

Teaching Critical Thinking Skills by Using Introduction to Statistics Course Content Material to Social Sciences Undergraduates in Turkey

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Abstract: Main aim of this study is to examine the effects of the introduction to statistics course realised on cooperative learning environment on critical thinking skills, statistics achievement and statistics attitude. The subjects of the study were the first year students of Department of Guidance and Psychological Counselling. 37 students were assigned to the experiment group that took the introduction to statistics course on cooperative learning environment and 32 students were assigned to the control group that took the same course with traditional method. The findings showed there were not significant differences between the experiment group and the control group in terms of critical thinking skills, statistics achievement and statistics attitude.

Key words: Critical Thinking Skills • Introduction to Statistics • Statistics Achievement • Statistics Attitude
• Cooperative Learning

INTRODUCTION

Improving students' critical thinking skills is accepted as a crucial goal of education and schools are considered where critical thinking skills can be developed. Undoubtedly, education system has to have a structure that serves in this context from elementary school to university. Fostering critical thinking skills is considered to be essential to safeguarding a democratic society with an able thinking citizenship and ensuring a competent workforce in an increasingly complex world [1].

There is a diversity of definitions of critical thinking skills in the literature. Critical thinking is a way of thinking that does not accept any assumption without questioning its validity and correctness [2]. Norris and Ennis [3] describe critical thinking as "a reasonable and reflective way of thinking focusing on deciding what to believe or do". Critical thinking is a process of evaluating various situations, ideas and experiences [4]. According to some researchers, the leaders of all the critical thinking definitions are Watson and Glaser and the most contemporary definitions of critical thinking are as comprehensive as this definition brought up by Watson and Glaser long ago [5, 6]. These researchers define critical thinking as a composite of attitudes, knowledge and skills and also employing and applying these

features. Besides, they explain this process as determining the evidence supporting the results systematically and logically, studying the logical connection between the evidence and the result and producing situations supported by reasoning and the evidence [7].

Critical thinking is not a "subject to be taught" but a "skill to be gained". Infact, teaching is not a suitable concept with critical thinking because education is a process of transferring a group of values or beliefs from one person to another [8]. However, an individual with developed thinking skills constantly asks questions such as "what is the meaning of this?, why does this happen?, what are the evidences of this?" and "how can I be sure?" [9].

Critical thinking can be developed by some activities such as providing the students to establish a connection between their past and present knowledge, teaching the skills plainly, guiding and giving regular exercises, providing feedback, modelling, using short evaluation in-class techniques (one-question examinations, minute papers, quiz, etc.) and teaching the students to evaluate themselves [10].

Generally, the courses supporting critical thinking skills should focus on discussion, problem solving and practices. The students in a typical course in the classroom should study the problems and questions

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given them with couples or small groups. This process enables the students to understand better and to use their control mechanisms better in discussions. Thus, the students become responsible to be ready to behave like learned participants whenever they attend the class [11].

Jones [12] summarizes the teaching techniques that contribute critical thinking skills more compared to the others as critical analysis, debate teams, dramatization, action maze, critical incident, scenario building, creative visualization, listening teams, journal writing, inventing and pluses, minuses, implications.

Adsit [13] summarizes the teaching strategies that help critical thinking skills to be developed as classroom assessment techniques, cooperative learning strategies, case study/discussion method, using questions, conference style learning, using writing assignments, dialogues (written and spontaneous group dialogues) and ambiguity (disputatious situations instead of clear information).

The compulsory introduction to statistics course presents challenges for students as well as instructors. It is a course that normally involves students from a variety of academic disciplines and levels of statistical and mathematical skills [14]. Therefore, teaching statistics is usually a problematic field for the students in social sciences [15-17]. In Turkey, the student achievements in this course are generally considered to be low accompanied by negative attitude, high anxiety and similar negative factors. Different in-class arrangements, teaching methods and evaluation techniques to improve achievement in statistics courses are among the studies of the researchers who study in this field all over the world. Recently, there has emerged a growing consensus in the literature on teaching strategies in favour of group-based methods of teaching for undergraduates rather than the traditional lecture methods [18]. Nevertheless, cooperative learning method offers opportunities to deal with all these challenges mentioned above. This method provides improvement both in critical thinking skills and statistics achievement.

Aim: Main aim of this study is to examine the effects of the introduction to statistics course realised on cooperative learning environment on critical thinking skills, statistics achievement and statistics attitude. In this framework, a hypothesis related to experimental process was tested. This hypothesis was that the variation observed in the Watson-Glaser Critical Thinking Appraisal Test (WGCTAT) pretest-posttest scores showed significant differences between the group that

took the introduction to statistics course on cooperative learning environment (experiment group) and the group that took the lesson with traditional method (control group) with the advantage on the former. Besides, following questions were also answered:

- Are there significant relationships between the Watson-Glaser Critical Thinking Appraisal Test (WGCTAT) subtest and total scores, Statistics Achievement Test (SAT) scores and the Statistics Attitude Scale (SAS) subtest scores in the experiment group and the control group?
- Is there a significant difference between the Statistics Achievement Test scores of the students in the experiment and control groups?
- Is there a significant difference between the Statistics Attitude Scale's "Interest", "Anxiety" and "Motivation" subtest scores in the experiment and control groups?

MATERIALS AND METHODS

Design: The pretest-posttest control group model of the experimental design was used in the research. There were two groups in the research: the group who took the Introduction to Statistics course on cooperative learning environment supporting critical thinking (Experiment Group-E) and the group with traditional method (Control Group-C). The students were randomly assigned to the groups. Watson-Glaser Critical Thinking Appraisal Test (WGCTAT)-(Form S) was applied as the pretest before the experiment and as the posttest after the experiment. Moreover, Statistics Achievement Test and Statistics Attitude Scale were measured only in the end of the study.

Subjects: The subjects of the study were the first year students of Ankara University's Department of Guidance and Psychological Counselling. Total 69 students ($n_e = 37$ and $n_c = 32$ in the control group), who took the compulsory "Introduction to Statistics" course for the first time, participated in the study.

Instruments: Data gathering tools used in the study were Watson-Glaser Critical Thinking Appraisal Test (WGCTAT) - (Form S) adapted into Turkish by Evcen [19], Statistics Attitude Scale developed by Köklü [15] and Statistics Achievement Test developed by the researcher (lecturer) to measure the statistics achievement of the students.

Procedure: Following the random student assignments into the experiment and control groups, the pretest was applied with the WGCTAT - (Form S) in the beginning of the experimental process. In addition to the traditional course programme, cooperative learning activities supporting the improvement of critical thinking skills were used throughout the experiment group while the course was applied by traditional method in the control group.

Cooperative learning activities were presented to the experiment group in each course and the students were asked to fill in the minute papers in the end of each course. Minute papers are written shortly by the students to evaluate the day's course [13]. The students were asked to write their point of views on the questions such as "what is the most important thing you have learned in today's course", "what is the thing you have liked most in today's course" and "what is/are the subject(s) you have not understood in today's course".

Some of the cooperative learning activities realised in the experimental process were discussions on different subjects in statistics in social sciences and reporting the result; evaluating the discussion reports of other groups by using some criterion given by the instructor; finding new examples appropriate to the subjects studied; graphic interpretation; data gathering and producing problems appropriate for different kinds of data; interpretations related to the form of different data distributions; solving the problems produced by different groups; evaluating and scoring the problem solutions of different groups etc.

The practice lasted for seven weeks until the midterm exam. The Statistics Achievement Test developed by the researcher was used to evaluate the achievement in the midterm exam. Afterwards, the Watson-Glaser Critical Thinking Appraisal Test - (Form S) was applied as the posttest. Statistics Attitude Scale was applied as well.

RESULTS

Some findings related to critical thinking skills, statistics achievement and statistics attitude were presented in this section.

The Split-Plot ANOVA main effect tests' results related to the comparison of the total and subtest scores of the Watson-Glaser Critical Thinking Appraisal Test - (Form S) showed that the group main effects were not significant in subtest or total scores. There was significant difference only in the "Interpretation" subtest of the measure or test main effect [$F_{(1,67)} = 4.57, P < .05$]. This finding showed that the change in the "Interpretation" subtest from pretest to posttest was significant without

having any group differentiations. Interpretation subtest concerns weighing evidence and deciding if generalizations or conclusions based on the given data are warranted. There cannot be seen any significant difference either in subtest or total scores in the interaction effect test, meaning that the cooperative learning activities conducted to increase the critical thinking skills of the experiment group students were not sufficient or effective in providing the development expected.

The relationships between Watson-Glaser Critical Thinking Appraisal Test (WGCTAT) subtest and total scores, Statistics Achievement Test (SAT) scores and the Statistics Attitude Scale (SAS) subtest scores were analysed and following relationships were significant in the experiment group: Inference subtest and the Statistics Attitude Scale's Interest subtest ($r = .40, p < .05$); Inference subtest and the Statistics Attitude Scale's Anxiety subtest ($r = .42, p < .05$); Inference subtest and the Statistics Attitude Scale's Motivation subtest ($r = .35, p < .05$) is significant. Also, following relationships were significant in the control group: Watson-Glaser Critical Thinking Appraisal Test total score and Statistics Achievement Test score ($r = .46, p < .01$); Deduction subtest scores and Statistics Achievement Test score ($r = .42, p < .05$); Deduction subtest and the Statistics Attitude Scale's Anxiety subtest ($r = .48, p < .01$); Deduction subtest and the Statistics Attitude Scale's Motivation subtest ($r = .36, p < .05$).

The findings related to the comparison of the Statistics Achievement Test scores in the experiment and control groups were analysed. The independent t test result showed that the difference between experiment and control groups was not significant [$t_{(67)} = 0.28, P > .05$], showing that the achievement of the groups was similar.

The comparison of the Statistics Attitude Scale's Interest, Anxiety and Motivation subtest scores of the experiment and control groups was analysed and it was found that the differences between the Statistics Attitude Scale's Interest [$t_{(67)} = 1.28, P > .05$], Anxiety [$t_{(67)} = 1.48, P > .05$] and Motivation [$t_{(67)} = 0.75, P > .05$] subtest scores of the groups were not significant. Therefore, the groups had similar attitude in terms of interest, anxiety and motivation towards statistics.

DISCUSSION

As the basic interest of the research implies, the main hypothesis that there would be an increase in the critical thinking skills of the experiment group is not supported.

There can be different comments on this finding. One of the most important reasons for the procedure not having been effective enough in improving critical thinking skills may be the limitation of the experimental process time by seven weeks against the possible interaction risk between the experiment and control groups. There are findings on the relating literature which show that the critical thinking skills cannot be improved in such a short period of time. For instance, McMillan [20] states that the researchers of the studies related to critical thinking skills generally try to measure the improvements in a semester or a academic year but the time between the pretest and posttest is too short for the improvement of a student's critical thinking skills and there will not be significant differences particularly when the Watson-Glaser Critical Thinking Appraisal Test is used. Besides, there were not seen improvements in students' critical thinking skills as a result of the practices of the English lessons lectured by Gelven and Stewart [21] for a year. The researchers state that this result is consistent with the findings and results which show that the critical thinking and problem solving skills cannot be improved in a short period of time.

It is stated by some researchers in the study by Terenzini, Springer, Pascarella and Nora [22] that the reason for various teaching techniques not seen as leading significant differences in the development of critical thinking skills is because of the traditional research approaches. Therefore, some reasons such as the short period of time between the pretests and posttests carried out in the studies, studying with small samples taken from only one institution or school and not using large scale instruments cause the differences in critical thinking not being significant. On the other hand, the reason for some courses seen as strengthening critical thinking skills is mentioned as the use of teaching techniques supporting the development of critical thinking skills.

Rapps, Riegel and Glaser [23] state that the development of critical thinking skills needs time and experience whereas Griffin [24] defends that the short critical thinking courses set in the normal curriculum of the lesson are not an effective strategy in teaching critical thinking skills. Moreover, there were not seen significant differences in critical thinking skills of the students in the Watson-Glaser Critical Thinking Appraisal Test - (Form S) measures in the studies by Teixeira [25] and Daly [26].

Another reason for not having significant differences between the experiment and control groups is the structure of the Watson-Glaser Critical Thinking Appraisal Test - (Form S). The structure of this test is

rather different from the other scales the students usually face and are familiar with. Besides, it is not an easy scale since it aims at measuring high level thinking skills and it requires concentration. Therefore, it can be said that the students might have had difficulties in paying attention to answer such a test in classroom environment. Also, Watson-Glaser Critical Thinking Appraisal Test - (Form S) is an adaptation test and some difficulties of the adaptation tests (cultural appropriateness, lingual equation, etc.) can be seen in this test. Evcen [19], who adapted the instrument, suggests a domestic Critical Thinking Appraisal Scale to be developed for the validity and reliability coefficients of the instrument are lower than the original instrument.

Moreover, Kubota [27] dwells on the cultural appropriateness of the critical thinking style and also emphasizes that there are some certain assumptions culturally set between the Eastern and the Western societies. From the standpoint of Japan, Kubota states that critical thinking is quite an unfamiliar concept for the Japanese culture. She emphasizes that individualism, self-expression and analytical thinking are important in the Western societies whereas cooperation and harmony are considered important in the Eastern culture. Thus, the Japanese student type is in harmony with the orientalist point of view. The Japanese high school education oriented towards exams is largely about remembering. Therefore, the Japanese researchers point out they have had more clarity on the definitions of critical thinking skills and they have agreed on the subject but they still have so many questions that have not been answered on the appropriateness of the teaching of critical thinking skills to the Japanese culture. In the study by Tiwari, Avery and Lai [28] it is seen that the critical thinking tendencies of the Chinese students are negative whereas it is positive in the Australian students. The same situation can be thought to exist in Turkish culture. Thus, this type of thinking skills can be considered not to be so familiar with the students who have studied in Turkish culture and Turkish Education System. Infact, Turkish Education System is mostly based on rote-learning style and is teacher-centered from elementary school to university. In addition to this, students are expected to remember the material they have been taught by the teachers in the examinations. Turkish students generally retain knowledge on lower levels of memorization and recitation, without having the ability to analyse, synthesise or evaluate it. However, critical thinking is a high level cognitive skill. Therefore, Turkish students do not need to use this kind of thinking skills.

The variations from the Watson-Glaser Critical Thinking Appraisal Test's pretest to its posttest do not show significant differences between the groups. However, not having differences in quantitative dimension might not mean that the experimental process is totally ineffective.

In this study, critical thinking skills were made content-centered instead of direct teaching. Therefore, the content of the introduction to statistics course was mainly used in teaching of the critical thinking skills. Since the research is based on the use of cooperative learning method in critical thinking skills development, the students were divided into small groups to study in all activities of the whole experimental process.

When the findings related to the activities of the whole experimental process were generally evaluated, it was seen that a great many activities such as forming a safe environment mentioned to be contributing to the development of critical thinking skills in the literature, teaching the students the mutual dependence, encouraging the participation and increasing the interaction between the students in the learning environment, letting the students take their time to think about the questions and the problems asked to them, finding problems, questioning instead of answering, gaining multidimensional points of view, being interested in open-ended questions that do not have only one correct answer [2] were successfully achieved. The experiment group members learned to trust and help each other by means of these activities. They also taught each other different approaches in solving different problems. The group focused on success and their time of studying together increased.

Moreover, Wakefield [29] listed some features to evaluate whether the critical thinking was realised or not. The answers to these provide evaluating the development in the class. When these features are taken into consideration, it can be seen that the students in the experiment group are active and always have dialogues with the reseacher (lecturer) and the social interaction in the classroom, the acceptance and the satisfaction levels are high for both sides.

Common discussions were held during the activities in the class, the questions that can be answered as "yes" or "no" and with only one correct answer were avoided and the students were asked to create as many problems as they could and not to solve them. The reason of this is "the skill of seeing the problem is more important than the skill of solving it" [30]. Exchange of ideas between the

peers was realised. The learnings were structured and planned activities were presented. The researcher guided the activities in the classroom. Her task was to be a facilitator and a guide more than being a lecturer. The researcher (lecturer) made connections between the goals, activities and the evaluations of the course with critical thinking, had enough time for discussions in the courses, presented the students tasks to be thought widely and gave students chance to interact with all the other students.

Therefore, these activities can be considered as useful for the development of critical thinking skills of the students. Although significant increase was not shown in the critical thinking skills of the students measured by the Watson-Glaser Critical Thinking Appraisal Test, it was thought that this lesson could be considered as a beginning for the use of high level thinking skills at least and that it led students to think critically, discuss and listen to other people's thoughts and evaluate them.

Although there were found some clues related to the development of critical thinking skills from the activities realised throughout the experimental process, the researcher held an extra activity to provide the process to be evaluated by the students themselves. After a half semester passed from the conclusion of the experimental process, 12 students randomly chosen from the experiment group were asked some questions relating the general evaluation of the experimental process and an application about a newspaper clipping was applied. It was determined that clues which could be related with critical thinking were rather frequently found among these views. In this point, the researcher thinks that the critical thinking skills exercises realised during the experimental process are useful activities that could get the students into action, enable them to think critically, motivate them and cause development. In addition to this, the observations the researcher had during the whole process support her thought. Moreover, using newspaper clipping concerning research results and / or statistical findings, determining the aim of that clipping, questioning the persuasiveness of it, getting results from it and realising similar activities are important in terms of doing some exercises relating some steps of high level thinking processes and this kind of exercises was successfully achieved by the students. Although the developments in the critical thinking skills were not quantitatively proved, some qualitative evidences were found in this study and they showed the process-result connections in a clearer way.

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