Students' expectations and social media sharing in adopting augmented reality

Alamäki, A., Dirin, A. & Suomala, J.

Purpose: This study examines students' emotional responses to augmented reality (AR) applications and their willingness to share on social media. It also compares user experiences of AR and virtual reality (VR).

Design: In line with expectation disconfirmation theory, the study focuses on students' experiences in the post-adoption situation where they had gained actual experiences of AR applications. The participants in this case study included 100 undergraduate students from higher educational institutes.

Findings: Augmentation as a value-creating mechanism seems to create surprising emotional reactions, as it created completely new and unexpected experiences for first-time users. This study also shows that positive user experiences increased the students' willingness to share AR content on social media channels. In addition, AR seems to be easier to adopt than does VR with "cardboard-style" VR headsets.

Research implications: More research is needed to determine which specific features of AR applications and pedagogical methods create positively surprising emotional experiences that affect rewarding learning experiences and social media sharing.

Practical implications: The results of this study allow designers and educators to select educational technologies that emotionally engage students to use and share them. Positively surprising emotional experiences are important for rewarding learning experiences. The findings also provide hints on the future preferences of new AR users.

Originality: This study created a new understanding of the emotional determinants of AR adoption and sharing on social media.

Paper type: Research paper

Keywords: Augmented reality, Educational technology, Emotions, Higher Education

1. Introduction

Studying users' experiences while they adopt and perform new technologies provides a new understanding of their expectations and preferences. This new knowledge allows designers to develop more useful and user-friendly digital services specifically in the learning context. We already know that perceived usefulness, ease of use, loss of control and user satisfaction affect the adoption of new technologies (Lee and Park, 2008; Venkatesh and Davis, 2000). In addition, prior research (Arpaci, 2016; Hallikainen *et al*., 2019a; Karjaluoto *et al.*, 2014) shows that several user-dependent factors—such as personal innovativeness, perceived value, technology readiness and trust—influence the adoption of new technologies.

However, there has been little research on the role of emotional factors in the adoption of augmented reality (AR), and research on students' willingness to share AR content on social media is scant. Although AR is a promising technology in the educational context, its educational use and research are in its infancy (Uhomoibhi *et al.*, 2020). This study focuses on user experiences of AR when students use the case study AR application. It especially pays attention to initial user experiences that provide us new knowledge concerning users' emotional responses when they use AR applications for the first time in their lives. In addition, the study examines the relationship between emotional experiences and willingness to share content on social media. Previous research (e.g. Garcia *et al.*, 2015) shows that students spontaneously use social media tools for educational purposes.

AR is a new technology that has gained significant interest, especially among academicians and practitioners (e.g. Dirin and Laine, 2018; Nguyen *et al.*, 2018; Olsson *et al.*, 2013). Understanding the determinants of technology adoption would allow designers, educators and marketers to develop technologies that diffuse faster (c.f. Jahanmir and Cavadas, 2018). Similarly, research findings about the behaviour of early adopters can provide hints on the future preferences of new user segments (Hallikainen et *al.*, 2019a). In addition, it is important to understand factors that

lead to strong emotional or cognitive reactions in AR usage (Ibáñez *et al.*, 2014). Negative word of mouth (WOM) about a new technology in social media channels may decrease the rate of adoption (Jahanmir and Cavadas, 2018). Moreover, more and more users make purchase decisions on the basis of WOM on social media (Chen *et al.*, 2012), and the use of social media in learning strongly supports information learning (Dabbagh and Kitsantas, 2012). Thus, the study examines surprising experiences and users' willingness to share AR content on social media.

The main goal of this study was to examine user experiences of 3D (three dimensional) -based AR applications. The research questions are as follows:

1. What are the first-time users' initial experiences of AR applications, and does the usage invoke emotions?
2. How do user experiences of AR differ from those of virtual reality (VR) at the general level?
3. How emotional responses relate to users' willingness to share AR applications on social media?

2. Related work

2.1 Augmentation as the value-creating mechanism

Kipper and Rampolla (2013) defined AR as the combination of a real-world environment and digital information. This combination has given rise to many opportunities in various sectors. In AR applications, a real scene viewed by the user is embedded in a virtual object. The virtual object often carries information that is generated by a computer or mobile device. Therefore, the user remains in the real world with augmented digital objects. Hence, AR applications are a means to provide rich digital information and interactivity to the user's perception in the real world. This increases the media richness of AR applications compared to traditional mobile applications in learning and teaching (Yoke *et al.*, 2019).

Mobile devices are used to deliver AR content to the target audience. Mobile AR applications are considered a tool for transferring self-augmentation into the user's self-concepts. This means that a mobile AR-branded application dominates the user's selection choices because they feel that the brand is a personal and supportive self-expression. Previous research on education (e.g. Huang *et al.*, 2016; Yoke *et al.*, 2019; Yuen *et al.*, 2011) shows that AR is able to motivate students, improve collaborative learning, enhance emotional attachments and imagination, assist with self-directed learning and create an authentic learning environment. Furthermore, various previous studies in the retail context (Pantano and Servidio, 2012; Poushneh and Vasquez-Parraga, 2017) have confirmed the impact of AR as a medium that influences user experience. Perceived augmentation correlates with the user's understanding of AR features and characteristics (Javornik, 2016). In line with this, He *et al.* (2018) investigated how the role of AR design elements, such as information type and environment augmentation, affects tourists' willingness to pay more for a museum experience. Their findings indicate that dynamic visual and verbal cues have a positive impact on users paying more to visit a museum. This effect is likely the result of verbal communication between the AR object and the user, which influences their decision-making. However, research on user experience in AR technology is vague and needs more investigation (Irshad and Rambli, 2014) despite significant improvements in user interaction solutions for this technology.

2.2 Expectation disconfirmation theory and emotional responses

For designers of new technologies, it is important to know the preferences of users in terms of the characteristics of digital media. Users interact with digital environments using various digital media solutions that are digital touch points to the resources, services and social networks of various service providers (Hallikainen *et al.*, 2019b). Rich media applications, such as VR or AR, are becoming increasingly popular among practitioners (e.g. Laine *et al.*, 2016; Nguyen *et al.*, 2018; Sánchez *et al.*, 2000). As audiovisual and interactive multimedia elements that enable the delivery of graphics,

images and videos, the media effect of rich media applications is based on their ability to transmit rich audiovisual information to create virtual user experiences. To understand users' emotional responses related to the adoption of new technologies, we need to study user experiences in post-adoption situations. User satisfaction describes the state of user experience in relation to certain technologies, products or services.

Expectation disconfirmation theory (Bhattacherjee and Premkumar, 2004; Oliver, 1977; 1980, 1993) explains user satisfaction as the phenomena in the post-adoption situation: The theory consists of expectations, perceived performance and disconfirmation of beliefs, all of which affect user satisfaction. Expectations in the theory refer to the attributes—such as attitude, assumptions or presumptions—that the user has before he or she uses a new technology, whereas perceived performance is related to the usage situation where the user adopts a technology in a real-world situation and gains actual real-time experiences from its performance. Disconfirmation of beliefs relates to the evaluation process where the user reflects his or her experiences of performance against the original expectations. Thus, according to expectation disconfirmation theory, overall satisfaction is the outcome of disconfirmation of beliefs and performance of technology, but it is also affected by the user's original expectations before the real usage situation. Disconfirmation and original expectations determine the level and direction of satisfaction, which influence the user's willingness to continue using new technology (Bhattacherjee and Premkumar, 2004; Thong *et al.*, 2006). Hence, disconfirmation of beliefs and affects may be both positive or negative depending on the original expectations. Satisfaction is an affective construct, and affects and other emotional responses are necessary in forming the level of satisfaction as the outcome of the adoption process (Mano and Oliver 1993; Oliver, 1993).

2.3 Emotional experiences and mobile adoption

Current behavioural and neuroscientific studies have shown that emotions play an essential role in human behaviour (Bechara and Damasio, 2005; Knutson and Greer, 2008; Pessoa, 2008). For example, messages that create strong positive emotions make the user act in accordance with the messages (Park *et al.*, 2017). In this respect, messages that create a strong negative emotion make the user act in the opposite direction of the messages (Knutson and Greer, 2008).

Users' emotional experiences affect the adoption of new mobile services (e.g. Eastin *et al.*, 2016; Gerpott and Thomas, 2014; Kim *et al.*, 2007). Users have also become more demanding in mobile services, and more and more emotional factors are measured besides cognitive measures in user studies (e.g. Harley *et al.* 2016; Huang *et al.*, 2015; Shapsough *et al.*, 2016). Emotional constructs in the measurement—such as boredom, empathy, enjoyment or happiness—measure the user's feelings while using mobile services. It has been found that emotional factors are significant variables to the user's behavioural intention or actual behaviour (e.g. Alamäki *et al.*, 2019; Anshari *et al*., 2016; Huang *et al.*, 2016). They also affect the adoption of mobile services, as they provide different levels of emotional triggers (Alamäki *et al.*, 2019). Thus, the speed of adoption of mobile services differs between applications (Kongaut and Bohlin, 2016).

Emotions affect the user's intention and actual behaviour in sharing online content (Berger and Milkman, 2012). Berger and Milkman (2012) showed that users shared positive content more often than they did neutral or negative content. Emotional responses are affected by triggers that prior literature (e.g. Roos *et al.*, 2004; Skarin *et al.*, 2017) has reviewed as means, situations or happenings that switch user behaviour forwards or backwards on their customer journey. Emotions play a crucial role in the theory of triggers, where they are called affective triggers. Affective triggers relate to feelings such as stress, safety and autonomy (Skarin *et al.*, 2017). Digital media applications, such as AR and VR, potentially deliver content and interactivity that triggers user behaviour.

2.4 AR in the social media era

Today, social media is very popular and used for various purposes, such as entertainment, communication and business. Various technologies are being used to make social media applications more robust and appealing for users. This includes AR technology exports and researchers pursuing a window in this popular environment, especially for young generations, through entertainment applications such as Snapchat (Vaterlaus *et al.*, 2016).

In Snapchat, user images are augmented with predefined images that users are able to share with peers and communities. Vaterlaus *et al.* (2016) have indicated that this social media has an interpersonal behavioural impact on individuals' and communities' perceptions. In line with this development in Snapchat, Pokémon Go has extended the AR functionalities of Snapchat to the next stage. Pokemon Go (Althoff *et al.*, 2016) is the first and most popular AR-based collective gaming application, which has a significant impact on users' physical performance. In addition to its physical impact, Ruiz-Ariza *et al.* (2018) have demonstrated that Pokemon Go affects the user's cognitive performance and social relationships. This collaborative and social AR application has also derived virtual learning researchers in recent years. Laine *et al.* (2016) have used AR in gamification for children to learn science—such as mathematics, physics and geometry—through social and physical engagement.

The development trend of AR technology and the popularity of social media indicate that we are moving towards more AR-based social media applications. The AR technology used in social media applications results in the user's emotional engagement and immersive experience. The authors believe that soon social media applications, such as Instagram or Facebook, would come up with AR-enhanced services to engage more users with their products as a new business opportunity because merging AR technology with social media would surely lead to new service experiences for consumers. The literature review shows that both academicians and practitioners are investing in the development of AR-based social media applications specifically to engage users in gaining more revenue (e.g. in the museum sector; Kargas and Luomos, 2020). Kargas and Luomos (2020) have

shown how merging AR with social media attracts more visitors, especially young, to museums. Similarly, the development of a mixed reality–based social media platform concept has been proposed by Du *et al.* (2019). Their geotagged information-sharing platform converts user-generated content into interactive 3D geotagged social media. This mirrors the world, allowing users to chat and collaborate with remote participants.

3. Research methods and data

3.1 Users and design

This was an experimental study using an explorative approach by discovering the effects of AR applications on students (Cohen *et al.*, 2013). We adopted a participatory technique to evaluate students' user experiences (Maguire, 2001). Students used AR and VR applications in real-life usage settings that enabled us to collect authentic user experiences in the user testing situation (Holtzblatt and Beyer, 1997). We analysed students' experiences in the post-adoption situation by collecting qualitative and quantitative data with a questionnaire after the experiment.

The participants included 100 undergraduate students from a Finnish university of applied sciences. The experiments were conducted in classrooms, with 20–25 users in each group. The selection criterion was that the participants should represent potential real-life users of AR applications. The socio-demographic profile represented the segment of higher education students, who were young males and females. In addition, 81% of the participants shared content on social media at least monthly and 47% shared weekly. Table I presents the students' socio-demographic profiles.

A 3D-based AR application was delivered to each participant. The researcher explained the purpose and procedure of the experiment at the beginning of the study and supervised the experiment, which lasted for 40 minutes on average, including the briefing, test usage and questionnaire completion. The researcher handed written instructions that included the AR target

image. In the experiment, the users downloaded the Arilyn application to their smartphones to scan the AR application. The 3D-based AR application was a part of the campaign of a dairy firm that was shared on their milk cans. The content of the AR application presented "an interactive 3D morning cat", and the users were able to play with the cat on the screen of their smartphones. They accomplished the experiment alone or shared their devices with two or three other users when conducting the VR headset and AR experiments. In addition to the AR experiment, we asked them to use 360-degree exercise-videos with or without VR headsets. The purpose of the VR experiment was to compare the user experiences of AR with those of VR mainly from the perspective of augmentation and virtual presence. The users responded to the research questions of the questionnaire right after they had used the AR application.

Table I. Users' socio-demographic data, prior experiences and social media activity

Gender			**Number (*N*)**	**Percent (%)**
	Female		39	39
	Male		61	61
Age (years)				
	18–20		7	7
	21–30		77	77
	30+		16	16
Previous experience				
	AR			
		Yes	55	55
		No	45	45
The frequency of content sharing on social media				

	Daily	12	12
	Weekly	35	35
	Monthly	34	34
	A couple of times a year	15	15
	Never	4	4

3.2 Measures

Several studies in the literature (e.g. Alamäki *et al.*, 2019; Gerpott and Thomas, 2014) have shown that emotional experiences or expectations affect the willingness to adopt new technologies. Therefore, we collected user experiences related to instant feelings of AR usage. We asked the users to respond to the following open-ended questions: "Describe your first impressions of the technology (AR)", "What issues surprised you about the technology (AR)?", and "If you compare your VR and AR user experiences, what differences are there from the user's perspective?" The willingness to share videos on social media was measured with the question "I would willingly share corresponding AR applications on social media". We adapted emotional scales on the basis of previous studies (Falk *et al*., 2016; Venkatraman *et al*., 2015) to carry out research into the emotional responses related to VR and AR experiences. The questionnaire included the following emotional questions rated on a 5-point Likert scale (5 = strongly agree to 1 = strongly disagree): "AR helped me to feel the following emotions: (boring, negative, depressing, unpleasant, exciting, encouraging, inspiring and relaxing)". In addition, five questions concerned the demographics and prior experience of AR applications and the willingness to share content on social media.

3.3 Data analysis

The data set consisted of 100 completed questionnaires. In the qualitative analysis of the open-ended questions (Tables II–IV), open coding was applied without predefined coding categories because the

literature review facilitated an understanding of user experiences (Strauss & Corbin, 1998). The coding of students' responses involved marking all comments, mentioning or explaining user experiences. The results showed that the students reported similar experiences with synonymous terms in the open-ended questions, which allowed for the construction of new categories.

Data analysis was performed using SPSS Statistics (v.23; IBM Corp. Armonk, NY, USA). First, the negative and positive experience variables were transformed so that the higher the number, the more participants agreed with the statements. Second, the positive and negative scales were formed by summarizingthe original variables. Because the level of Cronbach alpha was high (between 0.82 and 0.902), we used all original experience variables in each sumscale. Thus, we used six sum variables—negative and positive experiences relating to AR—as explainable variables in further analysis. We conducted independent-samples *t*-tests and one-way analysis of variance (ANOVA) with post hoc Tukey tests for each pairwise comparison to test the connections between the students' positive and negative AR experiences and their background variables. The alpha was set at 0.05. We also ran a correlation analysis to understand the connections between all variables. The relationships between the gender and user experiences of different applications are reported in another article (Dirin *et al.*, 2019) and are thus excluded from this one.

4. Results

4.1 Users' initial AR experiences

We asked the users if they had prior experience of using AR in order to analyse their initial experiences ("the first-timer users"). In this analysis, we used responses only from those who were using AR for the first time; thus, they were users with no prior experience. We classified positive and negative experiences (Table III) and grouped them into different themes. The results point out that the users' first experiences of AR were generally positive, and they mentioned themes to be most often "fascinating" and "interesting". However, the users also experienced technical challenges and dissatisfied experiences. For example, a 20- to 30-year-old female user who had no prior experience

with AR stated about her first experiences as follows: “I was positively surprised at how much additional information it is possible to deliver with AR, and how it livens up advertisements”. A 20- to 30-year-old male user who shares content on social media monthly shared his first experience with AR: “It requires only your own phone and an app; thus, I as a user have a lower threshold to open and watch the advertisement”.

Table II. Positive and negative experiences of using AR for the first time ($N = 45$)

Positive first experience of AR	**Number**
Fascinating	22 (49%)
Interesting	11 (24%)
Surprising (unexcepted experience happened)	6 (13%)
Made the advertisement livelier	2 (4%)
Other	7 (16%)
Negative first experience of AR	**Number**
Technical challenges	8 (18%)
Dissatisfactory experiences	9 (20%)
Useless	5 (11%)

The technology, which can be used to create a wonderful experience, impressed the users using the AR application for the first time. A male aged 20–30 years described his experience as follows: “It was a completely new experience. The way the cat jumped out of the logo was quite exciting and surprising”.

Table III. Surprising issues when using AR for the first time ($N = 45$)

Issues	**Number**

Wonderful experience	16 (36%)
No surprising issues	8 (18%)
Quality	8 (18%)
Ease of use	6 (13%)
The technology itself	1 (2%)
Made to feel sick or it hurt the eyes	0 (0%)

4.2 Comparing AR and VR user experiences

We asked the users to describe the differences they experienced between their AR and VR usage. The results show that the users found VR to be significantly more difficult to use, and even though VR provides a more virtual presence experience, they found AR experiences to be more interactive. VR creates a potentially deeper emotional experience because it creates "virtual presence" that the user audiovisually experiences. A 20- to 30-year-old male user described it as "difficult and more expensive but with the possibilities of creating great and bombastic experiences and emotions". The users also stated that "VR is more for watching and AR is more interactive" (male, 20–30 years, with prior VR experience, but no prior AR experience); "AR is boring; with VR you get to be a part of something" (male, 18–20 years, no prior VR and AR experience); and "With VR, you can only watch, but with AR you can also do" (male, 20–30 years, with prior VR and AR experience). The results indicate that AR is interactive and enables users to interact with the application, whereas VR involves watching and experiencing a virtually generated audiovisual experience.

Table IV. Users' perceived differences between VR and AR ($N = 93$)

VR	**AR**
More difficult to use 12 (13%)	Easier to use 17 (18%)

Provides VR 9 (10%)	Provides augmentation 6 (7%)
More emotional experiences 8 (9%)	More emotional experiences 2 (2%)
Easier to begin to use 2 (2%)	Easier to begin to use 6 (7%)
Hurts my eyes (unlike AR) 4 (4%)	—
More expensive (requires VR headsets) 2 (2%)	—
—	More interactive 9 (10%)
—	More interesting 8 (9%)
Other 5 (5%)	Other 7 (8%)

The users' initial perception changed by experimenting with AR and VR applications. Initially, the students hesitated to use AR and VR applications, as most lacked prior experience with these technologies. Positive AR and VR experiences were constructed after the experiment, although some students experienced technical challenges with the adoption of VR headsets. The findings presented in Table V show that the positive emotional experience constructed during the experiment affected their willingness to share them on social media.

4.3 The relationship between the willingness to share AR and the users' emotional experience

The Pearson correlation and coefficient of determination between the user experience and willingness to share variables are presented in Table V. A strong correlation was found between the willingness to share AR applications and positive user experience relating to AR ($r = .681$, $R^2 = 0.46$). In addition, the relationship between the willingness to share AR applications and negative user experience relating to AR ($r = -.569$, $R^2 = 0.32$) was statistically significant at the 0.01 level. The results show that the willingness to share AR on social media has a strong relationship with user experiences.

Table V. The relationship between the willingness to share and user experience variables

		User experience variables	
		Negative AR	Positive AR
Willingness to share variable AR	*r*	−.569**	.681**
	R^2	0.32	0.46

r Pearson correlation.

R^2 Coefficient of determination.

** Correlation is significant at the 0.01 level (two-tailed).

* Correlation is significant at the 0.05 level (two-tailed).

5. Discussion

In line with expectation disconfirmation theory (Oliver, 1980, 1993), we focused on user experiences in the post-adoption situation. In the post-adoption situation, the participants had just gained real-life usage experiences of AR applications before they responded to the questionnaire. In the following text, we discuss in more detail the findings from the viewpoint of the research questions.

The first research question of this study examined the users' experiences of using AR for the first time. The findings show that 45% had not used AR before (see Table I). The most-often-mentioned emotional responses of the users were categorized as interesting and fascinating (see Table II). In addition, the users found AR to be suitable for interacting, which is an important feature in developing user engagement. This differentiates AR applications from online videos or conventional websites, as users are directly interacting with AR content. The AR technology illustrates augmentation features and makes content livelier.

The augmentation as a value-creating mechanism seems to create a surprising emotional reaction because it created a completely new experience when an interactive 3D object jumped to the mobile phone screen while scanning the AR target (see Table III). Hence, this completes our understanding of expectation disconfirmation theory (Oliver, 1980, 1993), as performance may create

unexpected experiences. Thus, the adoption of AR in the first time does not necessarily confirm or disconfirm the original expectations, but it creates new expectations that have an effect in following usage experiences. This is an important finding in the educational context because prior research (e.g. Berger and Milkman, 2012; Huang *et al.*, 2016) shows that positive emotional experiences positively affect behavioural intentions and enhance learning outcomes. The users remember better issues related to their initial experiences, and it captures their interests.

The second research question was aimed at finding the differences between user experiences of AR and VR headsets at the general level. This study points out that the users found AR easier to use, and it seems to activate them more (see Table IV), which is an important finding in the selection of suitable digital means. The AR users need to download and install the correct AR application, scan the AR target image and interact with the content using their mobile phones. The VR experience requires installing, managing and interacting with 360-degree videos with "cardboard-style" VR headsets, which are more complicated to use for the first time. Prior research (Hornbæk and Hertzum, 2017) has shown that perceived enjoyment, namely emotional experience, has a stronger effect on attitude towards new technology than perceived usefulness and ease of use. Although this study shows that the students found AR to be easier to use, the difference was not that clear concerning emotional responses. Some experienced VR to be more interesting, whereas some preferred AR. Thus, emotional responses call for further research with more tight research settings. Hornbæk and Hertzum (2017) stated that it is still unclear why the relationship between emotional factors and attitude exists and in which situations.

This study shows that AR and VR applications have different roles as platforms in consuming digital learning content: VR creates telepresence experiences such as "I feel like I was there", whereas AR livens up digital content through higher interactive features such as "It embeds virtual into the physical". To put it simply, AR combines physical and virtual objects by activating interactions, whereas VR presents virtually remote visual surroundings without mixing physical and

virtual objects. For example, VR enriches learning by bringing the 3D-based audiovisual information of remote locations or situations to the actual learning situation, whereas AR provides additional 2D- or 3D-based audiovisual information tightly connected to physical objects or surroundings. However, AR and VR have shortcomings compared to conventional videos or other web or mobile content that is already widely used by the users.

The third research question focused on the relationship between the willingness to share on social media and the users' emotional responses to AR. The findings (see Table V) show a clear correlation between emotional responses and willingness to share AR content ($p < .01$). This is an interesting finding because 3D-based AR applications potentially promote WOM on social media, which is the ultimate goal of social media marketing (Tiago and Veríssimo, 2014). This study shows that the more users like AR applications, the greater their willingness to share them through social media channels. In fact, a similar effect happened in terms of both positive and negative constructs of emotional measures. The results indicate that negative experiences decreased the willingness to share content and positive experiences increased it. Berger and Milkman (2012) found a relationship between emotional responses and willingness to share digital newspaper articles, but we showed in the context of AR applications. This is also an important finding for educators, as students seem to share AR content only if they liked it. Prior research (Chen *et al.*, 2012; Jahanmir and Cavadas, 2018) shows that negative WOM about new technology decreases the rate of adoption and behavioural intention of users. Thus, we conclude that positive social media sharing related to AR content increases the rate of adoption and students' engagement with new technologies. Furthermore, positive emotional experiences enhance social media sharing that promotes students' informal learning.

The results of this study created a new understanding of the determinants of AR adoption. This study especially emphasizes the role of surprising positive emotions from the viewpoint of rewarding learning experiences. The findings suggest that AR is easy to adopt among first-time users, and it provides emotionally engaging tools to share learning content. Furthermore,

its user experience might sometimes be positively surprising, which is an important finding from the viewpoint of rewarding learning experience (Pagnoni *et al.*, 2002; Schultz, 2015). Positive user experiences also promote social sharing, which is important for informational learning. This would allow designers and educators to develop technologies that diffuse faster (Jahanmir and Cavadas, 2018) and engage students in informal learning through social media (Dabbagh and Kitsantas, 2012). They also provide hints on the future preferences of new AR users (Hallikainen *et al.*, 2019b).

6. Limitations and future research

This study has the following limitations: First, device-related issues may affect user experiences, for AR might provide slightly different usability experiences depending on the mobile phone versions. Second, this study used quite a small target group, which limits the generalizability of the results. Nevertheless, the role of emotions, augmentation (AR) and virtual presence (VR) merits further examination with identical content in more tight research settings. More research is needed to determine which specific features of AR applications create an actual effect that affects user experiences, surprising and rewarding learning experiences, and satisfaction. This knowledge could provide a new understanding of the mechanisms that create positive and negative emotions in adopting AR applications in different contexts.

Funding

This work was supported by the FESS-project and Helia Foundation.

Acknowledgements

Not applicable.

References

Alamäki, A., Pesonen, J. and Dirin, A. (2019), “Triggering effects of mobile video marketing in nature tourism: media richness perspective”, *Information Processing & Management,* Vol 56 No. 3, pp. 756-70.

Althoff, T., White, R. W., and Horvitz, E. (2016), "Influence of Pokémon Go on physical activity: study and implications”, *Journal of medical Internet research*, Vol. 18 No. 12, e315.

Anshari, M., Alas, Y., Hardaker, G., Jaidin, J. H., Smith, M., and Ahad, A. D. (2016), "Smartphone habit and behavior in Brunei: Personalization, gender, and generation gap", *Computers in Human Behavior*, Vol. 64, pp. 719-727.

Arpaci, I. (2016), “Understanding and predicting students' intention to use mobile cloud storage services”, *Computers in Human Behavior*, Vol. 58, pp. 150-157

Bhattacherjee, A., and Premkumar, G. (2004), “Understanding changes in belief and attitude toward information technology usage: A theoretical model and longitudinal test”, *MIS quarterly*, pp. 229-254.

Bechara, A. and Damasio, A.R. (2005), “The somatic marker hypothesis: a neural theory of economic decision”, *Games and Economic Behavior*, Vol. 52 No. 2, pp. 336-72.

Berger, J. and Milkman, K.L. (2012), “What makes online content viral?”, *Journal of Marketing Research*, Vol. 49 No. 2, pp. 192-205.

Chen, S. C., Yen, D. C., and Hwang, M. I. (2012), “Factors influencing the continuance intention to the usage of Web 2.0: An empirical study”, *Computers in Human Behavior*, Vol. 28 No. 3, pp. 933-941.

Cohen, L., Manion, L., and Morrison, K. (2013), *Research methods in education*. 7th edition. New York: Routledge.

Dirin, A. and Laine, T. (2018), “User experience in mobile augmented reality: emotions, challenges, opportunities and best practices”, *Computers*, Vol. 7 No. 2, pp. 33.

Dirin, A., Alamäki, A., and Suomala, J. (2019), “Gender differences in perceptions of conventional video, virtual reality and augmented reality”, *International Journal of Interactive Mobile Technologies*, Vol. 13 No. 6, pp. 93-103.

Du, R., Li, D., and Varshney, A. (2019), Geollery: A mixed reality social media platform. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, pp. 1-13.

Eastin, M.S., Brinson, N.H., Doorey, A. and Wilcox, G. (2016), “Living in a big data world: Predicting mobile commerce activity through privacy concerns”, *Computers in Human Behavior* Vol. 58, pp. 214-220

Falk, E.B., O’Donnell, M. B., Tompson, S., Gonzalez, R., Dal Cin, S., Strecher, V. and An, L. (2016), “Functional brain imaging predicts public health campaign success”, *Social Cognitive and Affective Neuroscience*, Vol. 11 No. 2, pp. 204-14.

Dabbagh, N., Kitsantas, A. (2012), "Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning", *The Internet and higher education*, Vol 15 No. 1, pp. 3-8.

Garcia, E., Elbeltagi, I. M., Dungay, K., Hardaker, G. (2015), "Student use of Facebook for informal learning and peer support", *The International Journal of Information and Learning Technology*, Vol. 32 No. 5, pp. 286-299.

Gerpott, T.J. and Thomas, S. (2014), "Empirical research on mobile Internet usage: A meta-analysis of the literature", *Telecommunications Policy*, Vol. 38, pp. 291–310.

Hallikainen, H., Alamäki, A. and Laukkanen, T. (2019a), "Individual preferences of digital touchpoints: A latent class analysis", *Journal of Retailing and Consumer Services*, Vol. 50, pp. 386-393.

Hallikainen, H., Alamäki, A., and Laukkanen, T. (2019b), "Lead users of business mobile services", *International Journal of Information Management*, Vol. 47, pp. 283-292.

Harley, J. M., Poitras, E. G., Jarrell, A., Duffy, M. C., and Lajoie, S. P. (2016), "Comparing virtual and location-based augmented reality mobile learning: emotions and learning outcomes", *Educational Technology Research and Development*, Vol *64*, pp. 359-388.

He, Z., Wu, L. and Li, X.R. (2018), "When art meets tech: the role of augmented reality in enhancing museum experiences and purchase intentions", *Tourism Management*, Vol. 68, pp. 127-39.

Hornbæk, K., and Hertzum, M. (2017), "Technology Acceptance and User Experience: A Review of the Experiential Component in HCI", *ACM Transactions on Computer-Human Interaction*, Vol. 24 No. 5, pp. 1–30.

Holtzblatt, K., and Beyer, H. (1997). *Contextual design: defining customer-centered systems*. Elsevier.

Huang, E.Y, Lin, S-W. and Fan Y-C (2015), **"**M-S-QUAL: Mobile service quality measurement", *Electronic Commerce Research and Applications*, Vol. 14, pp. 126–142.

Huang, T. C., Chen, C. C., and Chou, Y. W. (2016), "Animating eco-education: To see, feel, and discover in an augmented reality-based experiential learning environment", *Computers & Education*, Vol. 96, pp. 72-82.

Irshad, S. and Rambli, D.R.B.A. (2014), "User experience of mobile augmented reality: A review of studies", in *2014 3rd International Conference on User Science and Engineering (i-USEr),* IEEE, pp. 125-30.

Jahanmir, S. F., and Cavadas, J. (2018), "Factors affecting late adoption of digital innovations", *Journal of business research*, Vol. 88, pp. 337-343.

Javornik, A. (2016), “Augmented reality: research agenda for studying the impact of its media characteristics on consumer behavior”, *Journal of Retailing and Consumer Services*, Vol. 30, pp. 252-61.

Kargas, A., Karitsioti, N., and Loumos, G. (2020), "Reinventing Museums in 21st Century: Implementing Augmented Reality and Virtual Reality Technologies Alongside Social Media's Logics", In Virtual and Augmented Reality in Education, Art, and Museums, IGI Global, pp. 117-138.

Karjaluoto, H, Töllinen, A., Pirttiniemi, J. and Jayawardhena, C. (2014), “Intention to use mobile customer relationship management systems”, *Industrial Management and Data Systems,* Vol. 114 No. 6, pp. 966 – 978.

Kim, H.W., Chan, H.C. and Gupta, S. (2007), “Value-based Adoption of Mobile Internet: An empirical investigation”, *Decision Support Systems*, Vol. 43, pp. 111 –126.

Kipper, G. and Rampolla, J. (2013), *Augmented Reality: An Emerging Technologies Guide to AR*. Elsevier, Waltham, MA.

Knutson, B. and Greer, S. M. (2008), “Anticipatory affect: neural correlates and consequences for choice”, *Philosophical Transactions of the Royal Society B: Biological Sciences*, Vol. 363 No. 1511, pp. 3771-86.

Laine, T.H., Nygren, E., Dirin, A. and Suk, H.J. (2016), “Science Spots AR: a platform for science learning games with augmented reality”, *Educational Technology Research and Development*, Vol. 64 No 3, pp. 507-31.

Lee, T.M. and Park, C. (2008), “Mobile technology usage and B2B market performance under mandatory adoption”, *Industrial Marketing Management,* Vol. 37, pp. 833–840.

Maguire, M. (2001). Methods to support human-centred design. *International journal of human-computer studies*, *55*(4), 587-634.

Mano, H., and Oliver, R. L. (1993), “Assessing the dimensionality and structure of the consumption experience: evaluation, feeling, and satisfaction”, *Journal of Consumer research*, Vol. 20 No. 3, pp. 451-466.

Nguyen, N., Muilu, T., Dirin, A. and Alamäki, A. (2018), “An interactive and augmented learning concept for orientation week in higher education”, *International Journal of Educational Technology in Higher Education*, Vol. 15 No. 35, pp. 1-15.

Oliver, R. L. (1977), “Effect of expectation and disconfirmation on postexposure product evaluations: An alternative interpretation”, *Journal of applied psychology*, Vol. 62 No. 4, pp. 480.

Oliver, R. L. (1980), “A cognitive model of the antecedents and consequences of satisfaction decisions”, *Journal of marketing research*, Vol. 17 No. 4, pp. 460-469.

Oliver, R. L. (1993), “Cognitive, affective, and attribute bases of the satisfaction response”, *Journal of consumer research*, Vol. 20 No. 3, pp. 418-430.

Olsson, T., Lagerstam, E., Kärkkäinen, T. and Väänänen-Vainio-Mattila, K. (2013), "Expected user experience of mobile augmented reality services: a user study in the context of shopping centres", *Personal and Ubiquitous Computing*, Vol. 17 No. 2, pp. 287-304.

Pagnoni, Giuseppe, Caroline F. Zink, P. Read Montague, and Gregory S. Berns. (2002), "Activity in Human Ventral Striatum Locked to Errors of Reward Prediction." Nature Neuroscience Vol 5 No. 2, pp. 97–98.

Pantano, E. and Servidio, R. (2012), "Modeling innovative points of sales through virtual and immersive technologies", *Journal of Retailing and Consumer Services*, Vol. 19 No. 3, pp. 279-86.

Park, B., Blevins, E., Knutson, B. and Tsai, J.L. (2017), "Neurocultural evidence that ideal affect match promotes giving", *Social Cognitive and Affective Neuroscience*, Vol. 12 No. 7, pp. 1083-96.

Pessoa, L. (2008), "On the relationship between emotion and cognition", *Nature Reviews. Neuroscience*, Vol. 9 No. 2, pp. 148-58.

Poushneh, A. and Vasquez-Parraga, A.Z. (2017), "Discernible impact of augmented reality on retail customer's experience, satisfaction and willingness to buy", *Journal of Retailing and Consumer Services*, Vol. 34, pp. 229-34.

Roos, I., Edvardsson, B. and Gustafsson, A. (2004), "Customer switching patterns in competitive and noncompetitive service industries", *Journal of Service Research*, Vol. 6 No. 3, pp. 256-71.

Ruiz-Ariza, A., Casuso, R. A., Suarez-Manzano, S., and Martínez-López, E. J. (2018), "Effect of augmented reality game Pokémon GO on cognitive performance and emotional intelligence in adolescent young", *Computers & Education*, Vol. 116, pp. 49-63.

Sánchez, Á., Barreiro, J.M. and Maojo, V. (2000), "Design of virtual reality systems for education: a cognitive approach", *Education and Information Technologies*, Vol. 5 No. 4, pp. 345-62.

Shapsough, S., Hesham, A., Elkhorazaty, Y., Zualkernan, I. A., and Aloul, F. (2016, September). Emotion recognition using mobile phones. In *2016 IEEE 18th International Conference on e-Health Networking, Applications and Services (Healthcom)* (pp. 1-6). IEEE.

Schultz, W. (2015), "Neuronal Reward and Decision Signals: From Theories to Data." Physiological Reviews Vol. 95 No. 3, pp. 853–951.

Skarin, F., Olsson, E.L., Roos, I. and Friman, M. (2017), "The household as an instrumental and affective trigger in intervention programs for travel behavior change", *Travel Behaviour & Society*, Vol. 6, pp. 83-9.

Strauss, A. and Corbin, J.M. (1998), *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, 2nd ed., Sage Publications, Thousand Oaks, CA.

Thong, J. Y., Hong, S. J., and Tam, K. Y. (2006), "The effects of post-adoption beliefs on the expectation-confirmation model for information technology continuance", *International Journal of Human-Computer Studies*, Vol. 64 No 9, pp. 799-810.

Tiago, M.T., and Veríssimo, J.M.C. (2014), "Digital marketing and social media: Why bother?", *Business horizons*, Vol. 57 No. 6, pp. 703-708.

Uhomoibhi, J., Onime, C., Wang, H. (2020), “A study of developments and applications of mixed reality cubicles and their impact on learning”, *The International Journal of Information and Learning Technology,* Vol. 37 No1/2, pp. 15-31.

Vaterlaus, J. M., Barnett, K., Roche, C., and Young, J. A. (2016), “Snapchat is more personal”: An exploratory study on Snapchat behaviors and young adult interpersonal relationships”, *Computers in Human Behavior*, Vol. 62, pp. 594-601.

Venkatraman, V., Dimoka, A., Pavlou, P. A., Vo, K., Hampton, W., Bollinger, B., … Winer, R. S. (2015), “Predicting advertising success beyond traditional measures: new insights from neurophysiological methods and market response modeling”, *Journal of Marketing Research*, Vol. 52 No. 4, pp. 436-52.

Yoke, S. K., Ahmad, T. S. A. S., & Hasan, N. H. (2019). Exploring the potential of augmented reality in English for report writing: A perceptive overview, *International Journal of Education*, Vol. 4 No. 33, pp. 13-21.

Yuen, S. C. Y., Yaoyuneyong, G., and Johnson, E. (2011), "Augmented reality: An overview and five directions for AR in education. *Journal of Educational Technology Development and Exchange*", Vol. 4 No. 1, pp. 11.