Balıkesir Üniversitesi Sosyal Bilimler Enstitüsü Dergisi
BAUNSOBED Aralık 2023, Cilt:26 Sayı:50
https://dergipark.org.tr/tr/pub/baunsobed
Araştırma Makalesi / Research Article

A model that can be applied both online and face-to-face education: Problem based-quantum learning model

Çevrimiçi ve yüz yüze eğitimde uygulanabilecek bir model: Problem temelli kuantum öğrenme modeli

Gönderim Tarihi / Received: 26.08.2022
Kabul Tarihi / Accepted: 18.12.2023
Doi: 10.31795/baunsobed.1167511

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ABSTRACT: This study aims to investigate the influence of problem-based quantum learning on cooperative learning, self-efficacy beliefs, and metacognitive thinking skills among pre-service teachers and their views on it. In this research, an experimental research method was used. The participants were 2nd-year students in a state university's English Language Teaching program in Turkey.The data were collected by Student Letters, Teachers' Sense of Efficacy Scale, Metacognitive Thinking Skills Scale, and Attitude Scale for Cooperative Learning. The t-test from parametric tests and the Wilcoxon signed-rank test from non-parametric tests were used for the study of quantitative data. The content analysis method was used for the analysis of qualitative data. According to the data obtained from the research, it was concluded that the problem-based quantum learning model positively affected the attitudes of pre-service teachers towards cooperative learning and group work, their self-efficacy perceptions, problem-solving, thinking, research, and decision-making skills. Also, it was concluded that this model was effective in learning the content of the course, learning the information, and increasing the desire to learn, their attitudes towards the model changed, and the model was effective and fun.
Keywords: Online education, Face to face education, Problem-based learning, Quantum learning, Problem-based quantum learning

ÖZ: Bu çalışmanın amacı; uzaktan eğitimde problem temelli kuantum öğrenme modelinin öğretmen adaylarının işbirlikli öğrenme, öz yeterlilik inançları ve üst bilişsel düşünme becerilerine etkisini ve öğretmen adaylarının modele ilişkin görüşlerini belirlemektir. Bu araştırmada deneysel araştırma yöntemi kullanılmıştır. Katılımcılar, Türkiye'de bir devlet üniversitesinde 2. sınıfta okuyan İngilizce Öğretmenliği programı öğrencileridir. Veriler Öğrenci Mektupları, Öğretmenlerin Yeterlik Duygusu Ölçeği, Bilişüstü Düşünme Becerileri Ölçeği ve İşbirlikli Öğrenmeye Yönelik Tutum Ölçeği ile toplanmıştır. Parametrik testlerden t testi ve non-parametrik testlerden ise wilcoxon işaretli sıralar testi nicel verilerin analizinde; içerik analizi yöntemi ise nitel verilerin analizinde kullanılmıştır. Araştırmadan elde edilen verilere göre problem temelli kuantum öğrenme modelinin öğretmen adaylarının işbirlikli öğrenmeye ve grup çalışmalarına ilişkin tutumlarını, özyeterlilik algılarını, problem çözme, düşünme, araştırma yapma ve karar verme becerilerini olumlu etkilediği sonucuna ulaşılmıştır. Bir bütün olarak modele bakıldığında bu modelinin dersin içeriği ile bilgilerin öğrenilmesinde ve öğrenme isteklerinin artmasında etkili olduğu ve modele ilişkin tutumlarının değiştiği ve modelin etkili ve eğlenceli olduğu sonucuna ulaşılmıştır.
Anahtar Kelimeler: Uzaktan eğitim, Yüz yüze eğitim, Problem temelli öğrenme, Kuantum öğrenme, Problem temelli kuantum öğrenme

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GENİŞLETİLMİŞ ÖZET

Literatür taraması

Problem çözme becerisinin bireyler için önemi, kuantum öğrenme modelinin uygulanmasında başlangıç ve süreçle ilgili belirsizlik olması ve bu durumunda belirli bir program uygulanmasını zorlaştırması (Puk, 2003) ve kuantum öğrenme modelinin Yalçıntaş (2019) tarafından problem çözme, Tschannen-Moran ve Hoy (2001) ve Afacan ve Gürel (2019) tarafından ise özyeterlilik gibi yaşam becerilerini öğrencilere kazandırmada etkili olamayabileceğini ve bu sebeple bu becerilerin kazandırılabilmesi için bir modele ihtiyaç duyduklarını ifade etmeleri göz önüne alınarak bu çalışmada kuantum öğrenme ile bağlantılı, bu modelin yaşam becerileri arasında sayılan problem çözme, öz yeterlilik, düşünme becerileri gibi becerileri kazandırılmasını hedefleyen bir model geliştirilmiştir. Bu çalışma kapsamında geliştirilen modelde probleme dayalı öğrenme yönteminin basamakları ile kuantum öğrenme döngüsü birleştirilmiş ve bu problem temelli kuantum öğrenme modeli ismi verilmiştir. Bu bağlamda bu çalışmanın amacı; uzaktan eğitimde problem temelli kuantum öğrenme modelinin öğretmen adaylarının işbirlikli öğrenme, öz yeterlilik inançları ve üst bilişsel düşünme becerilerine etkisini ve öğretmen adaylarının modele ilişkin görüşlerini belirlemektir. Bu amaçla aşağıdaki problemlere cevap aranmıştır:

- ✓ Öğretmen adaylarının işbirlikli öğrenmeye yönelik tutumları, özyeterlilik inançları ve üstbilişsel düşünme becerileri ders öncesi ve ders sonrasında anlamlı farklılık göstermekte midir?
- ✓ Uzaktan eğitimde problem temelli kuantum öğrenme modeline ilişkin öğretmen adaylarının görüşleri nelerdir?
- ✓ Problem temelli kuantum öğrenme modelinde yapılan etkinliklere ilişkin öğrenci görüşleri nelerdir?
- ✓ Problem temelli kuantum öğrenme modelinin uygulanma sürecine ilişkin öğretmen adaylarının görüşleri nelerdir?

Yöntem

Bu araştırmada deneysel araştırma yöntemi kullanılmıştır. Katılımcılar, Türkiye'de bir devlet üniversitesinde 2. sınıfta okuyan İngilizce Öğretmenliği programı öğrencileridir. Veriler Öğrenci Mektupları, Öğretmenlerin Yeterlik Duygusu Ölçeği, Bilişüstü Düşünme Becerileri Ölçeği ve İşbirlikli Öğrenmeye Yönelik Tutum Ölçeği ile toplanmıştır. Parametrik testlerden t testi ve non-parametrik testlerden ise wilcoxon işaretli sıralar testi nicel verilerin analizinde; içerik analizi yöntemi ise nitel verilerin analizinde kullanılmıştır.

Bulgular ve tartışma

Uygulanan modelin öğretmen adaylarının işbirlikli öğrenmeye yönelik tutumlarında etkili olmadığı söylenebilir. Mektuplardan elde edilen veriler bu durumun sebebi olarak düşünülmektedir. mektuplarda öğretmen adaylarının bir kısmının grup çalışmalarını sevmediği ve grup çalışmalarına ilişkin önyargılarının olduğu görülmüştür. Öğretmen adayları grup çalışmasının meşakatli bir iş olduğunu ve işbirlikli çalışma alışkanlıklarının olmadığını ifade etmişlerdir.

Mektuplardan elde edilen veriler incelendiğinde öğretmen adaylarının öğretmenlik mesleğine ilişkin kazandıkları bazı yeterliliklere ilişkin görüşlerinin "Öğretim sürecini düzenlemeyi öğrendi", "Faklı yöntem ve teknik kullanmayı öğrendi", "Öğrenci merkezli eğitimi uygulamayı öğrendi", "Aktif katılımı sağlamayı öğrendi", "Öğretmenlik mesleğine bakışı değişti", "Mesleki gelişim için yeni kararlar aldı" olmak üzere altı kategori altında toplandığı görülmüştür.

Öğretmen adaylarının ders sonrası elde ettikleri kazanımlara ilişkin görüşlerinin "bilgi", "beceri", "tutum" ve "değer" olmak üzere dört kategori altında toplandığı görülmüştür.

Mektuplardan elde edilen verilere göre öğretmen adaylarının problem temelli kuantum öğrenme modelininin yapısına ilişkin görüşlerinin "Öğrenci merkezli bir model", "Problem durumları öğrenmeyi olumlu etkiledi", "Disiplinlerarası ilişki kurulması öğrenmeyi olumlu etkiledi", "Modelin yapısı bilgilerin kalıcı/dersin verimli olmasını sağladı", "Rapor hazırlamaya dair farklı görüşler" ve "Portfolya değerlendirme ve haftalık dönüt verilmesi daha etkili" olmak üzere beş kategori altında toplandığı görülmüştür.

Mektuplardan elde edilen verilere göre öğretmen adaylarının problem temelli kuantum öğrenme modelinin uygulanma sürecine ilişkin görüşlerinin "Dönem başındaki olumsuz görüşler dönem sonunda değişti", "İş yükü ile ilgili farklı görüşler var", "Uygulama sürecinde bir takım sıkıntılar yaşadı" olmak üzere üç kategori altında toplandığı görülmüştür.

Sonuç ve öneriler

Problem temelli kuantum öğrenme modelinin öğretmen adaylarının işbirlikli öğrenmeye ve grup çalışmalarına ilişkin tutumlarına etkisi olduğu sonucuna ulaşılmıştır. Grup çalışmaları esnasında zaman ayarlama, internet ve teknolojik cihaz erişimi, grup üyelerinin sorumluluklarını yerine getirmemeleri gibi problemler yaşanabildiği sonucuna ulaşılmıştır.

Problem temelli kuantum öğrenme modelinin uygulanması sonucunda araştırma verilerine göre öğretmen adaylarının öğretmen özyeterlilik algılarının olumlu yönde değiştiği sonucuna ulaşılmıştır. Öğrencilerin mesleğe bakışlarının değiştiği, öğrenci merkezli yöntem tekniklerini kullanma, öğrenci aktif katılımını sağlama ve öğretim ortamını düzenleme becerilerinin geliştiği görülmüştür. Araştırma bulgularına göre problem temelli kuantum öğrenme modelinin öğretmen adaylarının problem çözme, düşünme, araştırma yapma ve karar verme becerilerini olumlu etkilediği sonucuna ulaşılmıştır.

Problem temelli kuantum öğrenme modelinin bilgi ve beceri kazanımında etkili olmasının yanında öğretmen adaylarında olumlu yönde tutum değişikliğine de neden olduğu sonucuna ulaşılmıştır. Ders sonrası elde edilen kazanımlar incelendiğinde öğretmen adaylarının öğrenme isteğinin arttığı, öğrenci merkezli eğitimin önemini farkettikleri, grup çalışmasının ve öğrencilerin derse aktif katılımının önemini kavradıkları görülmüştür.

Araştırma bulgularına göre bu çalışma kapsamında geliştirilen problem temelli kuantum öğrenme modelinin öğrenci merkezli, öğrenme sorumluğunu öğrenciye veren ve etkili öğrenme sağlayan bir model olduğu ve öğretmenin rolünün rehber olduğu sonucuna ulaşılmıştır. Modelin geliştirilmesinde de bu anlayışın benimsenmiş olduğu düşünüldüğünde araştırma sonuçlarının modelin geliştirilme felsefesini doğruladığı görülmektedir.

Bu araştırma kapsamında geliştirilip çeşitli etkileri incelenen problem temelli kuantum öğrenme modelinin aşağıdaki bazı problemleri ortadan kaldırdığı görülmüştür: öğrencilerin probleme dayalı öğrenme modelinin uygulandığı sınıflarda görevlerini yerine getirecek yeterli zaman bulamaması, öğrenme sürecinde görevlerin fazla olması, (Yuan et al., 2011; Ünal ve Çakır; 2021), öğrencilerin bazılarının görevleri hiç yerine getirmemesi (Silva, Bispo, Rodriguez ve Vasquez, 2018; Ünal ve Çakır; 2021), kuantum öğrenme modelinde bir programın uygulanmasını zor olması (Puk, 2003) ve kuantum öğrenme modelinde problem çözme (Yalçıntaş, 2019), özyeterlilik (Tschannen-Moran & Hoy, 2001; Afacan ve Gürel, 2019) gibi yaşam becerilerini kazandırmada bazı sıkıntıların ortaya çıkması durumlarını ortadan kaldırdığı sonucuna ulaşılmıştır. Modelin öğrencilerin bilgi, beceri, tutum ve değer kazanımdaki etkileride göz önüne alındığında bu modelin etkili bir şekilde çalıştığı ve başarılı olduğu söylenebilir.

Introduction

Facilitating students' daily lives and preparing them for the business world are two of education's most important goals. (Trilling & Fadel, 2009). When they become adults, they need to develop their cognitive skills, including language, mathematics, and other school subjects, and many non-cognitive skills that will facilitate the application of these subjects to reveal their full potential (National Research Council, 2012). In a report published by the OECD (2018), it is noted that students should have interdisciplinary knowledge, practical problem-solving skills, metacognitive thinking skills, and social and emotional skills such as self-efficacy and cooperation in the 2030s. The 21st-century skills, which define what skills our children should be equipped with as they are being prepared for the future (Sing, 1991), also determined skills such as critical thinking, problem-solving, cooperation, information literacy, leadership, and responsibility as the basic competencies that students should have (Brown, 2018; Partnership for 21st Century Skills, 2009). This situation requires the use of methods and models that support high-level thinking in learning environments, encourage active participation of students, allow students to transfer what they have learned into practice, while incorporating social, academic, and life skills.

One of the models that can be used when organizing skill-based educational environments is the quantum learning model. In the quantum learning model, there are two groups of skills that students should acquire. These are academic skills and life skills (Demir, 2006). The quantum learning model, which aims to integrate academic skills and life skills on common ground and to gain these skills for students, actively participates students in the learning process and develops a sense of responsibility in them (Yalçıntaş & Sakız, 2018). Quantum note-taking, quantum memory, quantum writing, and quantum reading strategies are academic skills. Leadership abilities, innovative problem-solving methods, self-efficacy, the eight keys to excellence, effective communication skills, and responsibility are among the lifelong learning skills. (Deporter, Reardon & Singer-Nourie, 1999; Deporter, 2006; Given & Deporter, 2015).

One of the methods that are shown as a suitable example of the constructivist approach that can be used in skills training (Wilson, 1996) or that is stated to be the essence of the constructivist approach (Krynock & Robb, 1999) is the problem-based learning method. Academic studies in which this method has been applied show that this method is effective in students' problem solving (Siagian, Armanto & Siagian, 2019; Abidin et al. 2020; Suparman, Juandi & Tamur 2020), creative thinking (Parlindungan & Yennita; 2019; Zahro & Mitarlis, 2021), critical thinking (Purba et al., 2020; Seibert, 2021) and academic achievement (Chen & Wu, 2021). Individuals with problem-solving skills are successful in life. Because people with problem-solving skills have a flexible, logical, innovative, courageous, different thinking, self-confident, active, objective, energetic, responsible, creative, and productive structure (Germi, 2006). The process of developing problem-solving skills requires different abilities and skills. The development of this skill should be given importance in the progress and comfort of humanity. Because people have to act according to their own opinion in the face of the difficulties they experience (Akpınar, 2014).

A model was developed in this study taking into account the importance of problem-solving skills for individuals, the fact that the quantum learning model does not have a specific starting point and a single path to follow so it makes it impossible to implement any program (Puk, 2003), and that the quantum learning model may not be effective in providing students with life skills such as problem-solving (Yalçıntaş, 2019), self-efficacy (Tschannen-Moran & Hoy, 2001; Afacan & Gürel, 2019) and therefore a model is needed for them to fully acquire these skills, and that in the problem-based learning environment, there are too many tasks related to learning, there is not enough time to perform the tasks (Ünal & Çakır; 2021; Yuan et al., 2011), some students do not fulfill the tasks (Silva, Bispo, Rodriguez & Vasquez, 2018; Ünal & Çakır; 2021). This model aims to eliminate these problems in the quantum learning model and problem-based learning method and to improve life skills including problem-solving, self-efficacy, and cognitive abilities, which are connected to quantum learning and are listed among them. In the model developed within the scope of this study, the steps of the problem-based learning method and the quantum learning cycle were combined and this model was called the problem-based quantum learning model. In this context, this study aims to investigate the influence of problem-

based quantum learning on cooperative learning self-efficacy beliefs, and metacognitive thinking skills among pre-service teachers and their views on it. In the framework, this basic purpose has looked for answers to the following questions:

- Are there significant differences between pre-service teachers' attitudes toward cooperative learning, self-efficacy beliefs, and metacognitive thinking abilities before and after the lesson?
- What are the pre-service teachers' views on the problem-based quantum learning model?
- What are the pre-service teachers' views on the activities performed in the problem-based quantum learning model?
- What are the pre-service teachers' views on the application process of the problem-based quantum learning model?

Literature review

Quantum learning model

The Suggestopedia studies that Bulgarian educator Dr. Georgi Lazanov developed in the 1970s are the basis of quantum learning. In the 1980s Bobbi DePorter developed the concept of quantum learning in the USA, based on the definition of quantum as an interaction that "converts energy to light" (DePorter & Hernacki, 1992). Quantum learning is defined by Johnson (2002) as learning at the peak of people's thinking capacity; by Vella (2002) as the process of keeping structures together with personal methods by using all the neural networks in the brain to create meaningful information; by Hanbay (2009) as a model that enables individuals to realize themselves as a whole.

Quantum learning, which is created by starting from quantum physics and emerging as a synthesis of many new theories, includes learning methods and philosophical views that have proven to be effective for all age groups. These are"NLP", which enables the individual to develop himself by recognizing his strengths and weaknesses; "Brain-Based Learning" for consistent learning with the brain's natural learning process; "Learning Styles", which states that each individual has their own best learning style; "Multiple Intelligence", which states that individuals have different dominant intelligence dimensions and that they should be developed as a whole; "Emotional Intelligence", which supports academic success; "Holistic Education", which advocates the development of individuals as a whole in terms of body, mind and spirituality and "Creative Thinking" for generating new and original ideas (DePorter & Hernacki, 1992).

There are five basic principles adopted by quantum learning. These are as follows (DePorter, Rearden & Nourie, 1999): 1. The learning environment consists of adequate light, purposefully designated plants, colors, props, positive posters, and music. 2. Everything done in the course is done for the purpose. 3. Learning becomes more effective and permanent if newly learned information is combined with previous experiences. 4. Learning includes the risk factor. If the classroom is made more pleasurable, the student will learn more easily since they will perceive it as safe.5. Things that are worth learning are also worth celebrating. Appropriate and positive feedback establishes an emotional and positive connection with learning.

A quantum-referenced education program should not follow a predetermined route but should follow a flexible path that is suitable for the needs, tendencies, and learning styles of the student (Puk, 2003). For this reason, DePorter et al. (1999) created the Quantum Learning cycle design, which ensures that in every lesson, students are interested and curious.. This design consists of Enroll, Experience, Label, Demonstrate, Review and Celebrate. As an overview, the stages of the quantum learning cycle are as follows (DePorter, Rearden & Nourie, 1999; Ayvaz & Tuncel, 2011):

- Enroll: At this stage, in which the connection of the subject to be learned with the real world is established, interest in the subject is created, the attention of the students is drawn and their curiosity is aroused.

- Experience: First of all, connections are established by checking old information about the subject to be taught. At this stage, learners' prior knowledge is activated and their sense of curiosity is increased and their need for learning is ensured.
- Label: In the labeling stage, new information is tried to be built on students' prior knowledge. Learning strategies, memory techniques, and thinking skills are used extensively in this stage.
- Demonstrate: At this stage, the learner is free to acquire new information (combine it with existing information) and use it in various contexts. This stage is essential for learners to demonstrate what they know, make connections, and practice.
- Review: The review stage is the strengthening of the nerve connections with repetitions so that the learned knowledge and skills remain in the students' brains permanently.
- Celebrate: In the celebration stage, the achievements of the students are congratulated. Establishing intimacy between student and teacher depends on honoring student achievements.

Problem-based learning method

By presenting learners with problem situations that they could experience in daily life, the problem-based learning method develops their critical and creative thinking, research, problem-solving, and learning skills and prepares them for the profession (Duch, Groh & Allen, 2001). The purpose of this method is to help students become independent active learners. For this, students are given appropriate scenarios and they try to increase their problem-solving skills by thinking on their own (Boud & Felletti, 1997). Students take control of their learning during this process. As a result, they become more motivated to study and actively engage in the process (Barrows, 2002).

The main features of the problem-based learning method are listed as follows by Barrows (1996), Gijbel et al. (2005), and Reynolds and Hancock (2010): 1) This method is centered on the students. By engaging in real-world events, students take responsibility for their education and participate actively.2) A teacher's responsibility is to guide. 3) Students work in small groups. In this way, collaborative working skills are developed. 4) Problems increase the student's motivation to learn. Problems are presented to the learners in different ways such as through articles, videos, pictures, etc. 5) Students gain new knowledge in the process and develop problem-solving strategies and different solutions. 6) The problem situations given to the learners are of a quality that will improve the problem-solving skills of the students.

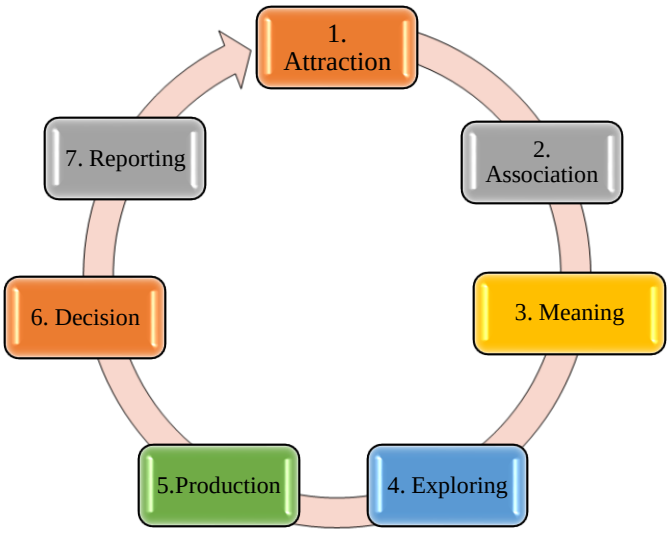
In the teaching process in which this method is used, problem situations should be complex, semi-structured (Duch et al., 2001), or unstructured (Albanese & Mitchell, 1993). While preparing scenarios involving problem situations, real-life situations should be taken into account, they should be interesting and increase student curiosity. Care should be taken that the solution of the problem includes more than one alternative solution (Duch et al., 2001; Savery, 2006).

The steps of the problem-based learning method were determined and applied in different ways by different researchers (Schmidt, 1983; Hmelo-Silver, 2004; Amir, 2016; Abello-romero, Mancilla & Viancos, 2019). In this study, the problem-solving steps stated by Saban (2004) were adopted. According to Saban (2004), the steps of the problem-based learning method consist of the 'Finding Step' in which the problem situation is planned; 'Preparation Step', where the problem situation is prepared; 'Welcome Step' where the problem situation is encountered; 'Identification Step', in which what is known about problem situations and what they need to know is determined; the 'Identification Step' where the problem is defined; the 'Collection Step' where data is collected and analyzed; 'Generation Step', where possible solutions are generated; the 'Presentation Step', in which the solutions are presented, and the 'Decision Step', where the appropriate solutions are determined.

Problem-based quantum learning model

The problem-based quantum learning model is designed in a way that gives the responsibility of learning to the student, aims to develop students' problem-solving and thinking skills, and requires students to work both individually and in groups in the process. In Figure 1, the formal view of this model, which is prepared in the form of a cycle, is shown.

Figure 1: Problem based-quantum learning model



- *Attraction:* This stage establishes a connection between the subject to be learned and the real world, generating interest in the subject, the attention of the students is drawn and their curiosity is aroused. First, a problem situation related to the contents of the unit is determined. This problem situation can be a cartoon, story, article, etc. may be. Attention is paid to the fact that the problem situations presented to the student will attract the attention of the student, increase his curiosity, and are suitable for real life.
- *Association:* Students are asked to make associations and analyze the problem situation by examining their previous learning. At this stage, learners' prior knowledge is activated and their sense of curiosity is increased and their need for learning is ensured. Students try to identify the problems felt. They examine their knowledge of the issue and the kind of information they require.
- *Meaning:* At this stage, students are expected to decide and define the problem situation.
- *Exploring:* Students are asked to build new information on their prior knowledge. Learning strategies, memory techniques, and thinking skills are used extensively in this phase. At this stage, students reach the information they determined in the 'Connection' stage and analyze the information. The information obtained is of a quality that will help them to solve the identified problem.
- *Production:* At this stage, students demonstrate what they know, associate with other disciplines, and practice. Discussion techniques, writing techniques, and various student-centered activities can be applied intensively at this stage. At this stage, they develop solutions for the determined problem using the information obtained. Care is taken to establish interdisciplinary associations in solutions.
- *Decision:* Students present their solutions. Students listening to the presentation are expected to analyze and criticize/comment on the presentation since it is thought that the repetitions made are important for the knowledge and skills learned during the presentation to remain in the brains of the students permanently. Solutions are evaluated and students' successes are congratulated.
- *Reporting:* Students report their individual and group work in the previous stages.

This model consists of 7 stages and 3 work types. The application process of the model consists of individual, group, and class activities. Which stages in the model will be done individually and which stages will be done with a group can be determined by the practitioner according to the situation of the class, the characteristics of the course, and the students. Students first work individually, then they come together with the group and do some activities, and the last class activities are held. In the problem-based quantum learning model, which can be applied to both face-to-face and distant learning,the duration of a cycle may vary according to the characteristics of the subject to be taught.

Methodology

Research model

In this study, the experimental research methodology was applied. The impact of the model was determined using a "pretest-posttest group design." An experimental group was designated for the group in the design. Table 1 shows the design's symbolic representation.

Table 1: Pretest-posttest research design

	Pretest	Treatment	Posttest
E_1	P_1	X_1	P_2

E1: Experiment Group-1, P1: Pretest, P2: Posttest, X1: Experiment Process-1

Working group

The participants were 2nd-year students in a state university's English Language Teaching program in Turkey. The working group for this study consisted up of participants in the course at the time. In the working groups, there are 36 female and 19 male students.

Application process

First stage

Within the scope of this research, first of all, a needs analysis study of the Teaching Principles and Methods course was made and a curriculum design was made. In this context, a Delphi study was conducted, interviews were held with teachers, teacher candidates, and school administrators, and the needs analysis study was completed by examining national and international reports and theses. According to the data obtained, the qualifications that teacher candidates should gain in the Teaching Principles and Methods course and the structure of the course curriculum were determined. The curriculum developed is based on an approach that directs pre-service teachers to use high-level thinking skills including critical, reflective, creative, and analytical thinking, enables permanent and meaningful learning, is associated with previous learning, and aims to integrate with other disciplines and daily life around professional competencies, skills and values, For this reason, it is thought that it is necessary to implement the program within the framework of a model that can be used effectively in both online and face-to-face education to achieve its purpose.

Second stage

The Teaching Principles and Methods course, which lasted a total of 14 weeks, was designed according to distance education in the problem-based quantum learning model. The course is designed to be both individual and group work. 11 groups in total were formed.. Students communicate with each other on Skype, Zoom, WhatsApp, etc. every week. They wrote the questions they wanted to ask the lecturers in Google Classroom and their questions were answered. Expectations from students during the course are explained as follows:

- In the course, individual, group, and classwork steps were followed every week.
- Classwork was held every Wednesday between 15.30-16.30 on the “UZEM Live Lesson Platform”.
- Worked in groups of 5 people. Group studies were carried out with the method determined by each group (zoom, WhatsApp, etc.) before the class study.
- Each group is registered to Google Classroom with the group names consisting of the names of the people in the group.
- The instructions for the work to be done for each subject (for 2 weeks) were sent to the students every Friday via Google Classroom
- The reports were taken as e-portfolios. Each group prepared a single portfolio.
- The reports were uploaded to Google Classroom as a single Word file at the end of each topic (at the end of 2 weeks) until 24.00 on Thursday.
- The head of the group was responsible for the preparation and sending of the reports. The group leader changed with each report submission.
- Individual studies, group studies, and forms filled during the presentation were included in the reports.

Each unit of the Teaching Principles and Methods course, which consists of 7 units, is designed to last 2 weeks. The steps that students will follow during these two weeks are described as follows:

The first week of each unit;

- ✓ Individually, the given scenario/situation/video/article was read and the information/situations here were associated and interpreted with the previous information.
- ✓ When associating with prior knowledge, the techniques given in the unit instruction were used.
- ✓ Individually interpreted situations and associated previous information were compared, discussed, and reported with the group. At this stage, the techniques given in the unit instructions were used.
- ✓ The problem situations felt by the group were determined and reported considering the contents of the unit.
- ✓ In the class, the prepared report was presented.
- ✓ While listening to the presentations of the other groups, the "He has, I don't have" form was filled out individually.
- ✓ After the lesson, the form of "He has, I don't have" was examined and the final version of the problem situation was decided.

The second week of each unit;

- ✓ Individually, the information required to solve the problem was obtained.
- ✓ The information obtained was reported using the techniques given in the unit instruction.
- ✓ The information obtained individually was discussed and analyzed with the group using the technique given in the unit instruction.
- ✓ Using the analyzed information, at least two different solutions were developed with the group.
- ✓ Associations with other disciplines (other educational science courses) were established in the solutions developed.
- ✓ In the class, the prepared report was presented.
- ✓ While listening to the presentations, everyone completed the peer review form individually.

The Teaching Principles and Methods course, which was organized according to distance education in the problem-based quantum learning model, was completed in 7 cycles in total, each unit being one cycle. An example unit cycle is presented in Table 2:

Table 2: A unit cycle in the problem-based quantum learning model

Week	Ünit	Cycle	Practices	Time	Work types	Activities
First Week	...	1. Attraction	• Encountering the problem	Out of course hours	Individual	• Cartoons, stories, articles, etc. examination
		2. Association	• Associating with previous knowledge • Problems felt • Determination of needed information	Out of course hours	Group	• Quantum writing • Quantum memory-association
		3. Meaning	• Identifying the problem	Course hours	Class	•Presentation • 'He has, I don't have the form
Second Week		4. Exploring	• Reaching for information • Analysis	Out of course hours	Individual	• Quantum writing • Note-taking techniques • Quantum memory-classification • Multiple intelligence activities
		5. Production	• Generating solutions • Making interdisciplinary associations	Out of course hours	Group	• Discussion techniques • Writing techniques • Student-centered activities
		6. Decision	• Sharing solutions • Determining the solution •Evaluation • Congratulation	Course hours	Class	•Presentation • Quantum memory-revival, acrostic, linking • Peer evaluation
		7. Reporting	• Reporting	Out of course hours	Group	• Report submission

As can be seen in Table 2, the course process includes both individual and group work, and both course activities and out-of-course activities. In the first week of the cycle, students who listened to the presentation during the presentation were asked to fill in the "He has, I don't have" and in the second week of the cycle, "Peer evaluation" forms were filled. In these forms, students were asked to evaluate the work of other groups and compare them with their work. In this way, it was ensured that the students saw the deficiencies in their studies and completed them.

Data collection

"Student Letters", "Teachers' Sense of Efficacy Scale", "Metacognitive Thinking Skills Scale" and "Attitude Scale for Cooperative Learning" were used to collect data.

- ✓ Student letters: At the end of the semester, the students were required to write a letter outlining their views and feelings regarding the procedure in order to assess their attitude toward the lesson. In the study group, 55 out of 55 students wrote letters.

- ✓ Teachers' sense of efficacy scale: The scale's 24 items and three sub-factors—student engagement, instructional strategies, and classroom management—were developed Çapa, Çakıroğlu, and Sarıkaya (2005). The reliability values of the scale's sub-factors were as follows, according to the study's reliability and validity: student engagement (r=82), instructional strategies (r=86), and classroom management (r=84). Calculated for all scale items, the Cronbach's Alpha reliability coefficient was found to be 93.

- ✓ Metacognitive thinking skills scale: The scale consisting of 18 items and four sub-factors was developed by Tuncer and Kaysi (2013). The scale's four sub-factor structure was shown to be able to explain 56,579% of the total variation, and the Metacognitive Thinking Skills (MTS) scale's Cronbach's alpha coefficient was calculated to be.881. The metacognitive thinking skills of students who score higher on the scale are higher, while those with low scores are lower.

- ✓ Attitude scale for cooperative learning: Consisting of 28 items and one dimension, the scale was developed by Şahin, Arseven, Ökmen, Eriş & İlğan (2017). It was seen that 28 items explained 45.38% of the total variance. In the internal consistency study of the scale, the Cronbach's Alpha coefficient was found to be 0.95 and the two-half reliability was found to be 0.90. Students who score high on the scale have more positive attitudes towards cooperative learning, while those with low scores have negative attitudes.

Data analysis

The analysis of the quantitative and qualitative data collected in the research is as follows:

- ✓ Quantitative data analysis: The Kolmogorov-Smirnov test was initially used in the analysis of quantitative data to determine whether the results were normal. According to the results of the normality test, it was seen that the students' attitudes towards cooperative learning and the metacognitive thinking skills scale did not show a normal distribution, while the teacher self-efficacy belief scale showed a normal distribution. In analysis; the t-test from parametric tests and Wilcoxon signed-row test from non-parametric tests were used.

- ✓ Qualitative data analysis***:*** Content analysis was used to examine student letters. There were three stages to the data analysis procedure. Data organization, data summarization, and data association/interpretation are these processes (Kılıç et al., 2019). Data were combined, grouped, and prepared for analysis at the stage of organization. In order to express each participant, the forms were coded. Direct quotations also made use of these codes. Data summarization included the use of coding and categorization procedures. The data's meaningful components were classified, and these codes were gathered into groups and subcategories. At the association/interpretation stage, the categories that emerged themselves were interpreted by connecting them to one another. Pseudonyms were also given to the students to ensure confidentiality in the presentation of the data. The statements of the students are quoted using their original words.

Findings and discussion

The research findings were examined under six headings: “Pre-service Teachers' Attitudes Towards Collaborative Learning”, “Pre-Service Teachers' Teacher Self-Efficacy Beliefs”, “Pre-Service Teachers' Metacognitive Thinking Skills” and “The Structure of the Problem-Based Quantum Learning Model”, “Activities in the Problem-Based Quantum Learning Model”, “The Implementation Process of the Problem-Based Quantum Learning Model”.

Pre-service teachers' attitudes towards collaborative learning

Table 3 contains the findings of the Wilcoxon signed-rank test, which was conducted to see if there was a statistically significant difference between the pre-test and post-test scores on the pre-service teachers' attitude scale toward cooperative learning.

Table 3: Wilcoxon signed ranks test results regarding pretest-posttest scores

	n	Mean of Ranks	Sum of Ranks	z	p
Negative Rank	14	15.11	211.50	-1.233	.217
Positive Rank	19	18.39	349.50		
Ties	1				

Table 1 shows that there was no significant difference in pre-service teachers' attitudes toward cooperative learning compared to the Wilcoxon signed-rank test result (z=-1.233, p.01). Accordingly, it can be said that the model applied is not effective in the attitudes of pre-service teachers towards cooperative learning. The data obtained from the letters are thought to be the reason for this situation.

When the data from the letters were analyzed, it became clear that the pre-service teachers' opinions on collaborative work could be divided into four categories: “They do not want to do group work”, “They cannot communicate to do group work”, “They have difficulties during group work”, and “They think that group work is fun and effective”.

- ✓ They do not want to do group work: Some of the pre-service teachers were seen to dislike group work and have prejudices about group work. Pre-service teachers claimed that group work was a challenging task and they did not have cooperative working habits.
- ✓ They cannot communicate to do group work: It was observed that during the distant education procedure the pre-service teachers could not communicate effectively with each other due to problems such as illness, internet, and access to technological devices. These problems are the problems arising from the distance education process, regardless of the model applied in the course. In addition to these, it was observed that pre-service teachers had difficulties in communicating because they had difficulties in arranging time.
- ✓ They have difficulties during group work: Some of the pre-service teachers stated that their groupmates did not make the necessary effort during group work and that they had to take on the responsibilities of the group members. This situation prevented pre-service teachers from carrying out group work effectively. Pre-service teachers think that it is difficult to be patient with group members and to find a common point in group work.
- ✓ They think that group work is fun and effective: Although there are some problems in the group work process, pre-service teachers think that discussing and analyzing common ideas through collaborative work is a good experience, that it is more beneficial than individual work, and that group work done within the scope of this model is more productive and valuable than other group work. It was observed that there were students who were satisfied with group work, found group work easy and enjoyable, and found themselves successful in group work.

Pre-service teachers' teacher self-efficacy beliefs

Table 4 contains the findings of a t-test that was conducted to see if there was a significant difference between the pre-test and post-test scores on the teacher self-efficacy belief scale for pre-service teachers:

Table 4: Comparison of pre-test and post-test scores of pre-service teachers' teacher self-efficacy beliefs scale

	Test	N	X	S.S	t	p
Total	Pre-test	33	3.80	.43	-2.48	0.018
	Post-test	33	4.00	.44		
Using Teaching Strategies	Pre-test	33	3.81	.52	-2.133	0.041
	Post-test	33	4.00	.46		
Classroom Management	Pre-test	33	3.80	.42	-2.036	0.050
	Post-test	33	4.00	.49		
Ensuring Student Participation	Pre-test	33	3.78	.53	-2.298	0.028
	Post-test	33	3.99	.44		

When Table 4 is examined, between the pre-test and post-test scores, there was a significant difference in total (t=-2.48, p<0.05), the dimension of using teaching strategies (t=-2.133, p<0.05), and the dimension of ensuring student participation (t=-2.298, p<0.05), and this difference appears to be in favor. In the classroom management dimension (t=-2.036, p<0.05), it was seen that the averages increased, but there was no significant difference. In this case, it can be said that the teaching principles and methods course, in which the problem-based quantum learning model was applied, positively affects the teacher self-efficacy beliefs of the pre-service teachers.

When the data from the letters were analyzed, it became clear that the opinions of the pre-service teachers on some of the qualifications they gained regarding the teaching profession were grouped under six categories: "He learned to organize the teaching process", "He learned to use different methods and techniques", "He learned to apply student-centered education", "He learned to actively participate", "He changed his view of the teaching profession", "He made new decisions for professional development".

He learned to organize the teaching process: Pre-service teachers were found to think that they have learned to prepare an effective lesson plan in their professional life, to create a learning environment suitable for cooperative learning, and to prepare and use different materials.

He learned to use different methods and techniques: Pre-service teachers stated that they understood how the methods could change for each lesson and subject and learned how to use these methods. T11 expresses his opinion on this subject as follows: "*We learned by applying many different methods this term. It's all in my mind. I look forward to applying these learned principles and methods in my class*."

He learned to apply student-centered education: It was observed that pre-service teachers learned to apply student-centered teaching and to prepare a student-centered teaching model when they started their profession.

He learned to actively participate: It was observed that pre-service teachers learned how to ensure active participation of students during the lesson, how to communicate with students, how to manage all kinds of classroom mobility and how to approach individual differences with an understanding.

He changed his view of the teaching profession: At the end of the application, it was observed that there was a change in the professional perceptions of the pre-service teachers. It was observed that teachers realized how valuable they are, there were positive changes in their perception of teaching and they learned what needs to be done in teaching life.

He made new decisions for professional development: To be an effective teachers, pre-service teachers realized their shortcomings and made new decisions to close this gap. Accordingly, pre-service teachers decided to plan, organize time, and learn the basics of educational philosophy, acquire different books on methods and techniques, and gain the habit of reading research and articles in the next process.

Pre-service teachers' metacognitive thinking skills

Table 5 contains the findings of the Wilcoxon signed-rank test, which was conducted to see if there was a statistically significant difference between the pre-test and post-test scores on the pre-service teachers' metacognitive thinking skills scale.

Table 5: Wilcoxon signed ranks test results regarding pretest-posttest scores.

		n	Mean of Ranks	Sum of Ranks	z	p
Total	Negative Rank	15	11.67	175.00	-.337	.736
	Positive Rank	12	16.92	203.00		
	Ties	1				
Thinking Skills	Negative Rank	11	11.00	121,00	-.521	.603
	Positive Rank	12	12.92	155,00		
	Ties	6				
Reflective Thinking Towards Problem Solving	Negative Rank	13	12.92	168,00	-.192	.848
	Positive Rank	13	14.08	183,00		
	Ties	4				
Decision Making	Negative Rank	14	12.46	174,50	-.704	.481
	Positive Rank	10	12.55	125,50		
	Ties	5				
Alternative Evaluation	Negative Rank	9	11.28	101,50	-1.393	.164
	Positive Rank	15	13.23	198,50		
	Ties	6				

According to the Wilcoxon signed-row test results, Table 5 shows that there was no significant difference in the total score (z=-.337, p.01) for the pre-service teachers' metacognitive thinking skills, in the thinking skills dimension (z=-.521, p<.01), in reflective thinking towards problem-solving dimension (z=-.192, p<.01), in decision making dimension (z=-.704, p<.01) and in alternative evaluation dimension (z=-1.393, p<.01). This situation differs in qualitative data.

There was a finding that the opinions of the pre-service teachers regarding the learning outcomes they gained after the lesson were grouped under four categories: " information", "skill", "attitude" and "value".

- ✓ Information: Pre-service teachers claimed they had acquired the following information within the scope of the model:
  - Information on the course content: 90% of the course, educational sciences concepts and terms, various fields and subjects, many websites, forums, and resources
  - New methods and techniques
  - Note-taking techniques
  - Various thinking techniques
- ✓ Skill: Pre-service teachers thought that they acquired the following skills within the scope of the model:
  - Problem-solving skills: Analyzing the problem, developing solution proposals, generating ideas, structuring knowledge
  - Research skill
  - Critical thinking skill
  - Ability to apply methods and techniques
  - Ability to do group work
  - Careful reading skill
- ✓ Attitude*:* Pre-service teachers thought that they gained the following attitudes within the scope of the model:
  - Personal attitude: The desire to learn increased, he understood the importance of planned and programmed work,
  - Professional attitude: He realized the importance of student-centered education, learning through research, group work, feedback, use of materials, and active participation of students in the lesson. T8 expressed his opinions on this subject as follows: "*We did a lot of research*

this term. The process was always under our control. Then I realized that the more active the student is in the process, the more he learns. Now I understand why student-centered education is important."

- ✓ Value: It was observed that the students thought that they gained the values of responsibility, justice, tolerance, respect, and patience as a result of the application of the model.

Structure of the problem-based quantum learning model

The data obtained from the letters showed that there were six groups in which the pre-service teachers' opinions on the problem-based quantum learning model were divided: "A student-centered model", "Problem situations have a positive effect on learning", "Establishing an interdisciplinary relationship has a positive effect on learning", "The structure of the model has made the information permanent / the lesson productive", "Different views on report preparation" and "Portfolio evaluation and weekly feedback are more effective".

- ✓ A student-centered model: It was determined that pre-service teachers perceived the applied model as a modern, democratic, cooperative, and active learning model. It was seen that the problem-based quantum learning model encourages students to research and learn, is based on learning by doing and experiencing, and is thought to provide effective learning when the steps of the model are followed. T8 expresses his opinion on this subject as follows: "*For the first time in my life, I had a student-centered education. In this process, I had the opportunity to criticize my teachers in the past. I realize their mistakes better now*."
- ✓ Problem situations have a positive effect on learning: It was determined that pre-service teachers found the problem situations interesting and problem situations showed them how a lesson should not be, saved the lesson from monotony, and shed light on the problems that pre-service teachers may encounter in their professional life.
- ✓ Establishing an interdisciplinary relationship has a positive effect on learning*:* It was observed that students found it fun to establish interdisciplinary relationships while solving problems within the scope of the model, and this enabled them to acquire new information and reinforced their existing knowledge.
- ✓ The structure of the model has made the information permanent / the lesson productive: The model's features such as students' doing research in the process, their efforts being essential, applying the knowledge they acquired, establishing interdisciplinary relationships, acquiring information for homework rather than exams, making discoveries on their own, synthesizing and sharing information, ensured that the information was permanent/productive.
- ✓ Different opinions on report preparation: Although the pre-service teachers found it tiring and time-consuming to prepare a report, it was observed that they thought that the report preparation process contributed to their learning.
- ✓ Portfolio evaluation and weekly feedback are more effective: The fact that the evaluation was based on the prepared reports and there was no exam was welcomed by the pre-service teachers. It was seen that giving feedback to the reports helped them to close their deficiencies. However, it was stated that group evaluation put some individuals in trouble.

Activities in the problem-based quantum learning model

The data obtained from the letters showed that the pre-service teachers' opinions on the activities of the problem-based quantum learning model could be divided into three categories: "Individual activities positively affected learning", "Classroom activities" and "Group work".

- ✓ Individual activities positively affected learning: It was observed that the activities performed by the pre-service teachers individually enabled them to learn new information and came prepared for the lesson and increased their active participation in the lesson.
- ✓ Classroom activities: The opinions of the pre-service teachers on the classroom activities within the scope of the model as follows:
  - He thinks that it is both stressful and beneficial: It was observed that the pre-service teachers thought that the presentations made within the scope of classroom activities were not only stressful, but also fun, they allowed them to see different ideas, and that the short presentations increased their interest.

- It contributed to individual development: Thanks to the presentations, pre-service teachers thought that their self-confidence increased, their fear of speaking in public decreased, and their perspective on teaching changed. T22 expressed his opinion about the presentations as follows: "*I am a bit of a shy person. So when I was going to do the presentation, I was getting stressed from the evening. But over time, my self-confidence developed. I feel more comfortable now*."
- Peer evaluation forms affected learning positively*:* Pre-service teachers reported that they had compulsory participation in the lesson, followed the presentations better, learned different ideas, and had the chance to complete their deficiencies, thanks to the forms they filled during the presentations.

✓ Group work: The opinions of the pre-service teachers on the group activities within the scope of the model are as follows:

- It helped them to strengthen their mental skills: It was determined that pre-service teachers thought that their observation skills increased, they learned to develop different solutions and contribute to a common product thanks to group work.
- He realized the importance of sharing ideas: Pre-service teachers claimed that group works taught them how to share ideas and that hearing different ideas improved them.
- He gained skills that he could use in his professional life: It was observed that the pre-service teachers thought that they could play a better and stronger role in the next group work, their self-confidence improved, they became aware of their responsibilities, and they realized that they could improve themselves from the deficiencies of their groupmates.
- Communication skills improved: During group work, it was observed that pre-service teachers made new friendships, developed existing friendships, and learned to get along with their peers. T38 expressed his opinion on this subject as follows: "*It was very good for me to meet with our friends in such a process. We created a group on WhatsApp for this lesson. But we were talking about other things as well. Thus, we became close. I met good people*."

The implementation process of the problem-based quantum learning model

The data obtained from the letters showed that the pre-service teachers' opinions on the problem-based quantum learning model's implementation process could be divided into three categories: "Negative opinions at the beginning of the term changed at the end of the term", "There are different opinions about the workload", "There were some difficulties in the implementation process".

✓ Negative opinions at the beginning of the term changed at the end of the term: It was found that pre-service teachers thought that this model would not be efficient at the beginning of the term and they were worried and afraid, but at the end of the term, their opinions changed. At the end of the term, pre-service teachers stated that this model is a fun and effective method and they feel lucky and valuable. T43 expresses his thoughts on this subject as follows: "*I must admit that at the beginning of the term I was very opposed. I said nothing like that would happen. But I was very surprised to see what I learned at the end of the semester. I couldn't believe it*." It was determined that this model enabled pre-service teachers to comprehend and accept the constructivist philosophy and they thought that they had the most interesting and different experiences.

✓ There are different opinions about the workload: While some of the pre-service teachers thought that the workload was too much, some of them stated that it did not take more than one day to complete both individual and group homework and when they looked at the information they learned, they did not think that the workload was too much.

✓ There were some difficulties in the implementation process: Pre-service teachers were observed to have difficulties in arranging a time to complete the tasks. It is thought that this situation is not due to the model but to the individual traits of the pre-service teachers or their inability to get used to the process of distance education. It was stated that not giving sample applications in order not to hinder the creativity of pre-service teachers during the application process made them indecisive and had difficulty in reaching sufficient information.

Results and recommendations

Attitude towards cooperative learning

It has been concluded that the pre-service teachers' attitudes toward group work and cooperative learning are affected by the problem-based quantum learning model.. Although there was no significant difference in quantitative data, there was an increase in the averages. The fact that in the distance education process, pre-service teachers had prejudices about group work and could not communicate effectively due to illness and technological problems may have prevented a significant difference. However, it can be said that the model has a positive effect on cooperative learning according to both the increase in the averages and the findings obtained from the qualitative data. Şenocak, Taşkesenligil, and Sözbilir (2007) and Wyness and Dalton (2018) also stated that The cooperative learning skills of students are positively affected by the problem-based learning model.

It was determined that there might be issues with scheduling, access to the internet and technological devices, and group members failing to perform their responsibilities during group work. It is thought that these problems are caused by distance education. In their studies, Batubara (2020), Alharthi (2020), Hebebci et al. (2020), and Çilek et al. (2021) have noted that technology issues with distant education have a negative impact on the teaching process.

Self-efficacy belief

According to the research findings, the use of the problem-based quantum learning model resulted in a positive effect in pre-service teachers' perceptions of their own teacher self-efficacy.It was observed that students' perspectives on the profession changed, and their skills of using student-centered method techniques, ensuring active participation of students, and organizing the teaching environment improved. Considering that Tschannen-Moran and Hoy (2001) and Afacan and Gürel (2019) stated that the quantum learning model may not be effective in gaining life skills such as self-efficacy, it is thought that it is important for this model to gain this skill. It is thought that the problem-based quantum learning model's combining knowledge and practice and enabling students to use the information they have reached are effective in this situation.

Metacognitive thinking skills

The research findings resulted in the conclusion that the problem-based quantum learning model had a positive impact on pre-service teachers' problem-solving, thinking, research, and decision-making skills. It was seen that the positive effects of problem-based learning on thinking, problem-solving, and research skills (Lohman & Finkelstein, 2000; Bashith & Amin, 2017; Simamora, Sidabtur & Surya, 2017; Hussin, Harun & Shukor, 2019) is effective in gaining skills such as problem-solving, different thinking and responsibility, which are considered among life skills of quantum learning.

The problem-based quantum learning model was found to be effective in helping pre-service teachers learn new skills and information as well as change their attitudes. When the lesson's learning outcomes were analyzed, it became clear that the pre-service teachers had a greater motivation to learn, were more aware of the value of student-centered education, and understood the value of group works and the students' active participation in the lesson.

It was observed that this model developed within the scope of the research was also effective in gaining values such as justice, responsibility, and respect for pre-service teachers. The fact that this model requires group work, gives the responsibility of learning to the student, and includes the processes of accessing and using this information has been effective in gaining values such as responsibility, respect, patience, and fairness. Because in value acquisition, The use of inquiry-based participatory models, which are process-based, student-centered, participatory, and encourage group learning and student participation, will help students develop their critical thinking, problem-solving, and cooperative skills. (Schwartz, Tessman & McDonald, 2013).

Problem-based quantum learning model

Structure and characteristics

The problem-based quantum learning model developed as a part of this study's scope is a student-centered model that assigns the responsibility of learning to the student and offers successful learning, and it was concluded based on the research findings that the teacher's role is that of a guide. Considering that this understanding was adopted in the development of the model, it was seen that the study's findings were regarded to confirm the model's development philosophy. In addition, it was seen that the problem situations used in the problem-based quantum learning model attracted students' attention and that establishing interdisciplinary relationships while defining and solving the problem in the process was effective on student learning. It can be said that establishing interdisciplinary relationships, which is an important part of quantum learning, is also effective in this model. While establishing interdisciplinary relations, students learn from their own experiences and construct knowledge, as in student-centered education (Daley, 2003). According to studies, this type of student-centered education provides students with depth in meaning, increases the level of recall of information, and increases their motivation to learn (Smart & Csapo, 2007). Ersoy and Başer (2011) also concluded in their study that problem situations used in problem-based learning have a positive effect on student learning.

It was concluded that both the preparation of the report and the feedback given to the reports during the process had a positive effect on student learning and that the evaluation system done on the portfolio, not the exam, affected the students positively. Kaya et al. (2020) examined the effect of feedback in their studies and concluded that feedback positively affects student learning and self-esteem. Sulistyo et al. (2020) and Barrot (2020) examined the effects of using portfolio assessment in the teaching process and stated that portfolio assessment was effective in student learning and students had positive attitudes. These studies are consistent with the results of this study.

According to the research findings, it was concluded that the individual activities of the students increased their active participation in the lesson by coming prepared. Brevik (2020) and Dolean and Lervag (2020) examined the effect of homework done before the lesson on students and stated that homework had a positive effect on student learning. It was concluded that student presentations in the classroom were stressful, but students' self-confidence increased. It was observed that giving tasks related to the presentation to the students who listen to the presentation during the presentation, on the other hand, allowed the presentations to be followed better and gave the students the chance to complete their deficiencies. Genç et al. (2020) stated that bad student presentations negatively affected distance education in their study examining student views on distance education. This situation shows that the student presentations made during this application process eliminate the negative situations during the presentation.

Effects on pre-service teachers

It was seen that group work contributed to pre-service teachers' mental skills, professional life, and social/communication skills. With the group work, it was concluded that the friendship relations, sense of responsibility, and cooperative working skills of the pre-service teachers improved. Despite several problems arising from distance education, it is thought that pre-service teachers' sharing of information, analyzing, and producing new solutions in group studies carried out regularly every week in the problem-based quantum learning model contribute to these positive results.

Looking at the model as a whole, it was concluded that this model was effective in learning the content of the course and information and increased the desire to learn, their attitudes towards the model changed, and the model was effective and fun. It was concluded that in the problem-based quantum learning model, students' doing research in the process, applying what they learned, establishing interdisciplinary relationships, and learning with their efforts made the lesson productive and the information permanent. In student-centered education, learning is more effective when students actively participate in the process (Scott, Buchanan & Haigh, 1997). Studies in the literature show that the problem-based learning method (Uygun & Tertemiz, 2017) and the quantum learning model (Trice, 2012; Usanmaz et al., 2017) both provide permanent learning. These research support the findings of the present study.

Conclusion

The problem-based quantum learning model was observed to eliminate some problems in the quantum learning model and problem-based learning method. The problem-based quantum learning model gives the responsibility of learning to the student, aims to develop students' thinking and problem-solving skills, and requires students to work both individually and in groups in the process. This model affects the attitudes of pre-service teachers towards cooperative learning and group work and the perceptions of teacher self-efficacy changed positively according to the research data. Also the problem-based quantum learning model positively affected the problem-solving, thinking, research, and decision-making skills of pre-service teachers. It is thought that the problem-based quantum learning model can be implemented in both online and face to face education effectively. Considering the effects of the model on students' knowledge, skills, attitudes, and value acquisition, it can be said that this model works effectively and is successful. Teachers should be encouraged to develop new learning models to improve teaching practices in distance learning.

References

Abello-romero, J., Mancilla, C., & Viancos, P. (2019). Diversity of the right to information and its negative effect on universities in Latin America. *Utopia and Latin American Praxis /Utopia Y Praxis Latinoamericana*, *24*(4), 5–9.

Abidin, Z., Herman, T., Jupri, A., & Farokhah, L. (2021). Gifted children's mathematical reasoning abilities on problem-based learning and project-based learning literacy. *Journal of Physics: Conference Series*,1720(1). DOI:10.1088/1742-6596/1720/1/012018

Afacan, Ö., & Gürel, İ. (2019). The Effect of Quantum Learning Model on Science Teacher Candidates' Self-Efficacy and Communication Skills. *Journal of Education and Training Studies*, *7*(4), 86-95. DOI: https://doi.org/10.11114/jets.v7i4.4026

Akpınar, Ş. (2014). *Öğretmen adaylarının problem çözme ve sosyal becerilerinin incelenmesi [Examining the problem solving and social skills of teacher candidates]*. (Unpublished Master's thesis). Sutcu Imam University.

Albanese, M., & Mitchell, S. (1993). Problem-based learning: A review of the literature on its outcomes and implementation issues. *Academic Medicine*, *68*(1), 52-81. Retrieved from https://www.researchgate.net/profile/Mark-Albanese/publication/14751207_Problem-based_learning_A_review_of_literature_on_its_outcomes_and_implementation_issues/links/560003a408aeba1d9f844a82/Problem-based-learning-A-review-of-literature-on-its-outcomes-and-implementation-issues.pdf

Alharthi, M. (2020). Students' attitudes toward the use of technology in online courses. *International Journal of Technology in Education*, *3*(1), 14-23. Retrieved from https://files.eric.ed.gov/fulltext/EJ1264084.pdf

Amir, M. T. (2016). *Inovasi pendidikan melalui problem based learning*. Prenada Media.

Ayvaz T. Z. (2011). Kuantum öğrenme modeli [Quantum Learning Model], In (Edt: Demirel, Ö.), *Eğitimde Yeni Yönelimler [New Directions in Education]*. Pegem Academy, 289-305.

Barrot, J. S. (2020). Effects of Facebook-based e-portfolio on ESL learners' writing performance. *Language, Culture and Curriculum*, 1-17. DOI:https://doi.org/10.1080/07908318.2020.1745822

Barrows, H. S. (1996). Problem-based learning in medicine and beyond: A brief overview. *New Directions for Teaching and Learning*, 68, 3-12. DOI:https://doi.org/10.1002/tl.3721996680

Barrows, H. (2002). Is it truly possible to have such a thing as dPBL? *Distance Education*, 23(1), 119-122. DOI:https://doi.org/10.1080/01587910220124026

Bashith, A., & Amin, S. (2017). The effect of problem-based learning on EFL students' critical thinking skills and learning outcome. *Al-Ta lim Journal*, *24*(2), 93-102. DOI:http://dx.doi.org/10.15548/jt.v24i2.271

Batubara, B. M. (2021). The problems of the world of education in the middle of the covid-19 pandemic. *Budapest International Research and Critics Institute (BIRCI-Journal): Humanities and Social Sciences*, *4*(1), 450-457. DOI: https://doi.org/10.33258/birci.v4i1.1626

Boud, D. & Feletti, G. I. (1997). *The challenge of problem-based learning*. London: Stirling (USA) Kogan Page.

Brevik, E. C. (2020). The effect of adding online homework assignments to a small introductory physical geology class. *Natural Sciences Education*, *49*(1),1-5. DOI: 10.1002/nse2.20020

Brown, S. (2018). *Best Practices in 21st Century Learning Environments: A Study of Two P21 Exemplar Schools*. (Doktora tezi), Brandman, California.

Cevik, M., & ŞentÜrk C. (2019). Multidimensional 21st-century skills scale: Validity and reliability study. *Cypriot Journal of Educational Sciences*. *14*(1), 011–028. Retrieved from https://www.researchgate.net/profile/Cihad-Sentuerk/publication/332061192_Multidimensional_21th_century_skills_scale_Validity_and_reliability_study/links/5ec144c1458515626cad0740/Multidimensional-21th-century-skills-scale-Validity-and-reliability-study.pdf

Chen, M., & Wu, X. Attributing academic success to giftedness and its impact on academic achievement: The mediating role of self-regulated learning and negative learning emotions. *School Psychology International*. DOI:0143034320985889.

Çapa, Y., Çakıroğlu, J., & Sarıkaya, H. (2005). The development and validation of a Turkish version of the teachers'sense of efficacy scale. *Education and Science, 30*,137.

Çilek, A., Uçan, A., & Ermiş, M. (2021). Pandemi sürecinde sınıf öğretmenlerinin uzaktan eğitime ilişkin görüşleri [The opinions of classroom teachers on distance education during the pandemic process]. *TURAN-CSR International Scientific, Peer-Reviewed & Refereed Journal*, *13*(49), 308-323. DOI: http://dx.doi.org/10.15189/1308-8041

Daley, B. (2003). A case for learner-centered teaching and learning. *New Directions for Adult and Continuing Education*, 98, 23-30.

Demir, S. (2006). *Kuantum öğrenme modelinin ortaöğretim düzeyinde öğrenci başarısına etkisi (Gaziantep Örneği)[The effect of quantum learning model on student achievement at secondary education level (Gaziantep Example)]*. (Unpublished PhD Thesis). Gazi Antep University.

Deporter, B. (2006). *Quantum Success*. Learning Forum Publications.

DePorter, B., & Hernacki, M. (1992). *Quantum learning: Unleashing the genius in you*, Dell Publishing Group.

DePorter, B., Reardon M., & Nourie S. S. (1999). *Teaching orchestrating student success*, A Viacom Company.

Dolean, D. D., & Lervag, A. (2020). Variations of homework amount assigned in elementary school can impact academic achievement. *The Journal of Experimental Education*, 1-18. DOI: https://doi.org/10.1080/00220973.2020.1861422

Duch, B. J., Groh S. E., & Allen, D. E. (2001). *The power of problem-based learning*. Sterling, VA: Stylus Publishing, Inc.

Erikli, S. (2016). *Development and implementation of a values education program for pre-school children* . (Unpublished master's thesis). Middle East Technical University.

Ersoy, E., & Başer, N. E. (2011). The effect on retention of applied scenarios in the problem-based learning method. *Journal of Uludag University Faculty of Education*, *24*(2), 355-366. Retrieved from https://dergipark.org.tr/en/download/article-file/153445

Genç, S.Z., Engin, G., & Yardım, T. (2020). Postgraduate students' views related to application of distance education during the Covid 19 pandemic. *Journal of Atatürk University Kazım Karabekir Education Faculty*,*41*, 134-158. DOI:10.33418/ataunikkefd.782142

Germi, H. (2006). *Gençlik ve spor genel müdürlüğünde görev yapan spor yöneticilerinin problem çözme becerilerinin değerlendirilmesi [Evaluation of problem solving skills of sports managers working in the general directorate of youth and sports]*. (Unpublished Master's thesis). Ankara University..

Gijbels, D., Dochy, F., Van den Bossche, P., & Segers, M. (2005). Effects of problem-based learning: A meta-analysis from the angle of assessment. *Review of Educational Research, 75*(1), 27-61. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.952.9652&rep=rep1&type=pdf

Given, B. K., & Deporter B. (2015). *Excellence in Teaching and Learning*. Learning Forum Publications.

Hanbay, O. (2009). "Kuantum öğrenme" temelli "öğreterek öğrenme" yönteminin ikinci yabancı dil olarak almanca'nın öğrenilmesine etkisi [The effect of "learning by teaching" method based

on "quantum learning" on learning German as a second foreign language]. *Journal of Dicle University Ziya Gökalp Faculty of Education,12, 17-27.* Retrieved from https://dergipark.org.tr/en/download/article-file/787127

Hebebci, M. T., Bertiz, Y., & Alan, S. (2020). Investigation of views of students and teachers on distance education practices during the Coronavirus (COVID-19) Pandemic. *International Journal of Technology in Education and Science (IJTES), 4*(4), 267-282. Retrieved from https://files.eric.ed.gov/fulltext/EJ1271267.pdf

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn?. *Educational psychology review*, *16*(3), 235-266. Retrieved from https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1049.2234&rep=rep1&type=pdf

Hussin, W. N. T. W., Harun, J., & Shukor, N. A. (2019). Problem-based learning to enhance students' critical thinking skills via online tools. *Asian Social Science*, *15*(1), 14-23. DOI: https://doi.org/10.5539/ass.v15n1p14

Johnson, D. S. (2002). Quantum Learning: Leadership for learning organizations. *Futurics; St. Paul, 26(3/4)*, 89-92.

Juandi, D., & Tamur, M. (2021, January). Review of problem-based learning trends in 2010-2020: A meta-analysis study of the effect of problem-based learning in enhancing mathematical problem-solving skills of Indonesian students. In *Journal of Physics: Conference Series* (Vol. 1722, No. 1, p. 012103). IOP Publishing.

Kaya, B., Ateş, S., Yıldırım, K., & Rasinski, T. (2020). Effect of feedback on Turkish fourth-grade elementary school students' fluent writing skills. *Education and Science*, *45*, 201. DOI: 10.15390/EB.2019.8413

Kılıç, A., Aydın, M., Ökmen, B., & Sahin, S. (2019). *Kuramdan uygulamaya ihtiyac belirleme [Identifying the need for practice from theory.]*. Pegem Academy.

Krynock, K., & Robb, L. (1999). Problem solved: How to coach cognition. *Educational leadership*, *57*(3), 29-32.

Lohman, M. C., & Finkelstein, M. (2002). Designing cases in problem-based learning to foster problem-solving skills. *European Journal of Dental Education*, *6*(3), 121-127. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.584.9006&rep=rep1&type=pdf

National Research Council. (2012*). Education for life and work: Developing transferable knowledge and skills in the 21st century*. Committee on Defining Deeper Learning and 21st Century Skills, Washington, DC: The National Academies Press.

OECD. (2018). The future of education and skills: Education 2030. Retrieved from https://www.oecd.org/education/2030/E2030%20Position%20Paper%20(05.04.2018).pdf

Partnership for 21st Century Skills. (2009). Framework for 21st-century learning. Retrieved from http://www.p21.org/our-work/p21-framework

Puk, T.(2003). Creating a Quantum Curriculum: Teaching and Learning in a Complex World, Retrieved from http://flash.lakeheadu.ca/~tpuk/metamodel/index.htm

Purba, D., Janah, M., & Arianto, F. (2020). The ımpact of problem based learning model on critical thinking ability in vocational education. *International Journal of Education and Research, 8(*12), 33-40. Retrieved from https://www.ijern.com/journal/2020/December-2020/04.pdf

Reynolds, J. M., & Hancock, D. R. (2010). Problem-based learning in a higher education environmental biotechnology course. *Innovations in Education and Teaching International, 47*(2), 175-186. DOI: https://doi.org/10.1080/14703291003718919

Saban, A. (2004). *Öğrenme ve öğretme süreci: Yeni teori ve yaklaşımlar [Learning and Teaching Process: New Theory and Approaches.]*. Nobel Publishing.

Savery, J. R. (2006). Overview of problem-based learning: Definitions and distinctions. *The Interdisciplinary Journal of Problem-based Learning*, 1(1), 9–20. DOI: https://doi.org/10.7771/1541-5015.1002

Schmidt, H. G. (1983). Problem-based learning: Rationale and description. *Medical education*, *17*(1), 11-16. DOI: https://doi.org/10.1111/j.1365-2923.1983.tb01086.x

Schwartz, K., Tessman, D., & McDonald, D. (2013). The value of relevant, project-based learning to youth development. *Journal of Youth Development*, *8*(1), 1-7. DOI: https://doi.org/10.5195/jyd.2013.109

Scott, J., Buchanan, J., & Haigh, N. (1997). Reflections on student-centered learning in a large class setting. *British Journal of Educational Technology, 28*(1), 19-30. DOI: https://doi.org/10.1111/1467-8535.00003

Seibert, S. A. (2021). Problem-based learning: a strategy to foster generation Z's critical thinking and perseverance. *Teaching and Learning in Nursing*, *16*(1), 85-88. DOI: https://doi.org/10.1016/j.teln.2020.09.002

Silva, A.B.D., Bispo, A.C.K.d.A., Rodriguez, D.G., & Vasquez, F.I.F. (2018). Problem-based learning: A proposal for structuring PBL and its implications for learning among students in an undergraduate management degree program. *Revista de Gestão, 25*(2), 160-177. DOI: https://doi.org/10.1108/REGE-03-2018-030

Simamora, R. E., Sidabutar, D. R., & Surya, E. (2017). Improving learning activity and students' problem-solving skills through problem-based learning (PBL) in junior high school. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, *33*(2), 321-331. Retrieved from https://www.researchgate.net/profile/Rustam-ESimamora/publication/317416532_Improving_Learning_Activity_and_Students'_Problem_Solving_Skill_through_Problem_Based_Learning_PBL_in_Junior_High_School/links/5939f2d0a6fdcc58aea6da21/Improving-Learning-Activity-and-Students-Problem-Solving-Skill-through-Problem-Based-Learning-PBL-in-Junior-High-School.pdf

Sing, R. R. (1991). *Education for the twenty-first century: Asia-Pacific perspectives*. UNESCO Principal Regional Office for Asia and the Pacific. Bangkok. Retrieved from http://unesdoc.unesco.org/images/0009/000919/091965E.pdf

Smart, K. L., & Csapo, N. (2007). Learning by doing: Engaging students through learner-centered activities. *Business Communication Quarterly*, *70*(1), 451-457. DOI:https://doi.org/10.1177/1080569907070040302

Sulistyo, T., Eltris, K. P. N., Mafulah, S., Budianto, S., Saiful, S., & Heriyawati, D. F. (2020). Portfolio assessment: Learning outcomes and students' attitudes. *Studies in English Language and Education*, *7*(1), 141-153. DOI: https://doi.org/10.24815/siele.v7i1.15169

Şahin, Ş., Arseven, Z., Ökmen, B., Eriş, H. M., & İlğan, A. (2017). Attitude scale towards collaborative learning: A validity and reliability study. *Kırıkkale University Journal of Social Sciences,* 7(1), 73-88. Retrieved from https://dergipark.org.tr/en/download/article-file/273947

Şenocak, E., Taskesenligil, Y., & Sozbilir, M. (2007). A study on teaching gases to prospective primary science teachers through problem-based learning. *Research in Science Education*, *37*(3), 279-290. DOI: https://doi.org/10.1007/s11165-006-9026-5

Trice, t. Y. (2012). *Quantum learning making prodigious strides in education*. (Unpublished Doctoral Dissertation), Trevecca Nazarene University, School of Education.

Siagian, T. A., Armanto, D., & Siagian, P. (2021, January). Development of learning device-oriented problem-based learning to improve students' mathematical problem-solving skills. In *Journal of Physics: Conference Series* (1731 (1), 012056). IOP Publishing. DOI:10.1088/1742-6596/1731/1/012056

Trilling, B., & Fadel, C. (2009). *21st-century skills: Learning for life in our times*. Francisco: Jossey-Bass.

Tuncer, M., & Kaysi, F. (2013). The development of the metacognitive thinking skills scale. *International Journal of Learning & Development*, *3*(2), 70-76. DOI:10.5296/ijld.v3i2.3449

Tschannen-Moran, M., & Hoy, A. W. (2001). Teacher efficacy: capturing an elusive construct. *Teaching and Teacher Education, 17*(7), 783-805. DOI: https://doi.org/10.1016/S0742-051X(01)00036-1

Usanmaz, E., Alci, B., & Çeliköz, N. (2017). The effects of the quantum learning approach on English vocabulary learning. *Turkish Journal of Education*, *2*(2), 95-107. Retrieved from https://dergipark.org.tr/en/pub/turkegitimdergisi/issue/33684/342184

Uygun, N., & Tertemiz, N. I. (2014). Effects of problem-based learning on student attitudes, achievement and retention of learning in Math course. *Education and science*, *39*(174). Doı: http://dx.doi.org/10.15390/eb.2014.1975

Ünal, E., & Çakır, H. (2021). Students' view on the learning environmet are designed based on the collaborative problem-solving method. *Afyon Kocatepe university journal of social sciemces, 23*(1), 70-84. Doı: https://doi.org/10.32709/akusosbil.834384

Vella, J. (2002). Quantum Learning: Teaching as dialogue. *New Directions for Adult & Continuing Education, 93,* 73-83.

Wyness, L., & Dalton, F. (2018). The value of problem-based learning in learning for sustainability: Undergraduate accounting student perspectives. *Journal of Accounting Education, 45*, 1–19. DOI: https://doi.org/10.1016/j.jaccedu.2018.09.001

Wilson, B. G. (1996). *Constructivist learning environments: Case studies in instructional design*. Educational Technology.

Yalçıntaş, M. (2019). *Fen bilimleri öğretiminde kuantum öğrenme modeli kullanmanın ilkokul dördüncü sınıf öğrencilerinin akademik merak, kaygı, özyeterlik ve baiarı düzeylerine etkisi [The effect of using a quantum learning model in science teaching on primary school fourth grade students' academic curiosity, anxiety, self-efficacy and success levels].* (Unpublished Master Thesis), Marmara University.

Yalçıntaş, M., & Sakız, G. (2018). The effect of the science course based on the quantum learning model on the academic self-efficacy and academic achievement levels of primary school fourth grade students.. In *1. International Congress of New Quests in Education.* Marmara University, 225-227.

Yani, A. P., Parlindungan, D., & Yennita, Y. (2021, January). Improving activities and learning outcomes of biology education students through learning the Problem-Based Learning model of entrepreneurship. In *Journal of Physics: Conference Series*,1731(1),012092. IOP Publishing. DOI:10.1088/1742-6596/1731/1/012092

Yuan, H. B., Williams, B. A., Yin, L., Liu, M., Fang, J. B., & Pang, D. (2011). Nursing students' views on the effectiveness of problem-based learning. *Nurse Education Today, 31*(6), 577- 581. DOI: https://doi.org/10.1016/j.nedt.2010.10.009

Zahro, B. L., & Mitarlis, M. (2021). Student worksheets oriented on project-based learning to train students creative thinking skills on acid-base material. *UNESA Journal of Chemical Education, 10*(1), 1-10. DOI: https://doi.org/10.26740/ujced.v10n1.p1-9

Ethical approval

This research was carried out with the permission of Duzce University Scientific Research and Publication Ethics Committee with the decision dated 03/12/2020 and numbered 2020/240.

Contribution rate of researchers

The authors of the study contributed equally to all processes of the study.

Conflict of interest

There is no potential conflict of interest in this study.