Examining Pre-Service Teachers' Experiences in the Learning by Teaching Process

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Abstract

The idea that teaching is a way of learning is not new and there is a big difference between learning for oneself and teaching for others. The factor that creates this difference is the teaching effect, in other words, the teaching expectancy. Studies have reported that the expectation of teaching others contributes to better learning of educational content and helps deeper learning. However, this method has attracted a little attention in teacher training. This study reports the findings from a case study that investigated the experiences of pre-service teachers within the learning-by-teaching activities. Learning-by-teaching entails a set of methods and mediums. In this study, a non-interactive video-producing approach was employed. A total of 23 pre-service teachers participated in the study. Research data were collected using semi-structured interviews. Three main themes and twenty codes have emerged from the analysis. The results indicated that producing instructional videos for peers positively affects students' learning, increases motivation, improves teaching skills, digital skills, self-assessment skills and promotes deep learning. In addition, the results have also revealed that learning by teaching is an effective learning method at the university level and in teacher education.

Öğretmen Adaylarının Öğreterek Öğrenme Sürecine İlişkin Deneyimlerinin İncelenmesi

Öz

Öğretmenin bir öğrenme yolu olduğu fikri yeni değildir ve kendi kendine öğrenme ile başkaları için öğretme arasında büyük bir fark vardır. Bu farkı oluşturan faktör ise öğretme etkisi, diğer bir ifadeyle öğretme beklentisidir. Araştırmalar, başkalarına öğretme beklentisinin öğretim içeriğinin daha iyi öğrenilmesine katkı sağladığını ve daha derin öğrenmelerin gerçekleşmesine yardımcı olduğunu raporlamıştır ancak bu yöntem bugüne kadar öğretmen eğitiminde çok az ilgi görmüştür. Bu çalışma, öğretmen adaylarının öğreterek öğrenme etkinlikleri kapsamındaki deneyimlerini araştıran bir vaka çalışmasından elde edilen bulguları rapor etmektedir. Öğreterek öğrenme, bir dizi yöntem ve ortam gerektirir. Bu çalışmada, etkileşimli olmayan bir video üretim yaklaşımı kullanılmıştır. Araştırmaya toplam 23 öğretmen adayı katılmıştır. Araştırma verileri yarı yapılandırılmış görüşmeler kullanılarak toplanmıştır. Analiz sonucunda üç ana tema ve yirmi kod ortaya çıkmıştır. Sonuçlar, akranlar için eğitici videolar üretmenin öğrencilerin öğrenmesini olumlu etkilediğini, motivasyonu artırdığını, öğretme becerilerini, dijital becerileri, öz değerlendirme becerilerini geliştirdiğini ve derin öğrenmeyi desteklediğini göstermiştir. Ayrıca araştırma sonuçları, öğreterek öğrenmenin üniversite düzeyinde ve öğretmen eğitiminde etkin bir öğrenme yöntemi olduğunu ortaya koymuştur.

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Genişletilmiş Türkçe Özet
Giriş

Öğrendiklerini öğretmeye çalışan öğrenciler, sadece okuyan/yeniden okuyan öğrencilerden daha iyi anlama ve bilgiyi akılda tutma konusunda ilerlemeye devam ederler (Jarrett, 2018). Başkalarına öğretme rolünün, öğretmenin *öğretme etkisi* (öğreterek öğrenme) olarak adlandırılan kendi öğrenmesini geliştirdiği gözlemlenmiştir (Koh, Lee ve Lim, 2018). Öğrenmek ve öğretmek iki farklı şey gibi görünmesine rağmen; öğretme ve öğrenme hem öğretmene hem de öğrenciye fayda sağlayan karşılıklı bir etkileşimi çağrıştırır. Bir başka deyişle, öğrenciler öğretmenden yeni beceriler ve bilgiler edinirken öğretmen de öğrencilerinden gelen geri bildirimlerden içerik hakkında daha fazla şey öğrenir (Chien, Zhu ve Chen, 2015). Lu, D'Angelo ve Willett (2019) bir kavramı öğrenmenin en iyi yolunun onu başkalarına açıklamak olduğunu vurgulamıştır. Bu türden bir öğrenme etkinliği *öğreterek öğrenme* olarak adlandırılmaktadır. Öğreterek öğrenme, öğrenilecek materyali/konuyu diğer bireylere öğretmek için hazırlama ve sunma süreçleri aracılığıyla öğrencilerin konuyu derinlemesine anlamalarını içerir.

Öğreterek öğrenme üç aşamadan oluşur: hazırlık, başkalarına açıklama ve etkileşim (Fiorella ve Mayer, 2013). Başkalarına anlatma aşaması akranlar, öğretmenler, veliler gibi gerçek dinleyicilere olabileceği gibi öğrencilerin video kaydı, ses kaydı, sunum, çizim gibi materyaller hazırlaması şeklinde olabilir (Fiorella ve Kuhlman, 2020; Hoogerheide, Deijkers, Loyens, Heijltjes ve van Gog, 2016). Öğreterek öğrenme süreci, etkileşimli ve etkileşimsiz olmak üzere iki farklı şekilde gerçekleştirilebilir. Etkileşimli ortamlarda akran öğretimi, işbirlikli öğrenme ve küçük grup tartışmaları gibi sınıf içi etkinliklerde kullanılmasının yanı sıra velilere öğretme gibi uygulamaları da bulunmaktadır (Tortumlu-Kaya, 2019). Etkileşimsiz ortamlarda ise öğrenci karşısındaki kişiye konuyu anlatır ve karşısındaki kişiden tepki alır. Öğrencinin bir konuyu çalışırken başkalarına öğreteceğini bilerek çalışması da öğrenme çıktılarını artırır. Etkileşimli olmayan öğretim yoluyla öğrenme, gerçek, uzak veya hayali bir kitleye öğretmeyi gerektirir ve diğer öğrencilerle etkileşimden yoksundur.

Alanyazında bu konuda akran öğretimi çalışmaları öğreterek öğrenme literatürünü oluşturmaya ve detaylandırmaya devam etmektedir (Fiorella ve Mayer, 2013; Frager ve Stern, 1970; Koh ve diğ., 2018; Roscoe; 2014; Roscoe ve Chi, 2007). Bu bağlamda etkililiği önceki araştırmalarda tartışılmakta ve güncel çalışmalarda tartışılmaya devam etmektedir. Bu nedenlerle bu çalışmada öğreterek öğrenme bağlamında video temelli akran öğretiminin etkililiği üzerine öğretmen adaylarının edindiği deneyimleri araştırmak amaçlanmıştır. Bu amaçla öğretmen adayları Özel Öğretim Yöntemleri dersi kapsamında belli bir kazanım için hazırladıkları dijital eğitim materyali tasarlama süreçlerini ve kullandıkları araçları akranlarına öğretmek amacıyla öğretim videoları hazırlamışlardır. Böylece öğretmen adaylarının öğretirken öğrenme süreçlerine yönelik görüşlerinin alınması sağlanmıştır. Öğretmen adayları ayrıca diğer akran videolarının kendi öğrenmeleri üzerindeki etkisine ilişkin görüşlerini de bildirmişlerdir.

Yöntem

Bu çalışma, eğitimde nitel yöntemlerden biri olan açıklayıcı durum çalışması kullanılarak tasarlanmıştır. Creswell'e (2008) göre durum çalışmaları, araştırmacının bir programı, olayı, etkinliği, süreci veya bir veya daha fazla kişiyi incelediği bir sorgulama stratejisidir. Bir vaka çalışması, bir vakanın kapsamlı bir şekilde tanımlanmasını ve analizini, vakanın ve olayların karakterizasyonunu içerir (Starman, 2013). Araştırmanın katılımcılarını Türkiye'de bir devlet üniversitesinin Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümünde öğrenim görmekte olan 15 öğretmen adayı oluşturmaktadır. Katılımcılar, dijital öğrenme ortamları tasarlama ve geliştirme konusunda zorunlu ders alan 23 öğretmen adayı arasından maksimum çeşitlilik örneklemesi kullanılarak seçilmiştir. Veri toplama aracı araştırmacılar tarafından geliştirilen yarı yapılandırılmış görüşme formudur. Nitel araştırmanın geçerliliğini ve güvenilirliğini sağlamak için farklı uzmanlık alanlarına sahip birkaç araştırmacı ve araştırmacı çeşitlemesi yapılmıştır (Denzin, 2017). Bunun için uzaktan eğitim geçmişine sahip bir araştırmacı, müfredat ve öğretim geçmişine sahip bir araştırmacı ve öğretim teknolojileri geçmişine sahip üç araştırmacı görüşme transkriptlerini ayrı ayrı kodlamış ve temalar geliştirmiştir. Son olarak, ortak temalar geliştirmek için işbirliği yapmışlardır.

Bulgular

Görüşme verilerinden elde edilen bulgular ışığında akranlara öğretmek için video oluşturma süreci, bu sürecin katkıları ve kendisi için öğrenmenin öğreterek öğrenmeden farklı yönleri olmak üzere üç ana tema ve yirmi kod altında incelenmiştir. Video oluşturma süreci temasına ilişkin, katılımcıların büyük çoğunluğu kullanımı kolay, ücretsiz, aşina oldukları ve hedef kitle için kabul edilebilir dijital araçları kullandıklarını belirtmiştir. Yine bu tema altında katılımcıların yarısı bir uzman veya akranlarıyla beyin fırtınası yaptıktan sonra video hazırlama sürecine başladıklarını ifade etmiştir. Bu temaya ilişkin son olarak katılımcıların bir kısmı akranları için videolar yapmak için müfredat örneklerini, öğrenme materyallerini, öğretim videolarını ve diğer öğrenme kaynaklarını incelediklerini dile getirmiştir. İkinci tema olan sürecin katkılarına ilişkin katılımcıların tamamı öğretmen adayı akranlarına öğretmek için video oluşturmanın dijital becerilerini geliştirdiğini belirtirken yine katılımcıların büyük

çoğunluğu geçirdikleri sürecin öğretme becerilerini geliştirdiğini düşündüklerini ifade etmiştir. Yine bu temaya ilişkin katılımcıların yarısı iletişim ve araştırma becerilerini geliştirdiğini belirtmiştir. Son tema olan kendisi ve başkasına öğretmek için öğrenmenin farklılıklarına ilişkin katılımcıların neredeyse tamamı başkasına öğretmek için gerçekleştirilen öğrenme etkinliğinin daha ayrıntılı ve detaylı olduğunu ifade etmişlerdir. Yine bu temaya ilişkin katılımcıların yarısından fazlası öğretim sürecinin açık ve anlaşılabilir olması için özen gösterdiklerini belirtmiştir. Ayrıca katılımcıların yarısı daha fazla sorumluluk gerektirdiği için öğreterek öğrenmenin kendi başına öğrenmekten farklı olduğunu düşündüklerini dile getirmiştir.

Tartışma ve Sonuç

Araştırma sonuçları, akranlar için öğretici videolar oluşturmanın öğrencilerin öğrenmesini olumlu etkilediğini, öğretim becerilerini, dijital becerileri, öz değerlendirme becerilerini geliştirdiğini ve derin öğrenmeyi desteklediğini gösterdi. Bulgularımız önceki araştırmalarla desteklenmektedir. Örneğin, Fiorella ve Mayer (2013) kontrol gruplu çalışmalarında, öğrencilerin öğrendiklerini akranlarına öğretmeleri beklendiğinde daha iyi öğrendiklerini bulmuşlardır. Başka bir vaka çalışmasında Stollhans (2016), başkaları için eğitici videolar hazırlamanın öğrenmeyi eğlenceli hale getirdiğini, beceri gelişimine katkıda bulunduğunu ve sürecin olumlu değerlendirilmesini sağladığını bulmuştur. Benzer şekilde Aslan (2015) fen bilgisi öğretmen adaylarının öğreterek öğrenme yöntemini öğrenme deneyimlerini geliştirmek için yararlı ve değerli bulduklarını, yöntemin kendine güveni, öz yeterliliği artırdığı için 21. yüzyıl becerilerinin gelişimini desteklediğini ve iletişim becerilerinin gelişimini desteklediğini ifade etmiştir. Ayrıca bu yöntem sorgulama becerilerinin geliştirilmesinde kullanılabilir (Aslan, 2017).

Katılımcılar tarafından ifade edilen kendileri için öğrenme ile başkalarına öğretirken öğrenme arasındaki önemli farklılıklardan bazıları daha önce öğrendiklerini uygulamış olmaları, kendilerini daha mutlu hissetmeleri ve öğrenme içeriğini daha detaylı yapmış olmalarıdır. Alanyazında bu deneyimleri destekleyen çalışmalar mevcuttur. Koh ve diğerleri (2018), başkalarına öğretmenin hatırlama ve öğrenme performansını iyileştirdiğini bildirmiştir. Pi ve diğerleri (2021), öğreterek öğrenme yönteminin video tabanlı dersler kullanılarak yapılan pasif öğrenmeye kıyasla daha yüksek motivasyon ve katılım sağladığını bulmuştur. Wang, Lin ve Chen (2021), ayrıca öğreterek öğrenmenin, öğrenme içeriğinin öğretim dışı koşullara göre daha iyi anlaşılmasını sağladığını da bulmuşlardır. Özetle bu çalışmada video oluşturmanın öğreterek öğrenmenin daha derin öğrenmeyi desteklediği ve daha etkili bir yol olduğu sonucuna varılmıştır. Öte yandan Kobayashi (2019a), öğretirken öğrenmede yüz yüze öğretim beklentisinin öğrenmeyi, video veya yazılı açıklamalar gibi diğer ortamları kullanmaktan daha fazla geliştirdiğini iddia ediyor. Bu çalışmadaki akran etkileşimi yalnızca geri bildirim alınması ile sınırlıdır. Ayrıca öğrenciler bireysel öğretim hazırlığı yapmıştır. Ancak işbirlikli öğretim hazırlığı, bireysel hazırlıktan daha yüksek öğrenme performansı sağlar (Kobayashi, 2021). Bu anlamda gelecek çalışmalarda akran etkileşimi ve işbirlikli öğretim hazırlığının öğreterek öğrenme sürecinde dikkate alınması sağlanabilir.

Introduction

Students who endeavor to teach what they've learned go on to show better understanding and knowledge retention than students who simply only study/restudy (Jarrett, 2018). This teaching to others role has been observed to enhance the teacher's own learning which is called the *teaching effect* (i.e., learning by teaching) (Koh, Lee, & Lim, 2018). It has been stated that while learning and teaching seem to be two different things; teaching and learning evoke a mutual interaction that benefits both the teacher and the student in that, while students acquire new skills and knowledge from the teacher, the teacher also learns more about their students and content from feedback (Chien, Zhu, & Chen, 2015). Students devote a noticeably respectable amount of time and effort to retrieve the information and material acquired along with teaching preparation through the teaching process (Koh et al., 2018). Lu, D'Angelo and Willett (2019) emphasized that the best way to learn a concept is to explain it to others, and stated that this way of teaching activity would identify the gaps in an individual's understanding. Furthermore, it has been emphasized that learning by teaching is an important generative learning strategy in which students reveal important parts of the topic, give various examples, integrate their prior knowledge into what they newly learned more effectively, and attempt to transfer this to others (Fiorella & Mayer, 2015). From past to present, learning by teaching has been the focus of attention of educators in different ways (Annis, 1983; Biswas, Leelawong, Schwartz, Vye, & The Teachable Agents Group at Vanderbilt, 2005; Duran, 2017; Frager & Stern, 1970; Ketamo & Suominen, 2008; Kobayashi, 2021; Kohleffel, 1996).

Learning-by-teaching includes making students understand the subject in depth through the processes of preparing and presenting the material/subject to be learned in order to teach it to other individuals (Fiorella & Mayer, 2015). It is aimed that students reach a level that can respond to demands such as selecting important concepts, bringing their own explanations, giving examples, expanding their knowledge to include applications, and trying to answer the questions of others, rather than repeating the material they have learned. In addition, one of the important points is to think about the questions that may come from other students and try to answer them. Learning by teaching consists of three stages: preparation, explaining to others and interaction (Bargh & Schul, 1980, as cited in Fiorella & Mayer, 2015). The stage of explaining to others can sometimes be to real listeners (e.g., peers, teachers, parents), while sometimes it can be in the form of students preparing material such as a video recording, sound recording, presentation or drawing (Fiorella & Kuhlman, 2020; Hoogerheide, Deijkers, Loyens, Heijltjes, & van Gog, 2016. Thus, learning-by-teaching can be performed in two different orientations; interactive and non-interactive environments. In addition to being used in classroom activities such as peer teaching, cooperative learning and small group discussions in interactive environments, it also has applications such as teaching to parents (Tortumlu-Kaya, 2019). In other words, students explain the subject to a person in front of them and get a reaction from the other person. Students' working on a subject, knowing clearly that they will teach it to others while studying, also increases the learning outcomes. Learning by non-interactive teaching entails teaching to an actual, remote, or imaginary audience, and lacks interaction with other students.

Peer-tutoring studies dominate the field of learning-by-teaching literature (Fiorella & Mayer, 2013; Frager & Stern, 1970; Koh et al., 2018; Roscoe; 2014; Roscoe & Chi, 2007). The principle of learning-by-teaching remains one of the most fascinating aspects of peer tutoring. It has been suggested that one of the most interesting and impressive aspects of peer tutoring is its potential to support learning for both the tutees and the tutors (Roscoe & Chi, 2007). Teaching peers through video, students generated instructional videos, is one of the most common methods of peer tutoring. Since student-generated videos could be later reused as instructional materials by their peers and others, they value individuals, peers, as well as possibly the wider community (Lee & McLoughlin, 2007; Pirhonen & Rasi, 2017).

Student-generated videos provide significant improvements in terms of learning retention, contextualizing, and applying of theoretical concepts since the production of the instructional video requires the grounding of a multitude of concepts as well as their integration into a wider theoretical context (Frank-Bolton & Simha, 2018). Although videos on the Internet are seen as supporting materials for students' learning in higher education (Moghavvemi, Sulaiman, Jaafar, & Kasem, 2018), the process of producing students' own videos as a learning activity is a very popular approach (Arruabarrena, Sanchez, Dominguez, & Jaime, 2021; Campbell, Heller, & Ulse, 2020). Today's students can no longer be viewed as only passive consumers since they want more control over content production on the web (Lee & McLoughlin, 2007). From this point of view, a rationale for engaging students in the production of instructional videos is providing them with opportunities for a more learner-centered, motivating, active, engaging and productive role in their learning process (Pirhonen & Rasi, 2017). In addition, it has been suggested that student-created videos help students to improve their performance (conceptual or practical) and be reacted positively by students (Feijóo-García & Gardner-McCune, 2020). Furthermore, it is stated that the ability to express oneself and what s/he knows through a video lesson will increase his/her social, digital and academic competencies (Orus et al., 2016). Although there has been a rapid increase in the number of video lessons in recent years, it is seen that the research mostly focused on the effectiveness of video lessons or their comparison with other methods (Brockfeld, Müller, & de Laffolie, 2018; Ou, Joyner, & Goel, 2019; Ramlogan, Raman, &

Sweet, 2014; Riyanto & Yunani, 2020). On the other hand, since the video lesson preparation process includes a learning process itself for students who prepare it, it is important to examine this process in the context of learning-by-teaching.

Gündoğdu, Altın, Üstündağ, and Altay (2018) found that pre-service teachers were inadequate in preparing lesson plans, creating lesson materials, assessing students and keeping students' records. To this end, it proposes the arrangement of lesson plans and material preparation, related course contents and practices. Similarly, Arıkan (2009) emphasized that pre-service teachers were limited in their use of method and technique, making assessments and keeping records of students, and it was suggested that they should reflect with micro-teaching.

Finally, to summarize, when the above literature is examined, there have been numerous studies on learning by teaching (Bergande, Weilemann, & Brune, 2020; Kobayashi, 2021; Pahl, 2019; Zhou, Chen, & Chen; 2019) on peer tutoring (Durán Gisbert & Vázquez Rivas, 2021; Evans & Moore, 2013; Galbraith & Winterbottom, 2011; Velasco & Stains, 2015) and on students generated videos (Jordan et. al, 2016; Murray, Toohey, & Thompson, 2017; Thomas & Marks, 2014) that are conducted in different contexts. As a matter of fact, no studies have examined learning by teaching through student-generated videos for peer tutoring. To fill this literature gap, in this paper we focused on how pre-service teachers will teach certain learning outcomes to their peers. It is aimed to teach their experiences to their peers so that they can better internalize the learning outcomes, experience the research and material development process. Briefly, it was emphasized how to teach the learning outcomes to their peers and to explain what they did in the teaching process to their peers/colleagues through a video. In this context, the student will not only depend on examples in the book but will think about how to bring these learning outcomes to the students by making research and effective instructional design to explain their process to their peers with a video lesson. Within this framework, it is aimed to increase both the technical and professional skills of the pre-service teachers for the information technology course learning outcomes.

Purpose of the Research

The main purpose of this study is to investigate the views of pre-service teachers on learning-by-teaching. It is also aimed to reveal both the effectiveness of that process on an individual's own learning and the difference between learning-by-teaching and learning for yourself while investigating the pre-service teachers' views. For this purpose, answers to the following research questions (RQ) were sought:

1. What were pre-service teachers' views and experiences of generating videos to help their peers' learning?
2. How did student/peer-generated videos affect pre-service teachers' learning?
3. How does learning-by-teaching differ from learning for oneself?

Method

Research Design

This research has been designed as an illustrative case study, which is a qualitative method used in education. Case studies, according to Creswell (2008), are a method of investigation in which the researcher investigates a program, event, activity, process, or one or more individuals in a specific context. A case study is a detailed description and examination of a specific case, as well as the case's characterization and occurrences (Starman, 2013). Illustrative case studies are primarily descriptive studies. They usually use one or two examples of an event to demonstrate how a situation works. Illustrative case studies serve primarily to familiarize the unfamiliar and to provide readers with a common language about the topic at hand (Becker et al., 2005). This allows for a better understanding of the subject at hand while also reducing the possibility of bias. Case studies can investigate single or multiple-cases at the same time (Fraenkel, Wallen, & Hyun, 2012). Current study uses a single-case design to explore pre-service teachers' experiences in the learning-by-teaching process within the context of special teaching methods course. To this end, pre-service teachers' experiences of generating videos were captured by using semi-structured interviews and analyzed at the end of the course.

Participants

Participants were chosen among 23 pre-service teachers taking a mandatory course on designing and developing digital learning environments via maximum variation sampling. Maximum variation sampling is a sampling method in which researchers attempt to collect data from as many different perspectives on a given topic as possible (Suri, 2011). Assuming that different participants illuminate different aspects of a case, maximum variation sampling can be used to build a holistic understanding of the case by synthesizing on multiple dimensions. Based on the evaluation of the videos by peers, five pre-service teachers were selected from each of the lower, middle and upper score groups to reveal both the effectiveness of that process on an individual's own learning and the difference between learning-by-teaching and learning for yourself while investigating the pre-service teachers' views. Participants of the study consisted of 15 pre-service teachers studying at the Department

of Computer Education and Instructional Technologies in a state university in Turkey. Eight of the participants were male and seven were female. The participants were seniors between the ages of 22-23.

Data Collection Instrument

The data of this study was collected using a semi-structured interview form developed by the researchers in this study. This form consisted of fifteen questions. The first three questions were designed to elicit pre-service teachers' preparations prior to beginning the video production process. The following four aimed to reveal pre-service teachers' video production experiences, including their satisfaction and perceived contribution to the process. Questions 8-12 were designed to reveal interactions with peers as well as content created by them and others. The following two focused on the effects of perceived digital competencies and teaching abilities. The final one focused on the differences between learning to teach someone else and learning to teach oneself.

Data Collection Process

Participants took a mandatory course on designing and developing digital learning environments. The aim of the course is to train pre-service teachers in online teaching methods that can be used in the field of computer education, as well as to assist them in designing, developing, and evaluating effective digital learning environments employing these methods. At the end of the semester, pre-service teachers were expected to both design and develop a digital learning environment for their students and generate a video for their peers' learning on their experiences of designing and developing a digital learning environment and the technology they used for developing that environment. It was a 14-week course and each week pre-service teachers designed and developed their digital learning environments step by step under the supervision of the course instructor. During the development of the peer-videos, the participants were provided instructions and a peer review rubric. In the directive, firstly, explanations were given to the participants on the following subjects. The instructions included guidance and detailed explanations on the following topics that the participants were expected to benefit from:

1. Deciding on an innovative learning method for the learning objective.
2. Deciding on the digital tool to be used in the material to be developed for the learning outcome.
3. Preparing the lesson plan for the relevant learning objective (Lesson plan format is given as an example).
4. Watching sample videos where students can explain lesson preparation compatible with their learning objectives to their peers (For example: Khan Academy or YouTube educational videos).
5. Dividing the video narration process into small parts, but preparing it holistically.
6. Delivery method and deadlines.

Following the explanations above, both in the instruction and in the peer rubric, the participants were informed to follow a development process and answer the following questions while preparing the peer video and the presentation:

- At what stage or stages of the lesson will you use the material you have prepared?
- Which software did you use while preparing the material?
- Is the material you prepared sufficient to achieve the pre-determined learning outcome by the student? (Take into account the level of the target audience.)
- What are the important points of the material for the students?

The criteria set students considered in producing peer videos:

- Use tools such as marking, crossing out or coloring to highlight important information.
- Interactive strategies should be used to increase audience participation.
- Everyday language should be used.
- Attention-grabbing audio and visual features should be utilized.
- Prepared videos should not take a lot of time and should be short.

In the last week of the semester, pre-service teachers presented their digital learning environments and the video they created for their peers. And their peers evaluated the videos based on the rubric course instructor had given them. Figure 1 and Figure 2 are the examples of the screenshots from peer videos presented by the Participant 6 who paid attention to short-term video creation criteria. Both videos have length of three minutes and nineteen seconds.
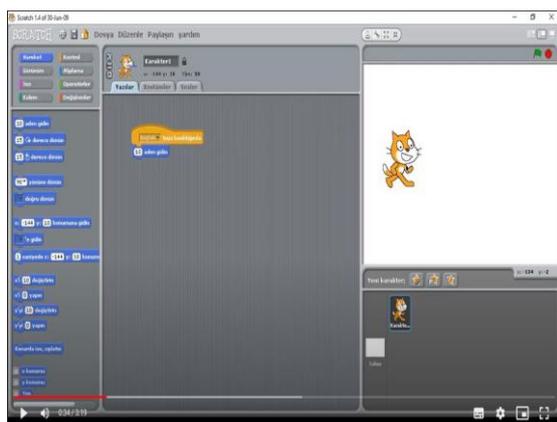
Figure 1. Example Screenshot   *Figure 2.* Example Screenshot
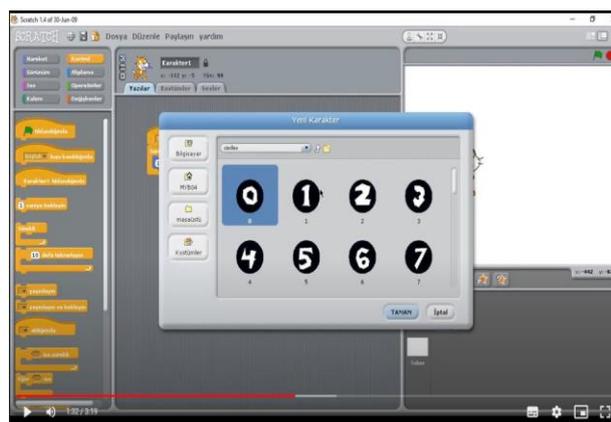
At the end of the semester, qualitative data were collected via semi-structured interviews conducted with 15 pre-service teachers about both their views and experiences on learning-by-teaching and the effect of peer-generated videos on their learning. Interviews have been conducted face-to-face and recorded as audio. The researchers participated in the process only as observers and did not take part except for the interviews.

Data Analysis

The analysis of data was carried out with the steps suggested by Creswell (2014): (1) organizing and preparing data for analysis; (2) reading all data; (3) coding the data; (4) generating descriptions or themes; (5) interrelating themes, and (6) interpreting the meaning of themes. Based on that, it was first transcribed, prepared and read by researchers, then it was coded via content analyses. Lastly, themes were generated and interpreted.

Different ways can be used to assure the validity and reliability of qualitative research (Creswell & Poth, 2016; Golafshani, 2003), and researcher triangulation is one of them (Denzin, 2017). It refers to the use of several researchers with various backgrounds. To do so, one researcher with a background in distance education, one with a background in curriculum and instruction, and three with a background in instructional technologies coded the interview transcripts and generated themes separately. Finally, they collaborated to generate shared themes and interpret the themes.

Role of the Researchers

Miles, Huberman, and Saldaña (2018) discuss two major sources of bias in case study research that can result in biased observations and inferences. The first is the researcher's effects on the case, which occur when the researcher threatens or disrupts ongoing social and institutional relationships. To avoid this, the researchers did not interfere with or direct the study's conversations or events. The second is the impact of the case on the researcher, which occurs when the researcher goes native and reports different or assumed versions of events. To avoid this type of bias, all researchers took part in the study to ensure that the data was correct.

Ethical Issues

An application for research permission was submitted to and approved by the Institutional Review Board prior to the research. The participants' agreement was then sought, and the study's aim and goals were described. It was also stressed that participation in the study was completely optional and that they could opt-out at any time.

Findings

The views of the pre-service teachers on learning-by-teaching in the course of designing and developing digital learning environments were examined under 22 codes within three main themes. D-S-E format was followed in discussing our findings. First, we *define* the theme, followed by a *story* or connection from the findings of our study, then present *evidence* or statements from our participants.

Theme 1: Creating Videos to Teach Peers

What is the procedure for creating a video? There is more to video production than simply pressing the record button on your video camera. From concept to completion, the process of creating a video is divided into several phases. In the first theme, *creating videos to teach peers* we try to understand the experiences of pre-service teachers while creating videos. In the study, pre-service teachers created videos to teach peers about the process of designing and developing digital learning environments. We extracted eleven codes within three sub-themes from the data: before and after creating videos and choosing digital tools. The data are shown in Table 1.

Table 1

Sub-themes and Codes with Frequencies for Theme 1

Theme 1	Codes	Frequencies
Before creating videos	Searching topics	7
	Watching sample videos	3
	Collaborating with an expert	6
	Conducting pilot trials	8
	Following the guideline	11
After creating videos	Getting peer feedback	8
	Comparing self-videos with peers	13
Choosing digital tools	Prior experience with the tool	5
	User friendliness	8
	Ease of access	5
	Age of the users	5

All of the planning and coordination takes place in the first step. According to pre-service teachers in our study, before creating videos, they searched topics, watched sample videos, collaborated with an expert, conducted pilot trials, and followed the guidelines. Pre-service teachers mostly stated that they followed the guidelines provided by the researchers ($f = 11$). P1 stated that "*I followed the instructions. There were expressions such as using language like telling a friend or telling a colleague. I tried to do it. While describing the program, I tried to zoom in and underline it. I tried to use simple language.*" In addition, P7 said that "*Throughout the process, I followed the instructions. To make it more permanent, I colored the important parts, circled them, and emphasized them.*" Also, eight participants stated that they were conducting pilot trials such as recording voices at various times and taking notes for talking because they wanted to be explanatory and didn't want to make mistakes before creating videos. For instance, P3 shared that "*I have taken the peer video again several times. Here, for example, I said by myself it didn't happen, I made a mistake or it wasn't exactly explanatory. I watched it again and again.*" P9 also reported that "*I did some trials first. At first, I made a recording, and then I listened to my own voice. I took some notes on which points I should focus on.*"

Moreover, seven participants stated that they search the topics to understand better how to teach the subject in the video. P6 stated that "*I looked at the lesson plans about coding software on the internet. I looked at the lecture videos and the slides prepared by the teachers before creating videos*". In addition to searching the topic, they also stated that they watched sample videos ($f = 3$) and collaborating with an expert ($f = 6$). For example, P7 reported that "*I asked my professors which programs would be more advantageous to use, would be easier, or would be suitable for my other friends to use.*"

When the video has been completed, it is time to review the work. Participants stated that they got peer feedback ($f = 8$) and compared self-videos with peers ($f = 13$) after creating videos. This phase might be helpful to revise the work before its final preview. In terms of peer feedback, P4 stated that "*Friends had warned that it would be better to use white writing, that white goes better with blue. So, it's a nice thing. They gave feedback.*" In addition to peer feedback, participants stated that they compared their self-videos to others to see what they had missed after making videos. P14 reported that "*For example, highlighting, shaping, or coloring with the mouse cursor. I didn't do these, but I had friends who did. I appreciated it. Apart from that, there were friends who put little things like warnings and animations in the videos. They added color to the video and made it more attractive. I was lacking in this as well.*"

The best video wins in today's highly competitive video-focused world! Investing in high-quality video production equipment/tool is another sure-fire way to improve the videos. Participants in our study prioritized user friendliness ($f = 8$), ease of access ($f = 5$), prior experience with the tool ($f = 5$), and user age ($f = 5$) when selecting a video creation tool. P3 emphasized the user friendliness of the tool by saying "*I looked at it to be simple, frankly, I looked at the simple interface. Others were very confused. I thought it would be better for me and my other friends to shoot video with a simple, plain interface in peer video.*" In addition to user friendliness, ease of access is another important criteria when choosing a video creation tool. P5 reported that "*I looked at the programs' availability, whether or not they could be downloaded, and whether or not they were available online.*"

Theme 2: Contributions of Creating Videos

What effect did peer-generated videos have on pre-service teachers' learning? Indeed, educational videos are well known to have some advantages in certain areas. However, in this research question, we were curious about what pre-service teachers learned in addition to the video content. Our participants shared their skills/knowledge they gained from their peers' videos. The second theme, contributions of creating videos, was categorized under seven codes; digital ($f = 13$), teaching ($f = 11$), communication ($f = 6$) and research ($f = 1$) skills, improving the self-

confidence ($f = 2$), learning from peers ($f = 8$) and assessing themselves ($f = 1$). Table 2 has shown seven codes and frequencies for Theme 2.

Table 2
Codes with Frequencies for Theme 2

Codes	Frequencies
Digital skills	13
Teaching skills	11
Communication skills	6
Research skills	1
Improving the self-confidence	2
Learning from peers	8
Assessing themselves	1

In terms of contributions of creating videos, all participants shared that they had acquired at least one skill while creating the videos. Thirteen participants stated that creating videos improved their digital skills such as searching and using various software and tools. P7 stated that "*I didn't know some programs, I already learned through research. After learning, I learned that these are easier and I can use them.*" P11 also added that "*I've seen many programs and new digital tools. I got some information about how to use them.*" Besides, eleven participants shared a development in their teaching skills. P13 describe that development as "*I think my teaching skills have improved. I was able to present and teach a subject better. I made more sense of the subject within myself. That was a good example in this regard.*" Last but not least, P2 mentioned acquiring their research skills by saying "*The system has changed a lot, there are blogs and forum sites. In other words, you can access all kinds of information. I noticed the sites where I could do research.*".

In addition to digital, teaching, communication, and research skills, two participants reported increased self-confidence after watching videos of what others were doing. P10 shared their experience by saying "*I had no idea at first. But as my friends did it over time, I believed that I could simply do it, so I said I could. I didn't have such self-confidence at the beginning, but eventually, I had such self-confidence. This lesson gave me that.*" And then P133 added that "*This is the first time I am presenting such a product. After all, you offer it to someone and they will benefit. My self-confidence has improved.*" Also, eight participants reported learning from their peers while creating the video. Because they could see which learning activities were used with various software programs in the other peer videos. It helps them to learn various software/tools they are not aware of and learning activities they can use in future. P14 reported that "*I've never created and edited animation videos before. I didn't know how either. A few of our friends prepared animations. It caught my attention. I tried to listen more carefully to their peer videos. I took note of the tools and websites they used. It gave me something about it. I learned something from my other friends.*".

Theme 3: Differences of Learning by Teaching from Learning for Yourself

What is the difference between learning-by-teaching and learning for oneself? We attempted to understand how pre-service teachers' experiences differ between learning by teaching and learning for yourself in this research question. So, we asked them what kind of process they had that differed from learning on their own. To answer this question, pre-service teachers had taken on the role of a teacher while creating videos to teach their peers. Five codes and frequencies for Theme 3 are shown in Table 3.

Table 3
Codes with Frequencies for Theme 3

Codes	Frequencies
Being a "teacher"	5
Feeling responsible for others	5
Elaborating the subject	11
Inclusiveness	7

Peer tutoring is a method of instruction in which students help each other and learn by teaching. As a result, it may differ from learning for yourself. In our study, pre-service teachers discussed the differences between learning-by-teaching and learning for yourself. Because they did not act as students while creating the videos, five pre-service teachers said they already felt like "teachers." P3 reported that "*While making that video, I felt very much like a teacher. So, you weren't a student when you made that video. You become a complete educator.*" Related with being a teacher, five students also stated that they felt responsible for their peers. According to them, learning-by-teaching differs from learning for yourself in that it entails more responsibility; you are now their teacher. P8

described that *"You feel more responsible. If you're learning for yourself, you don't work hard, you'll learn somehow, but if you're learning to teach someone else, it becomes even more responsible."* P13 also added that *"First of all, it puts some responsibility on me. It was actually a good responsibility. It is very nice to teach something to someone or your students. That's why I enjoyed it."*

The other difference is the need for elaboration of the subject. They had to learn more about the topics because they were teaching someone else. Regarding the elaboration, P1 shared their experience as *"While you are learning for yourself, you can learn in a shorter time, with less details, because you create the connections in your head. But when you're teaching someone else, you have to dig a little deeper."* P7 also supported that view and added that *"I can skip some things if I learn them myself. But since I will teach someone else, that subject has to be both detailed and fully equipped."* Lastly, participants also emphasized the need for inclusiveness when someone teach for peers. Learning by teaching necessitates being inclusive for all because they had to appeal to a large number of people. P13 supported inclusiveness and added that *"Teaching someone else is a whole different matter. You appeal to many people, many minds. You don't know how to perceive it. You have to be very fluid and open; you have to give what you are doing in a transparent way. I paid great attention to this. Because it had to be understandable to everyone."*.

To sum up, pre-service teachers stated mostly positive experiences with the learning-by-teaching process. They stated that the process of creating videos to teach others improved their digital, teaching, communication, and research skills. They also emphasized the differences between learning for themselves and teaching others, such as having more responsibility, rigorous elaboration of the learning content, and the need to be clear in order to be properly understood. They used brainstorming to create the videos, compared their videos to others to ensure quality, carefully planned and evaluated their video creation process, and examined numerous resources such as curriculum samples, learning materials, and teaching videos.

Discussion and Conclusions

In this study, we sought to investigate the views of pre-service teachers on learning-by-teaching process. It is also aimed to reveal both the effectiveness of that process on an individual's own learning and the difference between learning-by-teaching and learning for yourself while investigating the pre-service teachers' views. Results showed that generating instructional videos for peers positively affects students' learning, improves their teaching skills, digital skills, self-assessment skills and promotes deep learning.

Our findings corroborate with previous research. For instance, in their control group study, Fiorella and Mayer (2013) found that students better learn when they are expected to teach their peers what they learned. In a case study, Stollhans (2016) found that generating instructional videos for peers makes learning enjoyable, contributes to skill development, and leads to positive evaluations of the process. Similarly, Aslan (2015) reported that pre-service science teachers found the learning-by-teaching method useful and valuable for enhancing their learning experience, and the method supports the development of 21st century skills as it increases self-confidence, self-efficacy, and communication skills. Further, this method can be used in the development of inquiry skills (Aslan, 2017).

Data analysis showed that participants enjoyed the video generating process since it aimed at teaching others. Researchers also highlighted the importance of the motivating role of teaching expectancy in learning-by-teaching (Duran, 2017; Lachner, Hoogerheide, van Gog, & Renk, 2021). A recent meta-analysis conducted by Kobayashi (2019b) revealed that studying with teaching expectancy increases the acquisition of domain knowledge as compared to studying without teaching expectancy. Expectancy enhances the organization of knowledge and recall performance (Nestojko, Bui, Kornell, & Bjork, 2014). Besides, teaching expectancy affects not only cognitive but also motor learning performance (Daou, Lohse, & Miller, 2018). As evidenced by participant comments, our findings also suggest that expectation of teaching has an impact on learning. Thus, it was concluded that organizing learning activities to include such expectations can support learning.

Findings also showed that the majority of participants took advantage of others' feedback and compared their work with others during the learning process. In other words, implicit and direct social interactions played an important role in achieving learning goals. Social learning has the potential to improve the effectiveness of learning-by-teaching activities. Therefore, the design of such activities should consider the affordances of social and collaborative learning.

Participants commented on several contributions of generating instructional videos including improved skills and self-confidence. All of the participants mentioned that the process has improved their digital skills. It seems that the frequent use and hands-on experience with digital tools contributed to their abilities. As a result, it can be concluded that learning-by-teaching is a more powerful learning method when it involves learning-by-doing. Most of the participants expressed that this kind of learning improved their teaching skills and self-confidence. One possible explanation for that requires careful planning. Students first need to identify the content and think about

how they teach it. Research also has shown that using student-generated videos as a method to enhance knowledge acquisition leads to reduced cognitive load, better developed cross-curricular competencies, and improved learner independence (Epps, Luo, & Muljana, 2021).

Participants also commented on the differences between learning by teaching and learning for yourself. One of the significant differences was the application of what they learned before. Koh et al. (2018) reported that teaching others improves retrieval and learning performance. Some of the participants expressed that they felt happy in the learning process. Pi et al. (2020) found that the learning-by-teaching method provides higher motivation and engagement compared to passive learning using video-based lectures. Most of the participants said that they elaborated on the learning content. Thus, it was concluded that the method promotes deep learning (Biggs & Tang, 2007). A deep approach to learning indicates higher levels of student engagement in learning and results in more sophisticated learning. Wang, Lin, and Chen (2021) also found that learning-by-teaching provides a better comprehension of learning content than non-teaching conditions.

In light of the findings, it was concluded that generating videos is an effective way of learning by teaching. Research also has shown that explaining on a video to others improves learning compared to writing (Hoogerheide et al., 2016). On the other hand, Kobayashi (2019a) claims that the expectancy of teaching face-to-face enhances learning more than using other mediums such as video or written explanations. This highlights the social dimension of learning. Moreover, collaborative preparation of teaching yields higher learning performance than individual preparation (Kobayashi, 2021). Therefore, the design of the learning-by-teaching activities should consider peer interaction.

The findings of this study are important in many ways. Our study showed that learning-by-teaching is an effective practice for pre-service teachers in their teaching profession because they stated that they considered themselves as teachers rather than students. This role change brought more responsibility for learning and consequently promoted self-regulated learning because the pre-service teachers constantly self-assessed the videos they produced and compared their work with others. This process fostered their meta-cognitive skills such as goal setting, planning and assessment to develop a deep understanding of the subject matter. Moreover, this type of learning seems to be an effective way of increasing student engagement. Engagement basically refers to the amount of time and effort students put into their studies and other educationally purposeful activities (Kuh, Kinzie, Buckley, Bridges, & Hayek , 2006). As previously discussed, we observed that when students compared their own performance with their peers, a cycle was triggered that resulted in the improvement of learning products. The continuous comparison leads learners to invest more in their learning. Since student engagement is strongly correlated with student achievement (Lei, Cui, & Zhou, 2018) learning-by-teaching deserves more attention and more use in the classroom.

Limitations and Future Work

This study has several limitations. One of them relates to the student demographics. Participants were pre-service teachers, so studies at other educational levels might yield slightly different results because creating instructional videos needs a certain amount of technical skills and pedagogical knowledge. Therefore, future studies may focus on the effects of peer-generated video tutoring in K-12 settings within the learning-by-teaching activities. Lachner et al. (2021) argue that learning-by-teaching is relevant for educational practice because it can be realized as an individual study activity and it does not require the presence of or interaction with a teacher or a peer. In other words, the teaching phase can be with or without the audience. This study provides an example of non-interactive teaching using video format with the participation of pre-service teachers. Whether the teaching mode is interactive or not, there is still limited knowledge of the utilization of the learning-by-teaching method across disciplines other than language learning. There is also a need for studies on the effectiveness of the learning-by-teaching method within different modalities, such as online and blended learning. As previously mentioned, collaborative learning-by-teaching has the potential to increase the quality of learning outcomes. Future studies may focus on the effects of collaborative peer tutoring in the context of learning-by-teaching.

Acknowledgement

Declaration of Competing Interest

The authors declare that they have no competing interests.

Funding

Ethics Committee Permission Information: This research study was conducted with the Research Ethics Committee approval of Uşak University, dated 09.12.2021 and numbered 2021-204.

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