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Teacher Candidates' Understandings and Progress of Constructivism in Science Teaching*

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ABSTRACT Evaluations of any understandings, programs or tendencies in educational applications occasionally enable to check its improvement. Through a Science Teaching course included in a teacher training program, the authors utilized phenomenography to enlighten the teacher candidates' (TCs) understanding of constructivism in science teaching, which was captured in three categories: Non-constructivist, Semi-constructivist and, Constructivist. There is a hierarchical relationship between these categories. The aspects were grouped as general and science-specific. Additionally, it was investigated whether the Science Teaching course was aimed to make the teacher candidates understand constructivism and gain the skills in utilizing constructivist understandings in teaching science related subjects. A significant transformation from the non-constructivist to the constructivist approach and from the semi-constructivist to the constructivist approach was achieved. It is asserted that the model encapsulates a successful method of maintaining constructivist understanding.

INTRODUCTION

Most contemporary education communities regard so-called traditional approaches as obstacles to effective learning. One of the primary objections to such teaching applications is the passiveness of the learner during the learning process. Passive information receptor perceptions in learning extend back to early studies conducted by Locke. Locke (1824) stated that learners are passive receptors of knowledge. The mind is formed by empty cabinets (*tabula rasa*) that should be filled with these simple ideas through experiences. Constructivism, on the other hand, is a framework of many approaches that were conceived and improved as a reaction to such traditional, teacher-centered, behaviorist, direct instruction approaches in education (Sahin and Koca 2016; Danju and Uzunboylu 2017). According to constructivism, learning is an active process conducted by the learner deliberately. Educators may accept constructivism as the ultimate goal for education. A consistently large number of researchers have stated the benefits of constructivism in education environments regarding its many proposed aspects. Criticisms have also been towards constructivism, claiming the effectiveness of the direct instruction as opposed to constructivist strategies (Kirschner et al. 2006; Uzunboylu and Selcuk 2016; Bicer 2017; Borda et al. 2017).

Understanding Constructivism

The constructivist theory was developed unanimously over many years. Unanimous formation caused different understandings to constructivism (Phillips 1995; Perkins 1999), which has created ambiguity. The efforts to apply constructivist theory into teaching practice has increased the uncertainty even more, constructivism itself leaves teachers space to act freely in different instances; as Beswick (2007) identified, constructivist theory does not suggest constructivist teaching directly, but focuses on learning. Teachers can focus on different aspects of constructivism. For example, Perkins (1999) categorized constructivists into three groups: the first group is comprised of those who focus on individualistic learning (Piaget) stemming from biological/psychological mechanisms, the second group includes those who

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concentrate on social factors (Vygotsky) and the last group focuses on both (Glasersfeld). Applying constructivist principles may vary depending on various subjects, targets, class grades, etc. Real class environments are not simple, and the teachers could shift between different constructivist principles in the course of only one lesson and even context can change momentarily. Therefore, the expectations of the constructivist proponents are very high. They expect that constructivism will solve every problem faced by traditional, direct teaching as students would be self-directed, motivated and successful. Eggen and Kauchek (1994) warned about three types of misconceptions regarding constructivist teaching. The misconceptions regarding constructivist practices are that goals and planning are not important, discussions automatically end with learning and teachers are less important. Phillips (1995) stated three approaches for the understanding of constructivism: the good, the bad and the ugly. Phillips said that the good face of constructivism was that the learner's active engagement with the learning process enhances learning. The bad side occurs when the teacher places emphasize to every effort heading knowledge but neglecting reaching the truth. The ugly approach of constructivism is of the distrust in other methods of learning (called sectarianism by Phillips).

Researchers have utilized different measurement types, such as self-reporting (Gibbs and Coffey 2004; Aldrich and Thomas 2005; Struyven et al. 2010; Ocak 2012; Genc and Ozcan 2017). Additional, interviews and observations (Ocak 2012; Doruk 2014; Asiksoy and Ozdamli 2017), and metaphors (Krull et al. 2013) have been used to evaluate constructivist applications and teachers depending on their beliefs, perceptions, programs, and behaviors. Even a practical scale, which was invented by Taylor et al. (1997), can be utilized for determining future actions, based on the findings of the scale. The four scales are: Autonomy, Prior-Knowledge, Negotiation and, Student-Centeredness.

Success in Implementing Constructivism in Class

While some researchers have claimed to have been successful in implementing the constructivist perspective (Grippin 1989; Fox 1993; Ahlstrand and Nilsson 1999; Pandey and Ameta 2017), others have not (Smith 1989; Rafferty 1992). Tsai (2002) studied the teaching beliefs of Taiwanese science teachers and categorized them as traditional, process or constructivist. Additionally, Tsai categorized most science teachers as traditional and suggested the nested epistemologies idea, which affects teachers' perceptions of science teaching practice. One other categorization is dependent on how much constructivist are teacher candidates and instructors (Hills 2007; Sangsawang 2017). According to Hills, at one end of the continuum are those teachers who avoid constructivism because of the risks, and at the other end are those who are constructivist; however, he stated that most teachers fall somewhere in between. Martinez et al. (2001) in their study, found that most fourth-year teacher education students have a behaviorist perspective.

Experimental research has also been used to evaluate the success of implementing the constructivist view in class. Gibbs and Coffey (2004), for example, found that after training, university teachers became more student focused and less teacher focused, while their counterparts (control group) exhibited the opposite behavior. Krull et al. (2013) analyzed students' metaphors before and after a theoretical psychology education course in their study, and found that the cognitive-constructivist perspective increased at the end of the course, whereas the behaviorist perspective decreased. Partial success has also been observed in some studies. For example, Struyven et al. (2010), in their experimental study with student teachers, found constructivism enhanced student centered approaches, but was not effective at changed the teacher-centered learning approach.

Constructivist Tendencies in North Cyprus and Turkey

Some researchers have studied constructivism in the context of north Cyprus (Aliusta et al. 2015; Ozcan and Uzunboylu 2015). The educational reform initiated in 2005 required a focus on some constructivist aspects of the primary school program (The Cyprus Education 2005). The program developers aimed to organize pupil-centered teacher education programs in the years 2004-2008. Primary training was intended to give priority to learning by doing/living; to 'offer exercises and activities on core concepts';

as well as student-centered and constructive education. The program required teachers to create learning environments in line with the pupils' interests and skills, to provide interaction between students and their environment, and to use teaching techniques within the understanding of pupil-centered education. Moreover, the program expected teachers to enhance pupil characteristics, inquiry skills, and, scientific and logical thinking (Yilmaz and Hursen 2017). The new program also requires administrators to support constructivist applications. The science program, in particular, focuses on individual experiments in laboratories (Ozturk et al. 2016; Cinar 2017). However, data collected approximately six years after its implementation, in the year 2011, using quantitative and qualitative research approaches participated by teachers in north Cyprus showed inconsistent results (Aliusta et al. 2015). According to the study, teachers perceive themselves as upper immediate intermediate in terms of utilizing student-centered teaching strategies, while the researchers categorized the applications as non-constructivist. As a period of six years has passed since a previous study was conducted into this subject, the researchers deemed it to be sufficient to conduct a new study, based on the rapidly changing environment.

The staff teaching in the institute where the present study is conducted graduated from education faculties of universities that follow Turkish education programs; thus, it was deemed to be rational to mention the understanding of constructivism in the Turkish context. Turkish educators and researchers have accepted constructivism for many years and have demonstrated the importance of the issue by conducting research to validate the theory in the Turkish context. Additionally, curriculum designers have centered their teaching programs on constructivism. The inclusion of science courses in Turkish primary schools started in 1924. The program stated the need for observation, experimentation and placed importance on reaching new knowledge through positivist approaches, avoiding lecturing or direct instruction (Ozturk 2014). Ozturk stated that in 2004, it was attempted to implement post-positivist constructivist approaches in primary school programs, although this was only partially successful and the some positivist understanding still remained. Although more than a decade had passed, in their study conducted in 2016, Turkish primary school teachers Aydogdu and Selanik-Ay (2016) found that teachers offered both teacher and student/teacher centered instruction styles. In a study with Turkish teachers, Kucuktepe and Gurultulu (2014) found that teachers focus on different aspects of the constructivist approach.

Significance

Other than assigning importance to the learning by doing principle (Iran-Nejad 1995), the present study has additional significance. Firstly, phenomenography is believed to be an accurate research methodology used to reveal probable variations. Thus, phenomenography, which has not been used previously to show differences in constructivist applications, was successfully utilized in the present study.

Secondly, in previous studies conducted with the aim of determining the success of implementing constructivist approaches in learning/teaching environments, the objective was not to consider every possible aspect of the constructivist approach in a comprehensive manner. For example, Howard et al. (2000) were successful in improving teachers' three constructivist aspects they named as simple knowledge, quick learning and certain knowledge. Thus, instead of putting some aspects of constructivist practice based on prescribed criteria, researchers see it rational to seek for those principles emerged in their natural setting. In the present study, the Science Teaching Course was analyzed seeking constructivist principles.

Thirdly, the researchers refrained from asking the TCs what they understand about constructivism directly, which could have produced biased ideas, slogans or clichés regarding constructivist principles and applications. Instead, the researchers directed the TCs to evaluate their classmates' presentations, which indirectly conceive the TC's (in the role of an evaluator) constructivism understanding. The authors believe that by identifying and constructively criticizing others' faults, it is easier to learn more effectively about oneself.

Fourthly, there have been no studies revealing constructivist application conducted in the context of North Cyprus. Hence, there is a need to find out class approaches.

Finally, throughout the present study, the objective is to design a learning model representing a method of enhancing the constructivist environment.

Purpose of the Study

Evaluations of any understandings, programs or tendencies in educational applications occasionally enable to check its improvement. Education policies tried hard spending a lot of money and time to implement the constructivist approaches, particularly in the north Cyprus. The present study is founded on two fundamental objectives. The aim is to reveal whether TCs' understanding of teaching science is consistent with constructivist ideas or not. The second objective is to determine if a course grounded specifically on constructivist principles and applications and assuming different roles can enable TCs to achieve constructivist understandings.

It is anticipated that to impact the curriculum designers and teacher educators enhancing constructivist science class.

The Research Questions

The current study in particular aims to answer the following questions depending on TCs' evaluations of constructivist applications based on primary school science subjects:

1. How do the primary school TCs understand constructivism?
2. How do the primary school TCs, assuming different roles, progress through a constructivist based course?

METHODOLOGY

The present study followed a qualitative research. Qualitative researchers seek to understand participants' different in-depth understanding of the same phenomenon. The researchers supposed that TCs' evaluations in the present study reflect their constructivist worldviews. Furthermore, they accept the instructional course carried out in the study to enhance constructivist understandings (Creswell 2014: 8-9).

The authors preferred to use phenomenography to reveal the variation in constructivist understandings. Phenomenography is a qualitative research approach intended to expose the variation in opinions in small sample regarding any phenomenon and group those beliefs into several distinct categories, considering the whole data. The categories that emerge are mostly hierarchically related (Marton and Booth 1997: 125; Baysen In Press). The research intended to find a group of TC's variation in constructivism understandings. Adding second aim is to find if each TC developed during the course regarding understanding constructivism. The researchers achieved the second purpose through a quasi-experimental research design (Thyer 2012). Contradicting phenomenography, this time the data was not considered as one. Each TC was classified by analyzing the individual data collected in the first two and last two lessons (explained in data analysis), which were accepted as before and after intervention (Science Teaching Course), respectively.

Participants

Twenty TCs participated in the present study voluntarily. They acknowledged that the course would be monitored as a study area. TCs were in the first semester of third year of the four year teacher training program, which is designed to prepare them to be primary school class teachers. Constructivist teaching is supposedly followed in the training center. Apart from science related courses, namely Natural Sciences, Science, and Technology Laboratory, the TCs attended Learning and Teaching and Planning in teaching classes, which were all based on constructivist approaches. The significance of the participants regarding the present study is that the course would be the last one for improving teaching science, including the methods, strategies, approaches, and worldview. Additionally, the TCs' were considered to be particularly important as they will have a significant influence on children during the professional careers. The TCs declared that although they had learned the constructivist approach in terms of theoretical knowledge, no course before the present one had been implemented based on constructivist application.

Intervention and the Role of the Researcher

The present study was conducted during a one semester Science Teaching course, which is compulsory and lasts for one semester and is the last science related course in the teacher training program. The course was aimed at enabling the TCs to understand constructivism and acquire skills related to utilizing constructivist aspects in teaching science related subjects. The researchers in the present study were also teacher researchers. The teacher researchers required the participants at the beginning of the semester to prepare presentations regarding any science subject of their choice from the primary school program and deliver the 20-30 minute presentation to their classmates at some point during the course. The teacher researchers advised the TCs that the presentations should be based on constructivism. During the course, the teacher researchers and the TCs discussed constructivist aspects before the presentation session started. Teacher discussions followed after each week (three TC). Most of these talks by teacher researchers considered the principles and application strategies of constructivist approaches. Additionally, individual discussions were held between the teacher researchers and the individual TC regarding their presentation. In these individual discussions, the TC declared the non-constructivist behaviors they incorporated while presenting and how much the presentation contributed to their constructivist understandings and practices. They stated that they would eliminate these non-constructivist behaviors from their teaching and would improve their constructivist aspects.

Data Collection

The researchers collected the TC's written comments regarding each of their colleagues' presentations based on constructivist arguments. These observation results of the TCs constituted the primary data. The TCs were motivated by the fact that they were advised that their evaluations would be evaluated for their final scores. Thus, the data collected through this method for 20 TCs' over a period of 6 weeks was accepted as the data source for the present study. Each course lasted for 3 hours. Therefore, this constituted a total of 18 hours over the 6 weeks, with the final week's lesson comprised of only two presentations (1x2). The researchers collected 19 comments for each TC. Hence, a total of 170 A4 sheets of comments was collected and prepared for analysis.

Data Analysis

The researchers followed the phenomenography method of analysis (Marton and Booth 1997). The researchers analyzed data weekly, immediately after the three presentations of that particular week were completed and the TC's comments were collected. The researchers continued the analysis throughout the entire semester and finalized decisions at the end of the semester. The researchers utilized an iterative method of reading trying to determine the codes and categories of comments which are consistent with phenomenography. Codes were selected and then collated in order to reach the categories. After first coding and categorization, the codes were applied to the whole data and their correctness was determined. The categories were applied to the entire data after each reading session. Coding and categorization followed this method until a satisfactory result was achieved. The entire data was considered as one, not for each individuals TC. Thus, the analysis conducted was relevant to all the TCs. The intention was not to list every constructivist aspect and example in this research; instead, based on the TC's explanations, only those comments that provide comprehensive, interesting, explanatory and contradictory information regarding others were deemed to be sufficient to present and discuss the categories. The TCs' understandings (whole data) were group as non-constructivist, semi-constructivist and constructivist. For example, if a TC said that the class management aspect is under teacher control then this understanding was grouped as non-constructivist. If teachers talked about students' right to use (little) class time, then that understanding was grouped as semi-constructivist. If the TCs stated that the teachers themselves and the students are shareholders of class time management and they gave indications of how class time should be used, then this understanding was grouped as constructivist.

Consistent with the previous discussions, in deciding the constructivist levels of the TCs that emerged as non-constructivist, semi-constructivist and, constructivist, the evaluation reports for each TC from the first two weeks (2x3 presentations) and the last two weeks (1x3 and 1x2, for the last week) were chosen. It was decided that a TC is non-constructivist if s/he has non-constructivist understandings in any general or science-specific aspect. TCs were categorized as semi-constructivist if they have both non-constructivist and constructivist approaches in different aspects. Finally, those who have only constructivist understandings in all facets were declared to be constructivist.

This situation could be questioned by researchers and it could be regarded as weakness of the present study that not every aspect of constructivism could be tested. The authors believe that evaluating every constructivist aspect is not possible as not every aspect of constructivism can be observed in each presentation. Nevertheless, it is accepted that a broad range of perspectives reflecting non-constructivist, semi constructivist and constructivist understandings have emerged, which are sufficient to categorize the TCs regarding their constructivist beliefs.

Trustworthiness

The researchers took some measures to increase the integrity of the research. The researchers spent prolonged time in the search area to obtain in-depth meanings (Creswell 2003: 196; Padgett 2008: 179-190). The researchers placed particular emphasis on reducing any ideas formed about any TC regarding constructivism before the study and focused on remaining within the limits of the Science Teaching course, thus aiming to eliminate any researcher bias. The TCs were also warned about not exhibiting any prejudice while evaluating their classmates, which was thought to lower respondent bias. Some TCs declared how surprised they were when they observed some of their classmates' presentations, which showed that they refrained from their biased ideas about their classmates. The researchers think that the TCs disregarded their previous experienced and they concentrated on the course itself when giving their decisions. Inter-coder reliability was the other trustworthiness application (Hruschka et al. 2004) achieved by the researchers in present study. Inter-coder reliability, studied with a colleague, was conducted in an iterative manner in the phenomenography part while deciding codes and was finalized with proper categories. A similar approach was conducted in the experimental section to determine the constructivist statuses of each TC. Several reports were randomly chosen for the process. Inter-coder process was followed for the analysis. Difficulties were only experienced in two cases when deciding the categories. In those cases, the TCs' reports were read repeatedly (iterative way) and were discussed until a consensus was reached. Both cases were semi-constructivist in the first lessons before the intervention. Ultimately, it was decided to categorize one as constructivist and the other one as semi-constructivist agreement was reached regarding all other cases.

RESULTS

According to the research questions, the results were designed to present the variations in the TCs' constructivist understanding and the changes in between the first and the last lessons in the following sections of phenomenography results and experiment results, respectively.

Phenomenography Results

The teacher candidates' aspects of constructivism in science teaching were captured in three categories: Non-constructivist, Semi-constructivist and, Constructivist. There is a hierarchical relationship among these categories. Hierarchical relation of the categories are shown at Table 1. For example, wait-time in non-constructivist and semi constructivist is done in a serial fashion, it is used effectively in constructivist category. The aspects were grouped as general and science-specific.

Non-constructivist

This category included aspects of non-constructivist science teaching. The aspects of the non-constructivist category were grouped as General Aspects and Science Specific Aspects, which were then divided into subsections. Subsections were designed first to refer to the constructivist principles regarding that particular subsection, followed by excerpt example/s.

General Aspects

General aspects that were not specifically related to science subject were included in this section, such as class time, class management, teacher response, assignments, communication skills, questioning and answering, discussions, audiovisual aids and summarizing the subject learned.

Class Time

Teachers manage the class time appropriately according to the designed lesson plan. One TC said that her friend planned and used the

Table 1: Examples of codes for categories of aspects

	Non-constructivist	*Semi-constructivist*	*Constructivist*
Aspects General			
Wait-time	Serial fashion; no time to loose	Serial fashion; not much time to lose; depends on questions	Use wait-time effectively
Class-time	Managed, planned restrained by teacher	Students also use little class time, teacher dominates it	Teacher and students organize the class-time together
Class management	Students silently listen to the teacher	Students have limited freedom	Everybody adds to class management
Assignments	Teacher directed	Students choose from alternatives defined by teacher	Students decide their own assignments when they see a need
Communication	Students should hear their teachers easily	Communication is important, students should listen to each other	
Questioning and answering	Teacher- student questioning; ask permission to speak	Students can respond to others, but do not dominate the class time	Students can ask questions to each other; these sessions are important for student enhancement
Discussions	Teacher- student		
Audiovisual aids	Used frequently to attract student attention	Used frequently to attract student attention	Designed and used by students for their project presentations
Summarizing	Teacher summarizes	Student summarizes in evaluation sessions at the end of the lesson	Everyone in class can tell anecdotes; important for understanding student ` conceptions
Assessment	At the beginning and end of the lesson; chorus responses is beneficial; serial fashion	After class or secretly; open-ended	Open-ended; continuous; assignment alternatives; chorus not beneficial; not stop at right answer
Science-Specific			
Anecdotes	Teacher anecdotes are strategies to warm up students for learning	Students can tell their anecdotes following the teacher	Anecdotes can open new horizons and can dominate the class time
Exemplifying	Teacher gives a lot of examples	Students are encouraged to give examples	
Teaching concepts	Should teach students as appeared in the books	Should teach students information written books, but sometimes they need to understand prerequisite concepts	Teacher encourages students to construct their own conceptions through students' attempts
Student mobility	Students should remain in the same seats	Students should move only when really needed	Student can change their places to communicate with others
Experimental issues	Experiments should be didactic and conducted by the teacher	Students contribute to experimental procedures	Students can plan experiments depending on their problems
Role of the experiments	Experiments are not the main part of the lesson	Experiments should prove a generalization or a rule	Experiments have more benefits than proving, such as encouraging students to do new experiments
Draw hypothesis	There is no need to draw hypothesis	Only one hypothesis is enough for one apparatus set, otherwise students start guessing	Experiments can have more than one hypothesis, depending on students' curiosity
Expressing Conclusions/ Generalizations	Teacher dominancy	Teacher puts students' ideas into academic concepts	Student expressions are important
discrepancy	Unpredictable results ruin the lesson (experiments are risky)	Learning new things is exciting and important, but uncertainty is not good	Discrepant events are important when deliberately used
Experiments are risky	There is a risk of incorrect results which can ruin the lesson	Experimental risks can be tolerable	Students understand that there are , experimental errors

time reserved properly: "She used the time very efficiently, she has finished teaching the subject on time, as is the case at school."

Class Management

Teachers are solely responsible for class management. One TC stated how satisfied her classmate was with managing the class: "She kept us all silent; we were all ears."

Similarly, a TC emphasized that her classmate should not follow written direction: "When reading prepared notes in class, teachers lose their students' confidence."

Teachers should be kind but firm with their students. One teacher stated: "She was kind but firm to her students. Students love those kinds of teachers. This strategy facilitates class management."

Teachers should be serious while lecturing. A TC said: "She should be serious while she is lecturing, but she kept smiling throughout the lesson!"

Teacher Response

Teachers should respond to every question asked by their students. A TC considered this issue, "By responding to every question posed by the students, the teachers gain their students' trust."

Assignments

Teachers should organize and distribute the tasks to the TC. A TC stated: "Teachers should give the projects as assignments themselves."

Communication Skills

Teachers' communication skills must be excellent, although this category does not mention the students' communication skills and audibility in the class. One TC said: "Everyone in the class should be able to hear the teacher's voice easily."

One other TC stressed the teacher's speaking speed: "My friend spoke very fast, even I had difficulties with understanding her. I suspect that her students would not understand what she is talking about."

Questioning and Answering

Questioning and answering should be used deliberately with the aim of evaluating whether the course objectives have been reached. One teacher clearly stated a solid dependence on the purpose of the lesson: "Questioning and answering should be designed based on the objective of the lesson."

Teachers believe that each student question should be answered immediately to ensure that students correct their mistakes, otherwise they would not learn correctly. A TC reported: "She was correct to answer all the questions her students asked. Otherwise, her students would be in a state of uncertainty."

Discussion

Discussions in a class are important but should not dominate the class time. For discussions in class, students should be knowledgeable. A TC said: "Students should be knowledgeable regarding the issue being discussed. Otherwise, the discussion would be fruitless."

Audiovisual Aids

Teachers should use audiovisual aids in a limited fashion, in such a way that would strengthen their direct teaching and making the teacher the important person. One TC said: "She should not leave her students merely to watch the video; she should have guided them and explained each step shown in the video."

Summarizing the subject learned: At the end of the class, the teacher should summarize the issue. One teacher stated, "The teacher should have summarized the subject she taught through summative assessment."

Science-specific Aspects

The aspects related to the science subject in this section are expressing conclusions/generalizations, experimental issues, materials used and discrepant events.

Expressing Conclusions/Generalizations

Expressing conclusions/generalizations are issues directly stated by the teachers themselves. One TC said: "She advised: 'You shouldn't throw your waste into the sea', which was excellent advice for her students."

Experimental Issues

Experiments should be didactic. One TC said: "Her experiment was instructive, planned neatly to teach the subject. She followed each step carefully to reach the aims of the lesson."

Experiments are not the main part of the lesson. One TC said: "By consuming the class with the experiment, she was not able to cover the topic."

Experiments should not be time-consuming. One TC reported: "The experiment she conducted took a long time; she should have planned a shorter span of time for the experiment."

It is not necessary to draw a hypothesis before the experiment. A TC reported: "I felt unhappy when my hypothesis was not corrected. It would be better not to draw a hypothesis."

Teachers should know the results of the experiments as unpredictable results may ruin the lesson. Experiments are risky strategies. A TC stated: "She should have predicted those results. She was surprised, and everybody laughed at her."

Materials Used

Materials employed in the experiments must be professional. A TC stated that: "Materials used must be professional, not like the ones she has used. She used a toy car!"

Discrepant Events

Teachers should not place their students in a state of uncertainty. A TC stated: "It was an interesting experiment to learn new things, we were excited, but she put us in a condition of uncertainty."

The non-constructivist approach considers experiments as a means of attracting students' attention and supporting the lesson, although they should be an isolated part of the lesson. It seems that for the non-constructivist approach, there are two parts of the lessons - lessons and other applications. The TCs explained that there are actually two worlds regarding education. These are the imaginative one they experience in their institute and the reality they saw during the training periods in schools. During the class communications, the TCs expressed how much they were affected by the experienced teachers and school administrations. There is not a real need to add an experiment to the lesson. Instead, teachers can explain the results or generalizations directly and it is not necessary to waste time with experiments.

Semi-constructivist

The semi-constructivist category included aspects of both non-constructivist and constructivist approaches simultaneously. Issues were grouped as general and science specific. Subsections were designed first to refer to the constructivist principles regarding that particular subsection and excerpt examples.

General Aspects

General aspects, not specifically related to the science subject, were included in this section as class management, class-time, assessment, communication/wait-time, using anecdotes and concept definition.

Class Management

According to constructivism, learners have the right to manage their learning, learning periods and relaxation times. Contradicting this view, a TC stated that,

"Although using experiments for each learning context is important, she shouldn't leave her students alone while preparing for another experiment. She should keep an eye on her students during this period. It didn't happen in this situation because those so-called students were young people who have high auto-control, but in real conditions, she would face big problems."

Another TC stated: "She gave her students too much freedom. That would not work in real classes."

Class Time

Flexibility in using class time is necessary for the constructivist approach. A TC reported: "At first she was flexible in using the class-time. Students participated in activities they liked, and I liked that too, but this was not sustainable. Then she became aware of the amount of time left and used the time very efficiently."

Assessment

Teachers should conduct evaluations continuously, but should be careful with this approach. A TC stated: "She can evaluate her students during the class time or after the class, but she should do the assessment secretly."

Communication/Wait-time

Teachers should use wait-time for questioning and answering sessions but shouldn't use long wait-time. A TC stated: "Waiting for some time is important as it allows students to think comprehensively and encourages them to participate in the discussions, but she waited a lot. Waiting a lot caused students to deviate from the subject."

Using Anecdotes

TCs regard stories as only passage to the main lesson. Anecdotes are used to form a gradual passage to the 'main lesson.' Thus, telling stories are not real parts of lessons, they are mere strategies to start a lesson. A TC said: "He started his lesson by telling an anecdote and then *right after* continued by stating the subject. Using anecdotes like this is a good way of teaching."

Concept Definition

For this category, teachers should encourage students to define the concepts. However, teachers should correct them and there are no other correct interpretations than those found in the book and stated by teachers. A TC said: "She encouraged her students to make the definitions for proteins and carbohydrates, but afterward she gave the definitions herself based on scientific explanations written in the book, in order not to cause any misunderstanding."

Science-specific Aspects

Aspects related to science subjects in this section are expressing conclusions/generalizations and giving information.

Expressing Conclusions/Generalizations

As is the case in the Concept Definitions sections, teachers should correct their students' statements scientifically. A teacher stated: "After students expressed the conclusion of the experiment, he put it in more scientific terms: 'that is to say, increasing the inclination increases the velocity' which was appropriate behavior."

Giving Information

Teachers must lecture before starting an experiment. A TC stated: "It was excellent to experiment, she should first give information about the subject, only then can she progress and conduct the experiment."

Constructivist

The constructivist category included aspects of constructivist approaches. The researchers grouped the aspects as general and science specific. Subsections were designed to refer to the constructivist principles regarding that particular subsection and then explained through excerpt examples.

General Aspects

General aspects, not specifically related to science subjects, were included in this section as communication, wait-time, exemplifying, assessment, teaching concepts, group work, student mobility, and anecdotes.

Communication

Teachers should give their students the opportunity to express their opinions. One teacher stated: "She gave each of them the chance to answer, she did not separate any student."

Wait-time

Teachers should utilize wait-time correctly (Baysen and Baysen 2010). Using wait-time of more than 3-5 seconds is necessary for students to have the opportunity to think about every possible issue comprehensively, linking schemas to each other, resulting in quality discussions and learning. One teacher stated: "She shouldn't respond immediately, but have waited for her students. She should have waited for her students to answer or asked the same question to another student."

Exemplifying

Teachers should encourage their students to give examples of a phenomenon, in order to reveal if they have any misconceptions (Baysen et al. 2004). A teacher stated: "She made her students provide examples of the phenomenon to determine if they have any misunderstandings or not"

Assessment

Teachers should give their students a choice of alternative assignments. A teacher stated: "She gave alternative homework for students to choose from, depending on multiple intelligence theory."

Teachers should not stop, they should continue inquiry whenever students find the correct answer to a question. A TC reported: "She did not stop when a student responded correctly to a question, she asked another student."

Teachers should not include clues in their questions and questions should be open-ended. A teacher stated: "She asked many 'Isn't it?' questions which directed students to the answers. This is not a constructivist method of evaluation."

One other teacher reported that questions expecting chorus responses are not beneficial: "She should not ask for closed-ended yes or no answers and not let her students answer in a chorus fashion."

Teachers should include an assessment of a continuous strategy to understand students' learning. A TC reported: "While her students were drawing figures, she walked around to evaluate her students, which is a constructivist method of assessment, not including the assessment at the end of the lesson."

Teaching Concepts

Instead of defining or explaining a particular concept, teachers should make their students find the definition of that concept by themselves, through questioning and answering. One TC reported: "She should have encouraged her students to define the concept."

Group Work

Group work based on the socio-cultural approach is important. One TC said: "She used group work, which enabled students to improve their abilities, knowledge, etc. by affecting each other."

Student Mobility

Student mobility in the class is important. Teachers should allow the students to change places in order to facilitate communicate with their peers and the exchange of ideas. One TC said: "She let us change our seats, which contributed to learning."

Anecdotes

Anecdotes are not only used to start a lesson. A TC stated: "He used stories so that the students could familiarize with the issue, but then he followed this with a class discussion in which all volunteer students participated, and was not dominated by him. This allowed them to create new schemas and link those schemas found with strong connections. Additionally, the class can remember the anecdote for further learning."

Science-specific Aspects

Issues related to science subject were included in this section as experimenting, materials used, giving information, experimental materials, expressing hypothesis before experimenting, expressing conclusions/ generalizations and reporting.

Experimenting

Experiments are to be used in a constructivist manner. A TC stated: "Constructivist applications integrate experiments into the lesson and accept it as indispensable."

Materials Used

Materials employed in experiments must be from the students' environment, not the professional world. A TC stated: "Using those materials known to a person enhances their learning, only after that can we proceed to using other materials."

Giving Information

It is not necessary to start the lesson with direct instruction giving information regarding the subject; instead, teachers can start with an experiment, for example, to attract students' attention through a discrepant event. Additionally, teachers can encourage their students to conduct experiments for exploration. A TC stated: “She used experiments, not only to prove a particular formula or for generalization, but to make investigations. She encouraged her students to do other experiments.”

The experiments used in the class should attract students’ attention. One teacher stated: “The experiment was entertaining.”

Experimental Materials

Teachers should include a sufficient number of materials, giving the opportunity for each student to experiment. A TC stated: “She should have brought enough materials for each student.”

Expressing Hypothesis before Experimenting

Teachers should encourage their students to express hypotheses before experiments. A teacher reported: “He made his students hypothesize, which is necessary for experimenting consciously and preparing them to make reports.”

Expressing Conclusions/Generalizations

Teachers should encourage their students to state the conclusion/generalization of an experiment. One TC wrote: “She shouldn’t show the end of the experiment herself, but should have encouraged her students to do so.”

One other TC wrote: “Instead of asking his students what they had observed, he stated that the volume had increased.”

Reporting

Reporting the findings to present to others enhances learning, enabling schema constructions by summarizing those processes conducted through experimenting. One TC stated: “She made her students draw graphs in their notebooks, which was a significant action to learn how to report findings, summarizing by schematizing what has learned.”

Experimental Results

A change from the non-constructivist to the constructivist and from the semi-constructivist to the constructivist approach was achieved through the semester-long Science Teaching course (Table 2). Before the intervention, 15 of the TCs were categorized as non-constructivist, while only five of them were semi-constructivist and none of the TCs were constructivist. After the intervention, the number of TCs grouped as non-constructivist numbered only three, while the number of TCs categorized as semi-constructivist increased to 10 and finally, the number of TCs in the constructivist category was seven.

The magnitude of change for every TCs’ is found to be positive (+1 or +2) or zero, which is either TCs’ category of constructivist understanding is improved (fifteen TCs) or not changed (five TCs). Of those who improved, seven of them reached the constructivist level (Table 2.). Those fifteen changes are from non-constructivist to semi-constructivist (eight TCs); from semi-constructivist to constructivist (three TCs); from non-constructivist to constructivist (four TCs). Of those not changed are either non-constructivist (three TCs) or semi-constructivist (two TCs).

It should be noted here that some of the TCs resisted some of the particular understandings. Some of them changed to different non-constructivist understandings. For example, before the intervention, one TC thought that teachers should talk in a serious manner; otherwise students would cause chaos in the classroom. After the intervention, she changed her mind and

Table 2: TCs’ distribution of constructivist state before and after the intervention

TC	*Before intervention*	*After intervention*	*Change*
B1	NC	C	+2
G1	NC	C	+2
G2	SC	C	+1
G3	NC	SC	+1
G4	NC	NC	0
B2	NC	SC	+1
G5	NC	C	+2
G6	NC	C	+2
B3	NC	SC	+1
G7	NC	SC	+1
B4	NC	SC	+1
G8	NC	NC	0
G9	NC	SC	+1
G10	SC	C	+1
G11	SC	C	+1
G12	NC	SC	+1
G13	SC	SC	0
G14	NC	NC	0
G15	SC	SC	0
G16	NC	SC	+1

stated that she should use wait-time, but that pauses should only be utilized for those who are less skillful.

DISCUSSION

The results of the present study are similar to previous research which found that there is a variation in the understanding and application of constructivism (Tsai 2002; Nuangchalerm and Jin 2017); thus, a similar result applies for the North Cyprus context. The present study revealed that at first most TCs were non-constructivist. Contradicting, Hills (2007) reported that most teachers fall between constructivist and non- constructivist.

Variation in constructivist understandings is consistent with constructivism. According to constructivism and variation theory, each learner understands or focuses on different aspects of any phenomenon considered. A TC can show a constructivist understanding regarding one aspect, while she/he can demonstrate non-constructivist or semi constructivist in other aspects. Nevertheless, TCs can show mere non-constructivist or constructivist understanding in all aspects.

These findings can be interpreted to indicate that TCs' constructivist understandings can be improved (Gibbs and Coffey 2004), opposing some challenges faced in Chinese pedagogical reform (Tan 2017). The results of the current experimental research are consistent with the results of Struyven et al. (2010) where partial success was stated. It is likely that new misconceptions during this effort could be experienced and therefore care should be taken (Baysen 2003).

The current research add to the literature that, to enhance constructivism in teaching apart from doing constructivist teaching (Iran-Nejad 1995), there is another way, to deal with the issue more comprehensively. The key is to require TCs to plan their lessons obeying constructivist understandings, to apply it to their classmates, to observe and evaluate their classmates, and then assess and discuss possible improvements. It has been demonstrated that all these steps could be included in only one course. In other words, for the enhancement in constructivist understanding and applications, the results of the present study asserts a course constituted by roles acted comprehensively by TCs. The roles TCs actively assume in the course are the student, TC, teacher, and evaluator (Fig. 1). Taking different roles enabled the TCs to understand what each character experiences in the teaching environment. For example, TCs understand what students feel when a constructivist class is held. They understand to what extent they can excite their students when they present a discrepant event. Thus, a model is offered to increase constructivism in TCs. In summary, in this application model, the TCs take the role of:

Student: Participate in classmates' lessons as a student (target group) to improve based on the lesson goals.

Teacher: Choose a science subject, plan, and present it as a lesson.

TC: Follow presentations to understand, others understandings, methods or strategies classmates present to improve themselves.

Evaluator: Follow classmates' presentations to assess and to discuss.

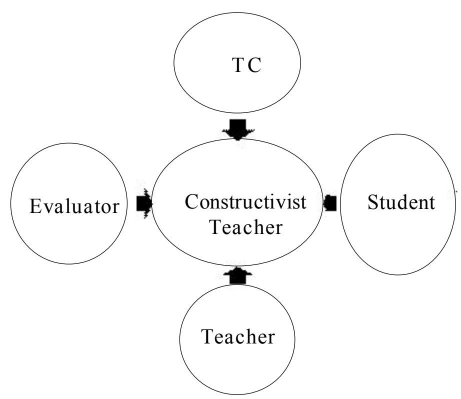

Fig. 1. Roles part of the learners in the constructivist teacher training course to achieve constructivist teachers
Source: Author

We improved "Learning by doing" or learning constructivism through doing constructivism. In the present context doing constructivism includes taking each of different roles of stakeholders namely, teacher, student, evaluator, and TC in a comprehensive and supportive way. In the process, TCs can't isolate themselves as only, for example, as a student because they knew that they were going to be inquired to give their opinions regarding the presentation/s as *evaluator*s. Additionally, they would also have to learn the subject provided by their classmates as *student*s do, and also they need to improve their constructivist understanding, because they are required to present a constructivist lesson as a *teacher*. Finally, they need to improve as a *TC* in order to achieve the objectives of the course.

CONCLUSION

Regarding TCs, there is a variation in constructivist understandings and applications which was captured in three hierarchical categories: Non-constructivist, semi-constructivist and, constructivist. TCs constructivist understandings can be improved through a course where the TCs take the roles of student, TC, teacher, and evaluator.

RECOMMENDATIONS

In a teacher training program it is important to consider TCs as having different constructivist understandings and not accepting them as a homogenous group regarding constructivist understanding. A course designed in the current study can be recommended for teacher trainers to implement constructivist understandings, to enable TCs take different roles as TC, evaluator, student, and a teacher.

REFERENCES

Ahlstrand E, Nilsson K 1999. Preparing to Become a Reflective Practitioner: A Swedish Perspective. Paper Presented at the Annual Meeting of the American Educational Research Association, Montreal. From <http://files.eric.ed.gov/fulltext/ED430928.pdf> (Retrieved on 7 June 2017).

Aldrich JE, Thomas KR 2005. Evaluating Constructivist Beliefs of Teacher Candidates. *Journal of Early Childhood Teacher Education,* 25(4): 339-347. Doi: 10.1080/1090102050250408.

Aliusta GO, Ozer B, Kan A 2015. The Implementation of Student-centered Instructional Strategies in Schools in North Cyprus. Education and Science, 40(181): 77-91. From <http://egitimvebilim.ted.org/index.php/EB/issue/view/199> (Retrieved on 11 March 2017).

Asiksoy G, Ozdamli F 2017. An overview to research on education technology based on constructivist learning approach. *Cypriot Journal of Educational Sciences,* 12(3): 133-147. doi: https://doi.org/10.18844/cjes.v12i3

Aydogdu B, Selanik-Ay T 2016. Determination of teacher characteristics which support constructivist learning environments. *Eurasian Journal of Educational Research,* 63: 293-310. doi:10..14689/ejer.2016. 63.

Baysen E 2003. *Fen Egitiminde Yeni Gelismeler ve (1960-1985 Dönemi) Türkiye'deki Uygulamalari.* Unpublished doctoral dissertation, Unpublished. Ankara: Gazi University.

Baysen, E (in press). Experimental activities (ea) - benefit conceptions of primary school teacher candidates: Before and after ea. *Kastamonu Education Journal.*

Baysen E, Baysen F 2010. Prospective teachers' wait-times. *Procedia-Social and Behavioral Sciences,* 2 (2): 5172-5176. doi: 10.1016/j.sbspro.2010.03.841.

Baysen E, Temiz B, Baysen Yagbasan R 2004. Ortaögretim ögrencilerinin atmosferde meydana gelen bazi doga olaylari ile ilgili yanlis algilamalari. In: Egitim *Bilimleri Kongresi Bildiriler.* Ankara: Gazi Üniversitesi Egitim Bilimler Enstitüsü, pp.1979-199

Beswick K 2007. Teachers' beliefs that matter in secondary mathematics classrooms. *Educational Studies in Mathematics,* 65: 95-120.

Bicer N 2017. The influence of student-centered methods in Turkish language instruction on academic success: A meta-analysis study. *Universal Journal of Educational Research*, 5(4): 687-697. doi: 10.13189/ujer.2017.050419.

Borda EJ, Boudreaux A, Fackler-Adams B, Frazey P, Julin S, Pennington G, Ogle J 2017. Adapting a student-centered chemistry curriculum to a large-enrollment context: Successes and challenges. *Journal of College Science Teaching*, 46(5): 8-13. From <http://static.nsta.org/files/jcst1705_8.pdf> (Retrieved on 15 May 2017).

Cinar D 2017. The Opinions of Teacher Candidates about the Use of Concept Cartoon in Science and Technology Teaching Courses. Contemporary Educational Researches Journal, 7(2): 50-56. From <http://sproc.org/ojs/index.php/cerj/issue/view/140> (Retrieved on 7 June 2017).

Creswell JW 2003. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.* 2nd Edition. London: Sage.

Creswell JW 2014. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* 4th Edition. Los Angeles: Sage.

Danju I, Uzunboylu H 2017. Analysis of gender stereotypes representations studies. *Ponte,* 73(6): 58-66.

Doruk BK 2014. The educational approaches of Turkish pre-service elementary mathematics teachers in their first teaching practices: Traditional or constructivist? *Australian Journal of Teacher Education,* 39(10): 113-134.doi:10.14121/ajte.2014v39n10.8.

Eggen P, Kauchek D 1994. *Educational Psychology: Classroom Connections.* 2nd Edition. New York: Merrill/Macmillian.

Fox DL 1993. The Relationship between Beginning Secondary Teachers' Conceptions of English and Their Instructional Practices: Two Case Studies. Paper Presented at the Annual Meeting of the National Reading Conference, Charleston, SC. From <http://files.eric.ed.gov/fulltext/ED366949.pdf> (Retrieved on 7 June 2017).

Genc Z, Ozcan D 2017. Department preference motivations of teacher candidates studying in gifted education department. *Ponte,* 73(5): 175-184.

Gibbs G, Coffey M 2004. The impact of training of university teachers on their teaching skills, their approach to teaching and the approach to learning of their students. *Active Learning in Higher Education,* 5: 87-100.

Grippin PC 1989. Using Research on Teaching Excellence to Re-Model Teacher Education. *Paper Presented at the Research Conference of the Eastern Educational Research Association,* February, Savannah, GA.

Hills T 2007. Is constructivism risky? Social anxiety, classroom participation, competitive game play and constructivist preferences in teacher development. *Teacher Development,* 11(3): 335-352. Doi: 10.1080/13664530701644615.

Howard BC, McGee S, Schwartz N, Purcell S 2000. The experience of constructivism: Transforming teacher epistemology. *The Journal of Research on Computing in Education,* 32(4): 455-465.

Hruschka DJ, Schwartz D, St John DC, Picone-Decaro E, Jenkins RA, Carey JW 2004. Reliability in coding open-ended data: Lessons learned from HIV behavioral research. *Field Methods,* 16(3): 307-331.

Iran-Nejad A 1995. Constructivism as substitute for memorization in learning: Meaning is created by learner. *Education,* 16: 16-32.

Kirschner PA, Sweller J, Clarck RE 2006. Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential and inquiry- based teaching. *Educational Psychologist,* 41(2): 75-86.

Krull E, Koni I, Oras K 2013. Impact on student teachers' conception of learning and teaching from studying a course in educational psychology. *Asia-Pacific Journal of Teacher Education,* 41(2): 218-231.

Kucuktepe SE, Gurultulu E 2014. Sample of metaphor study aimed at perception of teacher's related to notion of constructivist teacher. *Abant Izzet Baysal Universitesi Egitim Fakültesi Dergisi,* 14(2): 281-305.

Locke J 1824. The Works of John Locke in Nine Volumes. From <http://oll.libertyfund.org/titles/locke-the-works-vol-1-an-essay-concerning-human-understanding-part-1> (Retrieved on 8 April 2017).

Martinez MA, Sauleda N, Huber GL 2001. Metaphors as blueprints of thinking about teaching and learning. *Teaching and Teacher Education,* 17(8): 965-977.

Marton F, Booth S 1997. *Learning and Awareness*. USA: Lawrence Erlbaum Associates.

The Cyprus Education System 2005. Trans. S Alemdar. Nicosia: Ministry of National Education and Culture. From <http://talimterbiye.mebnet.net/CypTurEduSys.pdf> (Retrieved on on 11 March 2017).

Nuangchalerm P, Jin D 2017. Perception of preservice science teachers in the constructivist science learning environment. *Chemistry, Bulgarian Journal of Chemical Education,* 26(3): 332-340.

Ocak G 2012. An evaluation of teachers' success in building constructivist learning environments by pre-service and in- service teachers. *Education and Science,* 37(166): 25-40. From <http://egitimvebilim.ted.org.tr/index.php/EB/article/view522> (Retrieved on 11 March 2017).

Ozcan D, Uzunboylu H 2015. Training of special education teachers about curriculum development. *Andragoski Glasnik (Adult Education Gazette: Journal of the Croatian Andragogy Society),* 19(1): 23-37.

Ozturk F 2014. The transition from positivism to the process of post positivist/constructivist in the elementary school science curriculum in Turkey. *Ankara University Journal of Faculty of Educational Sciences,* 47(2): 17-136.

Ozturk GN, Altan E, Ercan S 2016. Investigating pre-service science teachers' laboratory approach choices. *International Journal of Learning and Teaching,* 8(1): 61-68. doi: https://doi.org/10.18844/ijlt. v8i1.509

Padgett DK 2008. *Qualitative Methods in Social Work Research.* 2nd Edition. Los Angeles: Sage.

Pandey L, Ameta D 2017. Effect of Constructivist Based Training on Learning and Teaching: An Experiment in Classroom. Journal of Education and Practice, 8(13): 67-72. From <https://eric.ed.gov/?idEJ1143831> (Retrieved on 12 April 2017).

Phillips DC 1995. The good, the bad and the ugly: The many faces of constructivism. *Educational Researcher,* 24(7): 5-12.

Perkins D 1999. The many faces of constructivism. *Educational Leadership,* 57(3): 6-11.

Rafferty CD 1992. What Will It Take to Ensure Implementation? A Content Literacy Dilemma. Paper Presented at the Annual Meeting of the National Reading Conference, San Antonio. From <http://files.eric.ed.gov/fulltext/ED352622.pdf> (Retrieved on 7 June 2017).

Sahin M, Koca S 2016. European Union lifelong learning key competences in early childhood education. *International Journal of Innovative Research in Education,* 3(3): 135-142. doi: https://doi.org/10.18844/ijire.v3i3.1854

Sangsawang T 2017. Constructivism perspective on multimedia games for hearing impaired children. *New Trends and Issues Proceedings on Humanities and Social Sciences,* 3(7): 100-108. doi: https://doi.org/10.18844/prosoc.v2i7.1990

Smith DR 1989. The Expansion of Field Experiences in the Reading Program. Paper presented at the Annual Meeting of the International Reading Association, April 30-May 4, New Orleans. From <ERIC database. (ED309389)> (Retrieved on 7 June 2017).

Struyven K, Dochy F, Janssens S 2010. 'Teach as you preach': The effects of student-centre versus lecture-based teaching on student teachers' approaches to teaching. *European Journal of Teacher Education,* 33(1): 43-64.

Tan C 2017. Constructivism and pedagogical reform in China: Issues and challenges. *Globalisation, Societies and Education,* 15(2): 238-247. Doi: 10.1080/14767724.2015.1105737.

Taylor P, Fraser BJ, Fisher DL 1997. Monitoring constructivist classroom learning environments. *International Journal of Educational Research*, 27(4): 293-302. doi: https://doi.org/10.1016/S0883-0355(97)90011.

Thyer BA 2012. *Quasi- experimental Research Designs*. New York: Oxford University Press.

Tsai CC 2002. Nested epistemologies: Science teachers' beliefs of teaching, learning and science. *International Journal of Science Education,* 24(8): 771-783.

Uzunboylu H, Selcuk G 2016. Pre-service teachers' self-efficacy beliefs in the context of teacher education program. *Anthropologist,* 24(3): 778-787.

Yilmaz N, Hursen C 2017. Defining Turkish language teachers' and students' inclination towards reflective thinking. *Ponte,* 73(7): 272-281.