

The Impact of Learning-Teaching Applications Based on Questioning Upon Students' Critical Thinking Dispositions and Levels

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Abstract: The present study aims to determine the impact of different applications that use questions in instruction process upon students' critical thinking dispositions and levels. The study employed the pre-test-post-test control group experimental design. The study group consisted of a total of 79 junior students studying in the department of Social Studies Teacher Training in the Faculty of Education at Ahi Evran University, of whom 33 were female and 46 were male students. The study data were collected from the target groups using the California Critical Thinking Disposition Inventory (CCTDI). The inventory consisted of a total of 6 sub-scales and 51 items and has a Cronbach alpha internal consistency coefficient of 0.88. The data were subjected to frequency, percentage, arithmetic mean, t-test and ANOVA analyses. At the end of the study, it was established that four different instructional applications that used questions positively contributed to the students' critical thinking dispositions and levels. Nevertheless, the greatest contribution was achieved with the instructional application based on student questions, which was followed by instruction based on teacher questions and blended instructional application, respectively. The smaller contribution to the students' critical thinking dispositions and levels was made by the traditional instructional approach. Blended instructional application contributed more to the students' critical thinking dispositions and levels, when compared to the traditional instructional application in the sub-dimension of open-mindedness. When, the total scores were considered, instruction based on student questions contributed significantly more than the traditional method.

Key words: Student questions, teacher questions, questioning, critical thinking, learning, teaching

INTRODUCTION

Modern developments in education science generally focus on the more functional use of brain through active thinking. One of the most valued ways of thinking is surely critical thinking (Wang, 2005; Sahinel, 2005).

Critical thinking could be defined as an active, organized and functional process performed to employ more effectively one's ability to understand and present both his/her and others' thoughts and ideas (Chaffee, 1994; Kokdemir, 2003). For Facione, critical thinking is the process of purposeful, self-regulatory judgment, which results in interpretation, analysis, evaluation and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon, which that judgment is based (Ozdemir, 2005).

Among the skills included in the process of critical thinking are the ability to distinguish between proved facts and proposed arguments; to test the reliability of references for the obtained information; to sort out

irrelevant information from the evidence; awareness of one's biases and cognitive errors; the ability to discern inconsistent judgments; to pose effective questions; to efficiently use verbal and written language and metacognition through, which one becomes aware of his/her own ideas etc. Thus, critical thinking can be evaluated as a reflection of the basic skills of analyticity, open-mindedness, inquisitiveness, self-confidence, truth-seeking and systematicity in a holistic sense (Kokdemir, 2000). Kokdemir (2003) defines these basic skills as in the following:

Analyticity: It is the skill of being alert to potential problem areas and the use of reasoning and objective evidence even in the face of difficult problems.

Open-mindedness: It refers to one's tolerance towards different ideas and sensitivity towards one's own mistakes. The basic assumption in open-mindedness is that an individual takes into consideration the opinions and ideas of others as well as his/her own ideas.

Inquisitiveness: It refers to an individual's disposition to be informed and learn new things without expecting any self-interest.

Self-confidence: It refers to the trust one places in one's own reasoning process.

Truth-seeking: It refers to the inclination to evaluate alternative ideas to solve a particular problem.

Systematicity: It refers to the disposition to being organized, orderly, focused and diligent in inquiry. It could also be expressed as the disposition to employ a decision-making strategy based on knowledge and following a certain procedure, rather than an impulsive reasoning behaviour.

Helping students acquire or improve this way of critical thinking that includes these attributes and sub-dimensions are considered among the most valued objectives of modern educational understanding and applications (Sahinel, 2005; Sanders and Wiseman, 1994). It is argued that different strategies and methods could be pursued in the instruction process to attain this goal. These methods and applications are proposed to include assigning researches-surveys, projects, having discussions, textual analyses and homework (Acikgoz, 2004; Sahinel, 2005; Kotzin, 2001; Eisenberg, 2005; Musselman, 2004; Wang, 2005). Questions constitute one of the instruments recommended for use to improve the skills of critical thinking and questioning (Drake and Brown, 2003; Thacker, 2007; Acikgoz, 2004; Kucukahmet, 1997; Kauchak and Eggen, 2003; Lombardi and Savage, 1994).

Drake (1997) suggests that the thinking process resulting in questions also includes critical thinking. With thinking, individuals are expected to arrive at generalizations, values and approaches to solve a problem and to discover the relationships between them. Berci and Griffith (2005) argue that since, the preliminary studies on classroom behavior in 1912, the questioning activities of teachers have been considered as an unchanging basic behavior. Since then, the idea that questioning activates thinking has been one of the basic points of emphasis in the research. Nevertheless, these studies usually focus on questioning strategies, while only a few studies have considered questioning as one of the basic aspects of instruction.

As Mitchell (2000) states, many scholars maintain that students can become thinking, productive individuals and participators in social life by questioning social and historical problems. Postman (1979) argues that all the

information possessed by humans is a product of their questions or attempts to question, one of the most significant mental instruments. Questioning is regarded as a method that triggers thinking. Thinking begins when questions are asked about a particular subject. Asking questions is of considerable importance in learning scientific thinking (Ozden, 2005; Wang, 2005). Furthermore, questioning is also considered among the essential factors that improve research skills to have access to information (Tyner, 1996).

On the other hand, experiences suggest that asking and answering questions occupies a crucial place among the skills required to build a questioning society (Filiz, 2002). As a matter of fact, questions are now regarded as one of the indispensable instruments of active learning applications. One of the most important reasons behind this is surely activation of a student's mind through appropriate questions. Complex mental processes are believed to take place as soon as the mind starts to think actively (Acikgoz, 2004; Wang, 2005).

VanSledright (2002) designed an instructional environment based on asking questions and questioning in a target group of fifth-grade students and demonstrated that this type of instruction both motivates students and improves their critical thinking skills. The researcher asserts that, by asking questions and participating in questioning, students started to become self-centered learners and they also sought to interpret and comprehend events, rather than memorizing them and to construct information using alternative perspectives, which they enjoyed a lot.

For Wang (2005), the ability to ask questions and use questions for instructional purposes is an ability that should definitely be improved in teachers. Thus, students can think at a higher order and improve their critical thinking abilities.

Nevertheless, it is not possible to improve students' questioning skills only by examining the current practices about activities on asking and answering questions (Berci and Griffith, 2005). Therefore, there is a need to implement different instructional applications and to examine their effectiveness on critical thinking skills. As a matter of fact, Humprey *et al.* (2005) argue that educators and researchers have not yet arrived at a common strategy to improve students' information on and skills of critical thinking and thus, studies are still/should be conducted on the subject.

The present study was carried out to contribute to the available studies conducted to improve students' information on and skills of critical thinking. In this context, drawing upon the relationship between students'

critical thinking skills and questioning abilities, the main problem of the study was to determine the contribution of learning and teaching practices based on asking questions to students' critical thinking dispositions and levels.

Sub-problems: Under main problem in question, this study mainly sought answers to the following questions:

- How are students' critical thinking dispositions and levels affected by instruction based on student questions, instruction based on teacher questions, blended instruction and traditional instructional applications?
- Are there any differences among the contributions of instruction based on student questions, instruction based on teacher questions, blended instruction and traditional instructional applications to students' critical thinking dispositions and levels?

MATERIALS AND METHODS

The study employed the pre-test-post-test control group experimental design.

Study group: The study group consists of the junior students studying in department of Social Studies Teacher Training in the Faculty of Education at Ahi Evran University, who took the course Assessment and Evaluation. They included a total of 79 students studying in four different groups, of whom 33 were female and 46 were male. Table 1 shows, the distribution of these students in terms of gender and groups. The experiment or control groups were randomly assigned.

Experimental procedures

Stages of the research process: During the research, the procedures and their contents used to construct the experimental design and to conduct the study could be summarized as follows:

Stage 1: Random assignment of groups (designation).

Stage 2: Administration of the Critical Thinking Disposition Inventory to the groups as a pre-test.

Stage 3: Instruction for 5 weeks using for different groups different instructional applications based on questions as explained.

Stage 4: Re-administration of the Critical Thinking Disposition Inventory to the groups as a post-test.

Table 1: Study group

Groups	Female	Male	Total
1 Experiment group	7	13	20
2 Experiment group	7	12	19
3 Experiment group	8	11	19
Control group	11	9	20
Total	33	45	78

Stage 5: Transferring the data to the SPSS for analysis and performance of analytical procedures.

Formation of the experiment

Groups and experimental procedures: The experiment groups formed and studies conducted for each group during the research process could be summarized as in the following:

Experiment group 1: The group receiving instruction based on student questions.

Prior to the application, this group was informed about the instruction process to be followed. In this context, the students were told that instruction would be based on the instructor's (researcher) answers to the questions they would themselves prepare beforehand and bring to the class. Particular emphasis was laid on the fact that no explanation would be provided on the subject by the instructor unless they ask questions. Furthermore, the students were motivated for the application by providing them with explanations about their possible acquisitions if they prepare questions and bring to class. What is more, a preliminary application was performed for a week (three class hours) prior to the application process, as a result of which, explanations could be offered about the problematic aspects and expectations and necessary precautions were taken.

During the application process (5 weeks) the students were informed 1 week beforehand about which, subjects would be covered within the next 3 h and were asked to prepare and bring questions to the class. During the application period, the classes were taught only through answers to student questions and no other explanation was provided. Furthermore, the students were asked to write their questions with their credentials on a piece of paper to be handed down to the instructor each week at the end of 3 h (150 min) session. At the end of each 3 h session, along with the questions they prepared beforehand, the students were also asked to prepare three questions for each subject treated that day and these questions were also handed down to the instructor. Thus, the students were encouraged to prepare (produce) questions.

Experiment group 2: The group receiving instruction based on teacher questions.

Prior to the application, this group received information about the instruction process to be followed. In this context, the students were told that instruction would be based on the questions prepared beforehand about each subject by the instructor, about which student opinions would be taken and which would be answered by the instructor. The students were asked to write down as many questions as they could and to establish links with the question, while they listen to the explanations. The possible contributions of the application to students' learning were explained and the students were sought to be motivated for the application.

Moreover, in order to make the students use questions as an instrument of organizing information, this group was asked to write down at the end of each session three of the questions that can organize what they have understood and to hand in to the instructor.

In this context, the instructor asked the students the following questions concerning the first unit (1st week, 3 h):

- What occurs to you when one speaks of the term assessment?
- What is assessment?
- Why is assessment needed?
- What procedures are followed in the assessment process?
- What do the concepts of "measurement, rule of measurement, unit, zero mean?"
- What are the types of measurement and in which, aspects to they differ from each other?
- What kind of measurements are made in daily life and in the education process?
- Why is the measurement process important for education and at which stages of instruction is measurement performed?

Experiment group 3: Blended Method: The group receiving instruction based on teacher and student questions.

Prior to the application, this group received information about the instruction process to be followed. In this context, the students were told that the instructor would ask questions and ask for answers about each subject in the instruction process and similarly, they themselves could ask questions to the instructor. To benefit from the application most effectively, they were told that they should try to answer the questions they would be asked and they could also ask as many questions as they wished about the subjects they could not comprehend or they were curious about. Furthermore,

the students were motivated for the application by providing them with explanations about their possible acquisitions if they acted in line with the provided explanations.

Moreover, the students were asked to write down the questions asked by the instructor or their classmates as best as they could and to establish links with the question, while they listen to the explanations. During the instruction process, the instructor first sought to answer student questions and he himself asked them questions in case they did not have any.

Control group: This group was also provided with information about the instruction process to be followed, as was the case in the experiment groups. In this context, the students were told that instruction would be largely based on lecturing throughout the class hour and were asked to take notes about the explanations provided. During the application, the subjects were taught by the instructor and at the end of each class hour, feedback was obtained about the students' learning levels about the subjects and additional explanations and examples were offered for further clarification.

In accordance with the above explanations, the design used in the study is summarized in Table 2.

Data collection instrument: The study data were collected from the target groups using the California Critical Thinking Disposition Inventory (CCTDI). This inventory was developed as a result of the Delphi project sponsored by the American Philosophical Association in 1990. Rather than measuring a particular skill, the CCTDI is used to assess an individual's critical thinking disposition, or speaking broadly, his/her critical thinking level. The CCTDI total score can also be used to assess the validity of training programs developed to improve people's critical thinking dispositions and/or skills (Kokdemir, 2003).

Originally written in English, the inventory was translated into Turkish and was subjected to the required validity and reliability analysis by Kokdemir (2003). Composed of a total of six subscales and 51 items, the new version of the inventory had an internal consistency coefficient (alpha) of 0.88. The total variance explained by the inventory was found to be 36.13%. The internal consistency coefficients (Cronbach alpha) for each dimension were as follows: 0.75 for Analyticity Subscale and Open-Mindedness Subscale; 0.78 for Inquisitiveness Subscale; 0.77 for Self-Confidence Subscale; 0.61 for Truth-Seeking Subscale and 0.63 for Systematicity Subscale (Kokdemir, 2003).

Table 2: Experimental design

Experimental process	Experiment group 1	Experiment group 2	Experiment group 3	Control group
Critical thinking dispositions and levels pre-test	X	X	X	X
Instruction based on student questions	X	-	-	-
Instruction based on teacher questions	-	X	-	-
Blended instruction	-	-	X	-
Traditional I instruction	-	-	-	X
Critical thinking dispositions and levels post-test	X	X	X	X

Data analysis: Within the framework of the sub-problems of the study, the collected data were mainly subjected to the following analyses:

- Percentage analysis to determine the percentage of students with low, medium and high critical thinking scores
- Arithmetic means and group standard deviations to determine the students' critical thinking dispositions and levels
- T-test to test the significance of the difference between the pre-test and post-test scores of the students in each group on their critical thinking dispositions and levels
- One-way Variance Analysis (ANOVA) to identify the source of the difference among the critical thinking sub-dimensions according to groups
- Scheffe test to determine the source of the significant difference obtained as a result of the variance analysis

On the other hand, the significance level of $p < 0.05$ was deemed as sufficient when determining the significance level of the contribution of each instruction application to the students' critical thinking levels within and among groups.

In data analysis, the responses to the six-point Likert type scale were added to calculate the raw scores for each subscale.

The calculated raw scores were divided by the number of questions and the result was multiplied by 10 and was then converted to the standard score with a minimum value of 6 and a maximum value of 60. The possible minimum and maximum values are constant for all subscales. Facione, Kokdemir (2003) suggest that individuals with scores < 40 for each subscale have low critical thinking dispositions (LS) in the subscale in question; those with a score between 40 and 50 have medium critical thinking dispositions (MS) and a score > 50 indicates high critical thinking dispositions (HS). In this context, taking critical thinking as a whole (including all sub-dimensions), it could be argued that for critical thinking disposition levels according to the score ranges obtained by the students at the end of CCTDI

administration, the students with a score < 240 (40×6) (LS) have in general low critical thinking dispositions; the students with scores between 240 and 300 have medium critical thinking dispositions (MS) and those with scores > 300 (50×6) have high dispositions (HS) (Kokdemir, 2003). The evaluations in this study were also based on these score ranges and their implications.

RESULTS AND DISCUSSION

- Contributions of different instructional applications based on asking questions to the students' critical thinking dispositions and levels

By taking into account the pre-test and post-test scores, this section summarizes the findings about the contributions made by the instructional applications based on student questions, teacher questions, blended method and traditional instruction to the students' critical thinking dispositions and levels.

- Contribution of the instructional application based on student questions to the students' critical thinking dispositions and levels

In order to determine the contribution of the instructional application based on student questions to the students' critical thinking dispositions and levels, the t-test was performed on the pre-test and post-test scores, the results of which are summarized in Table 3.

Table 3 reveals that there was a significant difference between the pre-test and post-test scores in experiment group I, which received the instructional application based on student questions both in terms of total scores ($t_{(1-19)} = -6.482, p < 0.01$) and for all sub-dimensions (analyticity ($t_{(1-19)} = -4.902, p < 0.01$), open-mindedness ($t_{(1-19)} = -3.312, p < 0.01$), inquisitiveness ($t_{(1-19)} = -2.113, p < 0.05$), self-confidence ($t_{(1-19)} = -2.596, p < 0.05$), truth-seeking ($t_{(1-19)} = -2.156, p < 0.05$), systematicity ($t_{(1-19)} = -4.511, p < 0.01$). This result demonstrates that the instructional application based on student questions significantly and positively contributed to the students' critical thinking dispositions and levels both in terms of total scores and each of the sub-dimensions. Thus, it could be argued that

Table 3: Contribution of the instructional application based on student questions to the students' critical thinking dispositions and levels

Variables	N	\bar{X}	SD	t	df	Sig.
Analyticity						
Pre-test	20	35.95	2.84	-4.902	19	0.000
Post-test	-	39.25	1.55	-	-	-
Open-mindedness						
Pre-test	-	41.00	3.23	-3.312	-	0.004
Post-test	-	42.85	3.05	-	-	-
Inquisitiveness						
Pre-test	-	36.10	5.10	-2.113	-	0.048
Post-test	-	37.50	4.05	-	-	-
Self-confidence						
Pre-test	-	36.65	6.45	-2.596	-	0.018
Post-test	-	38.95	5.04	-	-	-
Truth-seeking						
Pre-test	-	32.90	4.77	-2.156	-	0.044
Post-test	-	35.40	4.57	-	-	-
Systematicity						
Pre-test	-	36.30	6.80	-4.511	-	0.000
Post-test	-	44.15	8.24	-	-	-
Total point						
Pre-test	-	218.70	10.61	-6.482	-	0.000
Post-test	-	238.20	16.73	-	-	-

these results are in parallel with the results of other studies maintaining that instruction can improve individuals' critical thinking dispositions and levels (Sanders and Wiseman, 1994; Sahinel, 2005; Sundberg, 2006; Mucher, 2007). This could be attributed to the fact that students think more focused, when they prepare questions, more actively experience thinking processes, more closely interact with the subject in question both in cognitive and affective terms to pose a question and questions lead students to discover the interesting aspects of subjects.

As a matter of fact, studies argue that questions help identify a problem, tell about an interesting event, attract the attention of the students and help the students focus on their learning tasks (Ozerbas, 2007). Furthermore, it is also underlined that posing questions is a significant factor that triggers thinking and is regarded as a method that activates thinking (Robbins, 1995; Koray *et al.*, 2005). In this context, Drake and Brown (2003) recommend asking questions to students to assist them in their thinking and particularly encourage them to pose questions.

- Contribution of the instructional application based on teacher questions to the students' critical thinking dispositions and levels

In order to determine the contribution of the instructional application based on teacher questions to the students' critical thinking dispositions and levels, a t-test was performed, the results of which are summarized in Table 4.

Table 4: Contribution of the instructional application based on teacher questions to the students' critical thinking dispositions and levels

Variables	N	\bar{X}	SD	t	df	Sig.
Analyticity						
Pre-test	19	36.53	4.33	-3.655	18	0.002
Post-test	-	39.32	3.59	-	-	-
Open-mindedness						
Pre-test	-	40.26	3.35	-2.322	-	0.032
Post-test	-	42.05	2.74	-	-	-
Inquisitiveness						
Pre-test	-	36.42	2.91	-1.217	-	0.239
Post-test	-	37.11	2.69	-	-	-
Self-confidence						
Pre-test	-	38.26	3.98	-1.501	-	0.151
Post-test	-	39.84	4.99	-	-	-
Truth-seeking						
Pre-test	-	36.21	5.43	-0.520	-	0.610
Post-test	-	36.79	4.45	-	-	-
Systematicity						
Pre-test	-	36.84	8.71	-3.314	-	0.004
Post-test	-	44.26	9.54	-	-	-
Total point						
Pre-test	-	224.42	12.76	-5.407	-	0.000
Post-test	-	239.26	14.85	-	-	-

Table 4 reveals that there was a significant difference between the pre-test and post-test scores in experiment group 2, which received the instructional application based on teacher questions both in terms of total scores ($t_{(1-18)} = -5.407$, $p < 0.01$) and the sub-dimensions of analyticity ($t_{(1-18)} = -3.655$, $p < 0.05$), open-mindedness ($t_{(1-18)} = -2.22$, $p < 0.05$) and systematicity ($t_{(1-18)} = -3.314$, $p < 0.05$). Nevertheless, there was no significant difference between the pre-test and post-test scores in the sub-dimensions of inquisitiveness ($t_{(1-18)} = -1.217$, $p > 0.05$), self-confidence ($t_{(1-18)} = -1.501$, $p > 0.05$) and truth-seeking ($t_{(1-18)} = -0.520$, $p > 0.05$). This result demonstrates that the instructional application based on teacher questions significantly and positively contributed to the students' critical thinking dispositions and levels both in terms of total scores and the sub-dimensions of analyticity, open-mindedness and systematicity. As a matter of fact, Drake and Brown (2003) suggest that teachers should ask questions to their students to help them think and gain experiences about thinking. Similarly, in another study, Drake (1997) argues that thinking contains critical thinking and with questions, students who start thinking will also improve their critical thinking skills. Furthermore, Thacker (2007) claims that the use in instruction of open-ended questions in particular enhances students' attentive perceptions and encourages them to think throughout the process. Thus, it could be argued that, by asking questions to their students, teachers guide them towards thinking and questioning and students who gain experience in that will improve their critical thinking skills.

On the other hand, instruction based on teacher questions was determined not to make any contribution

Table 5: Contribution of the blended instructional application to the students' critical thinking dispositions and levels

Variables	N	\bar{X}	SD	t	df	Sig.
Analyticity						
Pre-test	19	37.37	3.06	-2.727	18	0.014
Post-test	-	39.37	2.27	-	-	-
Open-mindedness						
Pre-test	-	39.79	4.93	-2.385	-	0.028
Post-test	-	42.42	2.81	-	-	-
Inquisitiveness						
Pre-test	-	36.68	3.84	-0.466	-	0.647
Post-test	-	37.21	2.80	-	-	-
Self-confidence						
Pre-test	-	35.84	3.52	-1.372	-	0.187
Post-test	-	37.36	4.08	-	-	-
Truth-seeking						
Pre-test	-	34.63	5.45	-1.181	-	0.253
Post-test	-	36.11	4.25	-	-	-
Systematicity						
Pre-test	-	37.26	5.25	-2.830	-	0.011
Post-test	-	42.21	5.97	-	-	-
Total point						
Pre-test	-	221.68	10.30	-4.882	-	0.000
Post-test	-	234.63	9.41	-	-	-

Table 6: Contribution of the traditional instructional application to the students' critical thinking dispositions and levels

Variables	N	\bar{X}	SD	t	df	Sig.
Analyticity						
Pre-test	20	35.85	3.54	-2.367	19	0.029
Post-test	-	37.40	3.41	-	-	-
Open-mindedness						
Pre-test	-	42.25	4.36	1.151	-	0.264
Post-test	-	40.90	3.65	-	-	-
Inquisitiveness						
Pre-test	-	35.60	2.98	-0.944	-	0.357
Post-test	-	36.55	2.87	-	-	-
Self-confidence						
Pre-test	-	36.00	4.41	-1.273	-	0.218
Post-test	-	37.10	3.78	-	-	-
Truth-seeking						
Pre-test	-	36.15	5.00	1.115	-	0.279
Post-test	-	34.90	4.12	-	-	-
Systematicity						
Pre-test	-	34.60	5.45	-3.910	-	0.001
Post-test	-	40.00	7.15	-	-	-
Total point						
Pre-test	-	220.20	11.59	-2.213	-	0.039
Post-test	-	226.70	10.43	-	-	-

to the students' critical thinking dispositions and levels in the sub-dimensions of inquisitiveness, self-confidence and truth-seeking. This could be attributed to the fact that teacher questions are a product of the teachers' inquisitiveness, rather than that of students themselves. As the teacher focused on what is interesting for himself, when asking questions and posed questions out of his own curiosity, a sense of curiosity might not have activated the students. For questions are often asked about the aspects of a subject that raise curiosity (Kauchak and Eggen, 2003; Morgan and Saxton, 1994). It is not possible for teachers and students to always inquire the same things. Similarly, the fact that teacher questions did not contribute to the students' critical thinking dispositions and levels in the sub-dimensions of self-confidence and truth-seeking could be attributed to the origin of questions, which was teacher's curiosity rather than students' curiosity and desire.

- Contribution of the blended instructional application to the students' critical thinking dispositions and levels

In order to determine the contribution of the blended instructional application to the students' critical thinking dispositions and levels, a t-test was performed, the results of which are summarized in Table 5.

Table 5 reveals that there was a significant difference between the pre-test and post-test scores in experiment group 3, which received the blended instructional application both in terms of total scores ($t_{(1-18)} = -4.882, p < 0.01$) and in the sub-dimensions of analyticity ($t_{(1-18)} = -2.727, p < 0.05$), open-mindedness ($t_{(1-18)} = -2.385, p < 0.05$)

and systematicity ($t_{(1-18)} = -2.830, p < 0.05$). Nevertheless, there was no significant difference between the pre-test and post-test scores in the sub-dimensions of inquisitiveness ($t_{(1-18)} = -0.466, p > 0.05$), self-confidence ($t_{(1-18)} = -1.372, p > 0.05$) and truth-seeking ($t_{(1-18)} = -1.181, p > 0.05$). This result demonstrates that the blended instructional application containing the simultaneous use of teacher and student questions significantly and positively contributed to the students' critical thinking dispositions and levels both in terms of total scores and the sub-dimensions of analyticity, open-mindedness and systematicity, while it did not in the sub-dimensions of inquisitiveness, self-confidence and truth-seeking. This finding might have been due to the fact that in the blended instructional application, teacher questions were more dominant than student questions owing to the control of the teacher over the class. As a matter of fact, Acikgoz (2004) argues that student questions are less frequently used in the instruction process. The more dominant character of teacher questions might have resulted in a more passive position for the students due to the low frequency of the use of student questions.

- Contribution of the traditional instructional application to the students' critical thinking dispositions and levels

In order to determine the contribution of the traditional instructional application to the students' critical thinking dispositions and levels, a t-test was performed, the results of which are summarized in Table 6.

Table 6 reveals that, in the control group, which received the traditional application, there was a significant

Table 7: The critical thinking dispositions and levels of the students in each experiment group and the control group (pre-test)

Sub-scales	Experiment group (N = 20)			Experiment group (N = 19)			Experiment group (N = 19)			Control group (N = 20)		
	LS	MS	HS	LS	MS	HS	LS	MS	HS	LS	MS	HS
	(%)											
Analyticity	95	5	0	73.7	26.3	0.0	78.9	21.1	0.0	90	10	0
Open-mindedness	35	65	0	36.8	63.2	0.0	47.4	52.6	0.0	25	75	0
Inquisitiveness	75	25	0	84.2	15.8	0.0	78.9	21.1	0.0	95	5	0
Self-confidence	65	35	0	52.6	47.4	0.0	84.2	15.8	0.0	80	20	0
Truth-seeking	100	0	0	73.7	26.3	0.0	89.5	5.3	5.3	80	20	0
Systematicity	75	25	0	57.9	36.8	5.3	57.9	42.1	0.0	80	20	0
Total point	95	5	0	84.2	15.8	0.0	94.7	5.3	0.0	100	0	0

difference between the pre-test and post-test scores both in terms of total scores ($t_{(1-19)} = -2.213, p < 0.05$) and the sub-dimensions of analyticity ($t_{(1-19)} = -2.367, p < 0.05$) and systematicity ($t_{(1-19)} = -3.910, p < 0.05$). In particular, the significant difference between the total scores confirms the argument that critical thinking can be improved through instruction (Sanders and Wiseman, 1994; Sahinel, 2005; Sundberg, 2006; Mucher, 2007). In other words, this difference can be taken as a natural outcome of education. Nevertheless, the traditional instructional application did not create a significant difference between the pre-test and post-test scores in the sub-dimensions of open-mindedness ($t_{(1-19)} = 1.151, p > 0.05$), inquisitiveness ($t_{(1-19)} = -0.944, p > 0.05$), self-confidence ($t_{(1-19)} = -1.273, p > 0.05$) and truth-seeking ($t_{(1-19)} = 1.115, p > 0.05$). This could be regarded as a consequence of the fact that the students were highly passive in the traditional instructional application and could not perform the thinking action due to the lack of question use.

Consequently, to examine the different strategies of using questions, each strategy could be argued to significantly contribute to the total student scores in critical thinking dispositions and levels. This is in parallel with the study results that demonstrate the effectiveness of questions on the improvement of thinking skills. These studies could be exemplified by the studies of Wineburg (2001), VanSledright (2002), Levstik (1997) and Chowen (2005). A British educational researcher, Cooper (1995) stated that carefully posed questions will considerably contribute to students' higher-order thinking skills (Miller, 2007).

On the other hand, it has been determined that the traditional instructional application that does not use questions also resulted in an improvement in the students' critical thinking dispositions and levels, which could be considered as a natural outcome of the relationship between education and thinking skills.

- The difference among the contributions of different instructional applications based on asking questions to the students' critical thinking dispositions and levels

This study summarizes the findings about whether there was a significant difference among the contributions of the instructional applications based on student questions, teacher questions, the blended method and traditional instruction to the students' critical thinking dispositions and levels.

- Pre-application group equivalence

Table 7 summarizes the pre-test critical thinking dispositions and levels of the students in each experiment group and the control group.

As shown in Table 7, the results of the pre-test demonstrated that there were no students scoring high in critical thinking dispositions and levels in all the scales, only to the exclusion of experiment group 2 in systematicity (5.3%) and experiment group III in the truth-seeking (5.3%) subscales. The rate of students who scored high in the subscales of systematicity and truth-seeking is very low. On the other hand, the subscale, in which the medium-level scoring group percentage was the highest was open-mindedness (65% in experiment group 1; 63.2% in experiment group 2; 52.6% in experiment group 3; 75% in the control group); while, it was the lowest in the truth-seeking subscale for experiment groups 1 (0%) and 3 (5.3%) and in the inquisitiveness subscale for experiment group 2 (15.8%) and the control group (5%).

An examination of the total critical thinking scores reveals a high scoring group percentage of 0% for the students in all groups. However, the rate of the students with medium-level scores was 5% in experiment group 1, 15.8% in experiment group 2, 5.3% in experiment group 3 and 0% in the control group. To put it another way, a majority of the students are in the low-scoring group. Thus, the students in all groups could be argued to have low critical dispositions and levels.

Table 8 summarizes the findings about the pre-test scores in critical thinking dispositions and levels of the students in the experiment and control groups.

As revealed by Table 8, the mean group scores in the subscales are very close in all the subscales.

Table 8: The pre-test scores in critical thinking dispositions and levels of the students in the experiment and control groups

Sub-scales	Experiment group 1 (N = 20)		Experiment group 2 (N = 19)		Experiment group 3 (N = 19)		Control group (N = 20)	
	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Analyticity	35.95	2.84	36.53	4.33	37.4	3.05	35.85	3.54
Open-Mindedness	41.00	3.23	40.26	3.35	39.79	4.93	42.25	3.66
Inquisitiveness	36.10	5.10	36.40	2.91	36.68	3.84	35.60	2.98
Self-Confidence	36.65	6.45	38.26	3.98	35.84	3.51	36.00	4.41
Truth-Seeking	32.90	4.77	36.21	6.43	34.63	5.45	36.15	5.00
Systematicity	36.30	6.80	36.84	8.71	37.26	5.25	34.60	5.45
Total Point	218.70	10.61	224.42	12.76	221.68	10.30	220.20	11.59

Nevertheless, the highest mean score in all groups was obtained in the subscale of open-mindedness ($\bar{X} = 41.00$ for experiment group 1, $\bar{X} = 40.26$ for experiment group 2, $\bar{X} = 39.79$ for experiment group 3 and $\bar{X} = 42.25$ for the control group); while, the lowest mean score was obtained in the subscale of truth-seeking in the experiment groups 1-3 ($\bar{X} = 32.90$ for experiment group 1, $\bar{X} = 36.21$ for experiment group 2, $\bar{X} = 34.63$ for experiment group 3) and in systematicity in the control group ($\bar{X} = 34.60$).

On the other hand, an examination of the total score revealed total mean scores that are very close to each other for all groups. However, the mean score of experiment group 2 ($\bar{X} = 224.42$) is observed to be higher, while, the lowest mean score belonged to experiment group 1 ($\bar{X} = 218.70$).

To determine whether these observed differences are significant, the pre-test scores for critical thinking dispositions and levels were subjected to a variance analysis, the results of which are given in Table 9.

An examination of Table 9 reveals no inter-group differences both in terms of the pre-test total scores in critical thinking ($F_{(3,77)} = 0.897, p > 0.05$) and the pre-test subscale scores (analyticity ($F_{(3,77)} = 0.776, p > 0.05$), open-mindedness ($F_{(3,77)} = 1.390, p > 0.05$), inquisitiveness ($F_{(3,77)} = 0.291, p > 0.05$), self-confidence ($F_{(3,77)} = 1.038, p > 0.05$), truth-seeking ($F_{(3,77)} = 1.038, p > 0.05$), systematicity ($F_{(3,77)} = 0.602, p > 0.05$). This result could be interpreted as indicating a similarity among all groups prior to the application in terms of total scores in critical thinking dispositions and levels and subscale scores.

- The difference among the contributions of different instructional applications to the students' critical thinking dispositions and levels

In order to check the effect of differences among the pre-test mean scores across groups, the post-test-pre-test difference scores were first completed and later the significance between these difference scores was investigated using independent samples One-way Variance Analysis (ANOVA). Table 10 summarizes the data about the post-test-pre-test difference scores of the experiment and control groups.

Table 9: The results of the one-way variance analysis performed on the groups' pre-test critical thinking dispositions and levels

Sub-scales	Sum of squares	df	Mean square	F	Sig.	Significant differences
Analyticity						
Between groups	28.214	3	9.405	0.776	0.511	-
Within groups	896.658	74	12.117	-	-	-
Total	924.872	77	-	-	-	-
Open-mindedness						
Between groups	67.562	3	22.521	1.390	0.252	-
Within groups	1198.592	74	16.197	-	-	-
Total	1266.154	77	-	-	-	-
Inquisitiveness						
Between groups	12.779	3	4.260	0.291	0.831	-
Within groups	1081.337	74	14.613	-	-	-
Total	1094.115	77	-	-	-	-
Self-confidence						
Between groups	70.227	3	23.409	1.038	0.381	-
Within groups	1668.761	74	22.551	-	-	-
Total	1738.987	77	-	-	-	-
Truth-seeking						
Between groups	70.227	3	23.409	1.038	0.381	-
Within groups	1668.761	74	22.551	-	-	-
Total	1738.987	77	-	-	-	-
Systematicity						
Between groups	80.636	3	26.879	0.602	0.616	-
Within groups	3305.211	74	44.665	-	-	-
Total	3385.846	77	-	-	-	-
Total point						
Between groups	346.581	3	115.527	0.897	0.447	-
Within groups	9532.137	74	128.813	-	-	-
Total	9878.718	77	-	-	-	-

An examination of the mean post-test-pre-test difference scores of the groups calculated for the subscales in Table 10 demonstrates that the subscale, in which the mean difference score was highest for all groups was systematicity ($\bar{X} = 7.85$ for experiment group 1, $\bar{X} = 7.42$ for experiment group 2, $\bar{X} = 4.95$ for experiment group 3, $\bar{X} = 5.40$ for the control group), while the subscale with lowest mean difference score was inquisitiveness for experiment groups 1 ($\bar{X} = 1.40$) and 3 ($\bar{X} = 0.52$); truth-seeking in experiment group 2 ($\bar{X} = 0.58$) and open-mindedness in the control group ($\bar{X} = -1.35$).

As demonstrated by the post-test-pre-test total difference scores for critical thinking dispositions and levels, the mean difference score of experiment group I ($\bar{X} = 19.50$) was the highest, which was followed by experiment group 2 ($\bar{X} = 14.84$), experiment group 3 ($\bar{X} = 12.95$) and the control group ($\bar{X} = 6.50$), respectively. Furthermore, the lowest mean score was

Table 10: The groups' mean post-test-pre-test difference scores

Sub-scales	Experiment group 1 (N = 20)		Experiment group 2 (N = 19)		Experiment group 3 (N = 19)		Control group (N = 20)	
	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Analyticity	3.30	3.011	3.30	3.01	2.00	3.20	2.00	3.18
Open-mindedness	1.85	2.500	1.79	3.36	2.60	4.81	-1.35	5.24
Inquisitiveness	1.40	2.960	0.68	2.45	0.52	4.96	0.95	4.50
Self-confidence	2.30	3.960	1.58	4.59	1.47	4.68	1.10	3.87
Truth-seeking	2.50	5.190	0.58	4.86	1.47	5.44	-1.25	5.01
Systematicity	7.85	7.780	7.42	9.76	4.95	7.62	5.40	6.18
Total point	19.50	13.450	14.84	11.96	12.95	11.56	6.50	13.14

Table 11: Variance analysis of the post-test-pre-test difference scores of the groups for the subscales of critical thinking dispositions and levels

Sub-scales	Sum of squares	df	Mean square	F	Sig.	Significant differences
Analyticity						
Between groups	36.564	3	12.188	1.256	0.296	-
Within groups	718.308	74	9.707	-	-	-
Total	754.872	77	-	-	-	-
Open-mindedness						
Between groups	184.039	3	61.346	3.601	0.017	Experiment- control groups 3
Within groups	1260.679	74	17.036	-	-	-
Total	1444.718	77	-	-	-	-
Inquisitiveness						
Between groups	8.587	3	2.862	0.193	0.901	-
Within groups	1096.592	74	14.819	-	-	-
Total	1105.179	77	-	-	-	-
Self-confidence						
Between groups	15.093	3	5.031	0.275	0.843	-
Within groups	1355.368	74	18.316	-	-	-
Total	1370.462	77	-	-	-	-
Truth-seeking						
Between groups	151.369	3	50.456	1.919	0.134	-
Within groups	1946.118	74	26.299	-	-	-
Total	2097.487	77	-	-	-	-
Systematicity						
Between groups	121.943	3	40.648	0.649	0.586	-
Within groups	4634.929	74	62.634	-	-	-
Total	4756.872	77	-	-	-	-
Total point						
Between groups	1739.706	3	579.902	3.668	0.016	Experiment control groups 1
Within groups	11699.474	74	158.101	-	-	-
Total	13439.179	77	-	-	-	-

obtained from the control group. Therefore, arguably, all three instructional applications based on student questions, teacher questions and the blended method positively contribute to the students' critical thinking dispositions and levels.

However, the greatest contribution was observed in the groups that received instruction based on student questions. On the other hand, it could be argued that the instructional application based on teacher questions and the blended instructional application have similar effects with regard to their contributions to the students' critical thinking dispositions and levels. An interpretation of this could be the decreased contribution to critical thinking dispositions and levels as students experience thinking processes more passively since they assume a more passive position in using questions. This interpretation is compatible with the results of various studies (Mitchell, 2000; VanSledright, 2002; Wang, 2005).

To determine whether, the inter-group differences were significant for the total scores in critical thinking

dispositions and levels, the post-test-pre-test difference scores were subjected to variance analysis, the results of which are presented in Table 11.

Table 11 shows, a significant inter-group difference in the subscale of open-mindedness in terms of the post-test-pre-test difference scores in the sub-dimensions of critical thinking dispositions and levels ($F_{(3,77)} = 3.601$, $p < 0.05$). On the basis of the results of the variance analysis, the explanatory power of the factor (across the groups) for the total variance in the dependent variable was computed to be $\eta^2 = 0.127$. This shows that 12.7% of the total variance in the students' difference scores in critical thinking dispositions and levels resulted from the experimental application.

As a result of the Scheffe test performed to identify between, which groups the difference occurred, the significant difference was determined to be between experiment group 3 and the control group. The mean difference score of experiment group 3 in the open-

mindfulness sub-dimension was $\bar{X} = 4.81$; while, the mean difference score for the control group was $\bar{X} = -1.35$. So, apparently, the difference is in favor of experiment group 3. This result demonstrates that the blended instructional application contributed more to the students' critical thinking dispositions and levels in the open-mindedness sub-dimension when compared to the traditional instructional application. A more intensive teacher-student interaction with questions posed by both in the blended instructional application could have created a more democratic educational environment, which might have allowed students to express their ideas more freely.

On the other hand, no significant inter-group difference was detected in the sub-dimensions of analyticity ($F_{(3,77)} = 1.256, p > 0.05$), inquisitiveness ($F_{(3,77)} = 0.193, p > 0.05$), self-confidence ($F_{(3,77)} = 0.275, p > 0.05$), truth-seeking ($F_{(3,77)} = 1.919, p > 0.05$) and systematicity ($F_{(3,77)} = 0.649, p > 0.05$). This finding suggests that there was no difference in the contributions of different instructional applications in the sub-dimensions of analyticity, inquisitiveness, self-confidence, truth-seeking and systematicity.

Moreover, the results of the one-way variance analysis revealed a significant inter-group difference in the total post-test-pre-test difference scores for critical thinking dispositions and levels ($F_{(3,77)} = 3.668, p < 0.05$). The explanatory power of different instructional applications for the total variance in the dependent variable was calculated to be $\eta^2 = 0.129$. Based on this finding, it could be argued that 13% of the total variance in the difference scores in the students' critical thinking dispositions and levels resulted from the experimental application.

As a result of the Scheffe test performed to reveal among, which groups the difference occurred, the significant difference was between experiment group 1 and the control group. The mean difference score was $\bar{X} = 19.50$ for experiment group 1 and $\bar{X} = 6.50$ for the control group. Thus, the difference is in favor of experiment group 1. No significant difference was observed between experiment groups 2 and 3 and experiment group 1 or control group. This finding could be interpreted to indicate that the instructional application based on student questions contributed more to the students' total scores in critical thinking dispositions and levels when compared to the traditional method.

CONCLUSION

In the light of the above findings, the conclusions arrived at the end of the research could be summarized as follows:

- Conclusions concerning the contributions of different instructional approaches based on questions to the students' critical thinking dispositions and levels
 - When the total scores are considered, all of the four instructional applications implemented under the study positively contribute to the students' critical thinking dispositions and levels
 - With respect to the sub-dimensions of critical thinking dispositions and levels, the approach based on student questions significantly and positively contributes in all the sub-dimensions. However, the applications based on teacher questions and blended instruction significantly and positively contribute in the sub-dimension of analyticity, open-mindedness and systematicity, while it does not in the sub-dimensions of inquisitiveness, self-confidence and truth-seeking. Consequently, it could be argued that the instructional applications based on teacher questions and the blended approach have similar effects in terms of their contributions to critical thinking dispositions and levels

Traditional instructional application, on the other hand, positively contributes to the students' critical thinking dispositions and levels in the sub-dimensions of analyticity and systematicity; while, it does not in the sub-dimensions of open-mindedness, inquisitiveness, self-confidence and truth-seeking.

- Conclusions about the difference in the contributions of the different questioning-based instructional applications to critical thinking dispositions and levels
 - Students in all groups have low levels of critical thinking dispositions and levels
 - Prior to the application, all groups are similar in terms of their total and subscale scores in critical thinking dispositions and levels
 - All of the four different instructional applications used in the research positively contributed to the students' critical thinking dispositions and levels; while, the highest contribution was made by the instruction based on student questions, which was followed by those based on teacher questions and the blended method, respectively. The smallest contribution to the students' critical thinking dispositions and levels was made by the traditional instructional approach

- The blended instructional application contributes more to the students' critical thinking dispositions and levels in the open-mindedness dimension, when compared to the traditional instructional application. Yet, there are no inter-group differences between their contributions in the sub-dimensions of analyticity, inquisitiveness, self-confidence, truth-seeking and systematicity.
- As revealed by the total scores, the instructional approach based on student questions contribute significantly more to the students' critical thinking dispositions and levels, when compared to the traditional method. Nevertheless, there is no significant difference between the contributions of the instructional approaches based on student questions and the blended method to the students' critical thinking dispositions and levels.

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