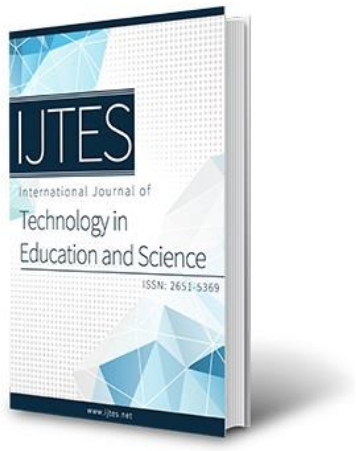

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Metaphoric Perceptions of Preservice Teachers Regarding Technological Change

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Abstract

The purposes of this study were to determine metaphoric perception of preservice teachers from different fields regarding technological change and to examine the differences and similarities between perceptions of preservice teachers (1st and 4th grades). This study employed single case (holistic) study as a qualitative approach. Participants consisted of 445 preservice teachers who have continued their education in different programs in 2019-2020 academic year in Faculty of Education. After informing participants about metaphor technique and its applications, each participant was asked to fill out a structured form. The structured form included a prompt: "Technological change is like ....., because.....". Content analysis technique was employed to analyze the data. Content analysis included developing conceptual categorization and themes based on the reasoning of metaphors. Results showed that most of the participants had similar metaphoric perception regarding technological change, considering "metaphoric categories" and "conceptual categories." However, "metaphoric categories" and "metaphoric concepts" had similarities and differences by year. And, "technological change as societal/cultural interaction" theme emerged from the analysis. This theme consisted of two categories (influencer and influenced) and these two categories were grouped in three sub-categories. Overall, the results indicate that preservice teachers' perceptions of "technological change" concept had some variations.

Introduction

Citizens in every corner of the world are increasingly exposed to technologies such as biotechnology, chemical technologies, transport technologies and information and communication technologies (Sade & Coll, 2003). Changes in societal needs with the advances in science and technology necessitate teachers keeping up with this transformation. The aim of modern education system is to educate individuals who investigate ways to access information, know when and how to use gained knowledge, and have critical thinking skills. Accomplishing this aim is possible with qualified teachers who adapt oneself to the changes and advances in science and technology (Şenel & Gençoğlu, 2003). While technology eases life by making individuals and societies stronger in the presence of facts and incidents, changes in technology bring new opportunities (Çelik & Kahyaoğlu, 2007). As technology has become of an interest to many fields and disciplines especially with digitalization, research

focusing on the concept of technology has increased considerably. One of the most important factors in the growth in research about technology is the pace in technological change (Parviainen, Tihinen, Kääriäinen, & Teppola, 2017).

Technological Change

According to Parayil (1994), technological change is a revolutionary and ongoing process that, to a great extent, cannot be reversable. In addition, exact nature of technological change in the future may not be predictable despite the known trends. Research has shown some exemplars about the nature of technological change. For example, Roumasset and Smith (1981) interpret technological change in their research study with an example as follow: Total labor by hectare decreased from 107,4 to 85,6 person/day from 1975 to 1978. A good part of decrease in labor was the result of labor saving technological change. Furthermore, Smith (2014, 200) emphasizes the importance of internet and provides an example. Considering internet as an example, Smith (2014) states that technological innovation may not solely change social organization and solve complex problems, although technology has a crucial role in daily life. This perspective challenges and even conflicts with the belief about positive influences of technological change in human life (Diener, 2017).

A literature review conducted by Coeurderoy, Guilmot, and Vas (2014) presents various indicators about adapting technological change. Frequency of occurrence, decision of acceptance (e.g. Gatignon & Robertson, 1989; Rogers & Shoemaker, 1971), and the number of individuals adopting innovations for a while (e.g. Rogers, 1995) are among these indicators. Diener (2017), however, states that technological change is not only an assumption in determining societal change based upon daily experiences (e.g. Wyatt, 2008, 169), but also a perspective taken in social sciences (e.g. Bull, 2007; Hjorth, 2009; Sørensen, 2006). According to Diener (2017), in today's world, social changes are perceived as closely interconnected with technological changes. There are some influences of this belief, which may continue. In the context of the given literature, metaphors were used to determine how technological change is perceived by pre-service teachers.

Metaphors

According to Devezas (2005), metaphoric language provides means to understand and talk about abstract ideas and assets that are not directly observable, considering multiple foundational physical and social perceptions. The more the system is complex and abstract, the better it is to apply metaphors. Language and cognitive competency (Greene, 1994), perspective and attitudes (Aubusson, 2002; Mcdermott, 2003) as well as educational experience and history (Hoyle & Wallace, 2007; Eripek, 1998) are listed among the factors that influence and play important role in metaphors.

Literature on metaphoric perceptions in the field of education has focused on various concepts within the last 10 years. Some of these concepts are science and technology (Çelik, 2016; Demirci Güler, 2012; Minas & Gündoğdu, 2013; Palic Sadoglu & Durukan, 2018), mathematics (Erdogan, Yazlik & Erdik, 2014; Güner, 2013; Oflaz, 2011), teacher (Afacan, 2011; Dursun, 2015), distance education (Kaban, 2021), traditional and digital

game (Hazar, Tekkurşun, & Dalkıran, 2017), value (Aydın & Sulak, 2015), evolution (Özbuğutu, 2018), project (Nacaroğlu, Mutlu & Meral, 2019), social media (Egüz & Kesten, 2018), and Facebook (Eren, Çelik, & Aktürk, 2014). When literature on metaphoric perceptions regarding the concept of technology is examined, concepts such as technology (Karaçam & Aydın, 2014;, Durukan, Hacıoğlu, & Dönmez Usta, 2016; Ergen & Yanpar Yelken, 2015; Kurt & Özer, 2013; Korkmaz & Ünsal, 2016), educational technology, technology leadership (Hacıfazlıoğlu, Karadeniz, & Dalgıç, 2011), and information technology teacher (Dursun, 2015) were investigated with participants from various levels of education. In the literature review, there are no metaphoric studies on the concept of "technological change". Therefore, it is thought that the study will contribute to the literature in the context of studies on technology. Research studies focusing on metaphors have investigated not only conceptual meanings of metaphoric notions but also analyzed gender, classification, and categorization of participants. Some of these analyses have focused on the nature of technology and its relationship with social context. Çavaş, Çetin, Palabıyık, and Çavaş (2019) examined metaphoric perceptions of 286 preservice teachers in primary school education and science education teaching programs regarding science and technology. Çavaş and colleagues found that preservice teachers developed metaphors about science and technology in nine categories. The results showed no significant difference between the fields. Çakır and Mete (2020) asked participants to develop metaphors about internet, smart phone, and social networking sites (Facebook, Twitter, and Instagram). They investigated whether there was any difference about metaphors among groups, considering abstract-concrete and positive-negative categorizations. The results showed that metaphors developed about social networking were more positive and concrete. Kurt and Özer (2013) conducted a research study in which they investigated 164 preservice teachers' perception of the concept of technology through metaphors. The results of the study showed that metaphors were categorized in seven groups: (a) "convenience technology", (b) "beneficial technology", (c) "harmful technology", (d) "both beneficial and harmful technology", (e) "emergent technology", (f) "technology that helps reaching the information," and (g) "necessary technology." The results indicated that the metaphors developed by preservice teachers did not differ by gender and their fields. Ergen and Yanpar Yelken (2015) conducted a research study in which they examined primary school 3rd graders' metaphoric perceptions of the concept of technology. The results of the study showed that students mostly perceived the concept of technology as a "game." Overall, the results of this study yielded eight different categories to explain metaphors: (a) informant technology, (b) technology as a game, (c) changing-advancing technology, (d) productive-operative technology, (e) technology as a tool, (f) technology as a need, (g) technology as a research, and (h) technology as a structure. Karaçam and Aydın (2014) examined secondary school students' metaphoric perception of the concept of technology. Their analyses yielded eight conceptual categories to group metaphors: (a) technology as a beneficial entity, (b) technology as both beneficial and harmful entity, (c) technology as a boundless and endless entity, (d) technology as a constantly changing entity, (e) technology as a rapidly-developing entity, (f) technology as a necessary entity, (g) technology as a fast-spreading entity, and (h) technology as a developing entity. Considering these metaphors, Karaçam and Aydın (2014) discussed that students had positive perception of technology. Durukan, Hacıoğlu and Dönmez Usta (2016) conducted a research study in which they examined 1st-year computer and instructional technologies field preservice teachers' metaphoric perceptions of technology. They found that 87,3% of preservice teachers developed positive metaphors about technology while 11,3% of preservice teachers developed negative metaphors of technology, and 13,2% of preservice teachers was neutral about

technology with their metaphors. Korkmaz and Ünsal (2016) investigated preschool teachers' metaphoric perception of technology. They found that 14,5% of preschool teachers developed negative metaphors about technology while the rest of the teachers had positive metaphors along with various categories. Waight (2014) particularly draws attention to the conceptualization of technology in science teacher training and professional development in science education. Because teachers educate individuals of an information society, they must keep up with changes and gain the knowledge and skills about technology brought by the information age. As Çelik and Kahyaoğlu (2007) state, preservice teachers graduate from education faculties with limited knowledge regarding the use of technology in classrooms. Jones (1997) emphasizes that the corpus of literature on technology education is predominantly associated with curricula and teacher education with the use of direct definitions. In addition, Jones (1997) claims that preservice teachers ought to understand technological concepts and processes and therefore, there is a need for future research to further understand and advance these concepts and processes. De Vries (2003) highlights the dearth of research focusing on students' understanding of technological concepts. According to International Technology Education Association (ITEA), most individuals who internalize and adopt technological change believes that technology makes their life easier. The most important result of accelerating technological change is the difference between technological ability and understanding levels (ITEA, 1996). Students in 9th through 12th grades need to learn that technological change is sometimes abrupt and obvious while evolutionary and subtle (ITEA, 2000). Zoller and Ben-Chaim (1990) claims that understanding the nature of science and technology as well as their interactions embedded within the society is important to advance the nature of science and technology at every level of science education. Therefore, the purposes of this study were to determine metaphoric perception of preservice teachers from different fields regarding technological change and to examine the differences and similarities between perceptions of preservice teachers from 1st- and 4th-year of college.

Method

This study employed single case (holistic) study as a qualitative approach. As Yin (2018, 97) stated that "You can then use the single-case to determine whether the propositions are correct or whether some alternative set of explanations might be more relevant".

Participants

Participants of this study consisted of 445 preservice teachers (N=445) who have continued their education in different programs in 2019-2020 academic year in Faculty of Education of a public university. Participants were 1st- and 4th-year preservice teachers trained in Primary School, Science Education, Mathematics Education, Social Sciences, Preschool, and Special Education teaching programs (see Table 1). Among the purposeful sampling strategy, criterion sampling (Creswell, 2012) was selected and employed to determine participants of this study. As Patton (2014, 425) state that "Criterion sampling also can be used to identify cases from standardized questionnaires for in-depth follow-up". Accordingly, two criteria were applied: (a) 1st- and 4th-year preservice teachers were included in this study and (b) teaching programs that accept students with equally weighted and science-math weighted scores earned at the national university entry exam were included. The

reason for including 1st- and 4th-year preservice teachers into this study was because the investigators aimed to do a comparison of metaphoric perceptions of preservice teachers who were newly started to the programs and will graduate soon.

Table 1. Distribution of Participants by Program and Year in College

Program	Science		Preschool		Mathematics		Social Sciences		Primary School		Special	
Year in college	1	4	1	4	1	4	1	4	1	4	1	4
Number of participants	42	20	48	22	30	20	45	54	30	58	47	29
Percentage	13.9%		15.7%		11.2%		22.2%		19.7%		17%	

Data Collection Tools and Processes

Participants of this study were informed about metaphor technique and its applications. Then, each participant was asked to fill out a structured form that was prepared by the investigators. The structured form included a prompt: "*Technological change is like ....., because....."* After informing participants about the technique, they were guided about how to fill out the form. The investigators explained that participants were expected to describe technological change with a concept as a metaphor and explain their reasoning. The investigators were not involved in the process of developing metaphors, while participants were filling out to form. Participants took part in this study voluntarily. The investigators did not limit the time during the application of developing metaphors. The average time of developing metaphors for preservice teachers ranged from 7 to 10 minutes. The investigators were actively involved in the data collection process.

Data Analysis

Content analysis technique was employed to analyse the data in this study. Content analysis is a systematic process (Merriam, 2013) that helps explain the concepts and relationships when analysing the data (Yıldırım & Şimşek, 2011). Metaphors developed by preservice teachers were analysed following four steps. These steps are (1) Naming/Coding, (2) Sorting /Screening-elimination, (3) Re-organising/Developing categories, (4) Validity and reliability, respectively.

(1) Naming / Coding step Naming/coding step included creating a temporary list of metaphors developed by participants. To create a temporary list of metaphors, Microsoft Office Excel 2010 program was used. At the end of this step, simple codes were assigned to metaphors developed by participants. Metaphors were taken out of the dataset when (a) its content was not supported by any logical reasoning, (b) it did not meet the conceptual definition of metaphor, (c) the metaphor prompt was incomplete in the forms, and (d) metaphors were not coherent or understandable.

(2) Sorting /Screening-elimination step In sorting/screening-elimination step, metaphors were marked as "weakly structured metaphor" if they were not reasonable. The weakly structured metaphors (33 forms) were excluded from the analysis by the investigators. Then, the investigators created a new list of metaphors. Using this new list, the investigators sorted metaphors to categorize.

(3) Re-organising/Developing categories Re-organizing/developing categories step included analysing the latest list of metaphors retrieved from the second step. The investigators analysed the data by creating double matrices in addition to categorizing metaphors based upon the categories found in the literature. Metaphors developed by preservice teachers were organized within two categories: (a) metaphoric categories and (b) metaphoric concepts. Metaphoric categories were created based on the reasoning that yielded 10 groups: (1) technological change as time, (2) technological change as continuity and infinity, (3) technological change as updating and renewal, (4) technological change as an alteration process, (5) technological change as advances and development, (6) technological change as a valuable phenomenon, (7) technological change as finiteness, (8) technological change as attachment, (9) technological change as obscurity, and (10) technological change as necessity and obligation. Metaphoric concepts were categorised in five groups: (1) equipment, (2) social and cultural, (3) environment and living creature, (4) abstract factors, and (5) field of study. The analysis based on reasoning yielded the theme of "technological change as societal/cultural interaction." This theme included two categories as follow: (1) technological change as influencer and (2) technological change as influenced. Subcategories emerged as positive, negative, and both positive and negative to present both side of effect. Thus, the investigators presented participants' metaphoric perception of technological change in detail.

(4) Validity and reliability The investigators employed various validity and reliability techniques during the content analysis process. Some of the data were coded by multiple coders and inter-coder reliability were examined. Three coders were involved in the coding process and they coded the data independently. Discrepancies among the coders were resolved after a discussion session in which the coders reviewed the codes and re-evaluated their coding. After discussing different codes, the coders reached a consensus and grouped each code into an appropriate category. The coders had full agreement in coding after discussion sessions. Thus, all data are coded with a common decision by the coders.

Findings

The findings of this study are presented in two parts in this section: (1) Findings regarding "Metaphoric Categories" and "Metaphoric Concepts" and (2) Findings regarding "Technological change as a societal/cultural interaction".

Findings Regarding "Metaphoric Categories" And "Metaphoric Concepts"

Metaphors developed by preservice teachers are presented in tables by each program (see Table 2-7). Accordingly, tables by programs are as follow:

Table 2. Metaphors Developed by Preservice Teachers in Science Education Program

"Metaphoric Categories (technological change as …)"	"Metaphoric Concepts"								
	Equipment		Social and Cultural		Environment and Living Creature		Abstract Factors		Field of Study
	1st Year	4th Year	1st Year	4th Year	1st Year	4th Year	1st Year	4th Year	4th Year
Time	Train					Orogeny			
Continuity and Infinity	Clock		Taste in Mu-sic Era		Hyperactive Child Water Life River	Day-Night "Sun-rise"	Endless road Passion, Space Day-Night Time Infinity	"Political Agenda"	
Updating and Renewal	Book Calendar Page Knitting		Revolu-tion (2) Conquest Need Educa-tion	Scientif-ic View	Stream New-born Baby, Newly met person	Genera-tion	A flight of imagina-tion	Fashion	
Alteration Process		Glass	Dol-lar Lan-guage	Preju-dice	Life Cycle Human(3), Water Mood, Coral, Frog Baby, Strata of Earth Sunrise	Generation Age Plum "Another life"	Toothache Idea	Black hole	Evolu-tion
Advances and Development		Cell Phone	Dol-lar		Avalanche (2), Baby, Human Hyperactive Child	Cheetah, Baby Common ivy	Space, Accelera-tion Time		
Valuable Phenomenon	Gold								
Finiteness						Human			
Attachment		Cardi-ac pace ma-ker							
Total	6	3	10	2	25	13	12	3	1

As metaphors developed by preservice teachers in science education program were examined, the results

showed that metaphors were developed conceptually. Accordingly, environment and living creature (f:38) was the most common metaphoric concept followed by abstract factors (f:15), social and cultural (f:12), equipment (f:9), and field of study (f:1). In terms of metaphoric categories, continuity and infinity and alteration process were more emphasized within the metaphors. In addition, finiteness, attachment, and valuable phenomenon categories called for attention in science education preservice teachers' metaphors.

In particular, the concepts that are embedded within science courses such as universe, time, acceleration, black hole, and strata of earth showed that science preservice teachers internalized these concepts they learned in their classes. Some of the representative examples for metaphoric concepts and metaphoric categories from Table 2 are listed as follow:

"Technological change is like dollar. Because the currency always goes up."

"Technological change is like frog or coral. Because it evolves and changes."

"Technological change is like water. Because it always is on the move."

Table 3. Metaphors Developed by Preservice Teachers in Primary School Education Program

"Metaphoric Categories (technological change as …)"	"Metaphoric Concepts"									
	Equipment		Social and Cultural		Environment and Living Creature		Abstract Factors		Field of Study	
	1st Year	4th Year	1st Year	4th Year	1st Year	4th Year	1st Year	4th Year	1st Year	4th Year
Time Continuity and Infinity		Clock Tool			Life, Water	Sky Space	Time	Time(2)		
Updating and Renewal	Babushka Doll	Wine	China	Need Revolu-ion Genera-tion Assistant	Cocoon	Cell New Day	Rain-bow New Year	Colours Knowl-edge		
Alteration Process		Phone Windmill Medicine, Vac-cine		Fashion Aesthetic pleasure(2)	River Human	Life(2), Child Cuttlefish Chamele-on Genera-tion Climate Season(2) Snakeskin, Human,	Time Milat	Idea Time		

						Forecast (2), Mud, Heart beats				
Advances and Develop-ment	Key Construc-tion Tower		Revol ution Refor m	Revolut ion	Human (2), Univer se Horizo n line World	Life, "Avarici ous person", Stepping , Child, Growing , Avalanc he Growth of a plant			Sci-ence	
Obscurity		Mask Lad-der				Mud, Earthqua ke				Evol ution
Necessity and Obligatio n										Math emat -ics
Total	4	9	3	9	10	27	5	6	1	2

As metaphors developed by preservice teachers in primary school education program were examined, the results showed that metaphors were listed by frequency (from the most to the least) as follow: environment and living creature (f:37), abstract factors (f:14), equipment (f:13), social and cultural (f:12), and field of study (f:3). In terms of metaphoric categories, characteristics specific to advances and development as well as alteration process were commonly stressed within the metaphors. In addition, obscurity, necessity and obligation, and field of study categories commonly took place in the metaphors developed by preservice teachers in primary school education program. Some of the representative examples for metaphoric concepts and metaphoric categories from Table 3 are listed as follow:

"Technological change is like a clock. Because it never stops and if it does, life ends for us too."

"Technological change is like mathematics. Because everyone needs to learn it."

"Technological change is like fashion. Because it always changes and advances."

As metaphors developed by preservice teachers in social sciences education program were examined, the results showed that conceptual metaphors were listed by frequency (from the most to the least) as follow in Table 4: environment and living creature (f:39), abstract factors (f:17), social and cultural (f:15), equipment (f:13), and field of study (f:3). In terms of metaphoric categories, characteristics specific to advances and development as well as alteration process were more commonly stressed within the metaphors. In addition, obscurity and necessity and obligation categories were commonly observed in the metaphors developed by preservice teachers in social sciences education program.

Some of the representative examples for metaphoric concepts and metaphoric categories from Table 4 are listed as follow:

"Technological change is like wind. Because it is never known what it brings.". "Technological change is like restoration. Because the changes made are most relevant to the needs of the time."

"Technological change is like a light. Because it shows us our way."

Table 4. Metaphors Developed by Preservice Teachers in Social Sciences Education Program

"Metaphoric Categories (technological change as …)"	"Metaphoric Concepts"									
	Equipment		Social and Cultural		Environment and Living Creature		Abstract Factors		Field of Study	
	1st Year	4th Year	1st Year	4th Year	1st Year	4th Year	1st Year	4th Year	1st Year	4th Year
Time Continuity and Infinity	Road	Train			Child	Blood Soil Universe (2)	Fictio n-al	Time		Hist o-ry
Updating and Renewal	Smart TV Restora-tion Machine	Grist -mill	Japan Revol ution (2)	Revolu -tion News	Birth	Global warming	Era		Sci-ence	Disc o-very
Alteration Process	Turkish Lira	Cloc k Teete r-totter	Fashi on(2)	Baby(2), Agricu l-ture Renais sance Social life	Weather Forecast Season, Cheetah, A Rotten Apple	World(2) , Life Mood Carrier Season, Tree Days, Rain	Lan-guage Era(6)	Time (2) Emo-tion		
Advances and Developme nt	High-speed train	High - speed train			Wave, Life Flower, Baby (2) Earth rotation Living creature, Human (2)	Human(2), World Baby, Life Chamele -on In rapid successi on	Futur e Lan-guage Time			
Obscurity				İskend er kebab Ideolo gy	Whirlpoo l, Wind		Dista nt lands			
Necessity and Obligation	Light, Container			Inamor ata	Life saver					
Total	8	5	5	10	18	21	13	4	1	2

As metaphors developed by preservice teachers in mathematics education program were examined, the results showed that conceptual metaphors were listed by frequency (from the most to the least) as follow: environment and living creature (f:17), abstract factors (f:12), social and cultural (f:10), field of study (f:7), and equipment (f:5). In terms of metaphoric categories, characteristics specific to updating and renewal as well as alteration process were more commonly stressed within the metaphors. In addition, the results showed that metaphors developed by preservice teachers in mathematics program contained concepts related to daily life.

Table 5. Metaphors Developed by Preservice Teachers in Mathematics Education Program

"Metaphoric Categories (technological change as …)"	"Metaphoric Concepts"									
	Equipment		Social and Cultural		Environment and Living Creature		Abstract Factors		Field of Study	
	1st Year	4th Year	1st Year	4th Year	1st Year	4th Year	1st Year	4th Year	1st Year	4th Year
Time Continuity and Infinity			Revolu-tion	Order of the day	Sea, Water		Time			
Updating and Renewal	Science Cyborg		Era Reform	Need	Flower	Earth-quake(2) Child New World	Picture Culture	New soul	Architect	Student
Alteration Process		Train	Fashion Revolu-tion(2) Medicine War		Human, Water Stream New-born baby(2)	Generation	Universe Time Life			Mathe-matics
Advances and Development	Intelli-gent person Com-pass	High-speed train Com-pass			Human Evolution	Evolution	Eternity-(4)			Develo-pment(4)
Total	2	3	8	2	11	6	10	2	1	6

Some of the representative examples for metaphoric concepts and metaphoric categories from Table 5 are listed as follow:

"Technological change is like an earthquake. Because it destroys current foundation and brings a new one."

"Technological change is like a high-speed train. Because it takes longer distance in shorter time."

"Technological change is like a Cyborg. Because it refreshes itself."

Table 6. Metaphoric Concepts and Categories of Metaphors Developed by Preservice Teachers in Preschool Education Program

"Metaphoric Categories (technological change as …)"	"Metaphoric Concepts"							
	Equipment		Social and Cultural		Environment and Living Creature		Abstract Factors	
	1st Year	4th Year	1st Year	4th Year	1st Year	4th Year	1st Year	4th Year
Time	High-speed train		Daily life					
Continuity and Infinity		Clock			Star, River Volcano, Cheetah	World		Never-ending Road
Updating and Renewal		Spacecraft, Lego	Need, Revolution New Era	New Language	Child, Author Sun, World		Education	
Alteration Process	Play Dough		Republic	Sorcery, Magic, Zodiac sign	Human, Water, River Baby, Caterpillar A breath of fresh air	Human, Thorny Rose, Sun, Food	Thinking Art	Savings Time
Advances and Development	Equipment		Life Game		Student, Birth Plant	Light, Human Baby brain Baby		Time
Total	3	3	7	4	17	9	3	4

As metaphors developed by preservice teachers in preschool education program were examined, the results

showed that conceptual metaphors were listed by frequency (from the most to the least) as follow: environment and living creature (f:26), social and cultural (f:11), abstract factors (f:7), and equipment (f:6). In terms of metaphoric categories, characteristics specific to alteration process were more commonly stressed within the metaphors. In addition, the results showed that metaphors developed by preservice teachers in preschool education program contained concepts related to their major. Some of the representative examples for metaphoric concepts and metaphoric categories from Table 6 are listed as follow:

"Technological change is like a new era. Because it brings innovations."

"Technological change is like a child. Because it grows and develops."

"Technological change is like a play dough. Because however new colours added in, it keeps its original colour inside."

Table 7. Metaphors Developed by Preservice Teachers in Special Education Program

"Metaphoric Categories (technological change as …)"	"Metaphoric Concepts"								
	Equipment		Social and Cultural		Environment and Living Creature		Abstract Factors		Field of Study
	1st Year	4th Year	1st Year	4th Year	1st Year	4th Year	1st Year	4th Year	4th Year
Time	Train								
Continuity and Infinity	TV Screen	High-speed Train Time machine Novel	Turkish Education System Language		"Renewable energy", Water Wind	World Life	"A clock that never run out of battery" Infinity Evolution Number Space Day-Night	Clock(1) Time(2) Light year Space Universe World	
Updating and Renewal	Ground Stone		Literature Eras Stepping into new age Turkish Education System	Illness Modernism	Fruit Garden	Human(2)		Education	
Alteration Process			Human life Cycle	Education Magic	Growth Wind	Chameleon Human(2) Stream World	Infinity	Universe	Complex process
Advances and Development			Travel Life(3)		Baby				
Total	3	1	8	3	7	9	7	8	1

As metaphors developed by preservice teachers in special education program were examined, the results showed that conceptual metaphors were listed by frequency (from the most to the least) as follow: environment and living creature (f:16), abstract factors (f:15), social and cultural (f:11), equipment (f:4), and field of study (f:1). In terms of metaphoric categories, characteristics specific to continuity and infinity were more commonly stressed within the metaphors. Some of the representative examples for metaphoric concepts and metaphoric categories from Table 7 are listed as follow:

"Technological change is like universe. Because it doesn't have any starts or ends."

"Technological change is like wind. Because it destroys everything it come across."

"Technological change is like evolution. Because it always changes and develops."

Findings Regarding "Technological Change as a Societal/Cultural Interaction"

In this section, findings regarding "technological change as a societal/cultural interaction" are presented in tables by each program (see Table 8-13). Accordingly, tables by programs are as follow:

Table 8. Categorization of Metaphors and Reasoning Developed by Preservice Teachers in Science Education Program

	Metaphor	Positive Reasoning	Negative Reasoning	Both Positive and Negative
Technological Change as Influencer	Period	Moves beyond the time		
	Acceleration	Gives directions		
	Book	Helps people develop		
	Stream	Brings innovations		
	Cardiac pacemaker		Dependent on it to live	
	Black Hole			It may mean the end of humanity Brings up new opportunities
	Plum			It is beneficial yet can be harmful if used too much
	Another life			It takes new opportunities away from us while bringing new ones
	Glass			Sometimes you hit and it protects from dangers
Technological Change as Influenced	Language			It takes a shape based on how it is used. Using it good or bad is under our control.

The results showed that metaphors developed by science education program consisted of two categories: (a) Technological change as influencer, and (b) technological change as influenced. The first category, technological change as influencer, included nine metaphors while the second category, technological change as influenced, had only one metaphor. Analysis yielded these two categories was grouped in three sub-categories: (a) positive reasoning (f:6), (b) negative reasoning (f:8), and (c) both positive and negative (f:5). As shown in Table 8, the most common reasoning observed among the metaphors was in technological change as influencer category and both positive and negative sub-category (f:4).

As shown in the table 9, the most common reasoning observed among the metaphors was in technological change as influencer category and positive sub-category (f:8).

Table 9. Categorization of Metaphors and Reasoning Developed by Preservice Teachers in Primary School Education Program

	Metaphor	Positive Reasoning	Negative Reasoning	Both Positive and Negative
Technological Change as Influencer	Need	Can't be lived without it		
	Reform	Improves a society		
	Water	Is always needed		
	Revolution	Moves life forward		
	Assistant	Enables innovations		
	Matching outfit	Impacts a term		
	Aesthetics	Appeals to the eye		
	Ladder	Moves somewhere else		
	War		Impacts me negatively	
	Mask		Hides the reality behind	
	Clock		If it stops, life ends	
	Grasping person		Enables gaining more by adding	
	Climate		We have to adopt new conditions	
	Earthquake		Shakes the world	
	Human			Grows by development
	Medicine			Has harms and benefits
	Mud			Has both good and bad sides
	Heartbeat			Either makes us live or die

	Vaccine	Dose and use of it is important
	Seasons	Influences both good and bad
Technological Change as Influenced	Generation	It is influenced by the differences
	River	Changes its colour every season

The results showed that metaphors developed by primary school education program consisted of two categories: (a) Technological change as influencer, and (b) technological change as influenced. The first category, technological change as influencer, included 20 metaphors while the second category, technological change as influenced, had only two metaphors. Analysis yielded these two categories was grouped in three sub-categories: (a) positive reasoning (f:8), (b) negative reasoning (f:6), and (c) both positive and negative (f:6). As shown in Table 9, metaphors within technological change as influenced category had reasoning under the two sub-categories (f:2).

As shown in the Table 10, the most common reasoning observed among the metaphors was in technological change as influencer category and positive sub-category (f:9).

Table 10. Categorization of Metaphors and Reasoning Developed by Preservice Teachers in Social Sciences Education Program

	Metaphor	Positive Reasoning	Negative Reasoning	Both Positive and Negative
	Need	Makes life easy		
Technological	Light	Enlightens our path		
Change as	Science	Design the future		
Influencer	Revolution x	Initiates a new era		
	Sun	Shows our way		
	Blood	Gives life as it flows		
	İskender kebab	Develops variations		
	Time machine	Makes us feel in different times		
	Life saver	Saves us from wrestles		
	Whirlpool		Suck people in	
	Far distances		Takes us to unknown	
	Ingrate cat		Is fed by societies/groups, which went through the	

		changes	
	Wind		What it would bring is not clear
Technological Change as Influenced	Baby		Goes as it is guided
	Turkish Lira		Changes its value

The results showed that metaphors developed by social sciences education program consisted of two categories: (a) Technological change as influencer, and (b) technological change as influenced. The first category, technological change as influencer, included 14 metaphors while the second category, technological change as influenced, had only two metaphors. Analysis yielded these two categories was grouped in three sub-categories: (a) positive reasoning (f:9), (b) negative reasoning (f:3), and (c) both positive and negative (f:3). As shown in Table 10, metaphors within technological change as influenced category had reasoning under the two sub-categories (f:2).

As shown in Table 11; the results showed that metaphors developed by mathematics education program consisted of two categories: (a) Technological change as influencer, and (b) technological change as influenced.

Table 11. Categorization of Metaphors and Reasoning Developed by Preservice Teachers in Mathematics Education Program

	Metaphor	Positive Reasoning	Negative Reasoning	Both Positive and Negative
Technological Change as Influencer	Reform	Refreshes the world		
	Forest	Is beneficial		
	Culture	Contributes to development of people		
	Monster		Destroys the interaction among people.	
	Earthquake		Has big impacts.	
	Order of the day		Is never easy to keep up with in today's world.	
	Seasons			Influences both positive and negative

	Revolution	Changes the world (2) Creates revolutionary changes.
Technological Change as Influenced	Human	Is shaped based on people's needs.

The first category, technological change as influencer, included eight metaphors while the second category, technological change as influenced, had only one metaphor. Analysis yielded these two categories was grouped in three sub-categories: (a) positive reasoning (f:3), (b) negative reasoning (f:3), and (c) both positive and negative (f:3). As shown in Table 11 metaphors within technological change as influenced category had reasoning under the two sub-categories (f:1).

As shown in Table 12 metaphors within technological change as influenced category had reasoning under the two sub-categories: positive (f:2) and both positive and negative (f:1).

Table 12. Categorization of Metaphors and Reasoning Developed by Preservice Teachers in Preschool Education Program

	Metaphor	Positive Reasoning	Negative Reasoning	Both Positive and Negative
Technological Change as Influencer	Light	Enlightens people's future.		
	Endless road	Creates new paths.		
	Republic	Moves a society forward progressively.		
	High-speed train	Decreases distances.		
	Equipment	Moves us forward.		
	A breath of fresh air	Changes our lives.		
	Fast-flowing river		We can't stand up against it nor catch its speed	
	Cheetah		We can't catch its speed	
	Fast-flowing waterfall		It's not possible to catch its speed.	
	Spacecraft			Fast changes happen constantly.
	Food			It has both benefits and harm.
	Life			Always astonishes.

	Thorny rose		It may have harms as much as it has beauty.
	Complex world		It has both good and bad sides.
	Stream		Changes life.
Technological Change as Influenced	Time	Has to change, develop, and advance.	
	Play dough	Because however new colors added in, it keeps its original color inside.	There are always changes on it.
	Water		Is fluid and always takes the shape of its time
Technological Change as Influencer And Influenced	Savings	Creates new products that develop and evolve.	

The results showed that metaphors developed by preservice teachers in preschool education program consisted of three categories: (a) Technological change as influencer, (b) technological change as influenced, and (c) technological change as influencer and influenced. The first category, technological change as influencer, included 15 metaphors while the second category, technological change as influenced, had only three metaphors. The third category, technological change as influencer and influenced, had only one metaphor that was supported with a positive reasoning. Analysis yielded these three categories was grouped in three sub-categories: (a) positive reasoning (f:6), (b) negative reasoning (f:3), and (c) both positive and negative (f:6).

In Table 13. Analysis yielded this category was grouped in three sub-categories: (a) positive reasoning (f:2), (b) negative reasoning (f:2), and (c) both positive and negative (f:1).

Table 13. Categorization of Metaphors and Reasoning Developed by Preservice Teachers in Special Education Program

	Metaphor	Positive Reasoning	Negative Reasoning	Both Positive and Negative
Technological Change as Influencer	Literature eras	Always touches people's hearts.		
	Future	It's our guide		
	Wind		Destroys everything it come across	
	Sorcery		Takes hold	
	Cenation			Inevitable need

The results showed that metaphors developed by preservice teachers in special education program consisted of only one category as shown in Table 13; Technological change as influencer (f:5).

Discussion

The results showed that all preservice teachers considered technological change as a process, which is similar to the findings presented by Parayil (1994). This result was observed commonly within "metaphoric categories". These common metaphoric categories might be listed as "technological change as time," "technological change as continuity and infinity," "technological change as updating and renewal," "technological change as an alteration process," and "technological change as advances and development". In addition to these common metaphoric categories, new and different metaphoric categories emerged in science education, primary school education, and social sciences education programs. For science education program, these categories were "technological change as a valuable phenomenon," "technological change as finiteness," and "technological change as attachment". For primary school education and social sciences education programs, these categories were "technological change as obscurity" and "technological change as necessity and obligation". All these metaphoric categories emerged from the analysis in this study were observed in research studies that examined the concept of technology (Karaçam & Aydın, 2014; Kurt & Özer, 2013; Ergen & Yanpar Yelken, 2015).

Another important point of the results is about "conceptual categories," which emerged from the analysis. It is notable that all metaphors developed by preservice teachers fell into "conceptual categories." Common conceptual categories were "equipment," "social and cultural," "environment and living creature," "abstract factors," and "field of study." Only metaphors from primary school education program did not include "field of study" conceptual category. "Train" and "high-speed train" concepts may also be explained with similar rationale as these concepts were listed among metaphors from all programs. This result might be explained with the fact that features of technology such as, developments and innovations, are associated with this concept. Although conceptual categories were common among the metaphors developed by preservice teachers, the concepts listed within these conceptual categories had similarities and differences, considering the programs and year in the college. For example, considering programs, the results showed that preservice teachers used concepts specific to their disciplines as metaphors. While science education program offered metaphors such as "generation" and "strata of earth," primary school education program included "generation" and "colours" as metaphors. Social science education program included "archaeology" and "restoration" as metaphors while mathematics education program offered "intelligent person" and "compass" as metaphors. Primary school education offered the concepts of "play dough" and "Lego," while "illness" and "life cycle" were provided by special education program. Aside from these concepts, the results showed that concepts such as "child," "baby," "education" were common among the programs. This result might be explained with preservice teachers' exposure to these concepts very often. Considering preservice teachers' year in the college, 4th-year preservice teachers were exposed to more education-specific concepts regarding their fields than those in their 1st-year. Overall, the results of this study showed that "metaphoric categories" and "metaphoric concepts" had similarities and differences by year in the college and programs of preservice teachers, considering the existing literature that has found similarities (Çakır & Mete, 2020) and differences (Çavaş, Çetin, Palabıyık & Çavaş,

2019; Kurt & Özer, 2013) by fields and gender.

Aydın and Sulak (2015) conducted a research study and investigated the relationship between field-dependent cognitive styles and cognitive structures of science education preservice teachers regarding technology. They found that preservice teachers had different level cognitive structure based on their fields. In other words, field-dependent individuals have more tendencies towards social sciences, whereas field-independent individuals have tendency towards science-related fields. Accordingly, the results of this study showed that more metaphors regarding technological change concept came out of social sciences fields, such as primary school education and preschool school education programs.

The results of this study specific to "technological change as societal/cultural interaction" theme showed that the categories and sub-categories emerged from the analysis were consistent with the relevant literature. The literature has focused on examples including, the effects of technological change (Roumasset & Smith, 1981), both sides of technological change (Smith, 2014), and close relationship between social and technological changes (Bijker, Hughes & Pinch, 1987; Diener, 2017; Latour, 1987). Similarly, sub-categories emerged from the analysis of this study were consistent with the metaphoric studies regarding technology (Karaçam & Aydın, 2014; Kurt & Özer, 2013). The literature shows that research studies regarding technology mostly resulted with positive perceptions about technology (Karaçam & Aydın, 2014; Çakır & Mete, 2020; Durukan, Hacıoğlu, & Dönmez Usta, 2016; Korkmaz & Ünsal, 2016). The results of this study showed that positive metaphoric perceptions of preservice teachers found in this study are similar to the relevant literature. This result may be interpreted as participants of this study were more positive about technological change.

The results of this study, focusing on the "technological change as societal/cultural interaction" may contribute to the literature. The results of this study showed that preservice teachers perceived technological change as an influencer. Although "technological change as influencer" category consisted of three sub-categories (positive, negative, and both positive and negative), the results showed more positive perceptions of preservice teachers regarding technological change. The results regarding the category of "technological change as influenced" suggest for future research as metaphoric perceptions of preservice teachers were both positive and negative and only primary school education preservice teachers had positive perceptions of technological change. In this context, Aydın and Kereste (2019) conducted a research study in which they investigated the relationship between values and technology. The results of their study showed that preservice teachers thought technology has an influence on values at high level. In addition, they discussed that preservice teachers' perspectives about how technology influences values were very limited.

Conclusion

In the study, it was examined metaphoric perception of preservice teachers from different education programs regarding technological change. The results of this study showed that preservice teachers developed metaphors that were mostly similar conceptually. However, the results showed differences in metaphors by programs and 1st- and 4th- year preservice teachers. It is noteworthy to state that there were no new categories emerged from

the analysis for mathematics education, primary school education, and special education programs. This result might be explained with the fact that science undergraduate education and social sciences undergraduate education in Turkey specifically involves science- and technology-based contents similarly. It is important to note that metaphors developed by preservice teachers mostly fell into "environment and living creature" category, without considering their program and year in the college. This result might be explained with the fact that human, by nature, is a part of environment and interacts with other living creatures around themselves. Considering preservice teachers' year in the college, the results showed that 4th-year preservice teachers used field-specific concepts more than those 1st-year preservice teachers. This result may also be explained that 4th-year preservice teachers were exposed to more education-specific concepts regarding their fields than those in their 1st-year. In addition, the results of this study showed that education received specific to a field had an influence on metaphoric perceptions of preservice teachers, which were reflected in metaphors. As a result, a remarkable point is that "technological change as societal/cultural interaction" theme emerged from the analysis of this study. This theme consisted of two categories (technological change as influencer and technological change as influenced) and these two categories were grouped in three sub-categories to present positive reasoning, negative reasoning, and both positive and negative reasoning.

To sum up, the results of this study showed that preservice teachers' metaphoric perceptions of the concept of "technological change" had variations. Using the results of this study, considering the variation in metaphors by programs and grade level, may inform educational approaches that will be undertaken in the future. Therefore, the results of this study need to be taken into account for all education programs. Future research may include exploring why technological change is not perceived as influenced. Accordingly, future research focusing on "technological change as influenced" may inform teacher education and bring a new perspective.

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