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The Effect of Augmented Reality Training on Teachers' Individual Innovativeness [2]

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ABSTRACT

This study aimed to ascertain the effects of augmented reality training on teachers' individual innovativeness. The study group which consisted of 35 teachers utilized one group pretest-posttest experimental design. The teachers who volunteered to take part in the study received 40-hour augmented reality training. Individual Innovativeness Scale was used as the data collection tool in the research. For data analysis, descriptive statistics, related samples t-test and Wilcoxon signed-rank test were used. It was found that the majority of teachers was in the "pioneer" category before the training and displayed high level individual innovativeness. Based on post-training measurements, it was concluded that the teachers reached the category of "innovative" in individual innovativeness and there was an increase in the number of highly innovative teachers. It is concluded that augmented reality training positively improves teachers' individual innovativeness of. As a result of the analyzes, it was found that the individual innovativeness of teachers who were females, over 30 years and taught social subject matters changed significantly while the change in other groups was not significant.

Introduction

The unchanging rule of today's world is change and innovation. Constant developments and innovations make it necessary for individuals to adapt to new situations in a short time. Rogers (1995) defines innovativeness as the ability to adopt new situations by individuals or groups (institutions) before others. In a simpler definition; Hurt, Joseph and Cook (1977) address the concept of innovativeness as the willingness towards innovation and change. In another definition, it is emphasized that what is important in innovativeness

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is the capability to go beyond the known (Demirel & Seçkin, 2008). Braak (2001), on the other hand, defines innovativeness as the individual's willingness to embrace new situations. Taking these definitions into consideration, Kılıçer and Odabaşı (2010) reported that innovativeness is an umbrella concept that includes terms such as risk taking, creativity and skillfulness in thought leadership.

Persons' distinctive individual characteristics create different reactions to new situations, ideas, practices and objects. When individuals encounter new situations, they act according to their personal characteristics and culture (Yi, Fiedler & Park, 2006). Rogers (2003) defines individual innovativeness as the period (degree) of adopting new ideas. In a broader expression, Kılıçer (2011) defines individual innovativeness as individuals' willingness towards innovation, their ability to adopt innovation and their desire to benefit from innovations. Yuan and Woodman (2010) consider individual innovativeness as the period of change in individuals' attitudes towards innovation.

Differences may exist among individuals in terms of individual innovativeness such as degree of willingness for change and adoption of innovation earlier or later compared to others. The period of acceptance of innovation is different for each individual due to various factors. According to Rogers (1995), individuals are divided into 5 different categories in terms of their innovativeness:

- Innovators: They are willing to try innovations and take risks. They are generally the first to experience innovation within the social structure in which they are a member. They have the courage and self-confidence to take the risk of the innovation they are involved with.
- Pioneers: They try the innovation following the innovators in their social structure. They guide other individuals who have doubts about experimenting with innovation. Thus, they serve as bridges between the innovators and the group that adopts innovations later. They have an important role in thought leadership.
- Interrogators: They are cautious about new situations. They need more time to have detailed information before adopting innovation. They do not want to take risks by experiencing innovation without establishing a sense of trust.
- Scepticals: They are skeptical towards innovations and they shy away from them. They wait for others to experience and adopt innovations first.
- Laggards/Traditionalists: They are biased towards change and the last group to adopt innovation. They expect other groups to adopt innovation and get positive results first.

One of the most important building blocks of individual and social progress is innovativeness. Teachers have important duties in educating innovative individuals in line with the expectations and needs of the society. In this context, innovativeness is one of the important qualifications for teachers to have. Innovative teachers can use the new knowledge and skills actively in classes and do not adhere to classical methods and tools. They strive to develop themselves by closely following the developments related to their professions. They act as role models for students and society in the adoption and implementation of innovations (Kurbanoğlu & Akkoyunlu, 2007). Innovative teachers can

ensure the correct integration of information and communication technologies in the classrooms (Kocasaraç & Karataş, 2018). They are willing to use new approaches, methods and tools in the classroom to ensure that the learning-teaching process is more efficient. In this context, augmented reality emerges as a tool that attracts the attention of teachers.

Augmented reality can be defined as the technology that uses the real image as the background which is enriched with simultaneously added virtual objects (Azuma, 1997, 1999). In other words, the real image is supported by virtual data such as graphics, animations, videos, 3D models and GPS developed in computer environment (Perez-Lopez & Contero, 2013). Thus, it becomes possible for individuals to access information that they cannot perceive under normal circumstances. Unlike virtual reality, this important advantage allows users to stay in touch with the reality of the environment they are in and it allows the real environment to be enriched with virtual objects. These advantages have brought to the agenda the use of augmented reality in the classroom which has become an important topic for both researchers and educators in recent years. Previous studies concluded that the use of augmented reality in educational environments has many advantages such as:

- Facilitating learning (Delello, 2014; Enyedy, Danish & DeLiema, 2015; Wojciechowski & Cellary, 2013),
- Attracting student interest to lessons (Bressler & Bodzin, 2013; Delello, 2014; Ibáñez, Di Serio, Villarán & Delgado Kloos, 2014),
- Increasing student motivation for lessons (Billinghurst & Duenser, 2012; Estapa & Nadolny, 2015),
- Increasing classroom participation (Ivanova ve Ivanov, 2011; Sırakaya & Kılıç Çakmak, 2018),
- Enabling students to learn by having fun (Dunleavy, Dede & Mitchell, 2009; Huang, Chen &Chou, 2016; Yilmaz, 2016),
- Improving spatial ability of students (Bujak et al., 2013; Wojciechowski & Cellary, 2013),
- Providing learning of abstract concepts by concretizing them (Shelton & Stevens, 2004; Wojciechowski & Cellary, 2013).

This study aimed to ascertain the effects of augmented reality training, some of whose advantages were mentioned above, on teachers' individual innovativeness. For this purpose, the following sub-problems were sought to be answered:

- What is the level of teachers' individual innovativeness before receiving augmented reality training?
- What is the level of teachers' individual innovativeness after receiving augmented reality training?
- Is there a significant difference between teachers' individual innovativeness scores before and after augmented reality training?

- Is there a significant difference between teachers' individual innovativeness scores before and after augmented reality training based on their demographic characteristics?

Method

Research Design

The study utilized one group pre-test and post-test experimental design. In this type of experimental design, the subjects were measured in terms of the dependent variable with the same measurement tool before implementation (Büyüköztürk, Kılıç Çakmak, Akgün, Ö., Karadeniz & Demirel, 2008).

Study Group

The study group consisted of 35 teachers from different subject matters. Table 1 presents the distribution of the study group based on their demographic characteristics.

Table 1. Distribution of the study group based on demographic characteristics

Variable	Category	f	%
Gender	Female	16	45.7
	Male	19	54.3
Age	30 and under	10	28.6
	Over 30	25	71.4
Subject matter	Science areas (Mathematics, Science, Communication Technologies)	19	54.3
	Social areas (Classroom, Social Sciences, T Turkish)	16	45.7
Level of Education	Undergraduate	22	62.9
	Graduate	13	37.1
Professional Experience	10 years or less	21	60.0
	More than 10 years	14	40.0

Implementation Process

Teachers who volunteered to take part in the study were given 40-hour augmented reality training during the implementation period of the study. Training began by giving teachers basic information such as definition, historical development and types of augmented reality technology followed by introducing the augmented reality applications that can be used instructionally. In the course of the training, teachers were introduced to environments where they could develop their own augmented reality applications and they were given opportunities to use them in practice.

Data Collection Tool

"Individual Innovativeness Scale" developed by Hurt, Joseph and Cook (1977) and adapted to Turkish by Kılıçer and Odabaşı (2010) was used as the data collection tool in the study. Kılıçer and Odabaşı (2010) stated that the adapted scale was grouped under 4 factors ("Resistance to change", "Thought Leadership", "Openness to experience" and "Risk taking") and these four factors explained 52.52% of the total variance. They reported that the internal consistency coefficient of the scale was 0.82 and test-retest reliability was 0.87. The 5-point Likert scale consists of 20 items.

The following formula was used to calculate the individual innovation score: positive items - negative items + 42. Innovativeness profiles and innovation levels of individuals can be calculated according to the score obtained (Hurt, Joseph and Cook, 1977). Accordingly, if the score obtained is over 80 points, it is interpreted as "innovative", 69-80 points as "pioneer", 57-68 points as "interrogator", 46-56 points as "skeptic" and 46 points as "traditionalist". If score obtained is over 68, it is interpreted as "innovator- high level ", 64-68 points as "innovator- medium level " and 64- as "innovator- low level".

Data Analysis

Whether the data showed normal distribution or not was explored before the analyses. For this purpose, Shapiro-Wilk test (Büyüköztürk, 2007) and Q-Q Plot graphs were used because the number of participants was less than 50. Since p> .05 according to the results of Shapiro-Wilk test and the graphs indicated normal distribution, the t-test was used in the analysis of the data for the whole study group. The Wilcoxon signed rank test was used to determine whether there was a significant change in individual innovativeness based on participants' demographic characteristics because the number of subjects recommended for sub-samples was under 30 (Roscoe, 1975, Cited in: Büyüköztürk et al., 2008). In addition, descriptive statistics were used.

Findings

What is the level of teachers' individual innovativeness before receiving augmented reality training?

Table 2 presents the descriptive statistics regarding teacher scores obtained from individual innovativeness scale before the training.

Table 2. Descriptive statistics for the scores obtained from the individual innovativeness scale before the training

N	$\bar{X}$	Ss	Min	Max
35	77.31	7.809	57	90

Table 2 shows the mean score ($\bar{X}$ = 77.31) obtained by teachers in the individual innovativeness scale. According to this mean score, teachers' individual innovativeness profiles were in "pioneer" category. Table 3 demonstrates the distribution of teachers based on their innovativeness profiles before the training.

Table 3. Distribution before training based on innovativeness profiles

Profile	Frequency	%
Innovator	14	40.0
Pioneer	17	48.6
Interrogator	4	11.4
Skeptical	0	0
Traditionalist	0	0
Total	35	100

According to Table 3, the majority of teachers had "pioneer" (f =17,%=48.6) individual innovativeness profile. However, an important part of the teachers was found to have "innovator" (f= 14,%=40.0) profile. It is interesting to note that only 4 teachers (%=11.4) had

"interrogator" profile while none of the participants had "skeptical" or "traditionalist" profile.

Table 4 presents the findings in regards to teachers' individual innovativeness levels before the training.

Table 4. Distribution by level of innovativeness before training

Level	Frequency	%
Innovator- high level	31	88.6
Innovator- moderate level	2	5.7
Innovator- low level	2	5.7
Total	35	100.0

Table 4 shows that 31 teachers (%=88.6) were high level innovators, 2 teachers (%=5.7) were moderate level innovators and 2 teachers (%=5.7) were low level innovators. This finding can be interpreted to mean that teachers already had innovative characteristics.

What is the level of teachers' individual innovativeness after receiving augmented reality training?

Table 5 presents the descriptive statistics regarding teacher scores obtained from individual innovativeness scale after the training.

Table 5. Descriptive statistics for the scores obtained from the individual innovativeness scale after the training

N	$\overline{X}$	Ss	Min	Max
35	81.49	7.184	65	94

Table 5 shows the mean score ($\overline{X}$ = 81.49) obtained by teachers in the individual innovativeness scale. According to this mean score, teachers' individual innovativeness profiles were in "innovator" category. Table 6 demonstrates the distribution of teachers based on their innovativeness profiles after the training.

Table 6. Distribution after training based on innovativeness profiles

Profile	Frequency	%
Innovator	20	57.1
Pioneer	13	37.1
Interrogator	2	5.7
Skeptical	0	0
Traditionalist	0	0
Total	35	100

According to Table 6, the majority of teachers had "innovator" (f =20,%=57.1) individual innovativeness profile. However, an important part of the teachers was found to have "pioneer" (f= 13,%=37.1) profile. It is interesting to note that only 2 teachers (%=5.7) had "interrogator" profile while none of the participants had "skeptical" or "traditionalist" profile. Table 7 presents the findings in regard to teachers' individual innovativeness levels after the training.

Table 7. Distribution by level of innovativeness after training

Level	Frequency	%
Innovator- high level	33	94.3
Innovator- moderate level	2	5.7
Innovator- low level	0	0
Total	35	100.0

Table 7 shows that almost all teachers (f=33, %=94.3) were high level innovators at the end of the training. 2 teachers (%=5.7) were moderate level innovators while there were no teachers with low level innovative characteristics.

Is there a significant difference between teachers' individual innovativeness scores before and after augmented reality training?

In order to test the effect of augmented reality training on teachers' individual innovativeness, related samples t-test was applied to teachers' pretest and posttest scores. Table 8 presents these results.

Table 8. Pre-test-posttest related samples t-test results

Measurement	N	$\bar{X}$	Ss	sd	t	p
Pretest	35	77.31	7.809	34	-2.969	.005
Posttest	35	81.49	7.184			

Table 8 demonstrates that while teachers' individual innovativeness mean scores before the implementation was ($\bar{X}$ = 77.31), it increased to ($\bar{X}$ =81.49) after the implementation. This difference was analyzed by related samples t-test and a significant difference was found in favor of posttest ($t_{(34)}$= -2.969, p<.05). According to this finding, it can be argued that augmented reality training had a positive effect on the development of teachers' individual innovativeness.

Is there a significant difference between teachers' individual innovativeness scores before and after augmented reality training based on their demographic characteristics?

Wilcoxon signed rank test was conducted on to teachers' test and post-test scores in order to test the effect of augmented reality training on teachers' individual innovativeness based on demographic characteristics. The test results are given in Table 9.

When Table 9 is examined, it can be seen that based on gender, augmented reality training significantly changed female teachers' individual innovativeness (z = -2.846, p <.05), whereas the change in male teachers was not significant (z = -1.156, p> .05). When mean rank and totals of difference scores were taken into consideration, the difference was found to be in favor of the posttest. Based on this finding, it can be argued that augmented reality training had a significant effect on the development of female teachers' individual innovativeness, whereas the development in male teachers was not significant.

While, based on age, augmented reality training did not significantly change the individual innovativeness of teachers aged 30 and under (z = -1.876, p> .05), the change in teachers over the age of 30 was found to be significant (z = -2.238, p <.05). When mean rank

and totals of difference scores were taken into consideration, the difference was found to be in favor of the posttest. Based on this finding, it can be argued that augmented reality training had a significant effect on the development of individual innovativeness of teachers older than 30 years, whereas the development in teachers who were 30 or under was not significant.

Table 9. Pretest-posttest Wilcoxon signed rank test results

Variable	Category	Posttest Pretest	Rank Average	Rank Total	n	z	p
Gender	Female	Negative	3.33	10.00	3	-2.846	.004
		Positive	9.17	110.00	12		
		Equal	-	-	1		
	Male	Negative	6.56	59.00	9	-1.156	.248
		Positive	12.44	112.00	9		
		Equal	-	-	1		
Age	30 and under	Negative	3.33	10.00	3	-1.876	.074
		Positive	6.43	45.00	7		
		Equal	-	-	0		
	Over 30 -	Negative	7.17	64.50	9	-2.238	.025
		Positive	15.11	211.50	14		
		Equal	-	-	2		
Subject Matter	Science Areas	Negative	6.28	56.50	9	-1.266	.206
		Positive	12.72	114.50	9		
		Equal	-	-	1		
	Social Areas	Negative	4.17	12.50	3	-2.701	.007
		Positive	8.96	107.50	12		
		Equal	-	-	1		
Education	Undergraduate	Negative	6.44	58.00	9	-2.227	.026
		Positive	15.00	195.00	13		
		Equal	-	-	0		
	Graduate	Negative	3.83	11.50	3	-1.917	.055
		Positive	6.81	54.50	8		
		Equal	-	-	2		
Experience	10 years or less	Negative	6.13	49.00	8	-2.096	.036
		Positive	13.42	161.00	12		
		Equal	-	-	1		
	More than 10 years	Negative	4.00	16.00	4	-2.063	0.39
		Positive	8.33	75.00	9		
		Equal	-	-	1		

In analyzes based on subject matter, while the augmented reality training was found not to significantly change the individual innovativeness of teachers who taught subject matters in science areas (Mathematics, Science, Information Technologies) ($z = -1.266$, $p > .05$), the change in teachers in teachers who taught subject matters in social areas (Classroom, Social Sciences, Turkish) was significant ($z = -2.701$, $p < .05$). When mean rank and totals of difference scores were taken into consideration, the difference was found to be in favor of the posttest. Based on this finding, it can be argued that augmented reality training had a significant effect on the development of individual innovativeness of teachers who taught subject matters in social areas, whereas the development in teachers taught subject matters in science areas was not significant.

While augmented reality training was found to significantly change the individual innovativeness of teachers at undergraduate levels according to education level ($z = -2.227$, $p < .05$), the change was not significant among the teachers with graduate degrees ($z = -1.917$, $p > .05$). When mean rank and totals of difference scores were taken into consideration, the difference was found to be in favor of the posttest. Based on this finding, it can be argued that augmented reality training had a significant effect on the development of individual innovativeness of teachers with undergraduate degrees, whereas the development in teachers with graduate degrees in was not significant.

According to analysis results, augmented reality training provided significant changes in the individual innovativeness of teachers with 10 years or less experience ($z = -2.096$, $p < .05$) as well as the teachers with more than 10 years experience ($z = -2.063$, $p < .05$). When mean rank and totals of difference scores were taken into consideration, the difference was found to be in favor of the posttest.

Results and Discussion

It was concluded that teachers were in the "pioneer" category before the augmented reality training and they were highly innovative. Various studies in literature indicate that teachers (or teacher candidates) were included in "interrogator" category(Abbak, 2018; Adıgüzel, 2012; Başaran & Keleş, 2015; Çuhadar, Bülbül & Ilgaz, 2013; Kert & Tekdal, 2012; Korucu & Olpak, 2015; Örün, Orhan, Dönmez & Kurt, 2015; Olpak, Arıcan & Baltacı, 2018; Özbek, 2014; Öztürk & Summak, 2014; Yılmaz, 2018). This study found that teachers were "pioneers" before training while they were "innovators" after the training and there was an increase in the number of highly innovative teachers. This result may be related to the fact that the study group was composed of volunteer teachers. It may be argued that volunteering to learn how augmented reality technology is used in the classroom requires innovativeness. This outcome is in line with the fact that teachers displayed high level of innovativeness before the training.

Analyses showed that teachers' individual innovativeness can be positively influenced from augmented reality training. Augmented reality is a technology that provides significant advantages in educational environments (Billinghurst & Duenser, 2012; Delello, 2014; Estapa & Nadolny, 2015; Shelton & Stevens, 2004; Sırakaya & Kılıç Çakmak, 2018; Wojciechowski & Cellary, 2013). In addition to the advantages mentioned before, this study concluded that augmented reality training positively affected teachers' individual innovativeness. In the literature, there are no studies which explored augmented reality and individual innovativeness in relation with one another. Further studies may examine in more depth how augmented reality technology changes teachers' individual innovativeness.

Based on the analyses, it was concluded that augmented reality training positively affected the individual innovativeness of both male and female teachers, while the change in female teachers was statistically significant. The studies carried out in the literature made comparisons based on gender and concluded that there was no differentiation according to gender (Abbak, 2018; Başaran & Keleş, 2015; Kocasaraç, 2018; Konakman, Yokuş & Yelken, 2016; Yılmaz, 2018).

In terms of age, it was concluded that augmented reality training significantly improved the individual innovativeness of teachers over the age of 30, whereas it was not significant for teachers who were 30 and under was not significant. Çetin and Bülbül (2017) state that school administrators show significant resistance to change over the age of 40.

While the analyses based on subject matter showed that the development of teachers' individual innovativeness was significant in teachers who taught subject matters related to social areas, the development in teachers who taught subject matters related to science areas was not significant. Similarly, Kocasaraç (2018) reported that science and mathematics teachers were more open to innovation than social science and literature teachers. Kılıç (2015) and Kocasaraç (2018) reported that level of innovativeness does not differ based on the subject matters teachers teach, while Bitkin (2012) stated that level of innovativeness does not differ based on teacher candidates' departments.

While augmented reality training positively affected the individual innovativeness of teachers with both undergraduate and graduate education, the development was statistically significant for undergraduate teachers. Kocasaraç (2018), on the other hand, concluded that the level of education does not differentiate teachers' individual innovativeness.

Analyzes based on professional experience demonstrated that augmented reality training had a positive effect on the development of individual innovativeness of teachers with more than 10 years' experience as well as teachers with less than 10 years' experience. While Kocasaraç (2018) reported that teachers with less experience had more innovative features, there are studies that concluded teachers' professional experiences did not affect their level of innovativeness (Abbak, 2018; Kılıç, 2015; Kocasaraç, 2018; Yılmaz, 2018).

This study is limited to 35 teachers who volunteered to receive augmented reality training. Their willingness to learn a new technology limits the research results in terms of generalizability.

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