The Effect of Cooperative Reading- Writing- Application Method on Environmental Science Learning and Writing Skills Development

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Abstract

This study aimed to investigate the effect of the reading-writing-application method from cooperative learning on the understanding of environmental science. Intervention mixed method design was used. The quantitative part of the study was designed with pre- and post-test applied the quasi-experimental design. For the qualitative part of the study, writing reports of preservice science teachers were examined. 58 (31 experiment, 27 control group) third level preservice science teachers were enrolled in the study. To collect data, Environmental Achievement Test, the Scale of Cooperative Working Skills and group reports prepared by preservice teachers were used. The reliability and validity of the measurement tools were assessed, and the test and scale were finalized. In the study, the cooperative reading-writing-application method was found effective for learning environmental science course. According to the data obtained from the Scale of Cooperative Working Skills, there was no difference between the groups in pre- and post-views. According to the data obtained from the group reports, there was progress in writing skills of preservice science teachers.

Keywords: Cooperative learning; reading- writing- application; environmental science course; writing skills; cooperative working skills

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INTRODUCTION

Today, the most important problems human beings face are environmental problems. For example, global climate change, biodiversity reduction, hunger and thirst, water, soil and air pollution have reached significant levels in the world. This situation affects countries in terms of environmental dimension, economic and social corrosion, and it also brings various political problems among countries. Considering that many people from all nations of the world are devoid of environmental awareness, measures taken to overcome environmental problems are still insufficient.

In order to minimize human damage to the environment and to raise awareness of individuals, various organizations around the world are established in the field of environment (Artun & Özsevgeç, 2018). Countries from all over the world participate in these organizations and various protocols are signed. One of the most important issues highlighted in meetings is related to training programs. Many countries have course contents for environmental science in the education system. UNESCO stated that environmental science courses should be included in curricula more than 30 years ago (Almedia & Vasconceles, 2013). One of these countries is Turkey. Environmental education all students take from primary school to university level is located within the primary targeted areas of learning In Turkey. Environmental issues that are being taught in the life science course in primary school and they are included in the science and social sciences course in secondary school. Within the science course, environmental issues are mostly examined by taking "living things" to the center. However, in social sciences course environmental science is mostly examined in terms of geography. Considering the fact that main managers of the livable environment are living things, it can be seen why environmental issues are important for science. Environmental science subjects were included in the Science Training Program which was updated in 2018 and it took part in the "World and Universe" and "Living Things and Life" topics (Ministry of Education, 2018). Besides, when the teacher training program is examined, it is seen that environmental science course has been taught since 2006 in the science teacher graduate program. Environmental science took part in new science teacher graduate program which was updated in 2018 as the name of "Environmental Education", again in Turkey (Higher Education Institution, 2018). The involvement of the environmental course in the science teacher graduate program is important in terms of raising conscious science teachers. Preservice science teachers who are sensitive about the environment may help their students to gain environmental consciousness when they start to teach. The existence of environmentally conscious individuals for a sustainable environment and sustainable development cannot be denied (Uyanık, 2017). In this respect, teachers can be ensured to have environmental awareness while they are at the undergraduate level, and they can aim to instill in their environment at every stage of their lives. This can only be achieved through effective environmental education. In this study, preservice science teachers were studied in environmental science course.

There were several studies related to environmental science in *primary and secondary school* (Artun & Özsevgeç, 2018; Braun & Dierkes, 2017; Çokadar & Yılmaz, 2010; Doğanca Küçük & Saysel, 2018; Herman, 2018; Karpudewan & Roth, 2018), *in high school* (Assaraf & Orpaz, 2010; Ebenezer, Kaya & Kassab, 2018; Moleón & Sánchez-Zapata, 2015; Lombardi, Bickel, Bailey & Burrell, 2018), *at the university level* (Çalık, Özsevgeç, Ebenezer, Artun & Küçük, 2014; Deniz, Donnelly & Yılmaz, 2008; Fettahlıoğlu & Aydoğdu, 2018; Jin, Hokayem, Wang & Wei, 2016; Kahraman, 2019; Trauth-Nare, 2015; Uyanık, 2017). There were also studied with teachers (Almeida & Vasconcelos, 2013; Daskolia, Flogaitis & Papageorgiou, 2006; Liampa, Malandrakis, Papadopoulou & Pnevmatikos, 2017). These studies aimed to *understand the topics and concepts* related to environmental sciences (Artun & Özsevgeç, 2018; Daskolia et al., 2006; Deniz et al., 2008; Doğanca Küçük & Saysel, 2018; Hokayem & Gotwals, 2016; Kiryak & Çalık, 2018). Also, they wanted to develop to *environmental awareness* (Can, Üner & Akkuş, 2016; Fettahlıoğlu & Aydoğdu, 2018; Hashimoto-Martell, McNeill & Hoffman, 2012). In addition, they determined the effect of some *learning methods and techniques* (Christenson, Rundgren & Zeidler, 2014; Çalık et al., 2014; Çokadar & Yılmaz, 2010; Doğanca Küçük & Saysel, 2018; Ebenezer et al., 2018; Ergazaki & Zogza, 2008; Fettahlıoğlu & Aydoğdu, 2018; Jin et al., 2016; Schramm, Jin, Keeling, Johnson & Shin, 2018).

Furthermore, they tried to increase *academic achievement* (Çokadar & Yılmaz, 2010; Jin, Johnson, Shin & Anderson, 2017; Mandrikas, Stavrou & Skordoulis, 2017) in these studies.

Besides, there were many studies especially related to *global climate change* (Liu & Roehrig, 2017; Meehan, Levy & Collet-Gildard, 2018; Puttick & Tucker-Raymond, 2018; Shea, Mouza & Drewes, 2016) and *biodiversity* (Bermudez, Battistón, García Capocasa & De Longhi, 2017; Kilinc, Yeşiltaş, Kartal, Demiral & Eroğlu, 2013; Weelie & Boersma, 2018) in environmental science studies. Provide the conceptual understandings (Bodzin & Fu, 2014; Kilinc et al., 2013; Puttick & Tucker-Raymond, 2018; Weelie & Boersma, 2018), teaching (Bermudez et al., 2017; Puttick & Tucker-Raymond, 2018), determine the students' views (Liu & Roehrig, 2017; Shea et al., 2016), and eliminate the misconceptions related to the topics (Meehan et al., 2018) was aimed in these studies. Similar studies were carried out with *ozone depletion* (Christidou & Koulaidis, 1999; Papadimitriou, 2004) and *greenhouse gases* (Groves & Pau, 1999; Uluçınar Sağır & Bozgün, 2017; Varela, Sesto & García-Rodeja, 2018). In these studies aiming to provide teaching as a whole and aiming to provide teaching with different methods, results were generally obtained that academic success was increased at environmental science course (Aslan Efe, 2015; Güngör & Özkan, 2012; Gürbüz et al., 2012).

Teaching methods and techniques which are suitable for constructivism approach and active learning have been used more frequently the 2000s. One of the ways that provide active learning is cooperative learning. Cooperative learning is a model in which learning is carried out both individually and on a group basis in collaboration with small heterogeneous groups (Belge Can & Boz, 2016; Johnson & Johnson, 2014). Cooperative learning have some properties. First, students in cooperative learning are responsible for both their own learning and their friends' learning in the group. Cooperative studies reveal a common group product. Second, the responsibilities are shared by group members in the cooperative learning. For this reason, there is an attempt to ensure a positive dependency among group members throughout the process. Third, with the principle of face to face interaction, students are encouraged to work together in the group process and students are aimed to develop socially (Johnson & Johnson, 1999; Slavin, 1996). Considering all these properties, cooperative learning has superior aspects compared to the individual teaching techniques.

There are some studies related to understanding environmental science by using cooperative learning (Gürbüz, Çakmak & Derman, 2012; Marinopoulos & Stavridou, 2002; Rozenszayn & Assaraf, 2011). For example, Marinopoulos & Stavridou (2002) investigated primary school students' conceptions about acid rain formation and its consequences to people and the environment. In their study, they divided into primary school students in experimental and control groups. The students of the experimental groups worked collaboratively in small groups. After the implementation, the experimental group students improved their conceptions about acid rain and they realized that not only physical but also chemical phenomena could take place in the air. Similarly, Gürbüz et al. (2012) studied with preservice biology teachers. They investigated the effect of cooperative jigsaw technique on understanding of environmental science course. They found that jigsaw increased preservice biology teachers' understandings related to environmental science.

There are several methods and techniques of cooperative learning that change in topic or grade level such as jigsaw, group research, student teams achievement divisions (STAD) and reading-writing- application (RWA). Among these methods, RWA provides multi-faceted learning by providing both reading, writing and application to students in the learning process (Özdilek, Okumuş & Doymuş, 2018). RWA is applied in three stages: reading, writing and application. Students are encouraged to read the subject in cooperative heterogeneous groups in the *reading stage*. In this process, students are given a set of reading materials, and they read this source together. Thus, face-to-face interaction and positive dependency among students are tried to be provided. At the *writing stage*, reading materials are removed and students are asked to write what they understand from the subject in the form of a group report. In this process, students fulfill their individual responsibility. The *application stage* can be carried out in the form of expression or experiment according to the content of the subject. At this stage, group members tell the subject in the form of a presentation or experiment (Okumuş & Doymuş, 2018a). RWA is an effective cooperative method for academic achievement and

conceptual understanding of science education (Koç & Şimşek, 2016; Okumuş & Doymuş, 2018a). RWA can be develop writing skills. Writing is an action that requires an individual to participate directly in the learning process. Because the individuals begin to write in writing process as a result of making sense in their own mind by reading or listening. Ungan (2007) states that listening, speaking and reading skills should be developed in order to improve writing skills. For this reason, the students can have an effective way to improve their writing skills in the RWA. Because an opportunity is given to the students to make sense of the subject at the reading stage of the RWA.

In countries where classrooms are crowded such as in Turkey, group working can be effectively. Because generally there are not sufficient materials and enough time for individual learning in crowded classrooms. Therefore, cooperative learning is a suitable method for the situation of lack of material and time. In this respect, the implementation of cooperative learning in both academic and social terms positively affects students (Johnson & Johnson, 1999; Okumuş & Doymuş, 2018a; Slavin, 1996) especially crowded classroom unlike conventional cluster study (Johnson & Johnson, 1999). This research study is aim to investigate the effect of the cooperative RWA method on the understanding of environmental science course, to develop cooperative working skills in the process and to enhance the writing skills of pre-service science teachers (PST) on environmental concepts. The main research question of this study is as follows. What are the effects of the cooperative RWA method to the PSTs' academic achievement, cooperative working skills, and writing skills in the environmental science course?

Sub- problems are:

- Are there any effects of the cooperative RWA method on the PSTs' learning related to environmental concepts?

- How do cooperative working skills of the PSTs change throughout the process?

- What is the level of writing skills of the PSTs in environmental science?

METHODS

Intervention mixed method design was used as the quantitative and qualitative data were collected together in this study. The aim of the intervention mixed method is to try to solve a research problem by adding a qualitative dimension to the experimental research process (Creswell, 2015/2017). When applying the intervention mixed method, first, how to use qualitative data is determined. Qualitative data can be obtained at the three stages (before the intervention, during the intervention and after the intervention). In this study the qualitative data were obtained during the intervention and it was obtained from group reports prepared by the PSTs. Besides, in order to obtain quantitative data, a quasi-experimental method with pre- and post-test was used. It is often impossible to carry out true experimental research since it is very difficult to control all variables completely in educational research. For this reason, generally the quasi- experimental method is preferred. In the quasi-experimental design, assigning subjects to groups is not random (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz & Demirel, 2012). That is, the probability of assigning each subject to the experiment and control group are not equal as the groups to be researched are usually pre-determined. The determination of branches at each class level by the school administration can be an example of this situation. In this respect, it is not possible to intervene in the quasi-experimental method of the previously formed groups. That is, classes are intact, or already organized for an instructional purpose. For this reason, which class will be the experimental and the control group are assigned randomly (McMillan & Schumacher, 2010). In this study, two branches were assigned as random experimental and control group. Research method is given in Figure 1.
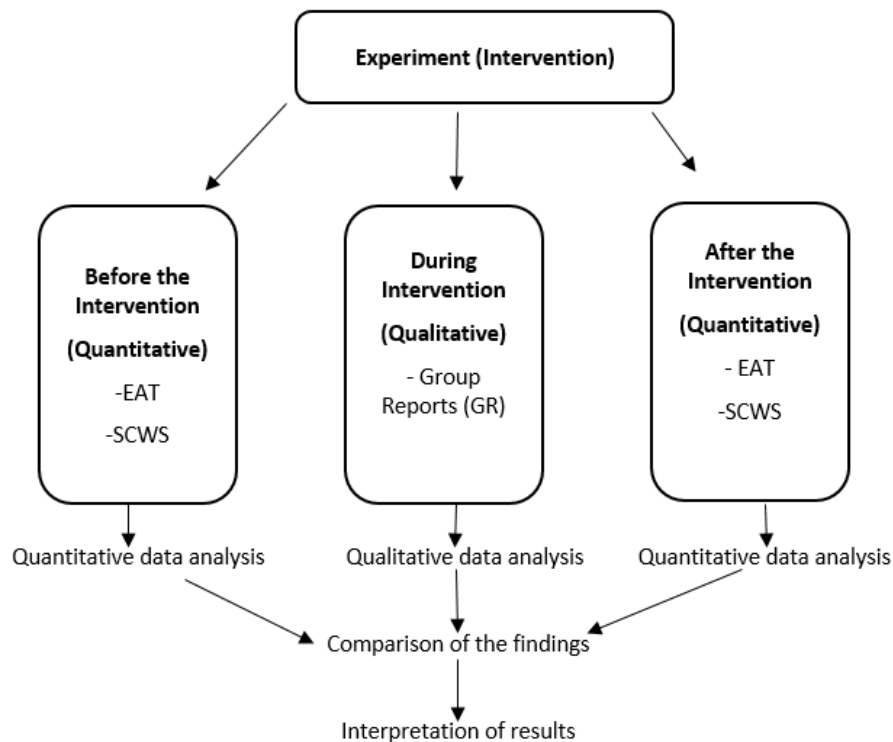
Figure 1. Research Method

Sample

The study was conducted at Atatürk University and convenience sample method was used. Convenience sample method means selecting the most appropriate sample in terms of money, time and feasibility (Büyüköztürk *et al.,* 2012). Because of the researcher studied at Atatürk University, convenience sample method was chosen. This study was carried out with 58 (47 female, 11 male) third- grade PSTs who take environmental science lesson in the spring semester of the 2017-2018 academic year. Cooperative RWA method was applied in the experimental group (n= 31; 29 female, 2 male) and traditional lecture methods were used in the control group (n=27; 18 female, 9 male). The names of the PSTs remained anonymous and PST1, PST2… codes were used.

Data Collection Tools

In order to collect data Environment Achievement Test (EAT), the Scale of Cooperative Working Skills (SCWS) and Group Reports (GR) were used. The EAT contained 30 multiple choice questions related to environmental science first created. For providing the scope validity, a statement table was prepared related to environmental science units (*Basic Concepts about Environmental Science, Major Ecosystems of the World, Food Chain and Food Web, Ecologic Affect, Ecologic Effect, Water and Soil Resources, and Ecological Issues and Problems*). An expert's view was taken and unclear items were corrected in the EAT. In order to provide the test reliability, a pilot study was conducted with 68 PSTs. After the pilot study, three questions were removed from the test and KR-20 reliability of the test was determined as .70. The EAT consisted of 27 questions and its maximum score was 100.

The SCWS was developed by Bay and Çetin (2012). There were five sub-factors in the SCWS: *Positive Dependency (PD), Face to Face Supportive Interaction (FFSI), Individual Responsibility (IR), Small Group Skills (SGS) and Group Process (GP)*. Validity and reliability of the

SCWS were tested by Bay and Çetin (2012). The reliability (Cronbach Alpha) of the SCWS was found α=.98 by Bay and Çetin (2012). Maximum score of the SCWS was 200.

Another data collecting tool was the GRs. These reports were created during the writing step of RWA by each cooperative group member together. The content of the reports included basic information about the subject of that week. Each cooperative group worked together and created their reports. These reports were cooperatively formed group products that formed jointly. In the study, 10 GRs were formed by each group during 10 weeks. The GRs created every week were examined in detail in terms of content, planning/ arrangement and use of the language.

Implementation

In the implementation process firstly, two branches of the third grade of science teacher education program were randomly assigned as experimental and control group. Then, the EAT and the SCWS were implemented as pre-test to all groups. Then, each group took the course according to their own learning method.

In the EG, the RWA of cooperative learning was implemented. Applications of the RWA continued throughout the semester (13 weeks). According to this, the PSTs were divided into six heterogeneous cooperative working groups according to their EATs pre-test scores. Groups were named as G1 … G6. Created groups have worked each week as cooperatively for each sub-unit of the course. The RWA was implemented as three stages: reading, writing and application. During the reading stage, the PSTs read the sub-topic of that week's unit in their group for one hour as cooperatively. At the second lesson, they removed subject materials from the table and wrote what they learned related to the topic in a group report. All cooperative working groups created the GRs. In the application stage, the researcher randomly called a group to the blackboard each week and group members told the subject to their classmates. Sub-topics of the environmental science course are taught in different times depending on the length of units. *"Basic Concepts about Environmental Science", "Major Ecosystems of the World", "Water and Soil Resources"* and *"Ecological Issues and Problems"* units were processed for a week. *"Food Chain and Food Web"* unit was processed for two weeks and the *"Ecologic Effect"* unit was processed for four weeks. The PSTs have created the GRs for 10 weeks in total. After the studies were completed in the class, the EAT and the SCWS were implemented as post-test.

In the CG, the researcher used the conventional method in universities. In this method, the lecturer taught the lesson to the PSTs. In this study, the researcher told the environmental science course to the PSTs. At the end of the semester, the EAT and the SCWS were implemented as post-test in the CG. The process of the study is given in Table 1.

Table 1. Implementation Process

Process /Units	Period
-General information about the course, pre- test of the EAT and the SCWS, creation of the heterogeneous cooperative groups	1 week
-Basic concepts about environmental science	1 week
-Major ecosystems of the world	1 week
-Food chain and food web	2 weeks
-Ecologic affect	1 week
-Midterm exam	1 week
-Ecologic effect	3 weeks
-Water and soil resources	1 week
-Ecological issues and problems	1 week
-Final exam (post-test of the EAT and the SCWS)	1 week
Total	13 weeks

Data Analysis

Firstly, in order to determine whether the data are suitable for normal distribution normality analyses were done. For this reason, Kolmogorov-Smirnov and Shapiro-Wilk normality tests (Can, 2017) were conducted to the data of the EAT and the SCWS. In order to find out the significance of the data, independent samples t-test (Can, 2017) was used to determine whether there was a significant difference between the groups in terms of academic achievement in the pre- and post-test. Also, Mann-Whitney U test (Can, 2017) was used to determine whether there was a significant difference in cooperative working skills. Shapiro-Wilk normality test was done for sub-factors of the SCWS. In order to determine significance of the SCWS Mann-Whitney U test (Can, 2017) was done. Also, effect size of the EAT was calculated. In order to have information about the magnitude of the statistical difference between groups, the effect size value should be known (Can, 2017). The effect size is determined as d=.58. d <.20 "small", .20 <d <.50 "medium", .50 <d <.80 "large" and d> 1 is expressed as "very large" impact size (Green & Salkind, 2005).

Content analysis was carried out for the GRs data. In the content analysis, the data similar to each other are organized in a way that the reader can understand by creating common codes and themes (Yıldırım & Şimşek, 2008). In this study, firstly, the GRs formed by cooperative groups were examined and codes were formed by the researcher. Then, the GRs were coded by an expert. The percentage of codes was checked. For this, Miles and Huberman's (1994) formulas [Reliability= agreement/ (agreement + disagreement) x 100] was used. The reliability percent of content theme was 84.4%, planning/arrangement theme was 95% and use of the language theme was 91.1%. The reliability percent of the all themes was 89.6%. The reliability percent are required to exceed 70% for providing the inter-rater consistency. Accordingly, this value was sufficient for the reliability of the GRs. Codes and themes created for the analysis of the GRs are given in Table 2.

Table 2. Codes and Themes Concerning the Analysis of the GRs

Theme	Sub-theme	Code
Content	Scientific accuracy	Correct as scientifically (CS)
		Incomplete as scientifically (IS)
		Incorrect as scientifically (INS)
	Scope	Complete (C)
		Incomplete (IC)
Planning/ arrangement	Meaningfulness	Meaningful (M)
		Not meaningful (NM)
	Systematic	Prerequisite information given before (PIGB)
		No specific order (NSO)
Use of the language	Word selection	Correct word (CW)
		Incorrect word/ Typing error (IW-TE)
	Structure of sentences	Easy-to-understand sentences (EUS)
		Unclear sentences (US)
	Fluency	Fluent (F)
		Not fluent (NF)

FINDINGS

Findings Obtained from the EAT

The normal distribution of the data obtained from the EAT was determined by Kolmogorov-Smirnov normality test as the number of subjects in EG was more than 30. Similarly, the normal distribution of the data obtained from the EAT was determined by Shapiro-Wilk test because as number of subjects in CG was less than 30. For pre- and post-test of EAT, results of the Kolmogorov-Smirnov test are given in Table 3 and the Shapiro-Wilk test are given in Table 4.

Table 3. Kolmogorov-Smirnov Test Results of the EAT

EAT	Group	Statistics	df	p
Pre-test	EG	.143	31	.11
Post-test	EG	.117	31	.20

According to Table 3 in the pre-and post-test data of the EAT were normally distributed [EG_{pre} (p=.11; p>.05) and EG_{post} (p=.20; p>.05)] in the EG.

Table 4. Shapiro-Wilk Test Results of the EAT

EAT	Group	Statistics	df	p
Pre-test	CG	.959	27	.36
Post-test	CG	.946	27	.17

According to Table 4 in the pre-and post-test data of the EAT were normally distributed [CG_{pre} (p=.36; p>.05) and CG_{post} (p=.17; p>.05)] in the CG. For this reason, independent samples t-test was run to determine the difference between groups. Results of the independent samples t- test are given in Table 5.

Table 5. Independent Samples t- Test Results of the EAT

EAT	Groups	n	X	SD	t	p
Pre-test	EG	31	51.42	12.495	-.615	.54
	CG	27	53.41	12.036		
Post-test	EG	31	79.52	9.976	2.199	.03
	CG	27	73.07	12.322		

According to Table 5, there was not a statistically significant difference between groups as in the pre-test (p>.05). However, there was a statistically significant difference between groups as in the post-test (p<.05). Accordingly, the EAT mean of the EG is higher than CG. The effect size is determined as d=.58. d <.20 "small", .20 <d <.50 "medium", .50 <d <.80 "large" and d> 1 is expressed as "very large" impact size (Green & Salkind, 2005). According to this, it can be said that the effect size was high in this study.

Findings obtained from the SCWS

The normal distribution of data obtained from the SCWS was determined by Shapiro-Wilk test as number of subjects is less than 30 in all groups. Shapiro-Wilk test results for pre- and post-test of the SCWS are given in Table 6.

Table 6. Shapiro-Wilk Test Results of the SCWS

SCWS	Groups	Statistics	df	p
Pre-test	EG	.952	25	.28
	CG	.894	22	.02
Post-test	EG	.925	25	.07
	CG	.840	22	.00

According to Table 6 in the pre- and post-test data of the SCWS were normally distributed [EG_{pre} (p=.28; p>.05) and EG_{post} (p=.07; p>.05)] in the EG. However, the pre-and post-test data of the SCWS were not normally distributed [CG_{pre} (p=.02; p<.05) and CG_{post} (p=.00; p<.05)] in the CG. For this reason, Mann-Whitney U test (Can, 2017) was run fort to the SCWSs pre-and post-test data. Results of the Mann-Whitney U test are given in Table 7.

Table 7. Mann-Whitney U Test Results of the SCWS

SCWS	Groups	n	Mean Rank	Sum of Ranks	U	p
Pre- test	EG	25	25.48	637	238	.43
	CG	22	22.32	491		
Post- test	EG	25	25.32	633	242	.48
	CG	22	22.50	495		

According to Table 7, there were not a statistically significant difference between groups as in pre- and post- test (p>.05).

In order to determine whether there was a significant difference between groups in terms of sub-factors, the post- test data of the SCWS were examined. Firstly, the data was checked for appropriateness to normal distribution. The normal distribution of data obtained from the SCWS was determined by Shapiro-Wilk test as number of subjects was less than 30 in all groups. Shapiro-Wilk test results for the post-test of the sub-factors of the SCWS are given in Table 8.

Table 8. Shapiro-Wilk Test Results of the Sub-Factors of SCWS

SCWS	Groups	Sub-factors	Statistics	df	p
Post- test	EG	PD	.920	25	,05
		FFSI	.875	25	,01
		IR	.796	25	,00
		SGS	.722	25	,00
		GP	.853	25	,00
	CG	PD	.814	22	,00
		FFSI	.878	22	,01
		IR	.726	22	,00
		SGS	.848	22	,00
		GP	.830	22	,00

According to Table 8, only PD sub-factor's data of EG was normally distributed [PD (p=.05; p>.05)]. In all other sub-factors, data were not normal distribution (p <.05). In order to determine the significant difference between the groups Mann- Whitney U test was done. The results of Mann-Whitney U test are given in Table 9.

Table 9. Mann-Whitney U Test Results of the SCWSs Sub-factors

SCWS	Sub-factors	Groups	n	Mean Rank	Sum of Ranks	U	p
Post-test	PD	EG	25	23.90	597.50	272.5	,9.96
		CG	22	24.11	530.50		
	FFSI	EG	25	25.62	640.50	234.5	,3.39
		CG	22	22.16	487.50		
	IR	EG	25	23.78	594.50	269.5	,9.90
		CG	22	24.25	533.50		
	SGS	EG	25	25.50	637.50	237.5	,4.41
		CG	22	22.30	490.50		
	GP	EG	25	24.90	622.50	252.5	,6.63
		CG	22	22.98	505.50		

According to Table 9, there was not a significant difference between groups in sub- factors (p>.05).

Findings obtained from the GRs

Findings obtained from the GRs were categorized into three themes: content, planning/arrangement and use of the language. These main themes were divided into sub-themes and codes. The GRs were created by cooperative group members in EG during 10 weeks. The analyses related to content theme are given in Table 10.

Table 10. Changes in the Groups' Writing Skills related to the Content Theme

Theme	Sub-theme	Code	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
	Scientific accuracy	CS*	All groups	All groups	All groups	All groups	All groups	All groups	All groups	All groups	All groups	All groups
		IS*	All groups	All groups	G2,G3, G6	G6	G3,G4, G5	G2, G3	G1, G5	-	G5	G6
		INS*	All groups	G1,G2, G3,G4, G5	G1, G6	G6	-	-	G4, G5	G4	-	-
Content	Scope	C	G5	G4, G5	G1,G3, G4, G5	G1,G2, G3,G4, G5	G1,G4, G5, G6	G1,G2, G4,G5, G6	G2	G2,G3, G4, G5, G6	All groups	G2,G3, G5,G6
		IC	G1,G2, G3,G4, G6	G1,G2, G3, G6	G2,G6	G6	G2, G3,	G3	G1,G3, G4,G5, G6	G1	-	G1,G4

* More than one classification was made in the relevant code.

According to Table 10, IS and INS expressions decreased in recent weeks in the scientific accuracy sub- theme. Regarding the scope sub-theme, the scope was tried to be created completely throughout the process, but the lack of reports formed by some groups in the last week stands out. The graphs showing the change in the GRs on a weekly basis according to the content theme are given in Figure 2.
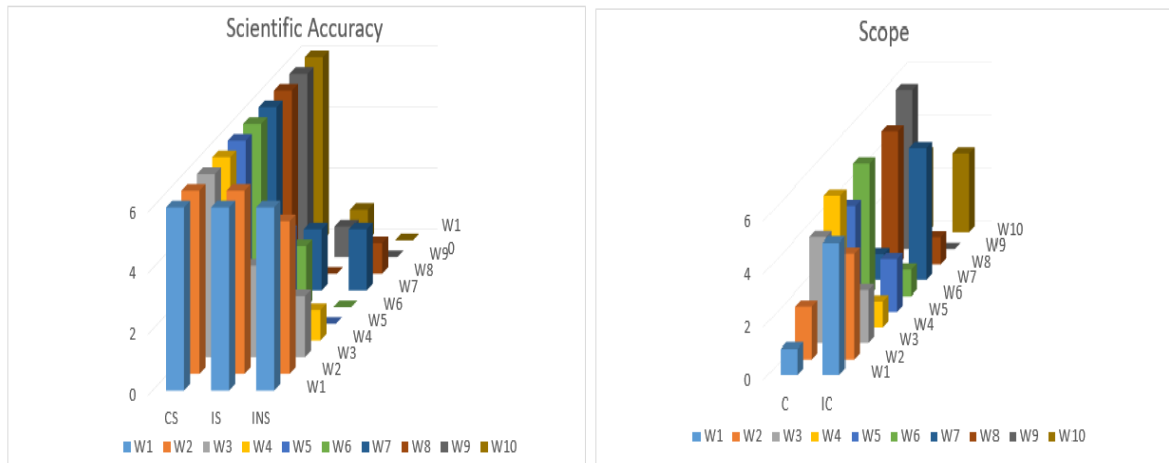
Figure 2. Change in the GRs related to the Content Theme

According to Figure 2, while there was a decrease in complete and missing reports during the process, the scope was tried to be created in general. Some examples related to the scientific accuracy sub- theme are given in Figure 3.
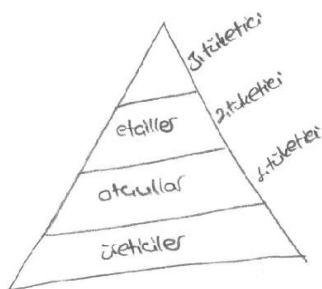
W3- G3

W5- G4

W2-G2

Figure 3. Examples of the GRs related to Scientific Accuracy Sub-Theme

In the third week, the report prepared by G3 was an example of the CS code. According to the report, the PSTs showed producers and consumers, they expressed the main energy source was the sun in the food pyramid. In addition, they stated that the energy decreases and bioaccumulation increases as they reach the upper levels in the food chain. Also, they expressed that the most efficient chain on account of energy is short chain. In the fifth week, the report prepared by G4 is an example of the IS code. According to the report, the PSTs prepared incomplete definition as scientifically related to the surface erosion. According to this, group members reported that surface erosion occurred on the surface of the ground, but this type of erosion did not indicate that rainwater was formed by carrying a thin layer of material on the surface at high slopes. In the second week, the report prepared by G2 had a misconception about desert concept and it was an example of the INS code. According to this, members of the group defined the desert concept as the hot regions of the earth and ignored the concept of cold desert.

The unit scopes related to scope sub-theme of content theme and missing parts of the GRs are shown in Table 11.

Table 11. The Scopes of Unit and Missing Parts of the GRs

Period	Scope	Missing parts					
		G1	G2	G3	G4	G5	G6
Week 1	1- Environment, habitat, ecological niche, species, population 2- Population characteristics, succession, 3- Ecosystem, features of ecosystem, 4- Some basic concepts in ecosystem, rules of tolerance, Liebig's minimum concept	2, 3, 4	2, 3, 4	2, 4	2, 4	+	2, 3, 4
Week 2	1- Terrestrial ecosystems: a. Forest, b. Maquis, c. Meadow, d. Desert 2- Aquatic ecosystems: a. Marine, b. Stream, c. Lake	1, 1c, 2c	1c, 2, 2c	2a, 2b, 2c	+	+	1a, 2c
Week 3	1- Food chain, food webb, 2- Types of food chain, 3- Properties of food pyramid, energy pyramids, bioaccumulation, 4- Live-environment relations, competition, common and mutual life, 5- The continuation of life, biomes, 6-Energy and work	+	5	+	+	+	1, 5
Week 4	A. Matter cycle: 1- Carbon cycle, 2- Phosphorus cycle, 3- Nitrogen cycle, 4-Oxygen cycle, 5-Water cycle. B. Population growth	+	+	+	+	+	4
Week 5	A. Erosion: 1-Geological erosion, 2- Erosion. a. Water erosion, b. Wind erosion, 3- Events caused by erosion, 4- Actions to avoid erosion, B. Forests, 1- Benefits, 2- Forest destruction, 3- Needs to be done to protect forests	+	A1, A2, A4	A2, A2a	+	+	+
Week 6	A. Urban environments, 1- Ecological effects of urbanization, 2- What to do to prevent damages of urbanization, 3. Behavior pollution, 4. Environmental pollution: a. Air pollution	+	+	A2, A4	+	+	+
Week 7	1. Water pollution: a. Stream pollution, b. Groundwater pollution, c. Sea pollution, d. Lake pollution 2. Soil pollution, 3. Depletion of the ozone layer	1, 1c, 1d	+	1b, 1c, 1d, 3	1c, 1d	3	1a, 2
Week 8	1. Radioactive pollution, 2. Noise pollution, 3. Marshes, 4. Waste Water	1, 4	+	+	+	+	+

		W1	W2	W3	W4	W5	W6
Week 9	1. Water resources, a. Turkey's water resources, b. Water consumption, c. Solutions for sustainable use of water, 2. Soil resources, a. Turkey's soil resources, b. Solutions for sustainable use of soil	+	+	+	+	+	+
Week 10	A. Environmental problems 1. Population Growth and space problem, 2. Energy Problem, 3. Agricultural Problems: a. Desertification, b. Desalination and Drought, c. Deforestation. 4. Destruction of Live Species, 5. Global warming	4, 5	+	+	3a, 3b, 4, 5	+	+

The "+" sign indicates that the scope is complete.

As can be seen in Table11, the topics in the GRs formed by the PSTs were usually prepared more extensively from week to week. In reports where deficiencies were detected, all subjects were given completely but the information about the subject was not given completely. However, there were shortcomings in reports of almost all groups in the seventh week. Also, there were missing parts in the fourth group's report last week. The analyses of planning/ arrangement theme of the GRs are given in Table 12.

Table 12. Changings of Groups' Writing Skills related to the Planning/Arrangement Theme

Theme	Sub-theme	Code	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Planning/ arrangement	Meaningfulness	M*	G1, G2, G3, G4, G5	All groups	All groups	All groups	All groups	All groups	All groups	All groups	All groups	All groups
		NM*	G2, G4, G5, G6	-	-	-	-	G1,G2	-	-	-	-
	Systematic	PIGB	G5	All groups	G1,G3 G4,G5 G6	All groups	G1,G3 G4,G5 G6	G2,G3 G4,G5 G6	All groups	G1, G2, G3, G5, G6	G1,G3, G4,G5, G6	All groups
		NSO	G1, G2, G3, G4, G6	-	G2		G2	G1	-	G4	G2	-

* More than one classification was made in the relevant code.

In Table 12, all reports of groups were understandable as per meaningfulness sub-theme. In the first week and the sixth week, there was a problem in the clarity of some reports. Regarding the systematic sub-theme, more systematic reports were created as the process progressed in all groups and pre-condition information was given at first. Especially, reports formed by G2 did not have a specific order in some weeks. The graphs showing the change in the GRs on a weekly basis according to the planning/ arrangement theme are given in Figure 4.
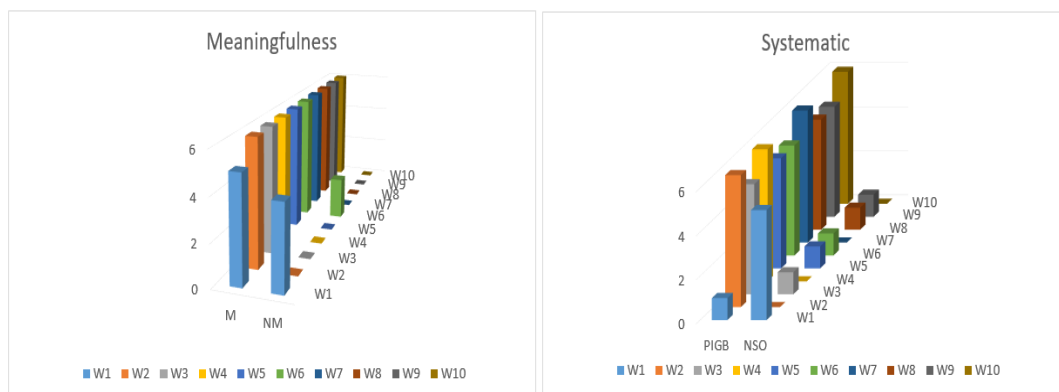
Figure 4. Change in GRs related to the Planning/ Arrangement Theme

Figure 4 shows that there was a positive improvement in the sub-themes of meaningfulness and systematic throughout the process. Some examples related to the meaningfulness sub- theme are given in Figure 5.
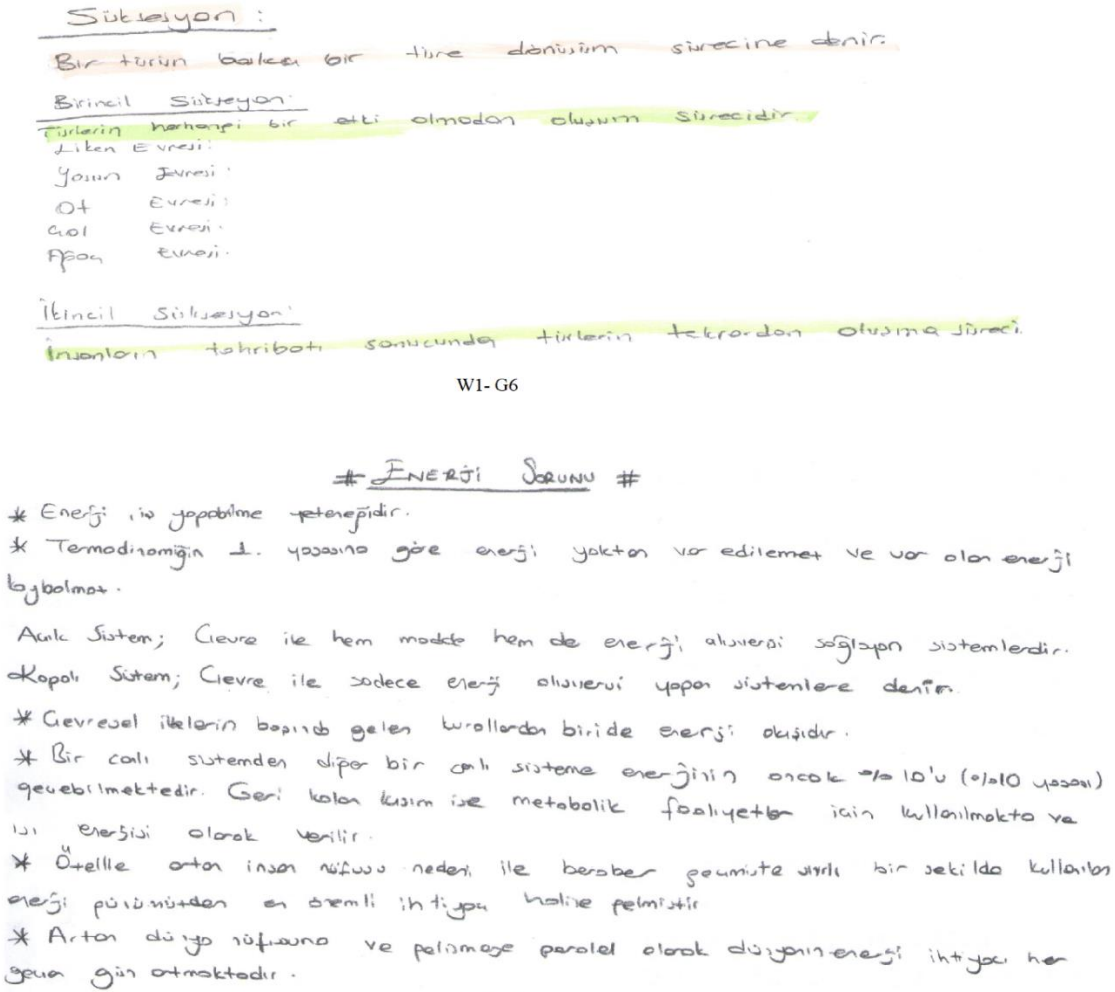

W1- G6

W10- G5

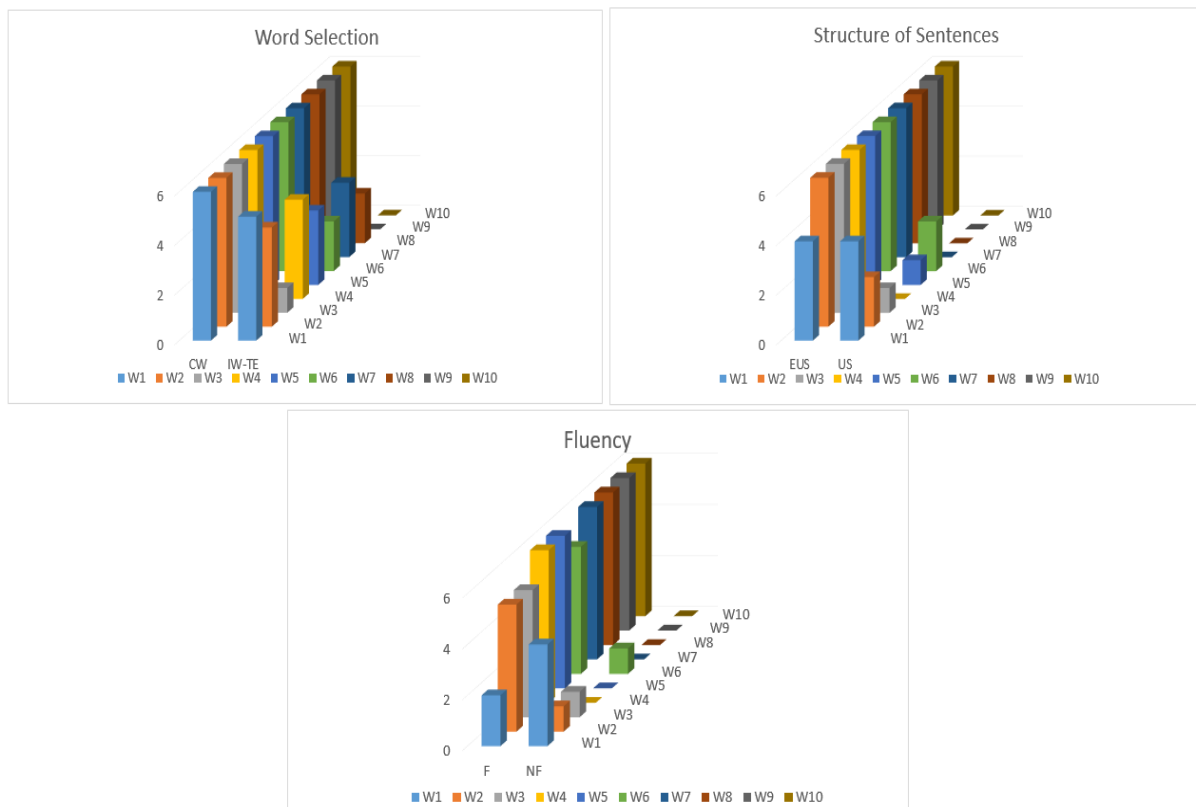**Figure 5. Examples of GRs related to the Meaningfulness Sub-Theme**

According to the report prepared by G6 in the first week, it was seen the members of the group did not know the definition of succession, they had deficiencies in concepts of primary and secondary succession and their sentences were not significant in Figure 5. In the 10th week, the members of the group mentioned the basic ideas about the energy problem in the report of G5. According to this, group members specified the definition of energy, the first law of thermodynamics, open and closed systems, 10% law and the importance of energy. In this respect, it can be said that the report was formed in a meaningful way. This example also pictures the systematic sub-theme. When the GRs prepared by groups regarding the systematics sub-theme of the planning/arrangement theme were examined, the order of presentation of subjects was not paid attention, especially in the first week reports. The reports were more systematic as the process progressed and the order of subjects was taken into consideration. The analyses of use of the language theme of the GRs are given in Table 13.

Table 13. Changes in Groups' Writing Skills related to the Use of the Language Theme

Theme	Sub-theme		Code	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Use of the Language	Word selection		CW*	All groups	All groups	All groups	All groups	All groups	All groups	All groups	All groups	All groups	All groups
			IW-TE*	G1,G2 G3,G4 G6	G1,G2 G3,G6	G1	G1,G4 G5,G6	G1,G2 G5	G2,G4	G2,G3 G5	G1,G3	-	-
			EUS*	G1,G3 G4,G5	All groups	All groups	All groups	All groups	All groups	All groups	All groups	All groups	All groups
	Structure sentences		US*	G2,G4 G5,G6	G2,G3	G1	-	G2	G1,G2	-	-	-	-
			F	G1,G3	G1,G2 G4,G5 G6	G1,G2 G3,G4 G5	All groups	All groups	G2,G3 G4,G5 G6	All groups	All groups	All groups	All groups
	Fluency		NF	G2,G4 G5,G6	G3	G6	-	-	G1	-	-	-	-

* More than one classification was made in the relevant code.

According to Table 13, in the sub-theme of the word selection words with the incorrect words/typing error were found along with correct words in all groups. Typing errors were often related to the misspelling of words. All reports related to the structure of sentence sub-theme contained easy-to-understand sentences, but there were difficult to understand sentences especially in the first weeks. Regarding the sub-theme of fluency, all reports progressed positively during the process but some reports were not fluent, especially in the first week. The graphs showing the change in the GRs on a weekly basis according to the use of the language theme are given in Figure 6.

Figure 6. Change in the GRs related to the Use of the Language Theme

According to Figure 6, the word selection was made correctly throughout the process, the structure of sentences improved gradually and the fluency increased. Some examples related to the word selection sub- theme are given in Figure 7.

W4- G6

W7- G2

Figure 7. Examples of the GRs related to the Word Selection Sub-Theme

Figure 7 showed that the PSTs experience problems in writing some terms. In this theme, IW-TE codes were high throughout the process. In the fourth week of G6s report, the word fossil was incorrectly written and also in the seventh week of G2s report, the words of eutrophication and erosion were incorrectly written. Some examples related to the structure of sentences sub- theme are given in Figure 8.

W3-G1

W5-G2

Figure 8. Examples of the GRs related to the Structure of Sentences Sub-Theme

According to Figure 8, in the third week, definitions of primary production and net primary production were written wrongly and definitions were not understandable in the report prepared by G1. Here, the term "producer" was referred to as the total primary producer and the net primary production was defined as the net first producer. So, written definition was not understandable. In the

fifth week of G2s report, there was a short sentence. What the sentence means was not exactly understood. Some examples related to the fluency sub- theme are given in Figure 9.
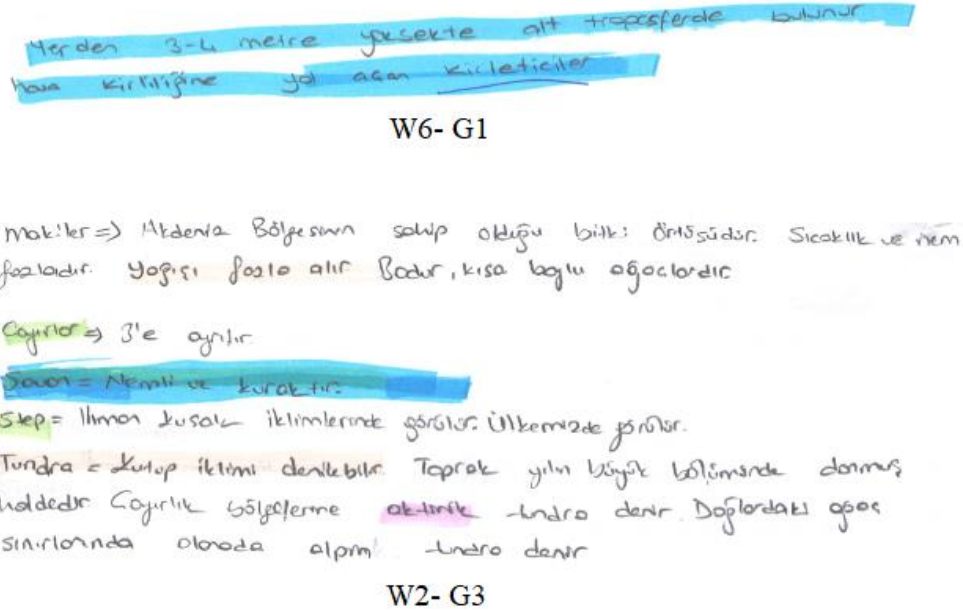
Figure 9. Examples of the GRs related to the Fluency Sub-Theme

According to Figure 9, G1s report in the sixth week was intended to provide information on pollutants causing air pollution, but the sentence was low. In the report prepared by G3 in the second week, an example was given from the section where maquis and meadows were told from biomes. Accordingly, there were both deficiencies and inaccuracies in explanations. So, sentences were not fluently prepared as a whole. That is to say, what the term meadow was not explained and the maquis is grown in places where precipitation was abundant in a wrong way. In addition, which climatic savannas dominate was not exactly stated.

DISCUSSION AND CONCLUSIONS

According to the findings of the first research question, these results were found. The mean of groups was equal in the pre-test of the EAT (p>.05). Considering that the PSTs in the experimental and control groups settled with similar scores to the science teacher education program and have not yet taken the environmental science course, it was expected that the PSTs' foreknowledge level was similar. A significant difference was determined between groups in favor of the experimental group with regard to academic achievement in post-test of the EAT (p<.05). Accordingly, the RWA method was effective in increasing academic achievement. The most important reason for the increase of academic achievement at the RWA method was the combination of reading, writing and application activities in group work. During the reading stage, the PSTs began to understand the subject by reading both individually and in groups, and in the writing stage, they formulated their reports in line with the common opinion of the group (Okumuş & Doymuş, 2018b). Writing stage demonstrated the PSTs' understandings from reading stage. Therefore, the PSTs expressed their understandings related to reading stage during writing process (Okumuş & Doymuş, 2018b). In the application stage, group members found the opportunity to reinforce their learning by telling their classmates. All these stages require direct participation of individuals in the learning process (Okumuş & Doymuş, 2018b). In traditional teacher expression, only auditory and visual learning is provided, which reduces the persistence of learning. However, when the individual reads and writes on her/his own, subjects remain more in mind and learning becomes easier. In this respect, the performance of the PSTs can be measured by looking at group reports in the RWA method. It is difficult to compare this study with other studies since no a study has been found in the literature related to the environment course in undergraduate level using the RWA method. Because, the use of RWA method in cooperative learning

is not very common (Okumuş & Doymuş, 2018a). But, in some studies conducted with secondary school and undergraduate students, the RWA method had a positive effect on academic achievement (Aksoy & Gürbüz, 2013; Okumuş & Doymuş, 2018b; Okur Akçay & Doymuş, 2014).

According to the findings of the second research question, there was not a significant difference between the groups in the pre- and post-test of the SCWS implemented for finding out the cooperative working skills (p>.05). Also, there was not a significant difference between groups with regard to sub-factors in the post-test (p>.05). It could not be reached enough study on the development of cooperative working skills in the cooperative learning researches. In addition, no research on the effect of the RWA method on cooperative working skills could be reached. In parallel to this study, in Varank and Kuzucuoğlu (2007) and Yılar and Şimşek (2016) studies, there was not a difference among students related to the cooperative working skills. According to this research results it could be said that a 10-week study period could not sufficient to provide principles (positive dependency, face to face supportive interaction, individual responsibility, small group skills and group process) of cooperative learning in this study. During the implementation stage, group members were encouraged to work together and the group was tried to be perceived as a single body. However, the guidance was not enough. In order to gain full group spirit, the PSTs may be given common group scores in evaluations. Thus, each member is responsible for the score of the other group members and cooperative working skills of members can be improved.

According to the findings of the third research question these results were found. As a result of examining the GRs in terms of the content, planning/arrangement and the use of the language themes, the PSTs' writing skills increased during the 10-week writing process. The content theme was analyzed in terms of how accurate reports were and how much the subject was covered. According to this, scientifically correct expressions were included in all reports, and statements that contained misconceptions and scientifically incomplete, and misconceptions generally decreased during the process. This situation may be an indication that the PSTs have increased their reading comprehension skills throughout the process. Because if the individuals understand what they read correctly, they may express concepts correctly. In fact, Lawwill (1999) stated that writing necessitates more thinking on concepts and develops thinking skills by linking the previous information with new information. Research on the development of writing skills has been reported to increase the conceptual understanding of students' development of writing skills (Akçay, Özyurt & Bezir Akçay, 2014; Akkuş, Günel & Hand, 2007; Chin, Yang & Tuan, 2016; Kıngır, Geban & Günel, 2013). For all that Armstrong, Wallace and Chang (2008) emphasized that students must be explicitly taught when and how to use different metacognitive strategies for effective writing. As a result of the findings obtained in this study, scientifically correct expressions have increased throughout the process and lack of incomplete expressions and misconceptions have a positive effect on conceptual understanding. In contrast to the results of this study, Armstrong, *et al.* (2008) reported that writing had a minimal impact on conceptual understanding in their study of the effect of writing assignments on conceptual understanding of biology. Regarding the scope sub-theme, reports usually contained the whole scope through the last weeks. PSTs' expressing the scope in their report shows that they understand the subject well. But in several reports in the seventh and tenth week, there were deficiencies related to the scope of the subject. This may be due to the fact that the PSTs do not pay due attention to reports. Because the PSTs may have fallen into disorientation in recent weeks because the school is close to finishing.

In the theme of planning/arrangement, reports were examined according to the sub- themes of meaningfulness and systematic. It can be said that the meaningfulness of group reports increased during the process. This shows that the PSTs started writing more meaningfully throughout the process. Similarly, reports written during the process were more systematically generated. So, the subject was understood correctly by the PSTs by looking at both sub-themes. In this respect, writing skills which were targeted in the RWA were reached. Conner (2007) carried out a research with high school students related to effective writing. She found that students who planned the process and monitored and evaluated their work produced essays of higher quality. According to this, it can be concluded that planned and scheduled action allows the reports to be more systematic and meaningful.

In the theme of use of the language, reports were examined according to sub themes of word selection, structure of sentences and fluency. Accordingly, incorrect reports and typing errors were determined in all reports. It was also seen that especially errors were corrected in the last two weeks. This may be due to the fact that the PSTs do not pay due attention to reports. Because the PSTs may have fallen into disorientation in recent weeks because the school is close to finishing. The correct use of the language, right choice of words, is essentially an issue of linguistics. Since, this study was related to the science, it does not analyze linguists. Instead, whether the PSTs correctly chose concepts in the environmental science and they made any mistakes in the writing of these concepts were examined. At this point, comments can be said about the correct use of the language in learning environmental science concepts. When statements in reports were examined, the PSTs sentences became more easily understood throughout the process. The same applied to the fluency sub-theme. Based on this situation, it can be interpreted that writing activities increase the ability of individuals to use of the language. Günel, Hand and McDermott (2009) expressed that students translate the science language into an everyday form of language that they can understand for themselves. Then, to provide meaning for their reader, they translate this meaning into an audience language in writing process. These translation process require students to engage in content knowledge (Jang & Hand, 2017) and also use language fluently. As a result of the combination of reading and writing activities of the RWA, individuals could read and understand what they read. Hence, they could made it easy to translate what they understand. As a matter of fact, Ungan (2007) emphasized that reading comprehension skills should be good for writing skills to be developed. Consequently, RWA increased academic achievement in the environmental science course, the PSTs improved their writing skills, and the desired level of cooperative work skills could not be reached. The results from this study are useful in providing additional information to a developing body of research on environmental studies in undergraduate level. Also, this study can contribute to the limited number of the RWA studies in the literature. Some suggestions could be given to the researchers for further studies:

- This study's sample size was small so, it does not allow for generalizable conclusions. This issue can be re-studied with a larger sample and at different universities.

- It can be advisable to implement the cooperative RWA method in comprehensive studies in which development and change of writing skills will be investigated.

- This issue can be re-studied with secondary school students and try to enhance writing skills and achievements of students.

- The activities that promote positive dependency and face to face supportive interaction may be further increased for developing cooperative working skills.

- Due to the fact that the environmental science course takes place in all levels of education and has an important place in gaining environmental awareness, studies could be carried out both in terms of conceptual and positive attitude by using different methods and techniques.

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