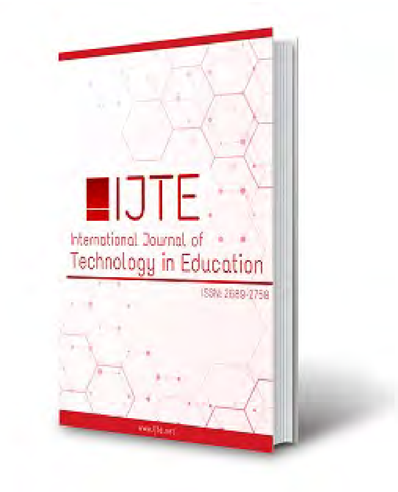

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Abstract

The aim of this study was to determine the effect of flipped classroom model on fifth grade students' 21st century skills and scientific epistemological beliefs. The sample of the study was consisted of 54 fifth grade students from a rural elementary school in Turkey. Quasi-experimental design with pre-test and post-test control group was used. As a data collection tool, "Scientific Epistemological Beliefs Scale" and "21st Century Learning Skills Scale" was used. For data analysis, independent t-test and dependent t-test were used. As a result of the study it was found that; at the beginning, there was no significant difference between the experimental and control group students' pre-test scientific epistemological beliefs. After the implementation, there was no significant difference between the experimental and control group students' post-test scientific epistemological beliefs mean scores. In addition, at the beginning of the study, there was no significant difference was found between experimental and control group students' 21st century skills. After the implementation, there was no significant difference was found between experimental and control group students' 21st century skills after the implementation.

Introduction

Epistemological beliefs are the beliefs about knowledge and knowing (Hofer & Pintrich, 1997). The epistemological beliefs researches have been changing and developing since Perry's work. Early studies (for example, King & Kitchner, 1994; Kuhn, 1991; Baxter Magolda, 1992; Perry, 1970) assumed that epistemological beliefs were unidimensional and developed longitudinally. Unlike unidimensional view of epistemological beliefs, some researchers like Schommer (1990) believed that epistemological beliefs were complex and multidimensional. According to Schommer, epistemological beliefs have four dimensions: *simple knowledge* (the structure of knowledge is integrated to simple), *certain knowledge* (knowledge is tentative to certain), fixed *ability* (ability is inborn to lifelong) and *quick learning* (the speed of learning is quick to gradual). Since each dimension is independent, all dimensions do not have to develop concurrently.

On the other hand, Hofer and Pintrich (1997) stated that *fixed ability* and *quick learning* dimensions are related to nature of learning, not nature of knowledge or knowing. Thus, these dimensions should not be included in epistemological beliefs dimensions, they are nature of learning. Then, Hofer and Pintrich (1997) proposed four epistemological beliefs dimensions; *knowledge is certain*, *knowledge is simple*, *source of knowing* and *justification for knowing*. They defined the epistemological beliefs as personal beliefs related to nature of knowledge and knowing. Accordingly, the *source of knowledge* and *justification of knowledge* is related to nature of knowing whereas *certainty of knowledge* and *simplicity of knowledge* is related to nature of knowledge. In the *source of knowledge* dimension, people having naïve epistemological beliefs think that the source of knowledge is external authorities such as teacher, textbook, parent whereas people having sophisticated epistemological beliefs think that the source of knowledge is her/himself. In the *justification of knowledge* dimension, people having naïve epistemological beliefs think that the knowledge claims are evaluated in terms of external authorities whereas people having sophisticated epistemological beliefs think that knowledge claims are evaluated by empirical data or findings. In the *certainty of knowledge* dimension, naïve belief is the knowledge is certain whereas sophisticated belief is the knowledge is tentative. In the *simplicity of knowledge* dimension, naïve belief is the structure of knowledge is simple, i.e. knowledge consisted of isolated pieces, whereas sophisticated belief is the knowledge is consisted of integrated pieces (Hofer & Pintrich, 1997).

According to Muis, Bendixen & Haerle (2006) and Hofer (2006), epistemological beliefs are domain specific, i.e. people could have different epistemological beliefs in science and mathematics domain. Thus, in the study, epistemological beliefs are considered in science domain and four epistemological beliefs dimensions proposed by Hofer and Pintrich (1997) were used, like Kuhn (1991), Elder (2002), Conley, Pintrich, Vekiri & Harrison (2004), Wegner and Weber (2017). Thus, in the present study, the change of fifth grade students' epistemological beliefs was examined by using Hofer and Pintrich view.

It was posited that it is difficult to determine younger students' epistemological beliefs so there was not much research on this topic and the studies related to development of epistemological beliefs was generally on older students, such as college students (Pintrich, 2002, Conley et al. 2004). There are some studies on younger students but valid intervention studies are needed on elementary students (Bendixen, 2016, Valla & Williams, 2012; Schiefer, Golle, Tibus, Herbein, Gindele, Trautwein & Oschatz, 2020). For example, Elder (2002) found that fifth grade students' epistemological beliefs in science was relatively sophisticated on justification of knowledge dimension and naïve beliefs on source of knowledge.

It is important to develop young students' epistemological beliefs in science in order to make students scientifically literate. Scientific literacy, which is main goal of many curriculums (such as Ministry of Education, 2018; National Research Council, 1996), includes some aspects of nature of knowledge and knowing such as epistemological belief dimensions of certainty of knowledge. Also, epistemological beliefs are positively correlated with some constructs such as academic achievement (Greene, Cartiff & Duke, 2018), conceptual understandings (Elby, Macrander & Hammer, 2016) and science interest (Fujiwara, Laulathaphol & Philips, 2012).

Learning environment, method and technique have a great influence on students' scientific epistemological beliefs (Deryakulu & Bıkmaz, 2003). For example, Conley et al. (2004) examined the effect of hands-on science activities on fifth grade students' epistemological beliefs. They revealed that at the end of the intervention, students' epistemological beliefs on source of knowledge and certainty of knowledge dimension changed to sophisticated but not the other dimensions. Like Conley et al. (2004), Schiefer et al. (2020) found out that third and fourth grade students' epistemological beliefs were improved by the intervention including inquiry and reflections on epistemic issues. Although there are some studies, Bendixen (2016) and Schiefer et al. (2020) stated that the studies related to the elementary students' change of epistemological beliefs are relatively novel and growing. Bendixen (2016) also stated that experimental or quasi-experimental studies related to epistemological beliefs is rare and there is need for this kind of studies.

Islıcık (2012) examined the effect of constructivist learning environments on eight grade students' scientific epistemological beliefs, it was determined that the effect of constructivist learning environments on scientific epistemological beliefs was positive. Flipped classroom is one of the constructivist student-centered instructional models (Felder, 2012; Lewis, Chen & Relan, 2018) since students learn the theoretical knowledge at home with online training materials such as video, film and sound; in class students do cooperative learning and problem solving activities (Bergmann & Sams, 2012). Thus, students construct their understanding actively at home while using online materials and give meaning to the content (Ng, 2014). Al-Samarraie, Shamsuddin and Alzahrani (2020) stated that flipped learning in science disciplines promotes epistemological beliefs. Lekhi and Nashon (2016) found out that undergraduate science students' epistemological beliefs were developed in the flipped classroom. Lee, Park & Davis (2018) stated that flipped classroom extensively used in higher education. According to our knowledge, there is not study related to the effect of the flipped learning on elementary students' epistemological beliefs. Thus, in the present study, this is investigated.

Like epistemological beliefs, the development of 21st century skills are also important. The reason is that in order to develop 21st century skills, it is necessary to develop epistemological beliefs (Shaakumeni, 2020). As new technologies and innovations are evolving in 21st century, students need some skills to keep up with these novelties. According to the curriculum documents (such as MEB, 2018; NGSS, 2013); knowing scientific topic alone is not adequate; students should develop reasoning ability, scientific thinking habits and decision making skills by using socio-scientific issues and also students should understand out of school science and be willing to develop career in science and develop entrepreneurship skills. Thus, in order to be successful, students should have 21st century skills.

Valtonen et al. (2017) stated that students should have 21st century skills for the present and the future. 21st century skills have variety of definitions (National Research Council NRC, 2011; Assessment and Teaching of 21st Century Skills ATC21S, Partnership for 21st Century Skills P21, 2015) but the common point of these definitions are: communication and collaboration skills, information-communication-technology literacy, societies and intercultural skills, creativity and innovation, critical thinking and problem solving. The development of 21st century skills is important because students could get high pay, satisfying and enjoyable jobs and also students get skills for renew their urban life (Schwarz & Stolow, 2006). Rahimi, Shute, & Zhang, (2021) stated that research related to foster 21st century skills is appropriate and beneficial. Having 21st century skills in the learning and teaching process enables students to lead a better quality and successful life, to find simple solutions to any problem and to approach events and situations from different perspectives (Şahin, Ayar

& Adıgüzel, 2014). Bridge (2019) found out that 8th grade students developed communication skills while using iPad devices and mini-lectures related to 21st century skills of communication and collaboration. The flipped classroom model could be effective for promoting students' 21st century skills since Chis, et al. (2018) stated that the flipped classroom develops 21st century skills of critical thinking, creativity, communication and collaboration. Also, Fulton (2012) mentioned that one of the advantages of the flipped classroom is efficient for 21st century learning because it has flexible and proper technology usage. Thus, in the present study, the effect of flipped classroom on elementary students' 21st century skills are investigated.

There are many definitions related to the flipped classroom model. Unlike traditional classes, flipped classroom model is defined as a model where the student learns the theoretical knowledge at home with online training materials such as video, film and sound; student reinforces the knowledge he/she learned by applying in the classroom, where all the time in the class he/she is active and he/she performs problem solving, group work and activities (Bergmann & Sams, 2012). The flipped classroom model consists of in-class group work, individual learning activities and out-of-class computer-based learning activities (Bishop & Verleger, 2013). Kara (2015) defines the flipped classroom model as a model in which the student takes an active role in her own learning, unlike traditional classes, the teacher guides students in their individual learning and where homework and lecture are replaced. The model has benefits such as guiding teachers, reducing classroom problems, saving time, communicating effectively with students, dealing with students individually or as a group (Gençer, Gürbulak & Adıgüzel, 2014).

The flipped classroom model is the method where creativity is at the forefront, and skills such as teamwork and leadership are used. It is thought that the application of the flipped classroom model will contribute to the development of students' 21st century skills and scientific epistemological beliefs (Herreid & Schiller, 2013). The flipped classroom model will positively affect the 21st century skills such as communication, collaboration, teamwork, leadership and responsibility during the activities. Students' scientific epistemological beliefs improve because students access information subjectively by using technology tools while accessing the information. Also, students will have awareness of what information they need, and have self-orientation during activities. In this study, the effect of the flipped classroom model on fifth grade students' 21st century skills and scientific epistemological beliefs were investigated. The research questions are as follow:

1. Is there a statistically significant difference between experimental and control group students' pre-test scientific epistemological beliefs?
2. Is there a statistically significant difference between experimental and control group students' post-test scientific epistemological beliefs?
3. Is there a statistically significant difference between experimental and control group students' pre-test 21st century skills?
4. Is there a statistically significant difference between experimental and control group students' post-test 21st century skills?

Experimental group students;

1. Is there a statistically significant difference between pre-test and post-test scientific epistemological

beliefs?

2. Is there a statistically significant difference between pre-test and post-test 21st century skills?

Control group students;

1. Is there a statistically significant difference between pre-test and post-test scientific epistemological beliefs?
2. Is there a statistically significant difference between pre-test and post-test 21^{st} century skills?

Method

Research Model

In the study, the pre-test and post-test control group quasi-experimental design (Fraenkel & Wallen, 2000) was used in that the two classes were assigned as a control group and an experimental group randomly. Thus, in the present study, the effectiveness of the flipped classroom model through 5E learning model (experimental group) versus 5E learning model (control group) on fifth grade students' 21^{st} century skills and scientific epistemological beliefs was investigated. In control group, students already instructed with 5E learning model.

Sample

The sample of the study consists of two intact 5^{th} grade classrooms in the middle school. One of these classes is control group and the other is experimental group and they were instructed by the same teacher. The control group (11 girls, 16 boys) and experimental group (10 girls, 17 boys) comprised of 54 students. The research has an ethical approval from ethical committee.

Instrumentation

In this study, "Scientific Epistemological Beliefs Scale" and "21^{st} Century Learning Skills Scale" were used as a pre-test and post-test to each group.

Scientific Epistemological Beliefs Scale

The Turkish Form of the Scientific Epistemological Beliefs Scale, which is the original version developed by Elder (1999) to measure the beliefs of elementary students within the scope of scientific knowledge, was adapted to Turkish culture by Acat, Karadağ, Tüken (2010). The scale consists of a total of 25 items, five factors and 15 items positive and 10 items negative. The scale is a 5-point Likert type (Strongly Disagree-1, Disagree-2, Undecided-3, Agree-4, and Strongly Agree-5). The factors of the scale adapted for Turkish culture are as follows; *authority and accuracy, the process of knowledge production, source of knowledge, reasoning* and *changing nature of knowledge*. *Authority and accuracy* factor includes the belief that the certainty of the scientific knowledge and scientific knowledge is outside the individual. *The process of knowledge production* factor addresses the empirical basis in the formation of the scientific knowledge. *Source of knowledge* factor addresses the beliefs of the individual regarding the accuracy of the knowledge he/she obtained from other sources of knowledge. *Reasoning* factor addresses the beliefs about the role of prior knowledge, logic and scientific curiosity in the formation of scientific knowledge. *Changing nature of knowledge* factor addresses the beliefs about the imprecise nature of scientific knowledge. In the present study, Cronbach's Alpha reliability coefficient was found as 0.86. Cronbach's Alpha reliability coefficient of the sub-dimensions of the scale varies between 0.51 and 0.89.

21st Century Learning Skills Scale

The 21st Century Learning Skills Scale was developed by Gülen (2013) for determining the 21st century skill levels of students. The scale is one of the 5-point Likert type (None- 1, Very little- 2, Sometimes- 3, Often- 4 and Always- 5). The scale consists of four sub-dimensions and 33 items. These are; *active learning skills, learning to learn skills, problem solving skills* and *cooperation and communication skills*. In the present study, Cronbach's Alpha reliability coefficient was found as 0.94. Cronbach's Alpha reliability coefficient of the sub-dimensions of the scale varies between 0.65 and 0.94.

Treatment

This treatment took 6 weeks. The first author observed the experimental and control group for teacher effects and treatment verification. Lesson plans for two groups were prepared on Matter and Change unit. Before intervention, the pilot study was conducted. The pilot study (10 girls, 17 boys) was consisted of 27 students. The teacher was trained by the first author about the flipped classroom model. The activities for both groups were prepared in cooperation with the first author and the teacher.

Control Group

The current curriculum was applied to the control group. This means that lesson plans were prepared according to 5E learning model, which is proposed in National Curriculum. The Matter and Change unit consists of four subheadings and four different lesson plans were prepared for each subtitle. These subtitles; The State of Matter, Distinct Properties of Matter, Heat and Temperature, and Heat Effects Matter. The experiments in the lesson plans were taken from the students' textbook.

A sample lesson plan implemented to the control group is as follows:

Engage; Students were given an interesting story about the change of matter (Ayşe and her father see that it is snowing and they make a snowman. Ayşe cannot sleep with joy that night. As soon as she gets up in the morning, she goes to the garden to the snowman. When she goes to the garden, she sees a pond where the snowman is, but the snowman disappears.). Students were asked that "What happened to the snowman?".

Explore: "What Happened to Candle?" activity was done in order to make students to observe the state of matter (candle) when the matter takes heat. Students were asked to record their observations. This activity was in their books.

Explain: Based on their observations, students explained how the matter changes its state.

Elaborate: "What Happened to Cologne? (when putting some on our hands)", "Where One Dries First? (on radiator, corner of the class, in front of the window or out of the window)", "Evaporation and Boiling" (heating of water), "How did Temperature of Water Vapor Change?", "What Happened to the Iodine?" (heating of iodine) activities were done. These activities were present in their books.

Evaluate: In order to evaluate what was learned, students were asked to prepare a concept map on the matter of change.

Experimental Group

The same lesson plans were prepared for both groups regarding the Matter and Change unit. Lesson plans and activities were examined by two science experts from university and one science teacher. After their comments, related changes were done and then they were implemented in the class. Video lessons for students were shared via the edpuzzle system. There were some problems while using edpuzzle system but they were solved. For example, pilot group students were not able to access the edpuzzle system and not able to reach the video lessons. In order to get rid of this problem, students were distributed the instructional manual of edpuzzle application. The other problem was that pilot group students could not enter the system due to the lack of computers or their parents did not have a smartphone. To solve this problem, students entered the system in the computer classroom of the school with the help of computer teacher or smart boards of the school with the help of the first author.

The process of a lesson applied in the experimental group was as follows:

1. Students watched the video prepared based on the flipped class model at home. The videos were about 10 minutes.
2. The teacher followed the students' video watching processes through the system.
3. Before starting the lesson, students had a quiz in order to check whether the video were watched or not.
4. The same activities in the control group were implemented. Students did activities with cooperative learning.

Results

Pre-test Results of Scientific Epistemological Beliefs

Independent samples t-test was administered to determine whether there was a statistically significant difference between the mean score of scientific epistemological beliefs sub-dimensions of the experimental and control group students before the intervention. The related results are given in Table 1.

Table 1. Pre-test Scientific Epistemological Belief Dimensions of Experimental and Control Groups

Scientific epistemological belief scale sub-dimensions	Group	Levene's Test for Equality of variance		$\overline{X}$	Sd	t	df	p
		F	p					
Authority and accuracy	Experiment	.453	.504	3.72	.668	.566	52	.574
	Control			3.62	.612			
The process of knowledge production	Experiment	2.92	.093	3.38	.523	-	52	.717
	Control			3.43	.328	.364		
Source of knowledge	Experiment	.162	.689	3.17	.778	.867	52	.390
	Control			2.99	.712			
Reasoning	Experiment	.642	.427	3.99	.776	-	52	.575
	Control			4.10	.665	.565		
The changing nature of knowledge	Experiment	5.62	.022	3.56	.872	-	45.2	.118
	Control			3.88	.578	1.59		

The results showed that there was no significant difference between the mean scores of the experimental and control group students' pre-test scientific epistemological beliefs sub-dimensions; authority and accuracy [t (52) =. 566 p = .574 p> .05], the process of knowledge production [t (52) = -.364 p = .717 p> .05], source of knowledge [t (52) =. 867 p = .390 p> .05], reasoning [t (52) = -.565 p = .575 p> .05], changing nature of knowledge [t (45.165) = -1.594 p = .118 p> .05].

Post-test Results of the Scientific Epistemological Beliefs

Independent samples t-test was administered to determine whether the experimental and control groups showed a statistically significant difference in terms of the post-test mean scores of the scientific epistemological beliefs. The results are given in Table 2.

The results showed that there was no significant difference between the mean scores of the experimental and control group students' post-test scientific epistemological beliefs sub-dimensions; authority and accuracy [t (52) = -1.333 p = .188 p> .05], the process of knowledge production [t (43.201) =. 581 p = .564 p> .05], source of knowledge [t (38.954) =. 504 p = .617 p> .05], reasoning [t (52) = -.536 p = .594 p> .05], changing nature of knowledge [t (52) = -1.207 p = .233 p> .05].

Generally; in the sub-dimensions of *the process of knowledge production* and the *source of knowledge*, the experimental group post-test mean was higher than the control group post-test mean. On the other hand, in the sub-dimensions of *authority and accuracy*, *reasoning*, and *changing nature of knowledge*, the control group post-test mean was higher than the experimental group post-test mean. Although there were differences in the post-test mean scores, these differences were not statistically significant. Mean scores were sometimes in favor of the experimental group and sometimes the control group.

Table 2. Post-test Scientific Epistemological Belief Dimensions of Experimental and Control Groups

Epistemological belief scale sub-dimensions	Group	Levene's Test for Equality of variance		$\overline{X}$	sd	t	df	p
		F	p					
Authority and accuracy	Experiment	2.25	.140	3.32	1.06	-	52	.188
	Control			3.65	.752	1.33		
The process of knowledge production	Experiment	6.84	.012	3.52	.347	.581	43.2	.564
	Control			3.44	.564			
Source of knowledge	Experiment	9.85	.003	3.18	1.02	.504	38.9	.617
	Control			3.07	.526			
Reasoning	Experiment	.261	.612	3.86	.848	-	52	.594
	Control			3.99	.845	.536		
The changing nature of knowledge	Experiment	.357	.553	3.73	.757	-	52	.233
	Control			3.96	.669	1.21		

Pre-test and Post-test Scientific Epistemological Belief Mean Scores in Experimental Group

Dependent samples t-test was applied to determine whether there was a statistically significant difference between pre-test and post-test mean scores with respect to scientific epistemological beliefs in the experimental group, and the results are given in Table 3.

Table 3. Pre-test and Post-test Scientific Epistemological Beliefs of Experimental Group Students

Experiment Group	N	$\overline{X}$	Sd	t	df	p
Authority and accuracy pre-test	27	3.72	.668	2.12	26	.044*
Authority and accuracy post-test	27	3.32	1.06			
The process of knowledge production pre-test	27	3.38	.523	-1.05	26	.305
The process of knowledge production post-test	27	3.52	.347			
Source of knowledge pre-test	27	3.17	.778	-.045	26	.965
Source of knowledge post-test	27	3.18	1.02			
Reasoning pre-test	27	3.99	.776	.687	26	.498
Reasoning post-test	27	3.86	.849			
Changing nature of knowledge pre-test	27	3.56	.872	-.790	26	.437
Changing nature of knowledge post-test	27	3.73	.757			

*p<0.05

The difference between pre-test and post-test mean scores of *authority and accuracy* sub-dimension showed a statistically significant difference [t (26) = 2.121 p = .044 <.05]. The difference between pre-test and post-test mean scores of *the process of knowledge production* sub-dimension did not show a statistically significant difference [t (26) = - 1.046 p = .305> .05]. The difference between pre-test and post-test mean scores of *the source of knowledge* sub-dimension did not show a statistically significant difference [t (26) = -. 045 p = .965>

.05].

The difference between pre-test and post-test mean scores of *the reasoning* sub-dimension did not show a statistically significant difference [t (26) =. 687 p = .498> .05]. The difference between pre-test and post-test mean scores of *the changing nature of knowledge* sub-dimension did not show a statistically significant difference [t (26) = -. 790 p = .437> .05]. Generally; post-test mean scores of sub-dimensions were higher than the pre-test. In the experimental group, the difference between the pre-test and post-test mean scores was statistically significant in *the authority and accuracy* sub-dimension.

Pre-test and Post-test Scientific Epistemological Beliefs Mean Scores in Control Group

Dependent samples t-test was applied to determine whether there was a statistically significant difference between the pre-test and post-test mean scores in terms of scientific epistemological beliefs in the control group and the findings are given in Table 4.

Table 4. Pre-test and Post-test Scientific Epistemological Beliefs of Control Group Students

Control Group	N	$\bar{X}$	Sd	t	df	p
Authority and accuracy pre-test	27	3.62	.612	-.256	26	.800
Authority and Accuracy post-test	27	3.65	.752			
The process of knowledge production pre-test	27	3.43	.328	-.180	26	.858
The process of knowledge production post-test	27	3.44	.564			
Source of knowledge pre-test	27	2.99	.712	-4.45	26	.000*
Source of knowledge post-test	27	3.99	.845			
Reasoning pre-test	27	4.10	.666	.631	26	.534
Reasoning post-test	27	3.99	.845			
Changing nature of knowledge pre-test	27	3.88	.578	-.762	26	.453
Changing nature of knowledge post-test	27	3.96	.669			

*p<0.05

The pre-test and post-test mean scores of *Authority and accuracy* sub-dimension did not show a statistically significant difference [t (26) = -. 256 p = .800> .05]. For t*he process of knowledge production* sub-dimension, pre-test and post-test mean scores did not show a statistically significant difference [t (26) = -. 180 p = .858> .05]. For, t*he source of knowledge* sub-dimension, pre-test and post-test mean scores showed a statistically significant difference [t (26) = - 4.449 p = .000 <.05]. For *the reasoning* sub-dimension, pre-test and post-test mean scores did not show a statistically significant difference [t (26) =. 631 p = .534> .05]. For the sub-dimension of *changing nature of knowledge*, pre-test and post-test mean scores did not show a statistically significant difference [t (26) = -. 762 p = .453> .05]. Generally; the post-test mean of the scientific epistemological belief sub-dimensions was higher than the pre-test. The difference between the pre-test and post-test mean scores of the control group was statistically significant only in the sub-dimension of *the source of knowledge* and in favor of the post-test.

Pre-test Results of 21st Century Skills

Independent samples t-test was applied to determine whether there was a statistically significant difference between the mean score of 21st century skills sub-dimensions of the experimental and control group students before the intervention and the results are given in Table 5.

Table 5. Pre-test 21st Century Skills Scores of Experimental and Control Groups

21st Century Skill Sub-dimensions	Group	Levene's Test for Equality of variance		$\bar{X}$	Sd	t	df	p
		F	p					
Active Learning Skills	Experiment	.081	.777	3.96	.605	-.144	52	.886
	Control			3.98	.576			
Learning to Learn Skills	Experiment	1.30	.260	3.79	.813	-1.67	52	.102
	Control			4.12	.620			
Problem Solving Skills	Experiment	2.07	.156	3.86	.906	-1.21	52	.231
	Control			4.11	.550			
Cooperation and Communication Skills	Experiment	1.35	.251	3.38	.924	-2.19	52	.033*
	Control			3.84	.596			

*p<0.05

There was no statistically significant difference between the experimental and control group students' pre-test scores in *active learning skills* [t (52) = -.144 p = .886 p> .05]. There was no statistically significant difference between the experimental and control group students' pre-test scores in *learning to learn skills* [t (52) = -1.666 p = .102 p> .05]. There was no statistically significant difference between the experimental and control group students' pre-test scores in *problem solving skills* [t (52) = -1.211 p = .231 p> .05]. There was a statistically significant difference between the experimental and control group students' pre-test scores in *collaboration and communication skills* [t (52) = -2.187 p = .033 p <.05].

Post-test Results of 21st Century Skills

Independent samples t-test was applied to determine whether the experimental and control groups showed a statistically significant difference in terms of the post-test scores of 21st century skills and the results are given in Table 6.

There was no statistically significant difference between the experimental and control group students' post-test scores in *active learning skills* [t (52) = -.717 p = .476 p> .05]. There was no statistically significant difference between the experimental and control group students' post-test scores in *learning to learn skills* [t (52) = - .437 p = .664 p> .05]. There was no statistically significant difference between the experimental and control group students' post-test scores in *problem solving skills* [t (52) = - .062 p = .951 p> .05]. There was no statistically significant difference between the experimental and control group students' post-test scores in *cooperation and communication skills* [t (52) = 1.247 p = .218 p> .05].

Table 6. Post-test 21st Century Skills of Experimental and Control Groups

21st Century Skill Factors	Group	Levene's Test for Equality of variance		$\overline{X}$	Sd	t	df	p
		F	p					
Active Learning Skills	Experiment	.812	.372	3.74	.660	-.717	52	.476
	Control			3.87	.667			
Learning to Learn Skills	Experiment	.969	.330	3.84	.896	-.437	52	.664
	Control			3.93	.610			
Problem Solving Skills	Experiment	.091	.764	3.90	.787	-.062	52	.951
	Control			3.91	.678			
Cooperation and Communication Skills	Experiment	.634	.430	3.84	.712	1.25	52	.218
	Control			3.59	.778			

Generally; in *active learning skills*, *learning to learn skills* and *problem solving skills* sub-dimensions, the control group post-test mean scores were higher than the experimental group post-test mean scores. On the other hand, in *the cooperation and communication skills* sub-dimension, the experimental group post-test mean scores were higher than control group post-test mean scores. However, these differences were not statistically significant and mean scores were sometimes in favor of the experimental group and sometimes the control group.

Pre-test and Post-test 21st Century Skills Mean Scores in Experimental Group

Dependent t-test was applied to determine whether there was a statistically significant difference between pre-test and post-test mean scores with respect to 21st century skills in the experimental group and the results are given in Table 7.

There was no statistically significant difference between pre-test and post-test scores in *active learning skills* [t (26) = 1.655 p = .110> .05]. There was no statistically significant difference between pretest and posttest scores in *learning to learn skills* [t (26) = -. 363 p = .720> .05]. There was no statistically significant difference between pretest and posttest scores in *problem solving skills* [t (26) = -. 207 p = .838> 05]. There was a statistically significant difference between pretest and posttest scores in *collaboration and communication skills* [t (26) = -.2.231 p = .035 <.05].

Generally; in the experimental group, pre-test mean scores of *active learning skills* was higher than post-test mean scores. On the other hand, the post-test mean scores of *learning to learn skills, problem solving skills and collaboration and communication skills* was higher than the pre-test mean scores. In the experimental group, the difference between the pre-test and post-test mean scores was statistically significant and favorable to the post-test only in the sub-dimension of *cooperation and communication skills*.

Table 7. Pre-test and Post-test 21st Century Skills of Experimental Group Students

Experiment Group	N	$\bar{X}$	Sd	t	df	p
Active Learning Skills Pre-test	27	3.95	.605	1.66	26	.110
Active Learning Skills Post-test	27	3.74	.660			
Learning to Learn Skills Pre-test	27	3.79	.813	-.363	26	.720
Learning to Learn Skills Post-test	27	3.84	.895			
Problem Solving Skills Pre-test	27	3.86	.906	-.207	26	.838
Problem Solving Skills Post-test	27	3.89	.787			
Cooperation and Communication Skills Pre-test	27	3.38	.924	-2.231	26	.035*
Cooperation and Communication Skills Post-test	27	3.84	.712			

*p<0.05

Pre-test and Post-test 21st Century Skills Mean Scores in Control Group

Dependent Samples t-test was applied to determine whether there was a statistically significant difference between pre-test and post-test mean scores with respect to 21st century skills in the control group and the results are given in Table 8.

Table 8. Pre-test and Post-test 21st Century Skills of Control Group Students

Control Group	n	$\bar{X}$	Sd	t	df	p
Active Learning Skills Pre-test	27	3.98	.576	.861	26	.397
Active Learning Skills Post-test	27	3.87	.667			
Learning to Learn Skills Pre-test	27	4.12	.620	2.27	26	.032*
Learning to Learn Skills Post-test	27	3.93	.610			
Problem Solving Skills Pre-test	27	4.11	.549			
Problem Solving Skills Post-test	27	3.91	.678	1.59	26	.124
Cooperation and Communication Skills Pre-test	27	3.84	.596	1.44	26	.161
Cooperation and Communication Skills Post-test	27	3.59	.778			

*p<0.05

There was no statistically significant difference between pre-test and post-test scores in *active learning skills* [t (26) =. 861 p = .397> .05]. There was a statistically significant difference between pre-test and post-test scores in *learning to learn skills* [t (26) = 2.269 p = .032 <.05]. There was no statistically significant difference between pre-test and post-test scores in *problem solving skills* [t (26) = 1.590 p = .124> 05]. There was no statistically significant difference between pre-test and post-test scores in *collaboration and communication skills* [t (26) = 1.444 p = .161> .05].

Generally; in the control group, pre-test mean scores were higher than post-test mean scores in all sub-dimensions. In the control group, the difference between the pre-test and post-test mean scores was statistically significant and favorable to the post-test only in the sub-dimension of *learning to learn skills.*

Discussion and Conclusion

The Effect of the Flipped Classroom Model on Students' Scientific Epistemological Beliefs

In the current study, there was no significant difference between the experimental and control group students' pre-test mean scores of the scientific epistemological belief sub-dimensions. Considering these results, it can be said that the experimental and control groups were equivalent at the beginning of the intervention. This provides an important advantage for comparing the effectiveness of the method applied. After the implementation, there was no significant difference between the experimental and control group students' post-test scientific epistemological beliefs. In other words, students' scientific epistemological beliefs did not change with the learning environment. The results of the current research are similar to the results of the study (Göğebakan-Yıldız & Kıyıcı, 2016) examining the effects of the flipped classroom model on pre-service teachers' epistemological beliefs. The reason of no differences between the experimental and control group students' scientific epistemological beliefs after the intervention could be that both groups were instructed with constructivist approach (Muis & Duffy, 2013). The other reason for no significant differences could be as Mirana (2016) stated the computer simulations and constructivist approach did not change high school students' epistemological beliefs.

In the current study, in the experimental group, there was no significant difference between the pre-test and post-test mean scores of the scientific epistemological beliefs sub-dimensions except *authority and accuracy* dimension. The reason of this difference could be that in the flipped learning environment; students worked cooperatively, they were active in the class (Bergmann & Sams, 2015). Thus, students could construct their knowledge and they could think that the knowledge is tentative. This result is also consisted with Schiefer et al. (2020). In the current research, in the control group, there was no significant difference between the pre-test and post-test mean scores of the scientific epistemological beliefs sub-dimensions, except for *the source of knowledge* dimension. This result also consisted with Conley et al. (2004). The reason of this could be that students could think that the accuracy of the knowledge obtained from other sources of knowledge was developed by 5E learning cycle model.

As a result of the study, it is thought that the reason why the experimental group students' epistemological beliefs were not developed is that theoretical knowledge was instructed with videos and so students could see the videos as a source of knowledge and authority in the experimental group. In the literature, it was emphasized that the flipped classroom model should not be limited to the video only (Bishop & Verleger, 2013). In the flipped classroom model, students could be unprepared for the activities to be held in the classroom may be the reason why the model is ineffective (Herreid & Schiller, 2013). While students in the flipped classroom are actively involved in the learning environment, the existence of students whose individual learning skills are not developed can be shown as the reason that the model does not contribute to the development of epistemological beliefs (Bolat, 2016). The other reason could be that the experimental and control group students are equivalent in terms of academic success. This may cause the flipped classroom model to be ineffective since students having higher academic success have sophisticated epistemological beliefs (Tsai, 2000; Conley et al., 2004; Islıcık, 2012; Kızıklı, 2016).

The Effect of the Flipped Classroom Model on 21st Century Skills

In the current study, there was no significant difference between experimental and control group students' 21st century skills before the implementation. Thus, it could be said that the experimental and control groups are equivalent at the beginning. This provides an important advantage for comparing the effectiveness of the method applied. After the implementation, there was no significant difference was found between experimental and control group students' 21st century skills. In other words, students' 21st century skills did not change in regard to learning environment.

In the current research, in the experimental group, there was no significant difference between pre-test and post-test mean scores of 21st century skills sub-dimensions except *the cooperation and communication skills*. This result is similar with Frydenberg (2013), Yavuz (2016) and Enfıeld (2013). They stated that the flipped classroom model improved students' collaboration and communication skills since it creates a collaborative environment while performing in-class activities. Also, the reason for this is that the experimental group students were more active in the classroom than the control group when applying the flipped classroom model, and they used their collaboration and communication skills more frequently. In the current study, in the control group, there was no significant difference between the pre-test and post-test mean scores of 21st century skills sub-dimensions except *learning to learn skills*. This result is similar with Gülen (2013). The reason for this is that the control group students were responsible for their own learning and they were aware of their learning needs.

The reasons for the absence of a significant difference between the experimental group and the control group students in terms of scientific epistemological beliefs and 21st century skills were that the experiments conducted in the both groups were the same, and also both groups were instructed with the same teaching approach. The other reason could be that the experimental group students' inadequacy in individual learning (Hayırsever & Orhan, 2018). Also, in the flipped classroom model, students conducted in-class activities, this may causes students to feel compelled to come prepared for the lesson, and this may decrease the effect of the model (Kara, 2015). The anxiety of not being able to complete in-class activities on time is considered to be the disadvantage of the flipped classroom model (Aydın, 2016). The difficulty of the experimental group students to adapt to the flipped classroom model can be shown among the reasons (Turan & Göktaş, 2015). The fact that the students follow the lessons over the video and this could lead to students for focusing on the videos or technological tools, which can reduce the effect of the flipped classroom model (Strayer, 2012). The fact that the experimental group students cannot ask questions immediately while watching the videos at home may also reduce the effect of the flipped classroom model (Gençer, Gürbulak & Adıgüzel, 2014). On the other hand, Makruf, et al. (2021) stated that with flipped classroom, students actively participate to class and work cooperatively and so like the present study results, students' cooperative learning skills improve.

Recommendations

Based on the results of the research, recommendations are as follows: Since this research was limited to 5th grade students, some studies could be conducted at different grades on the same topic. Since the duration of the research was limited to 6 weeks, longer studies can be done. Since the research was limited to the Matter and Change unit, studies can be done on different subject areas.

Notes

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