Investigating the Effect of the Activities Based on Explanation Assisted REACT Strategy on Learning Impulse, Momentum and Collisions Topics

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Abstract
The purpose of this study was to investigate the effect of explanation assisted REACT strategy which was based on context-based learning approach on prospective science teachers' (PSTs) learning in impulse, momentum and collisions topics. The sequential explanatory strategy within mixed methods design was employed in this study. The first phase of the study in which quantitative data werecollected represents the experimental aspect of the study, the second phase of the study in which qualitative data weregathered to support quantitative data represents the descriptive dimension. The study was carried out with 25 PSTs in the experimental and 25 in the control group. In this study, two-tier Impulse, Momentum and Collisions Concept Test (IMCCT) were used as a data collection tool. IMCCT which was consisted of 34 questions was administered as pretest before the intervention, posttest after the intervention and delayed test 9 weeks after the intervention. This study revealed that explanation assisted REACT strategy which was based on context-based learning approach was found more effective than the traditional teaching approach on impulse, momentum and collisions topic. Findings also showed that some of the alternative conceptions were significantly eliminated in the experimental group.
Keywords: alternative conceptions, explanation assisted REACT strategy, impuls, momentum and collisions, prospective science teachers, REACT strategy

1. Introduction

Context-based learning approach which foresees using familiar contexts in relating students' experiences to the new knowledge is built on the basis of the constructivist learning theory (Crawford 2001; Imel 2000). However, new knowledge begins to make sense when they are associated with events in people's environment and then appears useful to people (Souders 1999). In traditional teaching design, students are overloaded with a tremendous amount of subject matter knowledge and they often do not see the relations between topics (Pilot & Bulte 2006). Additionally, traditional teaching is insufficient in solving current problems of subject teaching and learning such as usefulness of the topic being taught in daily life and excess of topics without relating them with each other (Gilbert 2006). Because of this, knowledge should be placed in a need-to-know basis according to context-based learning approach. Thus, students could relate the topics with each other and see the usefulness of the new learnings in daily life, increasing students' interest and motivation.

Context-based learning approach does not only make students more active in learning, but also contributes to a more meaningful and permament learning within the relationship between physics and their daily life (Ng & Nguyen 2006). In addition, context-based learning approach helps students to better understand the natural environment to the world in which they live and (Lye, Fry & Hart 2001). Physics curriculum in some countries are rearranged according to context-based learning approach due to delivering positive results revealed from some context-based physics studies and being popular by the day in physics education (Wilkinson 1999). Context-based projects first began in Australia and New Zealand with VCE (Victorian Certificate of Education) in the field of physics. The other projects are SHAP (Salters Honers Advanced Physics) and SLIPP (Supported Learning in Physics Project) in United Kingdom, PiKo (PhysikimKontext) in Germany, ROSE (The Relevance of Science Education) in Finland, STEMS (Science, Technology Environment in Modern Society) in Israel, PLON (Dutch Physics Curriculum Development Project and NiNa) in the Netherlands (Wilkinson 1999).

The common feature of these projects is to present the desired content to the students by using the relevant context (Akpınar 2012). Through these projects, to eliminate students' common problem which is the inability to apply the scientific information to the personal and social life (Sanger & Greenbow 1996), to increase the intelligibility of scientific information (Taber 2007), to prevent boring science classes and to ensure students scientifically literate individuals (Akpınar 2012) wereintended. However,some studies revealed that teachers' knowledge and skills in applying context-based learning approach in real classroom settings were insufficient (Ayvacı, Ültay & Mert 2013).

In order to achieve context-based learning approach's aims, one of the strategies used in learning environments is the REACT strategy. CORD (Center for Occupational Research and Development) (1999a, 1999b), Crawford (2001) and Souders (1999) described the REACT strategy and its principles as shown in Table 1.

Table 1. The Principles of the REACT Strategy (CORD 1999a, 1999b)

Relating	Contextualization knowledge by establishing relationships with prior knowledge and past experience
Experiencing	Learning by experiencing, discovering and inventing
Applying	Data applications in learning environments such as classes and laboratories, and learning by introducing concepts that will be used
Cooperating	Learning by sharing and communicating knowledgewith the others
Transferring	Using the gained knowledge in a new context, unusual situations or environments outside the classroom

According to the REACT strategy, a selected topic which is related to daily life context(s) is taught in accordance with the principles of the relating, experiencing, applying, cooperating and transferring. There have been several studies in the literature indicating the problems encountered during the implementation of the REACT strategy and the need to improve the strategy (Coştu 2009; N. Ültay 2012; Ültay, Durukan & Ültay 2014).

In the REACT strategy, discussion and explanation parts were missing. Because teachersgot used to make explanations after each teaching activities and students got used to listen their teachers' explanations which were made for summarizing the activity; lacking of explanation part were obvious (Costu 2009; N. Ültay 2012). Also, discussion part was needed in the implementation of the REACT strategy (Coştu 2009). Class discussions may have guided students to think the subject from different viewpoints. Thus, discussion may also be added to the REACT strategy (Coştu 2009). To conclude, several experimental research findings indicated that the REACT strategy needs to be refined (Coştu 2009; N. Ültay 2012; Ültay et al. 2014). Coştu (2009), forinstance, suggested that explanation and discussion principles should have been added to the REACT strategy to prevent the failing points, and this requires further research to test the refined strategy. Additionally, Ültay et al. (2014) suggested adding explaining principle as a separate principle or adding to all present principles. Making explanation helps students to change unfruitful pre-existing ideas with the new ones because students often have difficulty in finding new thinking ways without the teachers' guiding (Özmen 2002). Therefore, teachers may help students make learning more meaningful by guiding, bringing students' experience together, explaining the results and creating new concepts (Akdeniz & Akbulut 2010). In this sense, explanation assisted REACT strategy which is the extended version of the REACT strategy by adding the explanation principle should be investigated that is the aim of this study. Apart from the REACT strategy, new strategies or teaching models should be developed for the implementation of context-based learning approach which is found as effective in learning environments in terms of increasing students' interest and motivation, relating content knowledge to daily life experiences, providing more meaningful learning.

On the other hand, when the context-based physics studies are taken into account, it is seen that force and motion (Akpınar 2012; Choi & Song 1996; Lye, Fry & Hart 2001; Park & Lee 2004; Rennie & Parker 1996, 1998), energy (Rennie & Parker 1998), electricity and magnetism (Finkelstein 2005; Peşman & Özdemir 2012), optics (Basir, Alinaghizadeh & Mohammedpour 2008; Testa, Lombardi, Monroy & Sassi 2011) and buoyancy force (Enghag, Gustafsson & Jonsson 2009) topics are highly studied. However, impulse, momentum and collisions are slightly preferred. Actually, impulse, momentum and collisions topic is an issue that students are familiar with their daily lives. For example, taw, collision of vehicles in traffic accidents, billiards game, recoiling after firing the weapon and fireworks show are among the events that students often face in their daily lives. Students firstly faced impulse, momentum and collisions at third grade in high schools but they studied force and motion topic which was the basis of the impulse, momentum and collisions topic from the third grade of primary school to the fourth grade of high school. Nevertheless, it is seen that students have many alternative conceptions about impulse, momentum and collisions topicas revealed in the current research results (Çirkinoğlu 2004; Kobayashi & Okiharu 2009; Şekercioğlu (Çirkinoğlu) & Kocakülah 2008; Tanel & Tanel 2010; Taşar, Ünlü & Kandil İngeç 2006; Ünlü, Kandil İngeç & Taşar 2006; Ünlüsoy 2006). Indeed, with the increasing importance given to the concept teaching in recent years, it is seen that most of the studies is seemed to be focused on the conceptual teaching of momentum and collisions (Fang 2012; George, Broadstock & Vásquez Abad 2000; Tanel & Tanel 2010). For instance, George et al. (2000) aimed to search the usage of technology and concept learning about collisions and conservation principles with the undergraduate students of physics department, while Tanel and Tanel (2010), Şekercioğlu (Çirkinoğlu) and Kocakülah (2008) and Ünlüsoy (2006) focused on determining the learning difficulties and misconceptions about energy and momentum. However, Fang (2012), George et al. (2000) and Kobayashi and Okiharu (2009) tried to eliminate students' alternative conceptions, in some studies eliminating alternative conceptions were not possible (Çirkinoğlu 2004; Kobayashi & Okiharu 2009).

Additionally, it is seen that various teaching methods and techniques were used in impulse, momentum and collisions studies. For example Ünlü et al. (2006) used concept maps in their study to investigate how the prospective teachers understood momentum and impulse concepts and how they relate these concepts in their minds. Similarly, Kandil İngeç (2008) used concept maps as an evaluation tool. Ünlüsoy (2006) aimed to investigate the effect of cooperative learning on eliminating the alternative conceptions about impulse and momentum at the second grade in high school. In a similar vein, Sarıay and Kavcar (2009) studied to determine the effect of cooperative learning on students' success. As seen, there a lot of studies about impulse, momentum and collisions, but in some studies like Çirkinoğlu (2004) and Tanel and Tanel (2010) were found unsuccessful at conceptual change. Furthermore, the studies revealed that students have still problems in relating these concepts (Kandil İngeç 2008; Taşar et al. 2006; Ünlü et al. 2006). Indeed, although an experimental design which revealed a successful result in conceptual change and conceptual learning, alternative conceptions in students' minds may still be existed because it is known that conceptual change takes a long time. Concepts in students' minds interact all the time with each other and even if an alternative conception is seemed as eliminated, after some time they can come back as a result of existing the other alternative conceptions (Çalık 2006).

To conclude, it is thought that it can be effective to teach the topic via relevant contexts at eliminating the alternative conceptions and establishing the relations between the concepts (Ültay & Ültay 2014). There are also few studies that used prospective teachers as participants in context-based physics studies. It is important to carry out the study with prospective teachers because when they learned in a right way, they conduct their scientifically accurate learnings to the future generations because prospective teachers tend to teach how they were taught. Teachers are the main actors shaping students' personality and their attitudes, and directly affecting their individual lives (Yapıcı 2007). Hence, the purpose of this study was to investigate the effect of explanation assisted REACT strategy which was based on context-based learning approach on PSTs' achievement on learning impulse, momentum and collisions topics.

2. Methodology

2.1 Reseach Design

The sequential explanatory strategy within mixed methods which includes two-phase design was employed in this study. The first phase of the study consisted of experimental research followed by the second phase of the study in which qualitative data were gathered to support quantitative data as stressed by Creswell (2013). In the first phase of this study, the objective was to determine the effect of teaching through the employment of explanation assisted REACT strategy on students' achievement in physics, which was examined through experimental design. In the second phase, on the other hand, qualitative data were gathered via interviews to explain, interpret and support the findings from the experimental phase.

2.2 Reseach Group

The research group was consisted of freshmen students studying at Science Education in the Faculty of Education of Giresun University. The study was carried out with 25 PST in the experimental and 25 in the control group. The prospective science teachers in the experimental group in which explanation assisted REACT strategy was used were coded as E1, E2, E3, …, E25, and the prospective science teachers in the control group in which the traditional teaching approach was used were coded as C1, C2, C3, …, C25. Six prospective science teachers were selected for the interview; three of them were females (E1, E13, E16) and three of them were males (E2, E14, E21) in the experimental group, and six were selected in the control group, four females (C1, C3, C9, C16) and two males (C2, C6). According to the IMCCT scores of prospective science teachers, three of them were selected from the group who had the highest score and three of them were selected from the group who had the lowest score. It is believed that these extreme positive and negative cases could provide in-depth information about the intervention.

2.3 Data Collection Tools

In this study, two-tier IMCCT was used as a data collection tool. The use of two-tier testing in educational settings began with Treagust (1988). Students make a choice among options that are predetermined in the first phase of the question; the second phase of the question which is open-ended gives more information about to what degree students know the concept (Çalık 2006). In addition, it is important to diagnosethe alternative conceptions that the students have about a topic (Tan, Taber, Goh & Chia 2005). The IMCCT which was consisted of 34 questions was administered as pre test before the intervention, post test after the intervention and delayed test 9 weeks after the intervention. The first tier of the questions was multiple choices, and the second tier of the questions was open-ended which gave opportunity to students for free writing about the reason of the choice made in the first tier. Some example questions from IMCCT were presented below:

7. An object which has a perpendicular speed vector to the glass's surface hits the glass. Which object of the following is likely to break the glass more?

a) A ball of 500 g with 2m/s velocity. **b)** A ball of 300 g with 4m/s velocity.
c) A ball of 100 g with 9m/s velocity. **d)** A ball of 50 g with 20m/s velocity.
e) A ball of 600 g with 3m/s velocity.

Because,……………………………………………………………………………………………
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21. Two people on the top of two skateboards stand facing each other on the horizontal frictionless floor.One of them pushes the other rapidly and they are separated from each other. If one of them is heavier;

a) The magnitudes of their momentums are equal. **b)** The heavier one's momentum is bigger.
c) The heavier one's momentum is smaller. **d)** They go equal paths in equal time.
e) Their momentums are equal.

Because,……………………………………………………………………………………………
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For the IMCCT's each question, the maximum score that can be taken is four points that are one point from multiple-choice section for correct choice, three points from open-ended section for scientifically accurate explanation. Considering that IMCCT includes 34 questions totally, the maximum score that can be taken from IMCCT is 34*4=136 points.

In this study, interviews were also used for data collection. As in IMCCT, the questions in the interview focused on diagnosing the participants' alternative conceptions about the topic, in order to explain, interpret and support the findings obtained from IMCCT. The interview protocol consisting of 15 questions was conducted with 12 prospective science teachers from the experimental and control groups, focusing on the alternative conceptions determined via IMCCT. Some example questions from the interview protocol follows "A vehicle with a mass of m is turning a corner without a speed change. Is impulse applied to this vehicle? *Explain with the reasons*.", "If two vehicles collide, how do you identify the type of the collision? *Explain with the reasons*."

2.4 Intervention

Two separate lesson plans were prepared according to the topic's objectives and explanation assisted REACT strategy's all principles were used in a cyclic process in the experimental group. All lesson materials which were used during the teaching period were developed by the first researcher and a physics education expert. "Impulse, Momentum and Collisions-1 (IMC-1)" booklet for the first lesson plan and "Impulse, Momentum and Collisions-2 (IMC-2)" booklet for the second lesson plan were developed. In both booklets, lesson content and questions were created by the help of some studies (Ayvacı et al. 2011a, 2011b; Bueche & Jerde 2003; Serway & Beichner 2002), the rest was developed by the researchers with the experts opinions.

Courses that were based on traditional teaching approach were carried out in front of the blackboard by using lesson plans and laboratory activity sheets. In necessary cases, everyday examples were given, class discussions were created and PSTs' ideas and thoughts were evaluated. The experiment which was done with Predict-Observe-Explain (POE) technique in the experimental group was done as a demonstration experiment in the control group. In the control group, lesson contents and questions were created by the help of some studies (Ayvacı et al. 2011a, 2011b; Bueche & Jerde 2003; Serway & Beichner 2002). Lessons were taught with presentation by the first researcher. The lesson objectives were determined by Higher Education Council in Turkey and they were the same with the experimental group. Similarly as in the experimental group, two separate lesson plans were created by considering expert opinions.

The first lesson plan which was implemented in the experimental and control groups was presented in Table 2.

Table 2. The First Lesson Plan of the Experimental and Control Groups

Group	Principle	The Role of the Researcher	The Role of the PSTs
Experimental Group	Relating - Explaining - Cooperating	Researcher wants PSTs to read "Ice Rink" text and find the cases related to impulse. In the meantime, there will be no guiding. While PSTs are trying to find the cases and the reasons about impulse on the visuals, researcher asks questions where needed and creates a discussion environment. He can guide PSTs. He can make explanations about unclear points about the topic. He carefully listens to the PSTs' presentations and guides them about missing parts.	PSTs read "Ice Rink" text and try to find the cases related to impulse. After that they try to find the cases and the reasons about impulse on the visuals. They write on the blanks on the sheet. PSTs try to interpret the graphs they draw about the impulse and momentum in groups. Then they make presentations and they share their results.
	Experiencing - Explaining - Applying	During the experiment, researcher goes to the tables and ask questions PSTs where they have difficulty, he provide them to interpretabout some cases and he makes explanations and guide them to the right way when needed. Researcher gives a research homework that should be done individually and warn them to present the homework in the following course.	PSTs perform the experiment which is based on POE technique. The questions on the laboratory activity sheet are answered by voluntary PSTs and the responses are discussed. In the meanwhile, "Ice Rink" context is related to the experiment.
	Applying - Explaining	While PSTs solve the questions on the blackboard, researcher asks them about some missing points for better understanding. He helps them to think more deeply. In addition, he makes necessary explanations when PSTs had difficulty.	PSTs individually solve the questions in the test about impulse and momentum. Then voluntary PSTs can solve them on the blackboard.
	Transferring - Cooperating - Explaining	Researcher guided PSTs to the right way during their presentations if they have missing or false points. In addition, researcher helps to make the topic's transferring to the rocket motions. Then, researcher presents the motion of rocket for better understanding and solves examples.	The homework which was given in the previous lesson by the researcher is presented by the voluntary PSTs. PSTs answer and present the responses of the group work entitled with "Daily life examples of momentum conservation and their explanations".
Control Group	Attention and motivation	Researcher begins the course with asking what impulse and momentum can be. Then he asks if momentum is conserved or not in some examples and explain the reasons. He helps PSTs' examples relating to daily life. In doing so, he attracts PSTs' attention to the course.	PSTs try to answer the researcher's questions and they discuss them in the class.
	Transition to course	Researcher presents impulse, momentum, momentum conservation and rockets topic. In the meantime, he asks questions by question-answer technique and tries to keep PSTs' attention alive.	PSTs listen to researcher's presentation and try to respond the questions he asked. PSTs ask for the lacking points and try to understand better.
	Individual learning activities	Researcher performs the experiment entitled with "The changes of momentum in an impulse" by demonstration technique.	After PSTs watch the experiment, they try to answer the questions and fill in the blanks on the laboratory activity sheet.
	Evaluation	Researcher asks questions about the whole topic and he wants PSTs to relate the topic with daily life.	PSTs try to respond the questions researcher asked and relate the topic to daily life.

2.5 Data Analysis

Scoring criteria used in this study to analyze IMCCT was created by utilizing the scoring scales mentioned by Marek (1986). The categories used in IMCCT and the criterias of these categories are given in the following:

- **Sound Understanding (SU – 3 points):** This category includes PSTs' scientifically completely accurate descriptions.
- **Partial Understanding (PU – 2 points):** This category includes PSTs' explanations which show some part of the correct answer but do not contain wrong information or alternative conception.
- **Partial Understanding with Specific Alternative Conception (PUSAC – 1 point):** This category includes partial understanding of scientific explanation with some alternative conceptions.
- **Specific Alternative Conception (SAC–no point):** This category includes PSTs' false explanations which are inconsistent with the scientifically correct answer and these answers can contain some alternative conceptions.
- **Irrelevant/Empty/Unclear (IEU - no point):** This category includes PSTs' irrelevant or not understood answers. PSTs can leave the question empty.
- **Right Option (RO – 1 point):** This category includes PSTs' selecting right option of the first phase of the question.
- **False/Multiple Option (FMO – no point):** This category includes PSTs' selecting false/multiple option of the first phase of the question.
- **Empty (E – no point):** This category includes PSTs' not selectingan option.

The responses of PSTs were evaluated and scored as in explained above and then their total scores of pre, post and delayed tests were statistically analyzed with SPSS 16.0 software. Because measurement is used in data analysis of IMCCT instead of ranking, counting and marking, the sample is chosen randomly, the sample consists of 50 participants (bigger than 30), p=0,086 (p>0,05) is found for Kolmogorov-Smirnov test, p=0,102 (p>0,05) is found for homogeneity of variances and normal distribution is seen at 0,05 level; parametric tests are preferred in data analysis of IMCCT.

In this study, recorded interviews were transcribed verbatim and analyzed deductively, using the categories in the analysis of IMCCT such as "Sound Understanding (SU)", "Partial Understanding (PU)", "Partial Understanding with Specific Alternative Conception (PUSAC)", "Specific Alternative Conception (SAC)" and "Irrelevant/Empty/Unclear (IEU)".

2.6 Validity and Reliability

In order to increase the validity and reliability all teaching materials and data gathering tools were piloted after taking expert opinion. In pilot studies, IMCCT was administered 55 PSTs and interviews were conducted with 12 PSTs. Thus, the responses of PSTs were examined and necessary additions and subtractions were done and the questions were rearranged. All lesson plans, teaching materials and data collection tools were examined by four physics education experts to provide face and content validity. They were also checked by language experts and necessary arrangements were done for clarity. In addition, in accordance with the opinions of experts IMC-1, IMC-2, IMCCT and interviews were rearranged in terms of layout and readability.

In data analysis of IMCCT, a scoring scale was used which was developed in analyzing the data of pilot study by the first researcher. However, this thinking would have not made very objective and accurate results, to ensure the reliability a different physics education expert was asked to evaluate the IMCCT data and then the match comparison between the two valuerwas calculated by SPSS 16.0 software package, and Cohen's Kappa (Cohen's kappa factor) value was found as 0,92 which was accepted as perfect match by Landis and Koch (1977)'s classification. After this stage, researchers evaluated the IMCCT data.

Because the questions in IMCCT were two-tier, item analysis was not performed (Çalık 2006; Ng & Nguyen 2006; Rennie & Parker 1998; Wilkinson 1999). But the reliability coefficient (cronbach alpha) was calculated as 0,87. If the reliability coefficient was higher than 0,70, the test can have been accepted as reliable (Hair, Black, Babin, Anderson & Tatham 2006).

Before the intervention and data collection process, the first researcher informed PSTs about that "this intervention and data were not used for assessment purpose", "the intervention and data will have been used only for this research" and "except some demographic information, everything will have not been shared with the readers". In addition, the intervention and data collection process were conducted in an environment where PSTs were familiar, namely in the classroom where PSTs were being taught.

In the second tier of the questions of IMCCT and interviews, data reduction were made, critical responses were identified and code lists were created at three different times to increase the study's credibility and consistency. These codes were classified into themes/categories. Additionally, after the interviews, data were checked by the PSTs who were interviewed for the puspuse of respondent validity. The results obtained were supported by providing enough raw data for the reader as Miles and Huberman (1994) stressed that providing enough raw data is the information required for confirmability.

For the ethical purpose, in the study PSTs' consents were taken about sharing data obtained from them. In addition, the participating PSTs were informed that no harm would come to them because of the nature and results of the study and some demographic information will have been shared (Drew, Hardman & Hart 1996). In the intervention and data collection process, some special dialogue passed between researchers and PSTs was not reflected in the data collection process to ensure the privacy and confidentiality principles. Furthermore, anonymity was provided by coding the PSTs in the experimental group as E1, E2, E3, …, E25 and in the control group C1, C2, C3, …, C25.

3. Findings

According to the groups, means and standard deviations of pre, post and delayed tests of IMCCT and the percentage changes between pre and post tests, post and delayed tests, and pre and delayed tests are shown in Table 3.

Table 3. Statistical Data of IMCCT

Groups	N	Pre test		Post test		Delayed test		Percentage change (Δ%)		
		Mean	s.d.	Mean	s.d.	Mean	s.d.	Pre-Post	Post-Delayed	Pre-Delayed
Experimental	25	18,3	8,8	47,2	15,5	39,6	18,1	21,2	-5,6	15,7
Control	25	14,9	6,0	33,9	13,4	28,5	11,3	13,9	-4,0	10,0

According to Table 3, the means of pre tests of both groups are quite close to each other. When the post test scores of both groups are considered, it is seen that both groups' means are increased. The experimental group's mean increased to 47,2 and the control group's to 33,9. However, both groups' scores are decreased in delayed test. The experimental group's mean decreased to 39,6 and the control group's to 28,5 but they are still higher than the groups' pre test scores. The percentage change and mean scores as shown in Table 3 revealed that students in experimental group scored better than those in the control group. Independent samples t-test is performed to determine if a significant difference is present among pre, post and delayed tests of both groups and the results are shown in Table 4.

Table 4. The Results of Independent Samples T-Test for Pre Tests

Group	N	Mean	Ss	Sd	t	p
Experimental	25	18,3	8,8	48	1,595	0,117
Control	25	14,9	6,0			

There is no significant difference between pre tests of the experimental and control groups which is administered to compare the groups' conceptual understanding levels ($t_{(48)}$=1,595: p>0.05). However, both groups' pre test means are close to each other, the experimental group's score is a little bit higher than the control group (X_{exp}=18,3; X_{con}=14,9). Table 5 presents the results of independent samples t-test for post tests of both groups.

Table 5. The Results of Independent Samples T-Test for Post Tests

Group	N	Mean	Ss	Sd	t	p
Experimental	25	47,2	15,5	48	3,232	0,002
Control	25	33,9	13,4			

As seen in Table 5, significant difference is found between post test scores of the experimental and control groups as a result of independent samples t-test analysis ($t_{(48)}$=3,232: p<0.05) in favor of the experimental group. The mean score of the experimental group's post test is quite higher than the control group's score (X_{exp}=47,2; X_{con}=33,9). Table 6 presents the results of independent samples t-test for delayed tests of both groups.

Table 6. The Results of Independent Samples T-Test for Delayed Tests

Group	N	Mean	Ss	Sd	t	p
Experimental	25	39,6	18,1	48	2,599	0,012
Control	25	28,5	11,3			

There is a decrease in the scores of delayed test according to post test scores even though the experimental group's score is still higher than the control group (X_{exp}=39,6; X_{con}=28,5). Additionally, there is significant difference between delayed tests of the experimental and control groups ($t_{(48)}$=2,599: p<0.05) in favor of the experimental group.

Table 7 presents the frequencies of PSTs' answers of pre, post and delayed tests according to categories for two-tier together.

Table 7. The Frequencies of PSTs' Answers of IMCCT According to the Categories

Categories	Experimental Group			Control Group		
	f_{pre}	f_{post}	$f_{delayed}$	f_{pre}	f_{post}	$f_{delayed}$
RO-SU	18	125	89	9	80	47
RO- PU	42	138	125	22	72	85
FMO- SU	0	3	0	0	0	0
E- SU	1	0	0	0	0	0
RO -PUSAC	4	15	9	4	26	5
FMO - PU	7	10	15	1	17	5
E- PU	0	2	1	0	0	1
RO -SAC	41	47	26	32	38	32
RO -IEU	192	139	171	223	170	213
FMO - PUSAC	2	14	11	6	17	2
E- PUSAC	0	3	0	0	1	0
FMO - SAC	126	115	91	72	108	84
FMO - IEU	271	142	198	343	237	254
E- SAC	0	0	1	1	1	3
E- IEU	146	97	113	137	83	119

According to Table 7, the frequencies of RO-SU and RO-PU categories in the experimental and control groups are considerably increased in post test. When delayed test scores are considered for the same categories, it is seen that the frequenciesare generally decreased according to post test scores. However, only the frequency of RO-PU category is slightly increased in the control group. Furthermore, an interesting point seen in the results of IMCCT is that although PSTs selected right option (RO) in the first tier of the questions, majority of them did not prefer to explain (IEU) in the second tier of the questions. This case was more seen in the control group than the experimental group. Moreover, it is seen that the frequencies of categories of post test were less than the other tests.

Another considerable point seen in Table 7 is that the frequencies of FMO-SAC, FMO-IEU, E-SAC and E-IEU categories which are very high. In post test, although the frequencies of these categories are significantly declined, the repeating of some expressions of PSTs that are classified in these categories is remarkable.

According to the groups, some alternative conceptions and their frequencies that were found in pre, post and delayed tests are presented in Table 8. These alternative conceptions were determined in the second tier of the questions in IMCCT.

Table 8. Alternative Conceptions and Their Frequencies Found In PSTs After IMCCT

Alternative Conceptions	Experimental Group			Control Group		
	f_{pre}	f_{post}	$f_{delayed}$	f_{pre}	f_{post}	$f_{delayed}$
AC1. Impulse is impulsive force that substances applied to each other.	13	2	3	4	2	4
AC2. Impulse means force exerted on an object, and then the change in acceleration or velocity is seen in the object.	6	1	7	8	4	4
AC3. Momentum is a scalar quantity (not understanding that momentum is a vectorel quantity).	10	7	11	4	7	6
AC4. Momentum is equal to impulse.	-	9	8	-	4	2
AC5. Momentum is a pushing force.	8	1	2	1	-	-
AC6. Momentum isthe multiplication of force and distance (confusing momentum with moment).	7	-	-	3	-	-
AC7. The greater the mass, the greater the momentum.	18	17	15	10	10	18
AC8. Momentum is a concept based on solely and entirely velocity regardless of the mass.	20	10	10	14	31	24
AC9. Momentum is preserved all time.	-	11	6	1	7	5
AC10. Conservation of kinetic energy is required for momentum's conservation.	2	3	3	-	2	-
AC11. Impulse is the vectorel summation of the first and last momentum.	1	6	4	3	8	7
AC12. Momentum is preserved if impulse is exerted on the object.	-	-	3	-	1	1
AC13. The direction of impulse is the same with the direction of momentum.	3	13	4	2	9	1
AC14. Impulse is a force that is exerted on a unit time.	1	-	-	3	-	-
AC15. Momentum is the ratio of force to mass.	3	-	-	-	-	-
AC16. If gravity does not exist, then change in velocity is not seen.	4	2	1	2	5	2
AC17. None of the components stay motionless that formed as a result of an internal explosion.	10	1	5	9	11	9
AC18. In inelastic collisions, coming object stops after hitting the motionless object.	6	11	9	4	5	3
AC19. Velocity is transferred to another object in collisions.	4	12	7	3	5	5
AC20. Momentum is transferred to another object in collisions.	4	4	1	-	3	3
AC21. Total velocity is conserved in collisions.	2	1	1	1	3	-

As it can be seen in Table 8, data revealed that the participating students have some relatively more intense alternative conceptions such as AC3, AC4, AC7, AC8, AC9, AC13, AC17, AC18, and AC19, which might be explained as the teaching materials and teaching itself had limitations and even some hinderances that might led some participating students to develop alternative conceptions (AC4, AC13, AC18, AC19). For example E2, E13, E14, E16, C1, C2, C9 and C16 stated that in the interview "momentum was not changed because the velocity was not changed" and thus even after the intervention they did not understand that momentum was a vectorial quantity (AC3). Another interesting result showed that some of PSTs thought that velocity can be transferred as seen in AC19. However, E13, E14, C14 and C16 said in the interview that "motion is existed because velocity is transferred to another object in elastic collisions". If AC7 is considered in Table 8, it is seen that the intervention did not make a significant change in PSTs' minds because in the interview E1, E13, E14 and C1 stressed that "mass was important because the greater the mass, the greater the momentum" in a question that asking for the momentum of two objects with different masses were exerted by two equal forces during same time interval. In a similar vein, in the interview C1 made almost the same explanations for a different question seeking an answer for the momentum of two people having different masses that pushed each other and AC7 was not eliminated. It is seen that AC18 and AC19's frequencies increased after the intervention. Thus, in the interview E14 explained the differences between elastic and inelastic collisions such that "the objects stopped in inelastic collision" (AC18). E2, E13, E14 and C16 made an explanation in a case that two discs with equal masses which one of discs was motionless and one was active collided, then "one of the object transferred its velocity to the other object" (AC19).

On the other hand, the frequency of some alternative conceptions of PSTs was decreased (AC1, AC2, AC5, AC8, AC16, AC17, AC21) or even not seen (AC6, AC14, AC15) after the instructions. For example in the interview E1 made an explanation that "Impulse was not applied because the object was going with constant velocity" and also C3, C6, C9 and C16 stated that "The person who was weaker had a bigger momentum because the object which had bigger velocity had bigger momentum" in the interview and it showed us that after the intervention AC2 and AC8 kept existing on PSTs' minds. In addition, C3, C6 and C16 said that in the interview question that asking for the momentum of two objects with different masses were exerted by two equal forces during same time interval "the smaller the mass, the greater the velocity; so the smaller the mass, the greater the momentum" and in a different question of the interview, C16 stressed that "the truck and the taxi collided head to head drag to the direction of the one having the greater velocity".

4. Discussion and Conclusions

This study revealed that explanation assisted REACT strategy which was based on context-based approach was found more effective than the traditional teaching approach on impulse, momentum and collisions topic. And according to this finding, it is evident that in physis teaching explanation assisted REACT strategy has positively affected PSTs' learning. Course materials prepared for the experimental group, contexts and citations for the contexts that were made in each stage of the intervention have been effective in keeping the interest of PSTs alive.

Also despite the fact that there is a decrease in delayed test mean scores from the post test, the t-test results show that there is a statistically significant difference in favor of the experimental group. This result suggests that the learning environment in which explanation assisted REACT strategy used is also more effective for permanent learning and retention of alternative concepts. The reason of this can be that daily life materials and contexts could have been effective because they may have attracted PSTs' attention and have made them to be more interested during the learning experience which was explanation assisted REACT strategy used (Rayner 2005). For instance, in advertising which was shown in collisions topic's relating principle, the different ways of collisions of vehicles were watched to attract the PSTs' attention. This material may have been effective in attracting PSTs' attention to the course because it included daily life conditions that they may have possibly encountered (Ültay & Çalık 2016).

"Ice rink" context used in the experimental group had been introduced at the beginning of the impulse and momentum topic by a reading text including some daily life examples PSTs could have lived. Because PSTs were accustomed to traditional teaching (i.e. teachers made presentations and PSTs took notes), to teach the topic in a different way could have made a positive impact on PSTs. This case is consistent with the results of some studies in which REACT strategy found effective instudents' achievement (Demircioğlu, Vural & Demircioğlu 2012; N. Ültay 2012). Moreover, it is known that traditional teaching approach is not such an effective way to teach at eliminating alternative concepts and constructing the new concepts (CORD 1999a; Kobayashi & Okiharu 2009; Ültay 2015; Westbrook & Marek 1991).

Findings remarkably showed that some of the participating PSTs developed some conceptions which were not seen in pre-tests. To have new alternative conceptions reveals that alternative conceptions interact with each other and they are part of the thinking system. In addition, it shows that alternative conceptions do not originate from one point. For instance, the alternative conception of *"Momentum is equal to impulse"* may have caused the formation of *"The direction of impulse is the same with the direction of momentum"*.The thought of PSTs' "impulse was equal to momentum not to the change in momentum" can be a result of difficulty in understanding the relation between the impulse and momentum (Bryce & MacMillan 2009; Pride, Vokos & McDermott 1998). In fact, the explanations of PSTs during interview supported this thought. Because there was no change in velocities, PSTs thought that momentums were equal. The alternative conception of *"Momentum is preserved all time"* was emerged in the experimental group's post and delayed tests, and it requires PSTs understand the related and complex concepts in order to comprehend that momentum can be not preserved if external force exists (Bryce & MacMillan 2009). To have this alternative conception of PSTs is an indication of the weak connection between these concepts. Also, the samples exemplifying momentum's conservation which were given in the majority of materials and experiments used in the experimental group may give rise to this alternative conception. On the other hand, the alternative conception of *"Conservation of kinetic energy is required for momentum's conservation"* that emerged in the control group's post test supported this thought. The reason of this thought of PSTs in the control group may have resulted from the idea that kinetic energy and momentum should have been conserved together (Ünlüsoy 2006).

"Momentum is preserved if impulse is exerted on the object" was firstly determined in this study and it was seen in the control group's post and delayed tests and in the experimental group's delayed tests. The reason of this alternative conception's formation may be that some of PSTs thought that impulse was equal to change in momentum and so momentum conservation was seenif impulse was exerted. The alternative conception of *"Momentum is transferred to another object in collisions"* was determined in the control group's post and delayed tests and according to Grimellini-Tomasini, Pecori-Balandi, Pacca and Villani (1993), PSTs evaluated collisions as a single event and they ignored the other factors affecting the process. In addition, it can be caused by the difficulty of transferring the energy and momentum conservation knowledge to different situations (Singh

& Rosengrant 2003).

It is seen that some alternative conceptions (i.e *"The greater the mass, the greater the momentum"*) were not eliminated although they were stressed by the activities and experiments. It shows that it is quite difficult to change hard-core alternative conceptions. The main point in failing some alternative conceptions' elimination may be following a logical sequence rather than a psychological sequence. For example, to teach firstly momentum and then velocity may prevent the formation of *"Momentum is a concept based on solely and entirely velocity regardless of the mass"*.

According to this study's findings, it can be suggested for teachers and researchers an experimental design that should include two experimental and one control group. If in the first experimental group explanation assisted REACT strategy is used and in the second experimental group REACT strategy is used, then the effect of explanation assisted REACT strategy on learning impulse, momentum and collisions should be seen more clearly.

Note

This study is a part of the first researcher's PhD thesis which is entitled "Investigating the effect of the activities based on explanation assisted REACT strategy in context-based learning approach on impulse, momentum and collisions".

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