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THE EFFECTS OF TECHNOLOGY SUPPORTED UbD BASED INSTRUCTIONAL DESIGN TRAINING ON STUDENT TEACHERS' TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE AND LEARNING – TEACHING CONCEPTIONS

(Research article)

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Abstract

The present study aimed to improve student teachers' technological pedagogical content knowledge (TPACK) and learning and teaching conceptions through technology supported UbD-based instructional design training. It employed an action research design that comprises quantitative and qualitative research processes. In the study, 215 student teachers in 25 different groups participated in UbD-based instructional design training that includes poetry design, PowerPoint design, video research and asking questions, scenario-based visual aided learning activity design, and UbD unit design tasks by Google Classroom. As data collection tools, TPACK self-efficacy beliefs scale and learning and teaching conceptions scales, and collective written diaries were used. Statistical findings showed that UbD-based instructional design contributed to a significant improvement in student teachers' TPACK and constructivist teacher conceptions while a decrease in behaviorist teacher conceptions. Content analysis results pointed out that the experiences and effects of UbD on student teachers were discovered under five themes: development of (a) TPACK, (b) constructivist teacher understanding, (c) lifelong learning experiences, (d) emotional orientation (e) the restrictions of UbD based instructional design. Within the professional development program's scope, it is suggested that the researchers should conduct projects, workshops, and research courses on the development of student teachers' competencies in UbD-based instructional design studies.

Keywords: Understanding by design, action research, instructional design, TPACK.

1. Introduction

Trying to teach textbooks that are getting thicker and more tiring has become a challenging issue in the present. The problem makes it difficult to teach rigorous conceptual structures that are visibly unrelated between subjects. As students move from one discipline to another or one subject to another, learning turns into an even more disconnected mass of knowledge. For this reason, teachers must explore ways of coping with it. They are expected to have the capacity to design and deliver integrative units or lessons instead of using textbooks and preferring teacher-centered teaching methods. A principle to be taken into account in this design and implementation process is harmony between components. In this way, it is possible to weigh students' learning experiences (Martin-Kneip, 2000). Currently, teachers are asked to more than just presenting information to students. Even more, they have been expected to become reflective practitioners adapting consciously research-based courses to their classrooms to make students better learners (Hahs-Vaughn & Yanowitz, 2009).

It is believed that qualified teaching is beyond involving basic pedagogical knowledge. A better instruction aims to increase students' content knowledge and enable teachers to think reflectively about their teaching (Zoellner, Chant & Lee, 2017). It is thought that constructing learning experiences improving practice-based teaching skills is a fundamental action of their'

professional developments (Kennedy-Clark et al., 2018). Suppose they understand more realistically processes playing a role in active teaching during professional training. In that case, they should be encouraged to critically look at teaching processes and evaluate the effectiveness of their teachings (Polard, 2000, 38). In this way, they can learn how they organize and analyze their teaching and instruct clearly knowledge and skills expected to be gained by students. They also can comprehend how they monitor their instructions, develop professional skills and improve them in the future during professional training such as lesson planning, evaluation, and activity design (Zoellner, Chant & Lee, 2017). Opportunities that enable them to improve their professional development should be offered.

1.1. Theoretical framework

1.1.1. Professional learning in teacher education

The opportunities that teachers participate in their professional learning and development can make meaningful contributions to students' learning (Timperley, Wilson, Barrar & Fung, 2007). In this context, they point out seven elements in their professional learning that affect student outcomes in a positive and meaningful way. (1) providing sufficient time for wider learning opportunities and using time effectively, (2) being involved in studies in different areas of expertise, (3) focusing on teachers' involvement in the learning process rather than whether they are volunteers or not, (4) discussion with problematic discourse, (5) providing opportunities to interact in a professional community, (6) ensuring that content is consistent with broad policy circles, and (7) having leaders effectively manage professional learning opportunities in school-based initiatives. The professional learning environment with these elements offers expanded learning opportunities through various activities, as well as helping them synthesize what they have learned with alternative methods of application.

Teacher educators can create diverse learning opportunities like formal course work, conferences, and practice-based informal learning environments for professional development practices at the college level (Maskit, 2013). The study aimed to plan the instructional materials, activities, and units based on the Understanding by Design Model, a curriculum or an instructional design model in the context of their professional development. This action research study improved student teachers' pedagogical knowledge and skills by making them think of themselves as instructional designers. It is known that such reflective teaching and action research processes are one form to increase teachers' and student teachers' capacities (Zellermayer, 1990; Schratz, 1993; Walker, 1994; Bottery, 1997; Marcos, Sanchez & Tillema, 2011; Ramlal & Augustin, 2020). It intended to improve student teachers' TPACK and learning - teaching conceptions as a reflective teacher competence.

1.1.2. Socio-cultural theory and zone of proximal development in teacher education

The instructional design education process carried out in this study is closely related to ‘the zone of proximal development’ and ‘scaffolding’ terms explained by Vygotsky in his socio-cultural education theory (Kozulin, 1986; Rieber, 1987). Vygotsky defined the zone of proximal development as the difference between the current level of cognitive development and the potential level of cognitive development. He claimed that students could achieve their learning goals by completing their problem-solving performances with their teachers or better interacting with their peers. He also believed that students might not be able to reach a higher level of learning by working alone. He explained that cognitive support is necessary as a development tool for students to become independent learners. Students complete small, reasonable tasks or steps to achieve the stated upper learning goal. Working in collaboration with a teacher, or mentor or more knowledgeable peers helps students to establish relationships between concepts (Kurt, 2020). In this study, the researcher gave basic information to student

teachers who did not have sufficient pedagogical knowledge about instructional design, unit design, activity and material design, with sample projects and presentations based on UbD. It aimed to raise the current cognitive knowledge and skills to a higher learning level by giving feedback on the performances prepared by student teachers as a group work through Google Classroom. In this way, with a series of feedbacks, it was ensured that the potentials of student teachers regarding UbD-based instructional design skills were brought to the next level of development.

1.2. Conceptual framework

1.2.1. Technological pedagogical content knowledge (TPACK)

TPACK, regarded as necessary for innovative classroom teaching and compelling, effective technology integration, provides teachers and teacher educators with a framework for the interactive and holistic instruction of technology, content, and pedagogy knowledge (Abbitt, 2011; Yiğit, 2014; Karakuş, 2018). TPACK also provides a foundation for a concrete, robust learning and teaching process (Kuo, 2015). TPACK is an open and helpful structure for researchers trying to understand technology integration. Although early studies about TPACK focused on understanding and explaining it, subsequent research directed at revealing instructional design studies' effects on TPACK in both research and development projects (Baran, Chuang & Thompson, 2011).

As mentioned previously, it comprises content knowledge, technology knowledge, pedagogy knowledge, pedagogical content knowledge, technological content knowledge, and technological pedagogical knowledge. According to Schmidt et al. (2009), content knowledge denotes knowing the main subject area learned in a discipline. Pedagogical knowledge expresses teaching methods and processes, student assessment, and lesson plan development. Technology knowledge covers digital technologies such as video, Internet, software programs, and interactive whiteboards from simple, pen and paper tools. Content knowledge of teaching processes within a particular subject area or discipline represents pedagogical content knowledge. Pedagogical content knowledge covers the teaching processes within a specific subject area or field. Technological content knowledge is how technology can offer new learning for a particular subject area and how teachers can modify the way students study and comprehend concepts by using a specific technology within a particular area of a subject. Technological pedagogy knowledge denotes how many technologies can be employed in teaching and how teachers can change their teaching style using these technologies. TPACK is the knowledge that enables teachers to properly incorporate technology into their instruction while teaching the content by utilizing appropriate pedagogy and technologies (Mishra & Koehler, 2009).

As a teaching framework, TPACK has a potential impact on learning approaches and professional development experiences designed for teachers and student teachers. In this process, new strategies are proposed to improve teachers' knowledge of successfully integrating pedagogical expertise and technology into their teaching (Schmidt et al., 2009). Geometes's Sketcpad (GSP) as a mathematical application (Meng & Sam, 2013), technology-assisted mathematical problem-solving course (Harper & Cox, 2012; Durdu & Dağ, 2017), short blended online education workshop (Marreo et al., 2010; Pryor and Bitter, 2008; Schrum et al., 2005) improves teachers' TPACK in technology-supported lesson design or integration studies (Hofer & Grandgenett, 2012; Yiğit, 2014; Karakuş, 2018; Altun & Usta, 2019).

1.2.2. Learning and teaching conceptions

In the last century, the history of education has witnessed ongoing controversial issues between the behavioral learning theory, which started psychology experiments, and the

constructivist learning theory, a 21st-century new learning approach. The educational process has undergone a paradigmatic shift from behavioral learning theory to constructivist learning theory. Undoubtedly, this transformation has led to a change in teachers' and students' roles. In the behavioral learning approach, the teacher can transfer the content to the students in the teaching process, while the students are also the passive recipients of this knowledge. In constructivist learning theory, students are expected to discover and construct knowledge and meaning by actively participating in the learning process with active learning approaches. The teacher is seen as only a facilitator of this process (Cox, 2011; Hassad, 2011; Richardson, 2015).

1.2.3. Understanding by Design model (UbD)

In essence, UbD, which aims to students understand the content and apply or transfer what is learned in other contexts, offers a robust assessment-oriented design framework for people involved in curriculum development to design their programs systematically and purposefully. UbD has three essential elements (Desired Results, Acceptable Evidence, Learning Plan) (Wiggins & McTighe, 1998):

The first stage of the design involves defining the results or objectives that students are expected to achieve or achieve at the end of the program. The model's basic idea is that students acquire basic knowledge, facts, concepts, and skills first, then make inferences between these concepts and phenomena, understand the relationships, and finally apply or transfer the learned knowledge and skills in new situations effectively (McTighe, & Wiggins, (2011).

In the second stage, in determining evaluation evidence, authentic performance tasks that allow students to apply what they learn in different contexts are designed. This stage takes place before the planning of the teaching process.

The design of the learning and teaching process of UbD consists of specific steps. Students' knowledge, concepts, and skills are expected to be acquired in the first step. The teacher explains the activity steps that the students will perform in the lesson. At the end of this course, the teacher gives students information about what they learned. The second step aims to stimulate the students' existing knowledge, make them willing to search for new ideas, attract their interests and curiosity, and participate in the activities. The third step is to help students explore a topic and experience key concepts, equipping them with the knowledge and skills necessary to accomplish final tasks. The fourth step allows students to repeat and review their works and rethink key ideas. Finally, the teacher aims to evaluate the results and develop action plans by making a self-evaluation of students' performances (Wiggins, & McTighe, 2012).

1.3. Problem statement

Contributing to a change in teachers' understandings of teaching and the formation of a sense of the research community, the Understanding by Design (UbD) enabled them to assess themselves as curriculum designers and practitioners (Kang & Yi, 2013). Kelting-Gibson (2003) also compared the unit plans developed using the traditional curriculum design model with the unit plans based on the UbD model. It was found that student teachers who used this design model performed better than those using the traditional model. As a matter of fact, it has been observed that projects, workshops, or research courses of instructional design on UbD have an impact on the professional competencies of teachers and student teachers. Likewise, some studies have shown that UbD supported instruction has an impact on the professional proficiency of teachers as a curriculum designer, evaluator, and instructional designer (Sohn, 2016; Kang, 2014; Viera & Magma, 2013; Kang & Yi, 2013; Park, 2013; Choi, 2012; Cho, 2005), motivations (Wiessa, 2011), practical knowledge and skills (Park, 2013; Boozer, 2014) and self-efficacy beliefs. The previous studies have shown the effectiveness of UbD. For this,

UbD model has been employed as the framework of instruction design as it is a powerful, advanced, and systematic model and has common effect on teachers' professional developments.

An effective instructional design allows students to learn in the best way possible. According to Savec (2017), students learn best when they are intellectually active and intertwined with learning material. Besides, students have meaningful experiences related to their lives in sound instructional design; they interact with peers and their new materials and use them with clear learning objectives. These learning and teaching processes are specified as processes that should be taken into account in teaching and learning design (Savec, 2017). For this reason, there is a need for an understanding of how technology, pedagogy, and content knowledge can be intertwined to support students' learning (Koh, 2019). It is stated that teachers can increase knowledge of technology, content, and pedagogy by producing authentic learning materials (Yangın-Ersanlı, 2016). In this study, UbD based instructional design sought to improve student teachers' TPACK and learning and teaching conceptions.

Some studies on UbD based instructional design blend with instructional approaches without technology, such as Inquiry strategy (Seeger, Wood & Romans, 2018), problem-based learning (Graff, 2011), Concern-based adoption model (Young, 2005), pedagogical content knowledge (Boozer 2014). However, the technology has been integrated into the present instructional design study. The design of technologies and practices have been devised as a part of instructional design. Henceforth, technology-assisted instructional design on UbD has differed from the studies abovementioned. The study provides o guide for the following instructional design studies on how to integrate the technology into the UbD curriculum design model.

This instructional design on UbD followed the model's learning steps in the planning phase of instruction (hook and hold, gathering information, sustaining attention, experience and thinking, and integration). In these steps, student teachers carried out the tasks of poetry design, PowerPoint design, video research, scenario-based visual supported activity design, and the unit's design. Considering the effects of UbD-based instructional design training on teacher capacity such as TPACK and learning-teaching conceptions of student teachers, it is thought that the current study can be a starting point in revealing the possible effects and reflections of instructional design studies based on this model to improve the professional development of teachers or student teachers.

1.4. The research goal

The current study aimed to reveal the effects and reflections of instructional design training based on Understanding by Design (UbD) on student teachers' TPACK and learning–teaching conceptions. Two sub-questions were followed to attain the findings of the present study goal.

- Does instructional design on Understanding by Design (UbD) training impact student teachers' levels of TPACK and learning-teaching conceptions?
- What are the experiences, acquisitions, and reflections of student teachers throughout UbD instructional design education?

2. Method

2.1. The research design

Aiming to uncover the effects and reflections of instructional design training based on UbD on student teachers' TPACK and learning – teaching conceptions, the current study was designed by action research. Action research in education enhances teachers' and students' learning and teaching processes (O'Hanlon, 2003). This study was conducted following the

action research design since it strives to promote the professional knowledge and competencies of student teachers who receive education about learning and teaching for the first time within the instructional principles and methods course.

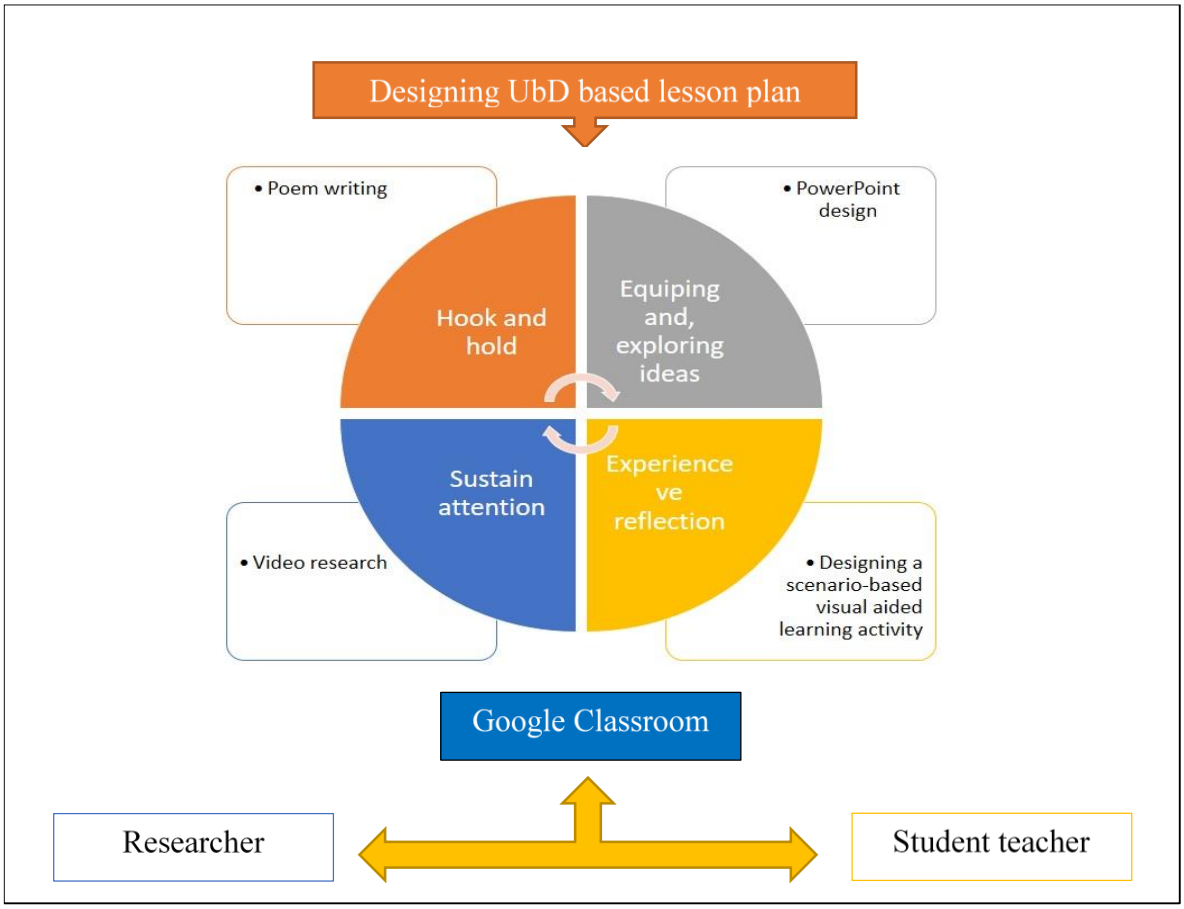

Figure 1. Technology supported instructional design based on UbD model

Theoretical courses on the fundamentals of learning and teaching processes were given before technology-supported instructional design-based UbD in the instructional principles and methods course. Courses and performance tasks on instruction design were taught face-to-face and provided with feedback on the tasks prepared by student teachers through Google Classroom. Process steps of the instruction that each lesson longs two hours are as below:

2.2. Steps to followed in UbD based instructional design training

Week 1: Basic concepts: In this topic, the concepts of education, instruction, learning, teaching, and the relations between these concepts, the relationships between instructional strategies, methods, and techniques are explained. Student teachers are asked to install the Google Classroom application on their mobile phones. Up to now, explanations and directions about the course have been sent through this application.

Week 2: Behavioral learning theory: Basic concepts of classical and operant conditioning, reinforcement and its types, tariffs, punishment, and types are mentioned. The educator uploaded videos about Pavlov's classical conditioning and Skinner's operant conditioning to Google Classroom environment. He asked to make asynchronous discussions by making comments about these experiments.

Week 3: Cognitive learning theory: Information processing model, information stores, cognitive processes, attention, perception, repetition, and coding concepts are discussed. While

teaching cognitive learning theory assumptions, the educator read a poem; he asked to interpret what is intended in this poem. Emphasis was placed on the importance of poetry to consider students' attention and readiness when starting the lesson.

Week 4: Learning and teaching strategies: The educator taught factors affecting learning; information processing; teaching strategies; learning strategies, repetition, interpretation, organizing, monitoring understanding, and emotional strategies.

Week 5: Instructional strategies: Information about teaching strategy by presentation, teaching strategy by discovery, teaching strategy by research, and comparison of three teaching strategies are explained. At the end of this course, the educator only introduced performances for them without giving information about UbD. The UbD teaching process, the goals, creation criteria, and steps of poetry design, PowerPoint design, video research, scenario-based visual aided learning activity design, and the unit design and writing performances with the UbD model template were mentioned (see Appendix 1).

Week 6: Teaching UbD unit design: The basic features, structure, phases, and processes of UbD are explained step by step with a sample lesson plan. The sample unit template has been transferred to the Google Classroom environment for student teachers to review during the performance process (see Appendix 2). Feedback is given for the students' works through the application by the end of the performances' design.

Week 7: Cooperative learning: Characteristics of cooperative learning method, collaborative learning models, and stages of the cooperative learning process are explained. At this stage, totally, 215 student teachers are divided into 25 groups in the cooperative learning process. They are also taught how to perform these tasks (see Appendix 1) assigned by their interests and abilities. Each group is asked to create a WhatsApp group to do idea exchange on tasks. It is expected to give a nickname and motto for each group.

Week 8: Scenario-based learning: The educator explained scenario writing, the application process of scenario-based learning, and scriptwriting over an example scenario. He also taught how to make a drawing compatible with the scenario to support this scenario visually. He taught them how to design a scenario-based visual-aided learning activity for the experience and thinking process in the UbD-based teaching process (See Appendix 3). As can be seen in the sample image presented in Appendix 3, this picture is illustrated with custom animated gestures designed in PowerPoint to clearly and concretely illustrate the stages and criteria in the specified scenario. The educator provided feedback on the learning activity's design and reflection process via Google Classroom.

Week 9: The theory of multiple intelligences: The concept of multiple intelligences, types of intelligence, multiple intelligences, and its effects on the learning process are explained. The role of multiple intelligences in a drawing activity, an add-on to the script, has been pointed out.

Week 10: Review of the units: Each of the student teachers in the groups sent the educator what they prepared about their tasks. The educator provided feedback on the errors or deficiencies he observed in these performances. This process continued until the performances were at their excellent.

After 10 weeks of face-to-face and online education, feedbacks were given to students over the google classroom for two weeks. After the performances of the students were checked by the instructor, the completion of the performance designs was completed.

2.3. The study group

The study group consists of student teachers enrolling at Instructional principles and methods course in Faculty of Islamic Sciences in a public university. Approximately, 215 student teachers from five separate classes participated in the study group. However, 129 student teachers participated in quantitative study where pre-test and post-test of scales are measured The demographic information of student teachers in the quantitative research part was presented in Table 1.

Table 1. *Frequencies and percentiles of student teachers in study group*

Gender		(f)	(%)
	Male	79	61,2
	Female	50	38,8
Technology usage at the college where they are studying		(f)	(%)
	Yes	103	79,8
	No	26	20,2
The time to technology use for educational purposes		(f)	(%)
	No	34	26,3
	0-4 hours	69	53,5
	5-9 hours	15	11,6
	10-14 hours	3	2,3
	15 upper	8	6,2
Technological tools used for educational purposes		(f)	(%)
	Computer	93	72
	Mobile phone	129	100
	Mp3 player	7	54,2
	Tablet	19	14,7
	Camera	13	10,1
Wanting to be a teacher		(f)	(%)
	Yes	112	86,8
	No	17	13,2
Reading any book or books on education		(f)	(%)
	Yes	66	51,2
	No	63	48,8
Information sources employed in studying		(f)	(%)
	Library	101	78,3
	YouTube	96	74,4
	Microsoft tools	31	24
	Social media	76	59
		129	

As shown in Table 1, 129 participants, including 79 males and 50 females, participated in the study group's quantitative part. 103 of 129 participants could technology the college where they are studying, on the other hand, remaining could not. Percentiles of the time to the technology used for educational purposes are, in turn, none (%26,3), 0-4 hours (%53,5), 5-9 hours (%11,6), 10-14 hours (%2,3), 15-upper hours (%6,2). Ninety-three of the pre-service teachers use computers, 129 mobile phones, seven mp3 players, 19 tablets, and 13 cameras for educational purposes. It is seen that 17 of them do not want to be teachers, while 112 participants wish to be teachers. Also, 66 participants stated that they had read any book or books about education so far; 63 did not read. Finally, it was stated that the sources of

information used by participants while studying were library (101), YouTube (96), social media (76), and Microsoft tools (31), respectively.

The study group of the qualitative dimension of the research consists of 215 students working in 25 separate groups including approximately 5-7 participants. All the student teachers participated in action research and they conducted 25 separate UbD based instructional design suitable to 25 different lesson units and objectives.

2.4. Data collection tools

In the present research, the researcher employed the Learning - Teaching Conceptions Scale and the TPACK Scale, and collective written diaries as the data collection tools.

2.4.1. TPACK Self-Efficacy Scale

The TPACK scale developed by Horzum, Akgün, and Öztürk (2014) was adopted to measure student teachers' self-efficacy for TPACK. The five-point Likert-type scale consists of 51 items and seven dimensions. Dimensions; 'technology knowledge (6 items)', 'pedagogy knowledge (7 items)', 'content knowledge (8 items)', 'technological content knowledge (6 items)', 'pedagogical content knowledge (8 items)', 'technological pedagogical knowledge (8 items) 'and' technological pedagogical content knowledge (8 items) '.

2.4.2. Learning and teaching conceptions scale

This scale, which Chan and Elliot (2004) developed and adapted to Turkish culture by Aypay (2011), consists of 30 items accumulated in two dimensions. It introduces the dimensions of behavioral teacher understanding (18 items) and teachers' constructivist understanding (12 items). These dimensions' reliability coefficients were found as .832 and .750, respectively.

2.3.3. Collective written diary form

They were asked to write a collective diary to acknowledge the impressions, thoughts, and experiences on the technology-supported instructional design on UbD. In this collective diary form comprising semi-structured questions, the student teachers in the groups stated their thoughts about the design activities they worked on, their experiences, and their acquisitions. Totally, 25 collective written diary forms were collected.

2.5. Data analysis

The data analysis of the research consists of two phases. Paired samples t-test was used to compare the pre-test and post-test scores of the TPACK Self-Efficacy Scale and the Learning and Teaching Conceptions Scale. The expressions in the written diaries, which are the qualitative dimension of the research, were subjected to content analysis. The student teachers' expressions for each performance they conducted were coded separately in the content analysis. The codes, also presented in frequency format, were then transformed into categories and themes. In this process, raw data - code, code - code, code - category, category - theme comparison was performed by constant comparative analysis method to minimize the coding error between performances (Lepper, 2000; Neundorf, 2002).

2.6. The trustworthiness and ethical considerations of the research

In this section, the processes related to data triangulation and rich and dense description are mentioned to ensure the credibility of the research. Ethical issues for preserving participants' privacy are also stated.

2.6.1. Data triangulation

Both quantitative (scales) and qualitative data (collective diary form) sources are employed to support the findings of effects of UbD based instructional design on student teachers' TPACK and learning and teaching conceptions (Silverman, 2016).

2.6.2. Rich and intense description

Steps to be followed in UbD based instructional design are explained in a detailed manner. The processes, purposes, and criteria of each task design were presented separately in Appendix 1. The basic features, structure, phases, and operations of UbD are explained step by step with a sample lesson plan in Appendix 2. Appendix 3 also includes examples of PowerPoint files illustrating tasks that student teachers perform collaboratively in groups. Besides, Appendix 4 covers scenario-based visual-aided learning activities for the experience and thinking process in the UbD-based teaching process. Information of all the performance tasks in Ubd based instructional design training are included in the manuscript's general layout. In this way, the research's trustworthiness is performed through rich and intense description (Merriam, 2015).

2.6.3. Ethical considerations

The participants' personal information is kept confidential. It is given a pseudonym to the participants while presenting their' statements on Ubd based instructional design training.

3. Findings

In this section, the findings obtained from the paired-samples t-test are included. Then, the codes, categories, and themes obtained through the diaries' content analysis are presented to support these findings.

3.1. The findings of first research problem

The researcher compared pre-test and post-test scores of the student teachers obtained from the scales to answer the question, "Does instructional design on the Understanding by Design provide a meaningful change in student teachers' TPACK and learning and teaching conceptions?". Table 1 present the results of the paired-samples t-test.

Table 3. *Paired samples t-test results about pre-test-post-test comparisons of learning teaching conceptions and TPACK*

Dependent variable		Mean	N	Standard deviation	t	df	p
Constructivist teacher understanding	Post-test	4,58	129	,35518	5,397	128	,000
	Pre-test	4,39	129	,42762			
Behaviorist teacher understanding	Post-test	2,55	129	,58259	-4,574	128	,000
	Pre-test	2,81	129	,63501			
Technology knowledge	Post-test	3,88	129	,79095	3,013	128	,003
	Pre-test	3,67	129	,80603			
Pedagogy knowledge	Post-test	4,20	129	,48207	5,592	128	,000
	Pre-test	3,87	129	,68062			
Content knowledge	Post-test	4,35	129	,49845	3,708	128	,000
	Pre-test	4,14	129	,60394			
	Post-test	4,09	129	,69283	3,753	128	,000

Technological content knowledge	Pre-test	3,83	129	,74619			
Pedagogical content knowledge	Post-test	4,26	129	,53443	3,722	128	,000
	Pre-test	4,04	129	,67013			
Technological pedagogy knowledge	Post-test	4,09	129	,68376	3,202	128	,002
	Pre-test	3,90	129	,70030			
Technological pedagogical content knowledge	Post-test	4,11	129	,71866	3,383	128	,001
	Pre-test	3,89	129	,71991			

As indicated in Table 3, the results point out that there is a significant and positive improvement in the constructivist teacher understanding of student teachers [t (128) = 5.397; p <.05], while a significant decrease in behavioral teacher understanding [t (128) = -4.574; p <.05]. They show also that the student teachers' technology knowledge [t (128) = 3,013], pedagogy knowledge [t (128) = 5,592], content knowledge [t (128) = 3,708], technological domain knowledge [t (128) = 3,753], pedagogical content knowledge [t (128) = 3,772], technological pedagogy knowledge [t (128) = 3,202], and TPACK [t (128) = 3,383].

3.2. Findings of the second research question

The student teachers' opinions about the instructional design on UbD were subjected to content analysis. The content analysis proved that the effects of UbD-based instructional design training on student teachers were grouped under five themes: (a) Constructivist instruction strategy, (b) TPACK, (c) lifelong learning, (d) affective orientation, and (e) restrictions in education.

In Table 4, 5, 6, 7, and 8, performance tasks are abbreviated as GC: Google Classroom; PD: Poem Design; PPD: PowerPoint Design; AD: Activity Design; UD: Unit Design; VR: Video Research; GID: General Instructional Design. The categories and codes observed in the performance tasks specified in these tables and the frequency values of these codes are shown. Throughout the writing of the findings, a single quote was included for each category of performance tasks.

3.2.1. Theme 1: Development of constructivist teacher understanding

As a result of the instructional design training on UbD, it is seen that there is an improvement in the constructivist teaching understanding of student teachers. Qualitative findings indicate that it supported thinking-oriented education readiness, cooperative learning, authentic learning, practice-based teaching, presentation, and discovery-based teaching, student-centered instruction, differentiated teaching, and the development of learning and teaching understandings.

Table 4. *Codes and categories of the development of constructivist teacher conceptions*

Categories	Codes	GC	PD	PPD	AD	UD	VR	GID
Thinking based instruction	Stimulating thought		3	1	1			7
	Reinforcing imagination				3			
	Establishing scenario-drawing connection				2			
	Creating consciousness		1					
	Proposing new ideas		1			1		

Considering readiness	Suitable for students' conceptions		3	1	2	5	
	Using instructional methods by grade		2				
	Regulating teaching by age group		3	3		1	
	Writing scenario by students' knowledge			1			
	Choosing suitable words by their knowledge	1					
	Writing a poem by grade	1					
	Writing scenario by students' interests			2		4	
	Considering students' needs			3			2
	Being able to attract attention				2		
Cooperative learning	Peer learning			1			
	Teamwork	2		3	9		4
	Inner group communication			1			
Authenticity	Being related to real world			1		1	
	Adapting what has been learned to different subjects			1			
The development of learning and teaching conception	Sense of teaching		1				
	Teaching to learn			1			1
	Awareness of teaching			1			
	Comprehending the teaching process				9		
	Ideal teacher conception						2
	Learning to love teaching						3
Teaching by presentation	Expression with known examples						1
Teaching by discovery	Discovering knowledge						1
Practice-based teaching	The ability to use information			1			
	Active learning			2			4
	Learning to design any activity						2
	Learning to teach with activities			1			

	Adaptability to different subjects	1		
	Transforming into practice	1		3
	Learning by trial and error			1
Scaffolding	Guiding			1
Student centered instruction	Student based understanding			3
	Enjoying student-centered education			10
Differentiated instruction	Different activities	1	1	1
	A different teaching process			1
	Presentation with different examples			1

In constructivist teacher conceptions, student teachers regard instructional design on UbD as thinking-based learning that comprises stimulating conscious thought, imagination, analytical thinking, awareness, and innovative ideas. A participant reported that scenario-based visual-aided learning activity design contributed to the thinking-based learning as presented below.

"While preparing the activity with my friend, we thought about how students understand and learn quickly, getting their attention without boring them. We want to read and imagine a short story. We wanted them to think that they can have an image in their mind. We tried to encourage them to speak instead of just passing by. Our primary purpose here was to think of him as a human being and show that his mission is not just a narrative; we also visually supported this."

Qualitative findings show that it developed student teachers' authentic learning as a characteristic of constructivist teaching. Student teachers also considered students' readiness as their knowledge and comprehension, attention, interest and age-grade, and needs throughout the training. A student teacher who made a poetry writing activity reported that this process contributes to authentic learning and students' readiness.

"In the poetry writing activity, I first wanted to draw the student's attention to some words. I thought of entering the subject by addressing the emotional aspects rather than direct information. Here I tried to understand whether they had prior knowledge about the poem's words. In short, I wanted to introduce the subject by addressing their feelings first."

The training process also helped improve collaborative learning, including teamwork, peer learning, and in-group interaction. A participant expressed the following statements:

"We first did extensive preliminary research for the unit and then determined what to do with the exchange of ideas within the group and the activity stages, and we came together as a group many times to complete the unit, and it was a fun process for me."

Student teachers' conceptions of learning and teaching proved the formation of a sense of teaching and awareness of teaching, learning to learn, understanding the teaching process, and the ideal teacher structure and learning to love teaching. Student teachers participating in the UbD-based instructional design training defined this process as practice-based teaching. In this instructional design process, which can learn effectively and learn by trial and error, student teachers could use information, learn to fulfill activities, learn to teach exercises, adapt what

was known to different subjects, and turn them into practice. A participant's view about contribution to student teachers' conceptions of learning and teaching and practice-based teaching is as follow:

"Through this lesson and with your efforts, we learned life and learning by doing and experiencing it. Experience is not only acquired by memorizing information; it must also be practiced so that we can become experienced people. I learned your thoughts and experience and how to be an experienced person. It was a very productive lesson. Thank you for everything."

The findings eventually explain that it reinforced differentiated instruction, including presentation-based instruction with known examples, discovery-based teaching, different activities, diverse examples, and educational processes. A participant expressed that *"The lessons were beneficial with different classroom activities and presentations. It helped us a lot. It was an enjoyable lesson worth learning."*

3.2.2. Theme 2: Development of TPACK

Qualitative findings show that UbD based instructional design education improved participants' technology knowledge, content knowledge, pedagogy knowledge, technological content knowledge, and technological pedagogy knowledge in the context of TPACK.

Table 5. *Codes and categories of the development of TPACK*

Categories	Codes	GC	PD	PPD	AD	UD	VR	GID
Technological content knowledge	Using the technology related to subject area			2			1	2
	Preparing efficiently PP			8				
Technological knowledge	Technology integration			2			1	2
	Purposeful technology use	2			1			
	Recognizing novel technologies				1			
	Improving technology usage	2		3				
	Learning to use technology			7				
	Active user (available)			4				
	Employing technological skills before			3				
	Communication	5						
	Rapid communication	15						
	Interaction with teacher	5						
	File submission	1						
	Providing material supply	2						
	Data exchange	3						
	Instant notification	2						

Technological pedagogical knowledge	Facilitating knowledge acquisition	1					
	Getting feedback	8					
	Ongoing information flow	2					
	Management of the lesson	1					
	Facilitating the design of performances	8					
	Learning to design lesson	4					
	Discussing topics	1					
	Making an evaluation	1					
Pedagogical content knowledge	Making teaching method – subject area connection		1				1
Pedagogical knowledge	Learning to design lesson by grade						1
	Pedagogy/technology knowledge			2			2
	Knowledge of teaching materials		1	1	3		
	Associating a teaching method with learning material		3		2	3	
	Making the unit – material association		1				
	Designing any activity				3		3
	Use of the sample unit				4		
	Basic unit design knowledge				9		
	Able to use UbD model				3		
	Reflectivity of unit design				5		
Content knowledge	Employing content knowledge		1			7	3

GC: Google Classroom; PD: Poem Design; PPD: PowerPoint Design; AD: Activity Design; UD: Unit Design; VR: Video Research; GID: General Instructional Design

Throughout the instructional design, student teachers' use of technology (PowerPoint, etc.) on a subject related to their discipline proved that they used the technological content knowledge. A participant reported that *"I studied the subject in a general way during the PowerPoint preparation process. Later, I used technological instruments to support it visually. With this experience, I learned how to do systematic research and to make use of technological tools when necessary."*

Qualitative findings show that they had pre-technology skills, recognized novel technologies used, and employed the technology purposefully and effectively. It provided data exchange, fast communication, file submission, and material provision in the context of technology knowledge. On associated with TK, a participant stated that *"Google Classroom enables to use the technology effectively. In order to prepare the lesson plan in the best way, you can communicate with the teacher and have the chance to fix the problematical pieces."*

They point out an improvement in their technological pedagogical knowledge, such as instant information, information acquisition, feedback, the instant flow of information, managing the lesson, facilitating performances, learning to design units, and discussing and evaluating topics, primarily via Google Classroom. Another participant said that *"I think this application is useful because it is easier to communicate with the teacher and transfer the information more easily. It provides direct communication with the student in all situations."*

The findings also indicate that they connected between a teaching method and subject topics in pedagogical content knowledge. Besides, pedagogical knowledge denotes knowledge of learning material, basic unit design, continuity principle in unit design, sample unit, activity design, and ability to use UbD model, plan a lesson by grade, associate learning material with a teaching method, and establish the unit-material relationship. A participant reported the statement on pedagogy and pedagogical knowledge.

"I saw a nexus between your teaching style and our topics. While explaining a subject, you enabled us to find the information by giving a hint rather than giving it to us directly. This situation reinforced our curiosity about the lesson."

Ultimately, qualitative findings demonstrated that they employed and extended their knowledge in the discipline. A participant explained that *"the poetry writing activity allowed me to review what I know about the position and what I do not know. It helped me to see where I was mastering the subject and shortcomings."*

3.2.3. Theme 3: Life-long learning experiences

Table 6 indicates that the instructional design on UbD helped improve operability, professional development, perspective development, facilitating learning, transferring, and research-based education.

Table 6. *Codes and categories of lifelong learning experiences*

Categories	Codes	GC	PD	PPD	AD	UD	VR	GID
Operability	Wishing to use it at next	3	3	4	2	10	5	
	Requesting unit planning							2
Professional development	Professional development	1			3			1
	Any learning experience		5			1		2
	Understanding student's mindset				2			
	Learning to think like a teacher					4		
Perspective development	Viewpoint				1			
	Imagination				3			
	Self-efficiency		7					
	Artistic thought		2					

	Historical empathy	1					
Facilitating to learn	Memorability	1		1			3
	Making better understandable the lesson			2		4	1
	Educational knowledge					7	2
	Supporting the knowledge with visuals		10				
	Making knowledge permanent		1			2	
	Reinforcing to learn	1	1			1	
	Strengthening to teach		2			2	
	Providing with exemplifications					1	
Transferring	Facilitating any course work		1				
Learning by research	Improving research abilities		1			4	
	Learning much more knowledge					1	
	Acculturation					2	
	Preliminary research				1		
Productivity	A educative teaching		6	4		1	
	A productive teaching		1		3		
	Useful activities for students				2		

GC: Google Classroom; PD: Poem Design; PPD: PowerPoint Design; AD: Activity Design; UD: Unit Design; VR: Video Research; GID: General Instructional Design

As shown in Table 6, student teachers wished to practice these design tasks (for example, unit design) in their professional life. Instructional design based on UbD also provided student teachers with a learning experience in professional development. It furthermore helped them feel like a teacher and understand student's mindsets. A participant reported on operability and professional development in a statement below.

"While preparing the lesson plan, I thought it would be difficult since we haven't done the homework before-mentioned. But as I planned the activities we did for the students, the questions we asked, and the plan we prepared, I felt like a teacher, and it made me happy. I think it will contribute to our teaching life in the future as a good course for us."

This educational process renewed student teachers' perspective, imagination, self-efficacy, artistic thinking, and historical empathy. A participant declared a statement about perspective development as follows.

"Designing a learning activity enabled me to produce a new and original idea in the educational field on the required subject when necessary. Exploring and experiencing and what we can do has prepared this kind of ground for the future."

Qualitative findings have shown that it helped retention what has been learned, facilitate their better understanding of the lesson, provide educational information and examples, support information with visuals, and support learning and teaching. A participant stated that *"it was a*

good experience. I think that children will understand and comprehend the subject better visually and effectively. Since it is a material that I can use in my professional life, I can use it when necessary."

Finally, UbD based instructional design training enabled them to transfer what they learned to another context. It has also influenced their research ability, learning much more information, acculturation, and preliminary research.

"While preparing the puzzle, I studied puzzle preparation programs. During my research, I met many applications. I witnessed again how important in our lives when we use technology correctly. I posed the questions with your group, and my ability to communicate with my environment advanced. Through the preparation, our research ability has improved even more."

3.2.4. Theme 4: Affective orientations

As shown in table 7, the effects of the UbD-based instructional design training on the affective orientations of student teachers are classified into four categories: (a) attitude, (b) emphasis on affective components, (c) encouragement of participation, and (d) the efficiency of the process.

Table 7. *Codes and categories of affective orientations*

Categories	Codes	GC	PD	PPD	AD	UD	VR	GID
Attitude	Satisfaction with use	1		2	1			
	Ease of communication	4						
	Enjoyable teaching		9	7	7	4	5	14
	Excitement to produce			1				
	Useful activity					4		
Productivity	Efficiency		1					
	Accessible						2	
	Educative			6	4		1	
	Productive			1		3		
	Helpful for themselves					2		
Emphasis on affective components	Increasing interest				2		2	2
	Captivating curiosity				1			1
	Drawing attention		4	8		2	5	
	Appealing to emotions		3					
Encouraging participation	Motivating students							4
	Getting students to speak				1			1
	Answering questions							2
	Making his/her express herself							3

GC: Google Classroom; PD: Poem Design; PPD: PowerPoint Design; AD: Activity Design; UD: Unit Design; VR: Video Research; GID: General Instructional Design

Student teachers' attitudes towards the training pointed out use satisfaction, ease of communication, excitement to produce, and helpful activity.

"I had some knowledge and experience before. I think I extended it through this activity. Since PowerPoint is a program that we will use in our educational lives, I believe that it is a great benefit to evolve in this course. For us, both the lesson and this activity were very different. I think it was friendly and fun."

The findings demonstrate that the instructional design on UbD helped increase interest, captivating curiosity, drawing attention, and appealing to emotions based on student teachers' statements. Also, they informed that it motivated them, encouraged them to speak, found answers to their questions, and helped them express themselves.

"Instructional principles and methods were generally a course that trains us as the teachers of the future, such as how to make the lesson effective, how to ensure active student participation in the class, how to conduct student-centered education, how to teach lessons in line with the needs of the students. Thank you for being a guide in this lesson, enjoyably teaching the lesson, and being an excellent example for us as a teacher."

Finally, they defined the instructional design process as educational, efficient, valuable, and productive.

3.2.5. Theme 5: Restrictions

As can be seen in Table 8, the challenges student teachers experienced were observed in three main categories: (a) difficulty in producing, (b) content area restrictions, and (c) pedagogical restrictions.

Tables 8.*Codes and categories of restrictions*

Categories	Codes	GC	PD	PPD	AD	UD	VR	GID
Difficulty of making	Challenging		3	2	3	20		
Limitation of the subject area	Limitation of the subject				1			
	Abstract subject matter				1			
Pedagogical limitation	Difficulty of adjusting the duration of the lesson				1			
	Difficulty of finding images				1			
	Difficulty of adjusting the script to student level		1		3	2	3	
	Difficulty of drawing images in abstract concepts							
	Difficulty of converting information into templates					1		
	Difficulty of attracting attention					1		
	Difficulty in the way the unit template is expressed					3		
	Difficulty in linking the objectives to the teaching process					1		

GC: Google Classroom; PD: Poem Design; PPD: PowerPoint Design; AD: Activity Design; UD: Unit Design; VR: Video Research; GID: General Instructional Design

According to the qualitative findings, student teachers defined the subjects are limited and abstract as content area restrictions. They also had difficulty in performing activities.

"Collecting and studying information was challenging to write to fit students' understanding. It was tiring to get it into the children's understandable form without boring, without adding unnecessary information to the plot. However, things got easier when he got used to it after a while."

Besides, it was observed that pedagogical restrictions or insufficiencies mainly caused the challenges student teachers experienced during these design studies. They are difficulties adjusting the lesson's duration, finding the visuals, arranging the scenario to the student age, drawing images in abstract concepts, converting learning and teaching processes into the unit template, drawing attention, writing the statements in the unit template while establishing the relationship between learning objectives - instructional methods.

"We found the scenario and any puzzle play as a learning activity, and our topic was already limited. We are always the most difficult. Finally, our activity took its final form by adding something from everyone. A friend of mine also did the last shot with her drawing."

4. Conclusion and Discussion

The study investigated the effects and experiences of technology-supported UbD-based instructional design training on student teachers' TPACK and learning and teaching conceptions. Obtained from the quantitative scales, which is one of the two data sources, the results indicated that it affects student teachers' all TPACK and related knowledge levels and constructivist teacher conceptions while a negative decrease in their behaviorist teacher understandings. The results obtained from the qualitative data analysis supporting the quantitative findings showed that it helps improve student teachers' TPACK, constructivist teacher conceptions, lifelong learning experiences, and affective orientations. They also experienced some restrictions in this process.

4.1. Conclusion and discussion of the development of TPACK

One of the main findings observed in the effects of technology-supported instruction design activities in the Google Classroom environment on student teachers is their TPACK improvements. Both quantitative and qualitative analyses indicated that their knowledge levels related to all the TPACK improved. Walter (2018), who examined the development of three mathematics teachers by blending the UbD model with the cognitive-oriented teaching approach, found that they improved their knowledge of mathematics as content knowledge. He observed that they could use problem-solving methods, formulating new learning goals for the unit plan, determining the evidence for students' learning, appropriate and differentiating performance selection, and teacher awareness as pedagogical knowledge.

No using technological instruments as in the study of Walter (2018), Seeger, Woods & Romans (2018), examined the effect of UbD-based unit design studies on teachers' inquiry strategies. They showed that UbD based instructional design impacts their lesson planning skills, knowledge, skills, and experiences of UbD in terms of pedagogical knowledge and pedagogical content knowledge. As can be inferred, both studies revealed the effects of only UbD-based instructional design on student teachers' content knowledge, pedagogy knowledge, and pedagogical content knowledge. In the present study, which coincides with these two studies' findings, the technology is both a part of teaching and its learning material. Google Classroom played a facilitator role during the instructional design. Therefore, the UbD based instructional design, including writing poetry, PowerPoint design, designing a gamified

learning activity, video research, and unit design, student teachers have not improved not only content knowledge, pedagogy knowledge, and pedagogical content knowledge, but also technology knowledge, technological content knowledge, technological pedagogical knowledge. They incorporated the technology into their lessons with superficial use of existing tools while student teachers designed learning activities and lesson plans using technology. It is stated that technological pedagogy knowledge increases when technology is used in an advanced form that will enable students to gain inquiry-based experiences (Özgün-Koca, Meagher & Edwards, 2010). Koretsky & Magana (2019) revealed that the effective use of technology in instructional design studies including learning outcomes, assessment and evaluation and teaching activities contributes to the professional development of teachers. Besides, some research show that technologies such as augment reality, integrated learning systems, multimedia, web board etc. in the classroom increase students' learning outputs (Khan, Johnston & Ophoff, 2019; Kurt, 2015). It is possible to say that technology supported instruction design activities enhance both the quality of instruction and students' achievements.

4.2. Conclusion and discussion of development of constructivist teacher understanding

The second main finding observed in the study is that student teachers' understanding of learning moves from behaviorism to constructivist understanding. Student teachers' teaching understanding of constructivist learning encompasses thinking-oriented teaching, cooperative learning, teaching through presentation and discovery, practice-based teaching, student-centered instruction, scaffolding, authenticity, readiness, and differentiated instruction. Jozwik, Lin & Cuenca-Carlino (2007), who put the UbD program design process into practice to develop service-learning projects based on the constructivist movement, revealed that teachers' feelings of social participation and social justice evolved. Through service-learning, participants apply their classroom learning by engaging with the community (Jenkins, 2011). In Jozwik, Lin & Cuenca-Carlino's (2007) study, teachers took actions that address society's needs and the program with a sense of shared responsibility while preparing plans for learning projects by serving. It can be said that the findings of Joswik, Lin & Cuenca-Carlino coincide with the features of experience-based learning, thinking-based teaching, cooperative learning, and authenticity associated with constructivist understanding in the present study. Many studies that carried out unit design projects using the UbD revealed that teachers promote collaborative learning and teaching (Ostinelli, 2006; Boozer, 2014; Yurtseven & Altun, 2017).

Likewise, Herro (2018) examined teachers' experiences of the UbD-based lesson planning in a professional learning community. They employed methods of organizing and differentiating teaching by students' interest and ability, developing activities, and conducting collaborative unit planning throughout the UbD based instructional design. Herro's findings showed similarities in the arrangement and differentiation of teaching by students' readiness in the current study. As in Herro's (2018) study, Peters-Burton (2012), who taught UbD-based instructional design to teachers with early stages of teaching, pointed out that teachers used the UbD model and student-centered design principles. Instead of using the lesson plans they received from senior teachers, it was seen that they could transform their teaching into student-centered teaching design through UbD. The planning of learning and teaching of UbD, by its nature, is based on differentiation of teaching, taking into account students' readiness, emphasizing experience and reflection (Wiggins & McTighe, 1998). Therefore, it is possible to say that the instructional design based on UbD gives a student-centered education approach. UbD enriches students' conceptual understanding, character and thinking development, problem-solving skills, and high-level thinking skills concerning student-centered education (Cho, 2005; Lee & Lee, 2014, 2015; Scott, 2015).

4.3. Conclusion and discussion of the emotional orientation

One theme of the qualitative findings is emotional orientation. Having stated that UbD supported instructional design emphasized students' interests and motivations and supported their in-class participation, student teachers developed a positive attitude towards UbD-based pedagogy. Ostinelli (2016), who reported the reflections of the instructional design developed by two Swedish teachers inspired by the UbD model, explained a relationship between understanding UbD and teachers' attitudes in his study. Depending on the relationship, he observed positive improvements in the Ubd-based unit planning skills of teachers, who identify the value of activity planning, which makes the classes interactive and participatory, attracts interest and enables students to attend the lesson enthusiastically, and who is in the mind of putting forward new ideas. It is possible to say that there may be an increase in teachers' desire and motivation to do an instructional design based on this model that reinforces students' interests, motivations, and participation. It can be stated that the attitude and motivation towards innovation and scientific thought, open-mindedness, and positive thinking are facilitators in unit planning of teachers who started using this model in the first years of their teaching (Ostinelli, 2006; Jozwik, Lin & Cuenca-Carlino, 2007; Walters, 2018).

4.4. Conclusion and discussion of the life-long learning experiences

Qualitative findings showed that technology-supported UbD-based unit design influences student teachers' lifelong learning experiences. In this context, they have had learning experiences in operability of what has been learned, learning to learn, learning by research, perspective development, and professional development. That is, the findings explain that it facilitated the desire and efficacy to use design activities in both personal and professional life in the future. It is believed that UbD can be used successfully if teachers fully understand the effects of the model on student learning (Trapani & Annunziato, 2018). As Kang & Yi (2013) stated, UbD allows teachers to develop reflective efficacies in the context of professional development. If teachers as curriculum designers or practitioners know what and why they would do, the possibility of transfer and comprehension rises increasingly (Guilott, Wigby, Owen & Parker, 2020). In this study, they are asked to balance each activity and learning material that they designed, instructional methods and techniques used, and instructional phases of UbD in the process of instructional design. The balance is associated especially on the UbD unit design template, in line with learning objectives (Meaning, skills, etc.), instructional methods and learning materials (discussion, PowerPoint, etc.), UbD learning phases (hook and hold, experience, etc.), and teaching statements. For example, it is aimed to give students teachers an understanding that the student should perform the scenario-based visual aided learning activity in the Experience and Thinking phase in order to gain meaning and skill-based learning goals. In addition, the works of the student teachers were regulated via the feedbacks given by the researchers. In this respect, it is thought that they grasp what and why they do reflectively the tasks in the instructional design process. This knowledge and skill acquisition may have changed their professional thinking, attitude, and understanding and increased the operability of what was learned. As a result, student teachers can use UbD to transform and improve classroom practices as necessary in professional life (Trapani & Annunziato, 2018).

4.5. Conclusion and discussion of restrictions about UbD practices

Finally, an observed theme is the restrictions or inadequacies that student teachers experience regarding the UbD-based instructional design process. It has been observed that the most critical restrictions emerging from the qualitative analysis depend primarily on the lack of pedagogical knowledge. Student teachers are insufficient in creating visuals, creating scenarios by student level, associating abstract concepts with visuals in learning activity based

on scenarios. They encountered many challenges in unit planning, such as transferring the teaching process to the unit design template, attracting attention, and establishing the relationship between the goals and the teaching process. Considering that they have not planned a unit based on traditional planning models a forehand, they may have such inadequacies in designing units in a complex, advanced and systematic model like UbD. Similarly, Graff's (2011) grounded theory study, which blends UbD with problem-based learning, revealed student teachers' processes and experiences in instructional design. Graff's research has shown that they have difficulties in organizing and planning instruction by grade, specific standards, and strategies in terms of pedagogical knowledge. It can be said that the findings in our study compatible with the findings of Graff (2011). Considering that teachers' low self-efficacy negatively affects their unit planning skills, it can be said that these restrictions stem from the lack of pedagogical knowledge (Ostinelli, 2006).

5. Recommendations

In this study, evidence points out that it is necessary to fulfill the infrastructure and regulations to improve teachers' and student teachers' lesson planning process and skills. According to the results, it is seen that they have pedagogical deficiencies. It is recommended to disseminate applied activities, research projects, and lessons on scientific, systematic, and rigorous instructional design models and approaches such as UbD in teacher education. In this regard, it can be aimed that student teachers reach both more constructivist knowledge, skills, and understanding as well as more advanced TPACK level by conducting instructional design studies on program design models such as The teaching for understanding, Hunter model, and Authentic design.

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