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The Possible Effects of 4th Industrial Revolution on Turkish Educational System*

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ABSTRACT

Purpose: We can see by reviewing the relevant literatüre that only half of the eight characteristics of Industry 4.0 have been studied for education and the other four characteristics still need to be investigated such as "internet of things", "autonomous robots", "cyber physical systems", "vertical and horizontal integrations". The purpose of this research was to determine the possible affects of the eight characteristics of Industry 4.0 on the Turkish Educational System.

Research Method: This research was a qualitative case study designed as a holistic-single case. The data of this study were collected through focus group interviewing. In order to better determine the study group, the maximum variation sampling technique was used as a purposive sampling method. For this purpose, the study group was formed by experienced school managers, assistant principals, teachers working in the education system, and candidate teachers who have yet to experience the teaching profession. It is preferred to use content analysis procedures for understanding the data. **Findings:** Participants' opinions about the possible effects of Industry 4.0; for academic achievement is concentrated mostly on the "Internet of things, Big Data and Cyber Physical Systems"; for the teaching profession is affected greatly by Autonomous Robots and Cyber Physical Systems. **Implications for research and practice:** For the participants' estimations, the eight characteristics of Industry 4.0 will affect communication in school, academic achievement of students, school concept, teaching profession and the future of society. The candidate teachers made further predictions. Researchers need to further study the eight characteristics of Industry 4.0 regarding the effects on academic achievement.

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Introduction

The world has witnessed three industrial revolutions. The first improved efficiency with hydropower, steam power and machine tools. The second brought electricity, mass production and assembly lines. The third came with automation through electronics and IT. The fourth industrial revolution is underway and affects how we work and communicate as well as how we express, inform and entertain ourselves. Schwab says (2015) the changes are historic in terms of their size, speed and scope. Governments, institutions, systems of education among many others are being reshaped.

What does Industry 4.0 emphasize? Industry 4.0 emphasizes the idea of consistent digitization and linking of all the productive units in an economy (Blanchet et al., 2014). According to Brettel et al. (2014), the upcoming industrial revolution will be triggered by the Internet, which allows communication between humans as well as machines in Cyber-Physical-Systems (CPS) throughout large networks. New business models will arise. These changes will also strongly influence society and people. Family life, globalization, markets, etc. will have to be redefined (Jazdi, 2014). This is the point where we need to know more about the new revolution.

The 2016 World Economic Forum (WEF) focused on the Fourth Industrial Revolution and described the new generation of technological advances such as robotics, artificial intelligence coming together defining the next wave of progress. These new technologies have the potential to change our lives and to solve many real-world problems. By using technology that is more intelligent, we could connect billions of people and things to the internet.

The discussion at the WEF focused on the negative impacts (e.g., job losses) of these technologies, rather than their positive potential (e.g., connecting billions of people and things). For Schwab (2016) a fearful theme was the potential for job losses. As automation continues to replace manufacturing or blue-collar jobs, artificial intelligence will do the same for skilled, white-collar jobs in banking, law or medicine. Advances in technology at the same time create new jobs, most of which we cannot even dream of today.

Another concern at the WEF was the "dehumanization" of our lives, which is driven by robotics and artificial intelligence. Another issue centred on the ethical and moral challenges of many advances; for example, could machines make positive decisions regarding human lives, such as, a self-driving car making a choice between hitting a pedestrian or sacrificing its passenger? Schwab (2016) says we should figure out how to avoid, or address, the negative, unintended consequences of these changes.

The eight characteristics of Industry 4.0 (Schwab, 2016):

1. Cyber – Physical Systems: Cyber-Physical Systems (CPS) is defined as transformative technologies for managing interconnected systems between its physical assets and computational capabilities, Lee (2015). A cyber-physical structure describes the relationship between humans and a Cyber-Physical System, which is again divided into a physical component and a virtual/digital component (Zamfirescu

et al., 2011). In Industry 4.0, systems will be far more connected to all sub-systems, processes, internal and external objects, as well as, the supplier and customer networks (Blanchet et al., 2014).

2. *Vertical & Horrizontal Integration*: There will be no hierarchy and everything will be equally distributed. It speeds up the flow of information from bottom to top. Everything will have an IP number. The process of production will be made easier.

3. *IoT "Internet of Things"*, (Services, Humans & Everything): At the beginning of the 21st century connectivity was only among the digital world, in Industry 4.0 the digital and real worlds are connected. For Gubbi et al. (2013) in the Internet of Things (IoT) paradigm, many of the objects that surround us will be on the network in one form or another. Machines, systems and human beings will exchange digital information via internet protocol. This means physical things will be linked to their data footprint. Production with interconnected machines becomes virtually seamless. Machines automatically adapt to the production steps. Even the product may communicate when it has been produced and ask to be picked up by a conveyor or send an e-mail to the ordering system.

4. *Autonomous Robots*: Robots already replaced human workers in the last industrial revolution. A number of multipurpose industrial robots have been developed in the Industry 4.0 since 2004. In the future, they will become intelligent, adapt, communicate and interact. In Industry 4.0, robots and humans will work together on interlinking tasks and use smart sensors with human-machine interfaces. These can be controlled remotely and if a problem occurs, the worker will receive a message on his mobile phone, so he can remotely review the problems and provide instructions in order for production to continue until they return to the work site. No more night shifts (Blanchet et al., 2014).

5. *Big Data and Analytics*: Big data analytics is the process of examining large and varied data sets to uncover hidden patterns, unknown correlations, market trends, customer preferences and other useful information that can help organizations make more-informed business decisions. Data is often referred to as the raw material of the 21st century. Indeed, the amount of data available to businesses is expected to double every 1.2 years (Blanchet et al., 2014).

6. *The Cloud*: An industrial plant of the future will be producing a huge amount of data that needs to be saved, processed and analysed. The means employed to do this will significantly change. In France, 63% of plant managers consider cyber security crucial to their competitiveness. Innovative methods to handle big data and to tap the potential of cloud computing will create new ways to leverage information (Blanchet et al., 2014).

7. *Augmented Reality*: An enhanced version of reality where direct or indirect views of physical real-world environments will be augmented with superimposed computer-generated images over a user's view of the real world, thus enhancing one's current perception of reality. Augmented reality (AR) can be defined as a technology which overlays virtual objects (augmented components) into the real world (Akcayir,

2017). Manufacturing instructions, real-time reports, messages, quality checks with cameras, and emergency directives will be included.

8. *Cyber Security*: Cyber-security is the protection of internet-connected systems including hardware, software and data, from cyber-attacks (Von Solms, 2013). A more comprehensive security framework, increased communication with access problems, vulnerable to cyber-attacks, and data privacy is critical.

A research review carried out by the National Thesis Centre of the Turkish Council of Higher Education under the heading of Education and Training has been determined that only three out of the eight characteristics of Industry 4.0 defined by Schwaub (2016) have been adequately studied by researchers. Past studies related to "augmented reality" have mostly been studied by researchers from different areas of education including; "computer education and instructional technology" (Akcayir, 2016; Akkus, 2016; Baysan, 2015; Erbas, 2016; Gun, 2014; Kucuk, 2015; Sirakaya, 2015; Yildirim, 2016; Yilmaz, 2014), "physics education" (Abdusselam, 2015; Dilek, 2016) and "science education" (Sahin, 2017). Research related to the Cloud under the title of "education and training" has been carried out by different disciplines including; "Computer Education and Instructional Technology" (Erdemir, 2014; Kaymak, 2015); "Teaching of English" (Yıldız, 2015), and "Distance Education" (Kayabaş, 2017). Only one research in social sciences was determined to be related to Big Data under the heading of "education and training" (Bayrakci, 2015). Although there are some studies related to Cyber Security in the fields of Law, computer Engineering, International Relations and Forensic Medicine, there was no research found associated with "education and training". It has been determined that there are no studies related to the characteristics of Industry 4.0 such as "internet of things", "autonomous robots", "cyber physical systems", "vertical and horizontal integrations" in any subject matter.

Every industrial revolution has changed the social structures of countries around the world. They created their own societies that exhibited the specific characteristics of their own natures. Industry 4.0 will also be expected to create its own society with the before mentioned eight dimensions of itself. The road to education 4.0 could be long and often very difficult. Many students, instructors, parents and stakeholders will choose to stay within the familiar confines of Education. Augmented reality, *Cyber – Physical Systems* etc. will be essential for the success of the teaching profession as well as in the production sectors. This is especially concerning, as the future of education, systems are associated with intellectual imagination, creativity, knowledge production, and innovation. Therefore, researchers should study these eight characteristics in order to anticipate what kind of societies we will exposed in our future lives. As we see by reviewing the relevant literature, only half of these characteristics have been studied and the other four characteristics need to be investigated. The research questions are:

1 - What are the probable effects of Industry 4.0 on the educational system according to the perception of participants?

2 - According to the perception of participants, how the eight characteristics of Industry 4.0 are connected with which characteristics of the education system?

Method

Research Design

This research was a qualitative case study designed as a holistic-single case. Qualitative research studies allow the qualitative processes for realistically and holistically propounding perceptions and events in the natural environment (Yildirim, 2016). The purpose of a case study is to conduct in-depth research on a particular case and to draw conclusions. That is, the factors related to a situation are examined through a holistic approach and focused on how they affect and how it is affected by the related situation. This approach has different forms (e.g., single case, multiple cases). The cases that no one works on or cannot work can be studied using a holistic single case design (Yildirim, 2016). The study of such cases is also important for later investigators in order to uncover a specific topic that was not previously known and to form or guide the work to be done later (Yildirim, 2016). For this purpose, a "holistic single case" design was used in this study.

One of the data-gathering methods, which can be employed within the framework of qualitative research, is the focus group interview. Focus group methodology is a way of collecting qualitative data, typically engaging a small number of people in an informal group discussion focused around a particular topic or a set of issues (Silverman, 2016). In other words, understanding what people think and feel about a topic is the main purpose of focus group interviews. Groups are more creative than individuals, can solve problems faster and can generate more alternatives in a shorter time (Yildirim, 2016). In the focus group process, the participants hear the responses and answers of the other participants, so they add something new to their previously stated views. For this reason, the data collected for this study utilizing the focus group interview technique.

Study Group

The maximum variation (e.g., heterogeneity) sampling technique was used as the purposive sampling method in order to determine the study group. For this purpose, the study group was formed by experienced school managers, assistant principals, teachers working in the education system and prospective teachers who have yet to experience the teaching profession. The study group was selected from the Faculty of Education and Institute of Educational Sciences students who took the course of Educational Administration in the spring semester of 2016-17 academic year. The data for this study were collected through focus group interviewing with 18 randomly selected candidate teachers from Pamukkale University, Faculty of Education, Department of Social Sciences Teaching during the spring semester of the 2016-17 academic year. In addition, 15 randomly selected principals, vice-principals and teachers working for the primary schools in the spring semester of the 2016-17 academic year in Denizli, Turkey. These 15 principals, vice-principals and teachers were also graduate students of the Institute of Educational Sciences at Pamukkale University and had attended several courses related to educational administration. The data were collected from the students of the Department of Social Studies Teaching because, when compared with other departments of Faculty of Education,

social studies teaching was seen as a collection of multiple disciplines. Social studies teaching includes various disciplines as geography, history, values education and so forth. Therefore, the students of this department may have a more sophisticated point of view related to the subject of this research.

Research Instrument and Procedure

A qualitative research model was used for this study and the data of this study were collected through focus group interviewing. The first three industrial revolutions, classical and neo-classical management theories and their effects on educational systems were explained to the 18 candidate social studies teachers, 15 principals, assistant principals and teachers during an educational administration class that lasted for 14 weeks. Afterwards, the class discussed the 4th Industrial Revolution. First of all, the eight characteristics of the 4th Industrial Revolution used by Schwab (2016) including; (1) Cyber physical systems, (2)Vertical-Horizontal Integration (3) Internet of things (4) Autonomous Robots, (5) Big data and Analytics, (6) I-cloud based solutions, (7) Augmented reality and (8) Cyber Security were explained by the researcher. Secondly, the participants were asked to guess the probable effects of these eight characteristics on the educational system. At this stage the focus group were allowed to discuss all dimensions and to exchange their opinions. Finally, the focus group was asked to specify their opinions about the possible effects of 4th Industrial Revolution on educational systems by considering the previous revolutions and their effects. Each member of the focus group was given a number and his or her opinions were registered separately.

The participants' predictions about the effects of these eight characteristics on the educational system have been categorized and organized as tables.

Validity and Reliability

According to Erlandson et al., (1993, cited in Yildirim and Simsek, 2013), in order to provide validity and reliability, some procedures like expert investigation were used. The studies regarding improving the reliability and validity of this research are mentioned below.

In order to increase the internal validity of this research it benefited from an expert with knowledge about the topic and competence of qualitative research methods. All documents about research process (e.g., data, analysis, results) were sent to the expert and some changes were made concerning the expert's feedback.

In order to increase the internal validity of the research, data was re-coded by another expert. The instances where both experts used the same codes were considered as consensus, the situations that the experts used different codes were considered as dissensus. The reliability coefficient for principals, vice-principals and teachers coded answers was 71% and for the candidate teachers coded answers was 70% according to the [Consensus/(Consensus+Dissensus) x 100] (Miles and Huberman, 1994).

Data Analysis

There are many ways of analysing focus group data, for example, through content, thematic, ethnographic, phenomenological, narrative, experimental, biographical,

discourse or conversation analysis. In this study, it was preferred to use content analysis procedures for understanding the data. Content analysis produces a relatively systematic and comprehensive summary or overview of the data set as a whole, sometimes incorporating a quantitative element (Silverman, 2016). In this study, the analysis technique of "content analyse technique" was used.

Data were entered into a computer and all expressions of the participants were coded. When analysing the data a code number was given to each participant. After the coding process, experts determined the themes and categories together. Each characteristics of Industry 4.0 were accepted as themes of the study. Based on the characteristics of Industry 4.0 the following categories emerged, "Communication, School concept, Academic achievement, Teaching profession, and Future of the society". The findings of the research were interpreted under these themes and categories.

Results

In this section, all the findings are provided. The predictions of the participants related to the first characteristic of Industry 4.0, "cyber physical systems" are given in Table 1.

Table 1

The Predictions of The Participants Related to The Theme of "Cyber Physical Systems"

Principals, Vice principals, Teachers	*n*	*Categories*	*n*	*Candidate teachers*
The cooperation will increase among teachers (borders between teachers will collapse; communication will be more effective and faster).	4	Communication	3	The faster feedback will be able to be given.
			2	The teacher will be connected to the classroom by hologram.
The school concept will change (schools will be socializing institutions; the concept of compulsory education will change).	4	School concept	5	There will be no books.
Simulations will help the effectiveness of values education.	6	Academic achievement	10	Simulations make teaching easier.
Personal training will be easier.	5		2	There will be no idle class session.
More time will be given to thinking and the creativity will increase.	3		1	The attention deficit will increase because of the excessive stimulus.
			1	Education will be carried out much easier
Teachers' roles will change	6	Teaching profession	2	Artificial intelligent will end the teaching profession.
The teachers will have less drudgeries.	4		1	The teachers' salaries will decrease due to robots.
We will move away from nature and human beings.	5	Future of the society	1	The empathic skills will develop by means of simulations.

For Table 1 it can be said that the common view of participants about possible effects of Industry 4.0 for cyber physical systems were positive. They estimated that the academic achievement of students will increase with the aid of this dimension in the educational process.

The predictions of the participants related to the second characteristic of Industry 4.0, "vertical-horizontal integration" are given in Table 2.

Table 2

The Predictions of The Participants Related to The Theme of "Vertical-Horizontal Integration"

Principals, Vice principals, Teachers	*n*	*Categories*	*n*	*Candidate Teachers*
The feedback will be very fast and effective; this will ensure that students know themselves more rapidly and education will be more transparent.	5	Communication	5	The horizontal organizational structure will accelerate the communication.
Faculties of education and schools will be restructured.	2	School concept	1	Principals' authority will be decrease.
The measurement and evaluation system in education will be changed and it will be easy to follow all stages of education.	3	Academic achievement	6	The students will be tractable more than ever before.
Teachers will be able to know students better.	3		4	The classroom will have a flexible structure (They can turn into a laboratory and curriculum will be flexible).
Student mistakes will decrease.	2		2	Everybody will be equal.
The gap between rural and urban students will be closed.	2		1	Individual differences will be able to be addressed.

For table 2 the views of the participants about "vertical-horizontal integration" are generally made on the acceleration of communication and academic achievement in the school process. Their opinions on the possible effects of this dimension were positive.

The predictions of the participants related to the third characteristic of Industry 4.0, "internet of things" are given in Table 3.

Table 3

The Predictions of The Participants Related to The Theme of "Internet Of Things"

Principals, Vice principals, Teachers	n	*Categories*	n	*Candidate Teachers*
Because of free communication (without barriers), the effectiveness will increase to 100% among teachers, parents and students.	2	Communication		
All types of documents about students will be recorded and saved.	1	School concept	1	The schools will be unfashionable and everywhere will be school.
School concept will be digitalized.	1		1	The schools will be safer places and students' stuff will not be lost anymore.
The dependability on school will decrease.	1			
Examinations will be removed.	1	Academic achievement	5	The teacher will be able to manage the time in classrooms more effectively.
The speed and depth of learning will increase.	1		4	Students' follow up will be easier for teachers and parents.
			3	There will be no more problems in terms of reaching books.
			2	The written exam will be outdated.
			1	The students will not waste their time taking notes.
			1	The smart tables will be used besides the smart boards.

In table 3, the estimations of the participants about "Internet of Things" were generally made on academic achievement and school concept. The opinions of participants regarding the possible effects of Internet of Things were in positive direction.

The predictions of the participants related to the fourth characteristic of Industry 4.0, "autonomous robots" are given in Table 4.

Table 4

The Predictions of The Participants Related to The Theme of "Autonomous Robots"

Principals, Vice principals, Teachers	*n*	*Categories*	*n*	*Candidate Teachers*
		School concept	12	The robots will replace school employees and some professions will be ended (canteen, cleaning, managing jobs, medical room, nurses, security, and school manager).
			7	The school will begin providing faster services.
			2	The scope of control over students and things will be narrower (tight control, instant detection and intervention).
Unimaginative teachers will lose their jobs	4	Teaching profession	4	The drudgeries of teachers will decrease.
The robots will transfer knowledge but teachers will always exist for the emotional and creative sides of people.	3		4	The robots will do many things better than teachers.
			1	The teaching profession will continue.
Human skills will decline.	4	Future of the society	3	The problem of robot protection will emerge.
People will use their brains rather than their bodies; this will ensure that future generations be more intelligent, a revolution will happen, human beings will move to a higher level and the life span of people will be longer.	3		2	Creativity will be very important for all professions.
Some groups of jobs will disappear.	1		1	Things will not be thrown away because robots will fix them all.
			1	Population will decrease; government will support the reduction of population; education will be free of charge.
			1	The ethics problems between robots and human beings (We will have to protect humans from robots).
			1	We will be longing the life without electricity (The demand of these sectors will increase; a new economy will be created).

In table 4, the estimations of the participants about "autonomous robots" were generally made on the future of the society, teaching profession and school concept.

The predictions of the participants related to the fifth characteristic of Industry 4.0, "big data and analysis" are given in Table 5.

Table 5

The Predictions of The Participants Related to The Theme of "Big Data And Analysis"

Principals, Vice principals, Teachers	*n*	*Categories*	*N*	*Candidate Teachers*
The new jobs will emerge (Directorates of data processing security)	1	School concept	2	It will be possible to adjust courses according to the levels of students; courses will be more flexible.
			2	All courses will evolve.
			1	The importance of mathematics and computer engineering will increase.
			1	Schools will not exist
The truth of knowledge will be the greatest difficulty (right according to whom?),	4	Academic achievement	3	Students will begin to invent new things; they produce the knowledge; their creativity will improve.
It will be very easy to access knowledge. People will not have problems for being expert.	2		1	The synchronization in education will increase (same education in same time).
There will be no textbooks.	1		1	The problem solving skills of students will improve.
			1	The repetition of an unlearned subject in classrooms will be easier.
			1	The anxiety related to knowledge will end.
Teachers' roles and teacher training systems will change (thinking, analysing and inquiring teachers) Teachers need to make knowledge more useful.	9	Teaching profession		

For table 5 the common view of the participants about big data and analyses was related to academic achievement and the positive effects of new industrial revolution. Only the candidate teachers had opinions about the possible effects of big data and analyses on the school concept.

The predictions of the participants related to the sixth characteristic of Industry 4.0, "cloud" are given in Table 6.

Table 6

The Predictions of The Participants Related to The Theme of "Clouds"

Principals, Vice principals, Teachers	*n*	*Categories*	*n*	*Candidate Teachers*
Parents will be able to follow the school day of the students and teachers	7	Communication		
By means of saved data, students will be oriented more effectively.	5	Academic achievement	9	To forget something (memories, courses) will be difficult.
			5	The effectiveness of courses will increase (to complete course deficiencies will be easy; courses will be more flexible)
			4	The improvement of students will be able to be followed step-by-step.
		Future of the society	1	Private life will end.
			1	The nostalgia will increase.

In table 6 the common view of the participants concerning the dimension of Industry 4.0, "clouds" was about the academic achievement of students.

The predictions of the participants related to the seventh characteristic of Industry 4.0, "augmented reality" are given in Table 7.

Table 7

The Predictions of The Participants Related to The Theme of "Augmented Reality"

Principals, Vice principals, Teachers	*n*	*Categories*	*n*	*Candidate Teachers*
Communication between teacher and student will be very fast and instant feedback will be supplied.	3	Communication		
		School Concept	1	The books will evolve.
			1	The school will not stay
Equity of opportunity in education will be achieved	4	Academic achievement	10	Lessons will be supported with 3D (3D makes students see the world in a multi-dimension frame, teachers will save their time)
			7	Permanence will increase
The perception of reality will change; innovations will increase; there will be no material problems.	2	Future of the society	1	The population will decrease.
			1	Ethical problems will arise.

The common view of the participants concerning the dimension of Industry 4.0, "augmented reality" is being about fast communication, which makes teachers save their time and academic achievement of the students.

The predictions of the participants related to the eight characteristics of Industry 4.0, "cyber security" are given in Table 8.

Table 8

The Predictions of The Participants Related to The Theme of "Cyber Security"

Principals, Vice principals, Teachers	*n*	*Categories*	*n*	*Candidate Teachers*
		Academic achievement	1	The mistakes in education will fall farthest (In university entrance exams the number of students who earn zero points in mathematics will be very low)
Security will be achieved by humans and robots together	1	Future of the society	3	The World Wars will begin due to captured information. (not with artillery and rifles)
Above all, there must be a tight control and the security of everything should be controlled.	1		2	People will organize the robots as terrorist groups.
The problem of security will emerge; knowledge theft and cyber terrorism will increase.	1		1	No private life
There will be security engineering.	1			
Universal security rules will be developed.	1			

The common view of the participants concerning the dimension of Industry 4.0, "cyber security" regarded the moral and ethical problems related to educational and social systems.

Discussion, Conclusion and Recommendations

The first question of this research was; "What are the probable effects of Industry 4.0 on the educational system according to the perceptions of participants?" Participants both estimated that academic achievement, school concept, society, teaching profession, and effectiveness of communication in the educational system would be greatly affected by Industry 4.0.

The second question of this research was; "According to the perceptions of participants, how are the eight characteristics of Industry 4.0 connected with which characteristics of the education system?" It has been found that the participants'

opinions about the possible effects of Industry 4.0 on academic achievement concentrated mostly on the Internet of Things, Big Data and Analyses, Cyber Physical Systems, and Augmented Reality. It was seen in the literature that the teacher and students suggested that augmented reality applications increased academic achievement (Akcayir, 2016; Akkus, 2016; Baysan; 2015; Erbas, 2016; Kucuk, 2015; Sahin,2017; Sirakaya, 2015; Yildirim, 2016). The four characteristics of Industry 4.0, which were seen as factors for academic achievement for students by the participants as well as in the literature, only augmented reality and cloud, were seen as a factor for academic achievement. The effect of Internet of Things, Cyber Physical Systems, Big Data and Analyses on the academic achievement of students needs further study by researchers.

Participants' opinions related to changing and affecting the school concept concentrated on the Internet of Things and Big Data. For the social sciences, "Big Data and Analysis" have been used much more post-2012 in comparison with pre-2012 period (Bayrakci, 2015). Participants indicate that, "School concept will be digitalized", because of IoT (Internet of Things). Industry 4.0 emphasizes the idea of consistent digitization and linking of all productive units in an economy (Blanchet et al., 2014). For the participants, school concept will be especially reshaped by the Internet of Things. As seen in the literature, researchers have some results about Big Data and Internet of Things, but the results are not related with school concept. The relationship between school concept and the characteristics of Industry 4.0 need to be studied by future researchers.

Besides academic achievement and school concept, participants estimated that society will change because of Industry 4.0. The estimates of the participants regarding this situation can be found in the literature about Industry 4.0. New business models, work processes and development methods that are currently unimaginable will arise and these changes will strongly influence the society and people. Family life, globalization, markets, etc. will have to be redefined (Jazdi, 2014; Gorecky, 2014; Buhr, 2015). Governments and institutions are being reshaped, as are systems of education, healthcare and transportation, among many others (Schwab, 2015). It has been identified from the results that the predictions of the participants about the future of society, that they believe there will be a remarkable increase in autonomous robots and cyber security.

According to the opinions of the participants about the probable changes in the teaching profession, they also believe it will be affected greatly by Autonomous Robots and Cyber Physical Systems. A consensus regarding the relationship between the teaching profession and Autonomous Robots and Cyber Physical Systems has not been reached in the literature, but Schwab (2015), says governments and institutions are being reshaped, as are systems of education, healthcare and transportation, among many others. These changes are historic in terms of their size, speed and scope. The participants' predictions regarding potential changes in these areas were similar to Schwab (2015).

Participants also predicted the negative effects of Industry 4.0 on systems; such as, humans will move away from nature, the problem of robot protection will emerge, ethics problems between robots and human beings will emerge (e.g., protecting humans from robots), the truth of knowledge will be threatened (e.g., right according to whom?), private life will end, nostalgia will increase, ethical problems will arise, the World Wars will start due to captured information (e.g., not with artillery and rifles), people will organize robots as terrorist groups, the problem of security will emerge, knowledge theft and cyber terrorism will increase, and there will be no private life. These negative effects are generally emphasized by the participants in relation to Cyber Physical Systems, Autonomous Robots and Cyber Security. Schwab (2016), stated we should figure out how to avoid, or address, the negative, unintended consequences of these changes. Global society – governments, business, academia, and civil society – have a responsibility to work together to better understand the emerging trends. How technology is changing our lives and those of future generations, and how it is reshaping the economic, social, cultural and human context in which we live.

The participants also asserted that the eight characteristics of Industry 4.0 would increase the effectiveness of communication in the educational system. Students stated that augmented reality learning materials would increase the communication between teacher and other students (Sirakaya, 2015). According to experts from industry and research, the upcoming industrial revolution will be triggered by the internet, which allows communication between humans as well as machines in Cyber-Physical-Systems (CPS) over large networks (Brettel et al., 2014). The results showed that cloud-computing technology eases communication (Erdemir, 2014). The two characteristics of Industry 4.0, which were most often mentioned by participants, related to communication effectiveness in schools, and were the cyber physical systems and vertical horizontal integrations. Perceptions of the participants about the relation between communication and characteristics of Industry 4.0 matched with the results from the literature.

The opinions of participants about the "Cloud", such as, "To forget something (e.g., memories, courses) will be difficult", and "The effectiveness of courses will increase" are similar to the results from Yildiz (2015) and Kaymak (2015). The Cloud was also seen as a motivator for academic achievement by the participants as well as in the literature. The participants have made some estimates about the effects of the fourth industrial revolution on education systems and our lives that were not seen in the literature of Industry 4.0.

In conclusion, the predictions of the principals, vice principals, teachers and candidate teachers related to the possible effects of Industry 4.0 on the education system were generally made regarding communication in education, academic achievement of students, the school concept, the teaching profession and future of the society. The candidate teachers made more predictions about the probable effects of Industry 4.0 on the educational system than school principals, vice-principals and teachers. A noticeable finding in this research was that teacher candidates apparently have expressed more foresight related to all dimensions of 4th Industrial Revolution than the group composed of principals, assistant principals and teachers. In order to find out the reason for this finding, the interviewing process and proceedings were re-examined. It was identified that in the group composed of principals, assistant principals and teachers; after specifying the

foresights, the members had stated that "these changes happen, but we cannot see" about the dimensions of "cyber physical systems", "autonomous robots" and "augmented reality". The teacher candidates never made expressions related to all dimensions. It seems that 4th Industrial Revolution is being perceived as very close in the near future by candidate teachers, yet as in the very distant future by the other groups.

Participants did provide positive opinions about the possible effects of Industry 4.0 on the education system. Participants speculated the probable effects of the eight characteristics of Industry 4.0 on the educational system would most likely be focused on academic achievement, school concept and the teaching profession respectively. Participants have a new point of view from the literature of industry 4.0, that empathic skills will develop by means of simulation and equity of opportunity in education will be achieved.

In conclusion, we have learned that he first, second and third Industrial Revolutions' social outcomes and their effects on educational systems can be understood by reading or experiencing them personally. It has not yet been more than ten years since the world took the 4th industrial revolution as a point of consideration. The work on this subject is mostly based on the increases in the automation and production sectors. Studies of what the effects of the 4th Industrial Revolution might have on the education system are very limited. In this study, participants were asked to give their opinions on the future effects of this new revolution. Truth is about the mind; for example, the one in the mind and the one that the mind produces, so technically speaking… the "proposition" (Arslan, 2017). The validity of the suggestions made by participants; such as, "many professions will come to an end", will ultimately be tested in our lifetimes and the future beyond. Reality is about the subject of proposition (Arslan, 2017). The fourth Industrial Revolution, which is the subject of the participants' suggestions, is real and accepted by the perceptions of the participants, and as a result, their foresight may help us to shape our future.

Educational philosophies form the basis of educational systems. Educational philosophy answers people's questions about how and what to be taught. It is obvious that any educational philosophy will be based on an opinion of what is good for human beings (Arslan, 2017). It seems that the autonomous robots, augmented reality, and cyber physical systems that will enter our life because of the 4th Industrial Revolution, will cause changes to the answers about what and how to teach people, and as a result, an emerging philosophy of education will be expected to redefine school, the teaching profession and offer new models of education.

Recommendations

The effect of Internet of Things, Cyber Physical Systems, Big Data and Analyses to academic achievement of students needs further study by both current and future researchers. The relationship between school concept and the characteristics of Industry 4.0 also needs further study by researchers. Importantly, global society – governments, business, academia, and civil society – have a responsibility to work together to better understand these emerging trends.

References

Abdusselam, M. S. (2015). *Artırılmış gerçeklik ortamı kullanılarak fizik dersi manyetizma konusunda öğretim materyalinin geliştirilmesi ve değerlendirilmesi* [Development and evaluation of an instructional material for physic lesson magnetism subject based on augmented reality environment]. (Unpublished Doctoral Dissertation), Karadeniz Technical University, Institute of Educational Sciences, Secondary Education Science and Mathematics Teaching, Physics Education, Trabzon.

Akcayir, M. (2016). *Fen laboratuvarında artırılmış gerçeklik uygulamalarının üniversite öğrencilerinin laboratuvar becerilerine, tutumlarına ve görev yüklerine etkisi* [The effect of augmented reality applications on university students' laboratory skills, attitudes and task loads]. (Unpublished Doctoral Dissertation), Gazi University, Institute of Educational Sciences, Computer Education and Instructional Technology, Ankara.

Akcayir, M., & Akcayir, G. (2017). Eğitimde artırılmış gerçekliğin avantajları ve dezavantajları: Literatüre sistematik bir bakış [Advantages and challenges associated with augmented reality for education: A systematic review of the literature]. *Educational Research Review*, *20*, 1-11.

Akkus, I. (2016). *Bilgisayar destekli teknik resim dersinde artırılmış gerçeklik uygulamalarının makine mühendisliği öğrencilerinin akademik başarısına ve uzamsal yeteneklerine etkisi* [Effects of augmented reality applications on mechanical engineering freshmen's level of academic achievement and spatial ability in computer aided technical drawing]. (Unpublished Master Thesis), Inonu University, Institute of Educational Sciences, Computer Education and Instructional Technology, Malatya.

Arslan, A. (2017). *Felsefeye giris* [Introducing Phylosophy]. 25. Basım. Ankara: BB101 Yayınları.

Bayrakci, S. (2015). *Sosyal bilimlerdeki akademik çalışmalarda büyük veri kullanımı* [The use of big data in academic researches in social sciences]. (Unpublished Master Thesis), Marmara University, Institute of Social Sciences, Department of Journalism, Information Sciences, İstanbul.

Baysan, E. (2015). *Arttırılmış gerçeklik kitap (AG-kitap) kullanımının öğrencilerin akademik başarısına etkisi ve ortamla ilgili öğrenci görüşleri* [The impact of augmented reality book (AR-book) usage on the students' academic achievements and students' reviews on it]. (Unpublished Master Thesis), Gazi University, Institute of Educational Sciences, Computer Education and Instructional Technology, Ankara.

Blanchet, M., Rinn, T., Von Thaden, G., & De Thieulloy, G. (2014). Industry 4.0: The new industrial revolution-How Europe will succeed. *Hg. v. Roland Berger Strategy Consultants GmbH. München. Abgerufen am 11.05. 2014, unter http://www.rolandberger. com/media/pdf/Roland_Berger_TAB_Industry_4_0_2014 0403. pdf*.

Brettel, M., Friederichsen, N., Keller, M., & Rosenberg, M. (2014). How virtualization, decentralization and network building change the manufacturing landscape: An Industry 4.0 Perspective. *International Journal of Mechanical, Industrial Science and Engineering,* 8(1), 37-44.

Buhr, D. (2015). Social innovation policy for industry 4.0. Friedrich-Ebert-Stiftung, *Division for Social and Economic Policies*, Bonn.

Dilek, U. (2016). *Kinematik deneylerinde kullanılmak üzere bir mobil uygulamanın geliştirilmesi* [Development of a mobile application for use in kinematics experiments]. (Unpublished Master Thesis), Dokuz Eylul University, Institute of Educational Sciences, Secondary Education Science and Mathematics Teaching, Physics Education, İzmir.

Erbas, C. (2016). *Mobil artırılmış gerçeklik uygulamalarının öğrencilerin akademik başarı ve motivasyonuna etkisi* [The effects of mobile augmented reality applications on students' academic achievement and motivation]. (Unpublished Master Thesis), Suleyman Demirel University, Institute of Educational Sciences, Computer Education and Instructional Technology, Isparta.

Erdemir, T. (2014). *Uzaktan eğitimde bulut bilişim teknolojileri ile proje tabanlı öğrenme uygulaması* [The application of project-based learning with cloud computing technologies in distance education]. (Unpublished Master Thesis), Karadeniz Technic University, Institute of Educational Sciences, Teaching of Computer and Teaching Technologies, Trabzon.

Gorecky, D., Schmitt, M., Loskyll, M., & Zühlke, D. (2014, July). Human-machine-interaction in the industry 4.0 era. In 2014 12th IEEE *International Conference on Industrial Informatics* (INDIN) (pp. 289-294). IEEE.

Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. *Future Generation Computer Systems*, *29*(7), 1645-1660.

Gun, E. (2014). *Effects of augmented reality applications on students' spatial abilities.* (Unpublished Master Thesis), Gazi University, Institute of Educational Sciences, Computer Education and Instructional Technologies, Ankara.

Jazdi, N. (2014, May). Cyber physical systems in the context of Industry 4.0. In Automation, Quality and Testing, Robotics, *2014 IEEE International Conference* on (pp. 1-4). IEEE.

Kayabas, I. (2017). *Açık ve uzaktan öğrenmede öğrenme analitikleri kontrol panelinin geliştirilmesi: Öğrenme Bulutu* [Development of learning analytics dashboard in open and distance learning: Learning Cloud]. *(*Unpublished Doctoral Dissertation), Anadolu University, Institute of Social Sciences, Department of Distance Education, Eskisehir.

Kaymak, Z. D. (2015). *Bulut bilişim araçlarının, çalışma türünün ve görev zorluğunun bilişsel yük ve öğrenme üzerindeki etkisi* [Effects of cloud computing tools, study type and task difficulty on cognitive load and learning]. (Unpublished

Doctoral Dissertation), Sakarya University, Institute of Educational Sciences, Computer Education and Instructional Technologies Sakarya.

Kucuk, S. (2015). *Mobil artırılmış gerçeklikle anatomi öğreniminin tıp öğrencilerinin akademik başarıları ile bilişsel yüklerine etkisi ve öğrencilerin uygulamaya yönelik görüşleri* [Effects of learning anatomy via mobile augmented reality on medical students' academic achievement, cognitive load, and views toward implementation]. (Unpublished Doctoral Dissertation), Ataturk University, Institute of Educational Sciences, Computer Education and Instructional Technologies Erzurum.

Lee, J., Bagheri, B., & Kao, H. A. (2015). A cyber-physical systems architecture for industry 4.0-based manufacturing systems. *Manufacturing Letters*, *3*, 18-23.

Miles, M.B. & Huberman, M.A. (1994). *An expanded sourcebook qualitative data analysis*. London, Sage.

Sahin, D. (2017). *Artırılmış gerçeklik teknolojisi ile yapılan fen öğretiminin ortaokul öğrencilerinin başarılarına ve derse karşı tutumlarına etkisi* [Effect of science teaching with the augmented reality technology on secondary school students' achievement and their attitude towards the course]. (Unpublished Master Thesis), Ataturk University, Institute of Educational Sciences, Department of Mathematics and Science Education, Erzurum.

Schwab, K. (2015, December 12). The Fourth Industrial Revolution: What It Means and How to Respond? *University of Denver, Forreign Affairs*. https://www.foreignaffairs.com/articles/2015-12-12/fourth-industrial-revolution

Schwab K. (2016, February 2). Could the Fourth Industrial Revolution help us reach the Global Goals? *GlobalAgenda, Davos*. http://www.weforum.org/agenda/2016/02/davos.

Silverman, D. (2016). *Qualitative research*. Sage Publications Inc., California.

Sirakaya, M. (2015). *Artırılmış gerçeklik uygulamalarının öğrencilerin akademik başarıları, kavram yanılgıları ve derse katılımlarına etkisi* [Effects of augmented reality applications on students' achievement, misconceptions and course engagement]. (Unpublished Doctoral Dissertation), Gazi University, Institute of Educational Sciences, Computer Education and Instructional Technologies Ankara.

Yildirim, A., & Simsek, H. (2016). *Sosyal bilimlerde nitel arastırma yontemleri* [Qualitative research methods in the social sciences]. Ankara, Seçkin.

Yildirim, S. (2016). *Fen Bilimleri dersinde artırılmış gerçeklik uygulamalarının öğrencilerin başarısına, motivasyonuna, problem çözme becerilerine yönelik algısına ve tutumlarına etkisi* [The impact of augmented reality to student's success, motivation, and their perception and behavior related to problem solving abilities in science classes]. (Unpublished Master Thesis), Ankara University,

Institute of Educational Sciences, Department of Computer Education and Instructional Technologies, Educational Technologies, Ankara.

Yildiz, D. (2015). *Ortaokul yedinci sınıf İngilizce dersinde okuma öncesi etkinliklerde sözcük bulutu kullanımının kelime öğrenmeye etkisi* [The effect of word cloud on learning vocabulary at pre-reading activities in the seventh grade English course]. (Unpublished Master Thesis), Afyon Kocatepe University, Institute of Social Sciences, Department of Educational Sciences, Afyon.

Yilmaz, R. M. (2014). *Artırılmış gerçeklik teknolojisiyle 3 boyutlu hikâye canlandırmanın hikâye kurgulama becerisine ve yaratıcılığa etkisi* [Effects of three-dimensional storytelling developed with augmented reality technology on narrative skill and creativity]. (Unpublished Doctoral Dissertation), Ataturk University, Institute of Educational Sciences, Computer Education and Instructional Technologies Erzurum.

Von Solms, R., & Van Niekerk, J. (2013). From information security to cyber security. *Computers & Security*, *38*, 97-102.

Zamfirescu C.B., Pirvu B.C., Schlick J. & Zühlke D. (2011). Preliminary insides for an anthropocentric cyber-physical reference architecture of the smart factory. *Studies in Informatics and Control* Vol. 22 No. 3.

4. Endüstri Devriminin Türk Eğitim Sistemi Üzerine Olası Etkileri

Atıf:

Tanriogen, Z. M. (2018). The possible effects of 4th industrial revolution on Turkish educational system. *Eurasian Journal of Educational Research*, *77, 163-184,* DOI: 10.14689/ejer.2018.77.9

Özet

***Problem Durumu*:** Endüstriyel devrimler sonrası ülkeler küresel boyutta yaşanan değişimlere ayak uydurmak zorunda kalmış ve bazı stratejiler geliştirmişlerdir. Almanya'da gündeme gelen dördüncü endüstri devrimi de bu stratejilerden birinin adıdır.Önceki endüstri devrimleri; insanoğlunu hayvan gücü kullanımından özgürleştirmiş, büyük miktarlarda üretimi mümkün kılmış ve milyonlarca insana dijital olanakları ulaştırmıştır. Ne var ki dördüncü endüstri devrimi esasen farklıdır. Öyle bir devrimin başlangıcında oluduğumuz öngörülmektedir ki bu temel olarak bizim yaşama şeklimizi, işimizi ve diğerleriyle kurduğumuz ilşetişimimizi değiştirecektir. Yeni icat edilen teknolojilerin geliştirilmesi ve adaptasyonu etrafındaki köklü belirsizlikler, bunların karmaşıklığı ve sektörler arasındaki bağlantı eksikliği global toplumun – hükümetler, işletmeler, üniversiteler ve sivil toplumlar- tüm paydaşlarının ortaya çıkan yeni eğilimleri daha iyi anlamak için birlikte çalışma sorumluluğuna sahip olmaları

gerektiğini düşündürmektedir. Türkiye Yüksek Öğretim Kurumu, Ulusal Tez Merkezi'nde, Eğitim ve Öğretim başlığı altında 2014 ve 2017 yılları arasında tarama yapıldığında Schwab (2016) tarafından tanımlanmış Endüstri 4.0'ın sekiz karakteristik özelliğinden üçü "artırılmış gerçeklik, bulut ve büyük veri" hakkında araştırma yapıldığı tespit edilmiştir. Siber güvenlik ile ilgili diğer alanlarda (adli tıp, uluslararası ilişkiler vb.) çalışmalar yapılmış fakat eğitim ve öğretim başlığı altında bir çalışmaya rastlanmamıştır. Nesnelerin interneti, özerk robotlar, siber fiziksel sistemler, vertical and horizontal integrations ile ilgili eğitim ve öğretim alanı da dahil olmak üzere hiçbir alanda yapılmış çalışma bulunmamaktadır. Araştırmanın cevap aranan soruları:

1-Katılımcıların algılarına göre Endüstri 4.0'ın eğitim sistemi üzerine olası etkileri nelerdir?
2-Katılımcıların algılarına göre Endüstri 4.0'ın sekiz karakteristik özelliği ile eğitim sisteminin hangi özellikleri arasında ilişki kurulmuştur?

Araştırmanın Amacı: Bu araştırmanın amacı Endüstri 4.0'ın Türk Eğitim Sistemi üzerine olası etkilerini; müdürlerin, müdür yardımcılarının, öğretmenlerin ve öğretmen adaylarının görüşlerine göre ortaya koymaktır.

Araştırmanın Yöntemi: Araştırma nitel araştırma desenlerinden durum çalışması deseninde olup, bütüncül tekli durum çalışmasıdır. Araştırmada çalışma grubunu belirlemek için amaçlı örnekleme yöntemlerinden maximum çeşitlilik örneklemesi kullanılmıştır. Bu amaçla çalışma grubu eğitim sisteminde çalışan deneyimli müdür, müdür yardımcısı, öğretmenler ile henüz öğretmenlik mesleğinde deneyimi olmayan öğretmen adaylarından oluşturulmuştur. Araştırmanın verileri rastgele seçilen 2016-2017 öğretim yılında Denizli'de görev yapmakta olan 15 müdür, müdür yardımcısı, öğretmen ve 2016-2017 öğretim yılı Bahar döneminde Pamukkale Üniversitesi Eğitim Fakültesi Sosyal Bilgiler Öğretmenliği Bölümü'ne devam etmekte olan 18 öğretmen adayından odak grup görüşmesi yöntemi kullanılarak toplanmıştır. Araştırma sırasında Endüstri 4.0'ın sekiz anahtar kavramı katılımcılara açıklanmış ve bu anahtar kavramların Türk Eğitim Sistemine olası etkilerinin neler olabileceği sorulmuştur. Daha sonra katılımcıların cevapları kategorize edilmiştir.

Araştırmanın Bulguları: Öğretmen adaylarının Endüstri 4.0'ın eğitim sistemine olası etkileri ile ilgili okul müdürleri, müdür yardımcıları ve öğretmenlere göre tahminleri daha fazla olmuştur. Katılımcılar Endüstri 4.0'ın eğitim sistemine olası etkilerine ilişkin daha çok olumlu yönde görüş bildirmişlerdir. Katılımcılar Endüstri 4.0'nun sekiz karakteristik özelliğinin eğitim sistemine olası etkilerine ilişkin sırasıyla en çok akademik başarı, okulun yapısı, toplumun geleceği ve öğretmenlik mesleği hakkında tahminlerde bulunmuşlardır. Katılımcıların Endüstri 4.0'ın akademik başarı üzerine olumlu etkisine ilişkin görüşlerinin Nesnelerin İnterneti'nde yoğunlaştığı Büyük Veri ve Siber Fiziksel Sistemler'in de takip ettiği görülmektedir. Katılımcıların okulun yapısının etkileneceği ve değişeceğine ilişkin görüşlerinin daha çok Nesnelerin İnterneti ve Büyük Veri için ortaya çıktığı görülmektedir. Toplumun geleceğine ilişkin tahminlerin ise Özerk Robotlar ve Siber Güvenlik için gözle görülür bir şekilde arttığı tespit edilmiştir. Katılımcıların öğretmenlik mesleğinde ortaya çıkabilecek değişimlere ilişkin görüşlerinin Özerk Robotlar ve Siber Fiziksel Sistemler'de toplandığı görülmektedir.

Katılımcılar Endüstri 4.0'ın eğitime olumsuz etkilerini de görmektedir. Bu görüşlerin daha çok Siber Fiziksel Sistemler, Özerk Robotlar ve Siber Güvenlik için ifade edildiği anlaşılmaktadır. Ayrıca katılımcılar Endüstri 4.0'ın, sekiz karakteristik özelliğinin eğitim sisteminde iletişimin etkililiğini artıracağına ilişkin de görüş bildirmişlerdir. Siber fiziksel sistemler ve Dikey-Yatay bütünleşme okuldaki iletişimin etkililiği ile ilgili en fazla görüş bildirdikleri iki özellik olmuştur. Katılımcıların diğer görüşlerine göre değerler eğitimi ve empati becerisini geliştirmek hiç olmadığı kadar kolay olacak. Fırsat eşitliği sağlanabilecek, dünya nüfusu azalacak, geçmişe ve elektriksiz hayata özlem artacaktır.

Araştırmanın Sonuçları ve Önerileri: Bu araştırmada müdürlerin, müdür yardımcılarının, öğretmenlerin ve öğrencilerin görüşlerine göre Endüstri 4.0'ın Türk Eğitim Sistemi üzerine olası etkileri ortaya konmaya çalışılmıştır. Katılımcılar ındustry 4.0'nun 8 characteristic özelliğinin eğitim sistemine olası etkilerine ilişkin sırasıyla en çok akademik başarı, okulun yapısı, toplumun geleceği ve öğretmenlik mesleği hakkında tahminlerde bulunmuşlardır. Öğretmen adaylarının ındustry 4.0 nun eğitim sistemine olası etkileri ile ilgili okul müdürleri, müdür yardımcıları ve öğretmenlere göre tahminlerinin sayıca daha fazla olduğu görülmüştür. Katılımcılar Industry 4.0'nun eğitim sistemine olası etkilerine ilişkin daha çok olumlu yönde görüş bildirmişlerdir. Katılımcıların tahminlerine göre Endüstri 4.0'ın karakteristik özellikleri akademik başarıyı olumlu yönde etkileyecektir. Katılımcıların Endüstri 4.0'ın siber fizksel sistemler boyutuna ilişkin görüşleri simülasyonların öğretimi kolaylaştıracağı, öğretmenlik rolünün ve okul kavramının değişeceği yönünde olmuştur. Dikey-Yatay bütünleşme boyutu için katılımcıların görüşü okul sürecinde iletişimin hızlanacağı şeklinde olmuştur. Birbirlerinden farklı olarak şeffaf eğitim ve esnek sınıf yapısı üzerinde durmuşlardır. Şeylerin interneti boyutunda katılımcılar okuldaki iletişimin etkililiği ve yazılı sınavların son bulacağı konusunda görüş birliğine varmışlardır. Özerk robotlar boyutunda bazı meslek gruplarının ortadan kalkacağı ve yaratıcılığa olan ihtiyaç konusunda ortak görüş bildirmişlerdir. Aday öğretmenlerin elektriksiz hayatın özleneceği, nüfusun düşeceği, nesnelerin robotlar tarafından tamir edileceği hiçbir şeyin atılmayacağı konusundaki görüşlerine literatürde rastlanmamasına karşın dikkat çekici bulunmuştur. Büyük veri ve analizi boyutuna ilişkin bilginin üretimi ve kullanışlı hala getirilmesi ortak görüş olarak ortaya çıkmıştır. Okulların ve ders kitaplarının varlığı konusundaki endişeleri dikkat çekici bulunmuştur. Bulut boyutuna ilişkin katılımcıların ortak görüşü öğrencilerin yüzsek düzeyde izlenebilirliği olmuştur. Arttırılmış gerçeklik boyutuna ilişkin ortak görüş öğretmenlerin zamandan tasarruf etmelerini sağlayacak hızlı iletişim üzerinedir. Siber güvenlik boyutunda eğitim ve sosyal sistemler hakkındaki moral ve etik sorunlar ortak görüş olarak belirmiştir. Endüstri 4.0'ın sekiz karakteristik özelliğinin herbiri ile akademik başarı arasındaki ilişkiler anlaşılmaya çalışılmalıdır. Nesnelerin interneti, Siber Fiziksel Sistemler, Büyük veri ve analizi'nin öğrencilerin akademik başarılarına etkilerinin araştırmacılar tarafından ortaya konmasına ihtiyaç olduğu düşünülmektedir. Okul kavramı ve Endüstri 4.0'ın karakteristik özellikleri arasındaki ilişkilerin gelecek araştımalarda çalışılmasına ihtiyaç bulunmaktadır.

Anahtar Kelimeler: Endüstri 4.0, Özerk Robotlar, Nesnelerin İnterneti, Bulut, Büyük Veri ve Analizi, Artırılmış Gerçeklik.