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## Analyzing the effects of the personality traits on the success of online collaborative groups

Seyma Kucukozer-Cavdar<sup>a\*</sup>, Tugba Taskaya-Temizel<sup>a</sup>

<sup>a</sup>*Department of Information Systems, Informatics Institute, Middle East Technical University, Ankara, Turkey.*

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### Abstract

The purpose of this study is to analyze how efficient online study groups can be formed among students based on their personality traits. A survey consisting of Ten Item Personality Inventory (TIPI) was conducted among the undergraduate students in a well-known university. Eighty-two students who did not know each other were assigned to 35 small online groups based on their personality characteristics. The group members were then asked to study collaboratively on a task by communicating via the university's learning management system (LMS) forums. It was found that other factors (such as gender) were more effective than personality traits on the group success, and groups with lower degrees of Emotional Stability scores obtained higher grades over the task. This study is one of the first examples that hierarchically show different factors affecting the success of online groups with data mining techniques. The findings of the study will contribute to the field of online collaborative learning that is one of the most prominent subject in distance education.

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### 1. Introduction

Collaborative online learning is a type of computer-based learning (Bernard & Rubalcava, 2000; Ku, Tseng, & Akarasriworn, 2013), and it has been seen as one of most effective approach of distance education by researches since 1990s (Eklund & Eklund, 1997). The number of online courses, online collaboration platforms and participants in the

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\* Corresponding author. Tel.: +90-312-2107716; fax: +90-312-2103745.  
*E-mail address:* [kseyma@metu.edu.tr](mailto:kseyma@metu.edu.tr)

last decade have been rapidly increased. According to Allen and Seaman (2009), online registrations have been growing faster than campus registrations. These bring about challenging problems with respect to online study group formations in computer supported collaborative learning (CSCL) domain. Several researchers stated that members who are socially familiar or emotionally bonded can work as a team more easily than who do not (Janssen, Erkens, Kirschner, & Kanselaar, 2009; Lee, Bonk, Magjuka, Su, & Liu, 2006; Stark & Bierly III, 2009). However, unlike in face to face classes, students in online classes usually may not have any opportunity to know each other very well. As a consequence, it may be difficult to form effective online collaborative groups in an unfamiliar environment (Brindley, Blaschke, & Walti, 2009).

Many studies investigated how to form study groups while taking into account diverse aspects of students such as their cognitive abilities (Chen & Macredie, 2002), personality characteristics (Chen & Caropreso, 2004), or emotional intelligence levels (Berenson, Boyles, & Weaver, 2008). When forming virtual (online) groups, social aspects of group members is one of the criteria that should be considered in order to increase the efficacy of groups. When forming virtual (online) groups, social aspects of group members is one of the criteria that should be considered in order to increase the efficacy of groups. Muehlenbrock (2006) stated that group quality can be increased by forming groups according to students' profiles and user-context information. Additionally, several studies such as Pieterse, Kourie, and Sonnekus (2006) showed that similarity or diversity on the personality of team members affects group success. The results of the recent studies such as Luse, McElroy, Townsend, and DeMarie (2013) showed that personality characteristics of the participants in virtual groups affect group performance.

Specifically, the relation between personality traits (Big Five Personality Traits) and group performance was investigated in several studies. For example, a positive relationship was found between Extraversion level and group performance (Baer, Oldham, Jacobsohn, & Hollingshead, 2008; Hórreo & Carro, 2007; Rhee, Parent, & Basu, 2013; Thoms, Moore, & Scott, 1996). Agreeableness levels were found positively related to group performance (De Dreu & Van Vianen, 2001; Peeters, van Tuijl, Rutte, & Reymen, 2006). Conscientiousness was considered as the most related trait in both individual and group success (Peeters et al., 2006) since conscientious individuals are described as hard-working, self-disciplined, and reliable. The researchers showed a positive relationship between conscientiousness levels and group performance (De Dreu & Van Vianen, 2001; Peeters et al., 2006). Emotional Stability (or reversely Neuroticism) was also investigated, and a negative relation between the Emotional Stability and group performance was found (Peeters et al., 2006; Rhee et al., 2013). Finally, Hórreo and Carro (2007) showed that heterogeneous groups based on Openness got better results than homogeneous groups, and Baer et al. (2008) found the level of Openness was positively related to the group performance.

The main purpose of this study is to investigate how efficient small online study groups can be formed based on personality characteristics. Two main hypotheses were developed and investigated not only with statistical tests but also with data mining techniques (namely decision tree fit). Unlike other studies in the literature, this study investigates online collaboration of students who do not know each other and study in different faculties. Other factors (such as gender) that affect online group success were also explored and showed in a hierarchical way according to their impact. The method used in this study (decision tree fit) has not been used in previous studies.

## 2. Methodology

The study consisted of two main steps: (1) *Pre-study survey*: It was designed to measure the personality traits of the students. The Turkish version of Ten Item Personality Inventory (TIPI) was applied in the pre-study survey, and (2) *Online study on a learning management system*: The students worked in small online groups which were formed based on their personalities. There were two types of groups in the study: homogeneous or heterogeneous based on the personality traits of the students. The students communicated through an online forum of a learning management system (LMS).

In this study, a causal-comparative design was used since the differences caused by the personality of individuals were investigated and they were not manipulated (Schenker & Rumrill, 2004). In addition, quantitative research methods were utilized for identifying the personality traits of the participants. As the population of the study, the undergraduate freshman students who were registered to an introductory service course about information technologies in a well-known university were chosen. This course was selected for the study as it is mandatory for several departments in the university and the scope of the course is very applicable to study on an online platform.

The main research question of the study is “Is group diversity effective on the online group success? Are there any other factors that affect the group success apart from group types with respect to personality?”. In the context of this study, the group success is measured by the group grade. Two hypotheses developed based on the question are: (1) *There is a difference between the success of homogeneous and heterogeneous online groups*, and (2) *There is a relation between the level of personality trait scores of the students in the group and the group success*.

The online groups were formed based on the personality of the students obtained by the pre-study survey. Since the study was designed to be conducted on an online platform, the bias caused by the students’ access to this online platform were tried to be minimized. For example; even though the students in a group had similar personality, their access to the LMS may have been different (e.g. some may have limited or no forum use experience). In order to minimize these problems, the students’ access information to the LMS was also considered while forming the groups i.e., students with similar access patterns were grouped together.

Homogeneous and heterogeneous groups were formed based on the personality traits. For all the students who had filled the pre-study survey, their personality scores were calculated. In the homogeneous groups, the personality scores between the students should vary marginally. Hence the homogeneous groups were formed in a way that the difference between the personality scores of the students is not greater than 1.5 for each trait.

The size of the groups was determined as three. In case a member dropped out the study, the remaining two members could continue to study together and they were also considered as a group. The group diversity was calculated for determining the level of heterogeneity of groups as in the study of Pieterse et al. (2006) with the following formula:

$$\text{Group Diversity} = \sum_{i=1}^5 f(K_i) \quad (1)$$

$$f(K_i) = \begin{cases} 0 & \text{if all group members have the same preferences in dimension } i \\ 1 & \text{if all but one group member have the same preferences in dimension } i \\ 2 & \text{otherwise} \end{cases}$$

In Equation 1,  $K_i$  refers to the personality scores (preferences) of group members for each trait (dimension)  $i$ . For example, if all the members in the group has same Extraversion scores,  $f(K_1)$  will be equal to zero. If the group diversity was equal to zero, that group was considered as a homogeneous group because all members in the group had similar scores on all the traits. If the group diversity was greater than zero, the group was considered as a heterogeneous group. After the groups were formed, the task which consisted of the topic about “Computer maintenance, security and problem solving” was delivered to the groups. The task consisted of four random questions out of 13 questions. Four sample questions are as following:

- Your computer screen is black. The led button at the bottom of the screen is off. What type of problem is it? (Hardware, software or both, virus etc.) Find a solution to the problem.
- Your colleague, who received your Word document, would like to modify it. However, the document you sent is read only. Give two solutions to handle this situation.
- The Ethernet cable is plugged. Local Area Connection seems to be connected; however the web pages could not be opened with browsers. What type of problem is it? (Hardware, software or both, virus etc.) Find a solution to the problem (there could be multiple solutions to this problem).
- The following error message is received: “Windows cannot start this hardware device because its configuration information (in the registry) is incomplete or damaged.” What type of problem is it? (Hardware, software or both, virus etc.) Find a solution to the problem.

The questions were open-ended, and appropriate to discuss and collaborate online. Four days were given to the students to finish the task. There was no limitation on the duration of working together on the task, however, at the end of four days they were required to submit their answers through the LMS. Before delivering the task, it was ensured that the related materials were provided to the students. The students were only allowed to communicate via the LMS platform’s forums. The reason for forcing them to communicate via the forum was to observe their behaviors

when studying together, to analyze the number and content of messages that each student sent, and also to help them when there was a problem. Each group was able to see only their own group's forum but no one else's. At the end of the study, each group's answers were evaluated by the course instructors. Each group received a grade over 100 points depending on their answers.

### 3. Data analysis and results

In total, 35 online groups (13 homogeneous, 22 heterogeneous groups) finished the task successfully. In these 35 groups, 82 students actually participated in the study. 37.8% of the students were male, and 62.2% of them were female. The results of the analyses are given in the following sub-sections respectively.

**H1:** *There is a difference between the success of homogeneous and heterogeneous online groups.*

The descriptive statistics for the homogeneous and heterogeneous groups are presented in Table 1. Before performing the statistical tests, it was checked whether the group grades were normally distributed. According to the result of Shapiro-Wilk Test, the group grades were normally distributed ( $W=.95$ ,  $N=35$ ,  $df=35$ ,  $p=.10$ ). Hence, t-test was performed on the grades of the groups. However, the result showed that the difference between the grades of the homogeneous and heterogeneous groups was not statistically significant ( $t=-1.14$ ,  $N=35$ ,  $df=33$ ,  $p=.26$ ).

Table 1. Descriptive statistics of the group grades.

	Homogeneous	Heterogeneous
Number of groups	13	22
Minimum grade	36	36
Maximum grade	84	98
Median of grades	73	79.50
Mean of grades	67.46	73.95
Standard deviation of grades	14.65	17.23

In order to further analyze the effects of diversity on group grades, data mining techniques were utilized. It was aimed to find whether there were any other indicators on group grades other than the personality differences such as gender or faculty information. The information about gender, faculty, and total studying days of the groups were added to be analyzed. The total active study days, hereafter called as *ActiveStudyDay*, were determined by analyzing the forum messages of the students. Since the students used the forum of the LMS to communicate and discuss the answers, it was possible to determine in which day they had started to study and in which day they had finished.

It was aimed to identify the most and least effective factors (attributes), so it was best to construct a decision tree upon these factors because decision trees identify the most important variables and remove the unimportant ones if necessary (Timofeev, 2004). The decision tree was fitted by using CART (Classification and Regression Tree) algorithm (Breiman, Friedman, Olshen, & Stone, 1984), and it is depicted in Fig. 1.

It is observed that the first and second splits are based on the *Faculty* attribute which means the faculty of the students is the most related with the group grades. In addition, *ActiveStudyDay* and *Gender* features are effective; the group diversity is the least effective factor on the grades compared to the others. The leaves of the tree show the expected group grade corresponding to the attributes on the branches that they are attached to. For example; if a group belongs to *Faculty 5 class* (i.e., there is no natural science students but only social sciences students in a group), then the expected group grade is 50.33. However, the groups including at least one student from natural sciences performed better compared to the groups comprising only social science students. As expected, those who worked more than other groups (*ActiveStudyDay*>1.5) obtained higher grades than other groups did. In general, the groups comprising at least one male student perform better than the groups comprising solely female students. It is seen from the tree that even though the group diversity based on personality traits in online groups is a factor that affects the group success, there are other more effective factors such as the background of the students (*Faculty*), *ActiveStudyDay* and *Gender*. The effect of diversity varies depending on these variables. At the deepest node, it can be seen that the homogeneous groups (*Diversity*<1) got better results from heterogeneous groups (*Diversity*>=1).

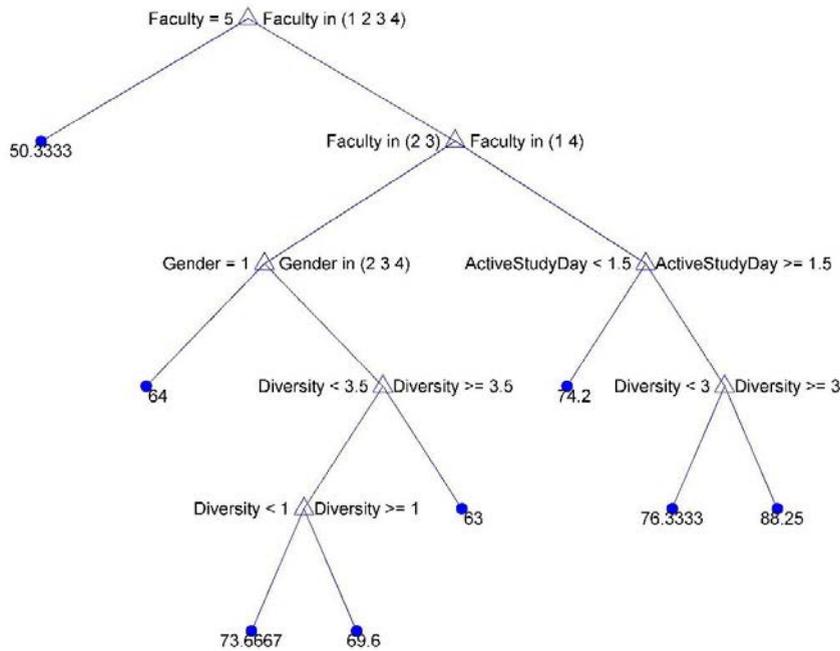


Fig. 1. Regression tree constructed upon faculty, gender, active study days and diversity.

**H2:** *There is a relation between the level of personality trait scores of the students in the group and the group success.*

To analyze the hypothesis, Pearson’s R correlation was used in order to identify the relation between the personality trait scores and the group grades. The results showed that Emotional Stability had a negative effect on group grades ( $R=-.47, N=24, p=.02$ ). However, no significant effect was found for the other traits ( $p>.05$ ).

**4. Discussion and conclusion**

This study aimed to analyze the personality effects on the group success in an online environment. The groups were formed from the students who had not known each other. Unlike other studies in the literature, this study showed the effect of personality differences on the online group success as well as other important factors such as gender, and faculty information of the participants.

Two hypotheses were developed in this study about the personality effects on the group success. The statistical tests were performed in order to analyze the effects of the group type on the group success but the results showed that there was no statistical difference between the grades of homogeneous groups and heterogeneous groups. Different from the previous studies, a regression tree was developed on the attributes of faculty, gender, active study days, and the diversity of groups. The tree showed that the most effective attribute (which was on the first split on the tree) was the faculty. This result is not contradictory with previous studies. As Kolb (1981) stated, the students from different departments or faculties have different learning styles and they may generate different group dynamics. Based on the difference of learning styles between natural science students and social sciences students, it is not surprising that faculty information in the study was found as the most effective factor on the online group success. The study of Alfonseca, Carro, Martín, Ortigosa, and Paredes (2006) also showed similar findings which was that different learning styles affect the student performance in a collaborative setting.

In lower splits of the tree, gender of the students was observed as a second effective factor. This is also another expected result since previous studies showed the effect of gender on online collaborative groups (Ella, Roberta,

Andrea, & Manuela, 2007). The diversity on personality was on the lowest level of the tree which means that it is the least effective factor on the group success. The result can be interpreted as following: The personality traits were considered as an independent variable in this study but there may be other factors which in fact affect the personality and make the personality as a dependent variable. For example, it was shown that the personality characteristics were affected by gender and culture in the study of Gosling et al. (2003). As a result, the factors such as faculty and gender appeared more effective factors than the personality in the tree.

The effects of the personality score levels were also investigated on the group success. The results showed a significant negative correlation between the Emotional Stability scores and the group grades. It can be interpreted as the online groups that have a lower average score on Emotional Stability get higher grades for collaborative tasks. This result is consistent with the previous studies such as the study of Peeters et al. (2006) and Rhee et al. (2013).

This study has several contributions different from previous studies: The first and main contribution is that this study analyzed the effects of several factors (e.g., gender, personality, background of students, and the number of days spent on online study) on the success of online groups simultaneously for the first time in the literature. Previous studies mostly focused on one or two effective factors on the success of online groups. Additionally, the four factors were prioritized based on the level of their effects by using data mining techniques which were not used previously in the studies. The regression tree is a visual result for observing the levels of the factors included hierarchically. The results of the tree were easy to follow and to make predictions about group success based on the effective factors.

The results obtained from this study could help researchers and academics in distance education domain while creating efficient online groups and managing them since online collaboration is one of the most prominent subject in this field. In addition, grouping students based on their personalities still can be considered as a successful method since it leads a better collaborative process (e.g. greater cohesion, communication, or work styles).

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