Can Augmented Reality (AR) applications enhance students' experiences?
Gratifications, engagement and learning styles

Journal:	*Information Technology & People*
Manuscript ID	ITP-10-2021-0823.R2
Manuscript Type:	Article
Keywords:	Blended learning < Phenomenon, Interactive media < Technology, User satisfaction < Individual attribute < Unit attribute, Structural equation modeling < Quantitative method < Method, Partial least squares < Quantitative method < Method, User participation < Information system development < Practice

Can Augmented Reality (AR) applications enhance students' experiences? Gratifications, engagement and learning styles

Abstract

Purpose

The use of augmented reality (AR) and experiential learning go hand in hand. Although AR learning opportunities have been previously explored, there is limited empirical research on the use of AR within higher education settings. Drawing from the Uses and Gratifications Theory (U&GT), this study investigates the use of AR for learning satisfaction and student engagement, while also examining differences in learning styles.

Design/methodology/approach

This study used experiments with higher education students in the UK to explore the use of AR as part of the learning experience. Data from 173 students who experienced AR as part of their learning experience was analysed using Partial Least Square analysis.

Findings

We found that hedonic, utilitarian, sensual and modality gratifications influence AR learning satisfaction and student engagement. Furthermore, we found differences between active and passive learners with regards to utilitarian (information seeking, personalisation) and sensual gratifications (immersion, presence) and effects on learning satisfaction.

Originality

This study developed and validated a U&GT framework incorporating different learning styles rooted in Kolb's learning cycle. Findings provide important implications for the use of commercial AR applications as part of the learning experience within higher education settings.

Keywords: *Augmented Reality; Kolb's experiential learning cycle; satisfaction; gratifications; engagement; U&GT*

Introduction

"*What is fascinating about learning is that it cannot occur without experience* (Morris, 2020, p. 1064). Fun - engaging – informative - are words used to describe augmented reality (AR) (Calbero-Almenara *et al.*, 2019; Moorhouse *et al.*, 2019). Compared to traditional learning approaches (e.g., static, 2D information), AR adds a new layer of interactive information through the digital overlay of content into users' immediate surroundings (Alimamy & Nadeem, 2021; Ghazali *et al.,* 2019; Uriarte-Portillo *et al.,* 2023). This is especially important

in the current climate, as an increasing number of educators seek value adding learning tools to create blended learning approaches. Covid-19 forced many institutions to move to offline and blended teaching, reducing possibilities for student interaction (van der Keylen *et al.*, 2020; Lemay *et al.*, 2021), sparking a shift and increased interest in technology-enhanced learning tools to improve personalisation and create user-centered experiences (Iqbal *et al.,* 2022). Although AR learning opportunities have been well discussed (e.g., Akçayır and Akçayır, 2017), there is a general lack of empirical research on the use of AR within higher education settings. Recent studies call for further investigation of ARs potential as a learning tool in higher education settings (e.g., Avila-Garzon *et al.* 2021; Sırakaya and Sırakaya, 2022), especially in the field of business and law (Garcon and Acevedo, 2019). But are students satisfied with current learning activities? Does AR enhance learning experiences? Further research is necessary to understand higher education students' satisfaction and engagement using AR as a learning tool.

Originating in human communications research, the Uses and Gratifications Theory (U&GT) proposes "audiences consciously choose the medium that could fulfil their needs and that they are able to recognize their reasons for making media choices" (Shao, 2009, p. 8). U&GT is centred on the assumption individuals use media to gratify specific needs (e.g., enjoyment, socialising) (Raacke and Bonds-Raacke, 2008; Rauschnabel *et al.*, 2017) and has been used to explain why people choose to consume one media over another (e.g. Gallego *et al.*, 2016; Luo and Remus, 2014). As such, U&GT explores the social and psychological motives, and the consequences of pursuing these needs from a media use and consumption perspective (Katz *et al.,* 1973b). Thus, it is assumed psychological needs will result in specific expectations (behavioural intentions) of media usage (Chen, 2011).

To date, U&GT research has largely focused on the adoption of media in the traditional sense. However, learning techniques within the classroom are developing and new media is starting to become a staple part of interactive learning experiences (Engerman and Otto, 2021). Consequently, exploring the gratifications that are evoked as part of the learning experience is an important research endeavour. Interestingly, to the best of our knowledge, no previous research explores how commercial AR applications (e.g., IKEA Place, Wanna Kicks) influence the learning experience of business and marketing students. Rauschnabel *et al.* (2019) suggested that AR is an integral part of future marketing strategies. Consequently, the incorporation of commercial AR applications within higher education is considered an important step towards educating future managers, technology consultants and crucially addressing the skills gap by encouraging the development of skills and awareness of immersive

technologies increasingly demanded by industry. Therefore, we propose to address the following research question:

RQ1: What gratification factors influence AR learning experiences in higher education?

In addition, studies confirmed the suitability of immersive technologies, such as AR, as a tool to improve experiential learning (e.g., Lai *et al.*, 2009). One of the leading theories to explore experiential learning experiences is Kolb's Learning Cycle (Kolb, 2014). However, to date there has been limited investigation of the suitability of AR for different learning styles. Although there are a broad range of studies exploring Kolb's learning cycle within the education domain (e.g., Moorhouse *et al.*, 2019), as well as research on U&GT as part of the immersive technology experience (e.g. Rauschnabel *et al.*, 2017), a holistic and all-encompassing model integrating Kolb's learning cycle as part of a multigroup analysis and U&GT has not yet been developed. According to Rueda *et al.* (2017, p. 1059), "understanding how information technology (IT) resources create value in management education requires new and more powerful theories". Therefore, we are exploring how different learning styles react to and are satisfied by AR leading to the second research question:

RQ2: How do learning styles influence the AR learning experience?

Theoretical Background

Uses and Gratification Theory

Stemming from media research, the U&GT stipulates that consumers actively choose media based on goal-orientated behaviours to meet their social and psychological needs (Katz *et al.,* 1973b). Compared to more traditional media research which considers audiences as passive consumers of communication; U&GT is strongly rooted in the notion that consumers have different individual needs and wants and that different media is suitable for different purposes (Katz *et al.,* 1973b). Especially with the emergence and proliferation of technology (e.g., social media, immersive technology), an increasing number of scholars recognise the suitability of U&GT to explore consumers' media usage (e.g. Gan and Li, 2018; Ha *et al.*, 2015). Ruggiero (2000) agreed that the increasingly interactive nature of technologies strengthens the importance of U&GT as it emphasises its nature of the user being an active part of the communication process. Ko *et al.* (2005), focusing within their study on the use of the Internet,

revealed that U&GT is a motivational theory that provides one of the most relevant perspectives on psychological and behavioral dimensions in mediated communication. However, they also revealed that the majority of U&GT research relies on self-reported measures which may not be effective to fully explore motivational behaviours and consequences. Stafford *et al.* (2004), reiterated that an understanding of uses and gratifications of new technologies is essential in order to assess consumers' uses of media, as well as developing approaches that are more responsive to their needs. Early research on the sources of gratifications differentiated between media content, media exposure and the social context (Katz et al., 1973a). However, with the emergence of technologies, "the [U&GT] approach provides a nomological network for research rather than providing a predefined set of constructs or factors" (Li *et al.,* 2015, p. 262). The nature of media has changed, according to Sundar and Limperos (2013), with a stronger emphasis on interaction as part of the media consumption. It is therefore essential to explore specific needs rather than solely categories of needs, common in earlier studies (Rubin, 2009). As illustrated in Table 1, previous U&GT studies have examined a variety of contexts and constructs. Researchers have explored numerous gratifications, ranging from hedonic, social, utilitarian to technology, sensual and symbolic. Interestingly, there have been some overlaps in terms of defining gratifications. For example, whist Rauschnabel *et al.* (2017) classified enjoyment as an emotional gratification, the majority of previous studies categorised it as a hedonic gratification. This demonstrates the flexibility of the theory within different contexts and therefore applicability to study the gratification factors for AR learning experiences.

Please insert Table 1 here

As can be seen from Table 1, the U&GT has been applied to various contexts including AR, however research on the learning experience is limited. Traditional learning uses limited media and thus, U&GT may have had partial applicability in this context in the past. The emergence of new online and immersive teaching approaches raises questions regarding the fulfilment of students' needs with regards to media consumption and usage. The exploration of consequences of U&GT was an aspect often lacking from early research studies that focused on simply exploring motivations of media usage (Rubin, 2009). Therefore, focusing on a new medium such as AR and how this can be implemented as part of the higher education learning experience through the use of relevant gratification factors can contribute to future theoretical advancements, as well as practical changes to course design and development. In their recent

meta-analysis of AR in STEM education, Sırakaya and Sırakaya (2022) outlined only 17% of studies examined AR use in higher educational settings, instead commonly focusing on primary and secondary settings. They called for further investigation in this setting, to understand AR potential as an education tool. In addition, according to studies (e.g., Rauschnabel, 2018; Gan and Li, 2018) future U&GT research should incorporate moderators in order to fully understand differences in media adoption. Our study responds to this call for future research by conducting a multigroup analysis to explore differences in learning styles to fully understand the engagement of students through AR. Finally, as shown in Table 1, the majority of U&GT research to date was based on surveys, hence findings are dependent on participants memories of the experience of using the medium. In order to overcome this limitation, our study uses an experiment and survey design whereby participants try the AR medium prior to completion of surveys.

AR learning experience

Due to globally enforced population lockdowns and the resultant move to online digital teaching, educators have encountered a number of challenges. A consequence of this is that AR has gained much attention as a tool to improve learning experiences (Avila-Garzon *et al.* 2021; Sırakaya and Sırakaya, 2022; Uriarte-Portillo et al., 2023), because of its ability to add a layer of digital content to facilitate seamless interaction between reality and virtuality (Rauschnabel, 2021). According to tom Dieck and Han (2022, p. 110) "AR integrates virtual content in a user's perception of the real world, whereas traditional media typically present content separately from reality". As discussed by Rauschnabel *et al*. (2022), the advancement of AR capabilities and technologies will bring a stronger degree of local presence to the experience according to the XR framework. AR has been proven to enhance the achievement of learning outcomes and visualisation of information, by creating richer, more immersive content (Chen and Wang, 2018; Sırakaya and Sırakaya, 2022). Specifically, this has also been found to have a positive impact on learning motivation, interaction among learners, satisfaction, levels of engagement (Akçayır and Akçayır, 2017; Chen and Wang, 2018) and achievement (Sırakaya and Sırakaya, 2022). One advantage of AR over traditional teaching materials is its ability to enable users to view phenomena not possible in the real world (Yang *et al.*, 2018). Previous studies explore AR as a tool to improve learning experiences, for example in chemistry, history (Lim and Lim, 2020) and mathematics (Cai *et al.*, 2019).

Higher education students are mostly digital natives, having grown up with technology and consequently expect it to be integrated into all elements of daily life (Barak, 2018). Interestingly, common concerns regarding usability and unfamiliarity with new technologies have not been found to negatively impact the use of AR in education (Akçayır and Akçayır, 2017). For example, in a meta-analysis of studies between 2010-2018 Garzón and Acevedo (2019) reported a positive and moderate effect of AR on learning outcomes. Similarly, in a meta-analysis of AR in STEM subjects between 2010-2017 Ibáñez's and Delgado-Kloos (2018) found AR has a positive impact on students' conceptual understanding, motivation and engagement. In their recent meta-analysis, Sırakaya and Sırakaya (2022) confirmed AR positively improved learning achievements in STEM subjects. AR has also been proven to enhance the achievement of learning outcomes and visualisation of information, by creating richer, more immersive content (Chen and Wang, 2018; Wu *et al.*, 2013). As such, AR is reported to have a positive impact on learning motivation, interaction among learners, satisfaction and levels of engagement (Sırakaya and Sırakaya, 2022). Thus, AR can support pedagogical issues such as a "need for more class time, unsustainability in crowded classrooms" (Akçayır and Akçayır, 2017, p.8).

Kolb's experiential learning cycle

In stark contrast to traditional behavioural learning theories, experiential learning has been widely discussed in past decades with a strong emphasis on transforming experiences (Morris, 2020). One of the leading theories on experiential learning is Kolb's experiential learning cycle; rooted in earlier models of Lewin (1939), Dewey (1938) and Piaget (1970). Kolb's learning cycle consists of a number of characteristics: (1) learning is best conceived as a process, not in terms of outcomes, (2) learning is a continuous process grounded in experience, (3) learning is a holistic process of adaptation to the world, (4) learning involves transactions between the person and the environment, and (5) learning is the process of creating knowledge" (Moorhouse *et al.*, 2019, p. 407). Kolb's experiential learning cycle proposes that learning is a circular and ongoing process, whereby learners move from concrete experiences, reflective observations, abstract conceptualisations to active experimentations; however, the stage at which learners see themselves within the cycle is highly dependent on the specific learning situation. As shown in Figure 1, along the horizontal axis learning can range from active experimenters (pragmatic) to reflective observers (critical) depending on the learning experience. The vertical axis represents the perception continuum and ranges from concrete experience (contextually rich) to abstract conceptualisation (contextual specific) (Kolb, 2014).

From these, four groups emerge: (a) Divergers (CE/RO): includes students with higher imaginative and creative abilities to look at a situation through multiple perspectives and solutions. (b) Assimilators (RO/AC): are those students with an ability to plan, organize, and analyse systematically a variety of information. (c) Convergers (AC/AE): involves students with the ability to solve problems and make decisions proficiently with past lessons. (d) Accommodators (AE/ CE): are those students with active experimentation of learning that apply its experience to solve new problems (Manolis *et al.*, 2013).

Previous studies incorporated the model into their research on online classes (e.g Baasanjay, 2013), AR (Huang *et al.*, 2016); AR museum experiences (e.g., Moorhouse *et al.*, 2019), virtual computer labs (Konak *et al.*, 2014) and business simulation games (e.g., Ahn, 2008, Bamford *et al.*, 2012). However, according to Morris (2020), whilst experiential learning has the potential to strongly influence students' deep and contextual understanding, more research is required in order to fully understand how highly immersive experiences can enhance students' learning experiences. Hence, today's educators should also consider involvement, engagement, challenges, problem solving, and collaboration all of which have been identified as important learning experiences (Morris, 2020). In the context of the present study, we aim to explore how AR influences learning experiences and the differences between different types of learners. A previous study by Li *et al.* (2013) supported the use of Kolb's learning styles as moderators in order to fully understand differences in learning experiences.

Please insert Figure 1 here

Hypotheses development

Hedonic gratifications and learning satisfaction

According to Elson *et al.* (2014), hedonic gratifications are defined as users' immediate response of pleasure as part of an experience. Hedonic gratifications have been widely used in U&GT research ranging from enjoyment, passing time, fantasy, escapism, gaming and entertainment (e.g., Gan and Li, 2008; Li *et al.*, 2015). However, classification of these hedonic gratifications depends on the context of study. In previous AR studies, enjoyment and flow have been found as common hedonic gratifications by Rauschnabel (2017; 2018a; 2018b), which was therefore adopted for the context of our study.

Cheng and Jiang (2020) supported that hedonic gratifications influence user satisfaction of artificial intelligence (AI) applications; but this was found to be less significant than for instance utilitarian gratifications. This shows that gratification factors are highly context-

specific. For example, within the context of travel review websites, Wang and Li (2019) found that hedonic gratifications are the strongest predictor of user satisfaction; highlighting the difference between gratifications for AI (computer driven) and websites (consumer driven). Therefore, we propose:

H1: High hedonic gratifications have a positive influence on learning satisfaction.

Utilitarian gratifications and learning satisfaction

Human motivations can be divided into extrinsic and intrinsic (Rauschnabel, 2018a). Utilitarian gratifications are part of an extrinsic motivation and users' desire to gain utilitarian benefits such as convenience or the seeking of enhanced information. The concept is part the consumer behaviour literature that emphasises on consumers' and users' desire to obtain value as part of the experience (Chiu *et al.*, 2012). In addition, Cheng and Jiang (2020) defined utilitarian gratification as the fulfilment of individuals' utility needs, including information seeking. The positive influence of utilitarian gratifications on satisfaction has been confirmed within previous studies (e.g., Cheng and Jiang, 2020). Especially in the education and learning context utilitarian gratifications play a significant role in the satisfaction formation process. For instance, according to Thongpapanl and Ashraf (2011), personalisation is an essential concept as it reduces complexity for users and therefore enhances satisfaction. In line with Chiu *et al.*s' definition of utilitarian value, personalisation is an extrinsic motivation that enables users and consumers to receive enhanced and tailored information which is an important part of learning experiences. In addition, information seeking is one of the key aspects of education and is becoming increasingly important as a result of blended learning and online learning (El-Maamiry, 2017); and hence can have a strong effect on student satisfaction. Therefore, we propose:

H2: High utilitarian gratifications have a positive influence on learning satisfaction.

Sensual gratifications and learning satisfaction

"Augmenting people's senses with computational support can improve the ability to perceive information and perform tasks" (Kim and Dey, 2015, p. 9587). Studies have explored sensor augmentation and the extent to which individuals are able to sense aspects of the environment that are not normally perceivable (e.g., Kim and Dey, 2015). This study adopted the term sensual gratifications used by Rauschnabel (2018a), which refers to changes in an individuals' senses based on changes in their immediate environment. Within the learning context, Morris (2020, p. 1074) claimed "when learners are immersed, with their body, in a contextually rich

experience, sensory-motor information becomes embodied in memory traces [and therefore] it is thought that embodiment is essential for deep conceptual understanding and for human cognition to develop at the highest level". Therefore, immersion and presence have strong effects on AR learning satisfaction. Immersion is an important concept within AR research; referring to users' deep involvement within an experience. Presence is "a psychological state or subjective perception in which even though part or all of an individual's current experience is generated by and/or filtered through human-made technology, part or all of the individual's perception fails to accurately acknowledge the role of the technology in the experience" (Themelis *et al.*, 2020, p. 261). The influence of presence and immersion on satisfaction has been widely proven within the business and education context (e.g., Bulu, 2012; Zhu *et al.*, 2019). Further, Rauschnabel (2018b) proposed that sensual gratifications influence user reactions (e.g., satisfaction) and therefore, we propose:

H3: High sensual gratifications have a positive influence on learning satisfaction.

Modality gratifications and learning satisfaction

Sundar and Limperos (2013) proposed that due to the emergence of technologies, from more traditional media to new media, U&GT research needs to consider new gratifications in order to account for changes in behaviours. According to Lin *et al.* (2017), modality gratifications refer to the concept of different technologies revoking different responses in users. Modalities address "specific motivations of curiosity" (Vaterlaus *et al.*, 2019, p. 601). Among these modalities, the novelty and coolness factor of latest technologies were proposed to influence user behaviours (Sundar and Limperos, 2013). Novelty has been generally described as a lack of familiarity or experience with a given technology from the user's point of view (Hopp and Gangadharbatla, 2016). According to Wells *et al.* (2010), the novelty factor, its newness and freshness, is a key characteristic of any new innovation and technology. This is understood to strongly influence attitudes and adoption behaviours (Wells *et al.*, 2010). Especially in technologies such as AR (Song et al., 2019). The novelty factor has been found to be the strongest in initial interactions with a new technology and tends to decrease with continued usage of technologies and innovations (Hopp and Gangadharbatla, 2016). Especially with regards to AR and its limited use for learning purposes, the novelty factor is considered a key consideration in terms of creating satisfying experiences. In the context of the present study, we believe that the novelty factor of using AR applications contributes to students' satisfaction. Therefore, we propose:

H4: High modality gratifications have a positive influence on learning satisfaction.

Learning satisfaction and engagement

Satisfaction is a leading indicator of technology adoption, acceptance and behavioural intentions (Huang *et al.*, 2017; Wixon and Todd, 2005); and one of the most important factors in the field of marketing according to Dash *et al.* (2021). According to Papacharissi and Rubin (2000), communication satisfaction is an important outcome that relates to the fulfilling of expectations within U&GT research. Recently, Jessen *et al.* (2020) conducted a study on the potential of AR and found that customer engagement through AR leads to a greater anticipated satisfaction and increased behavioural intentions. This was confirmed within different business marketing (e.g. Huang *et al.*, 2017; Jung *et al.*, 2015) and learning studies (Liaw, 2008; de Melo Pereira *et al.*, 2015). Within the education context, learning satisfaction was found to particularly influence behavioural intentions within e-learning contexts. According to Pham et al. (2019, p. 9), "student satisfaction is always one of the university's most important goals" and therefore it is essential to explore how different learning techniques contribute to learning satisfaction, which in turn creates strong behavioural intentions.

Another important construct within the digital education domain is engagement, which as a behavioural intention within technology adoption research has so far received limited attention. There have been various definitions for student' engagements using terms such as involvement, motivation, connectedness, experience and the creation of interest (Groccia, 2018). As part of the student experience, engagement is a crucial factor as it was found to lead to improved learning outcomes (Rueda *et al.*, 2017). Skinner et al. (2008) motivationally conceptualised student engagement and differentiated between behavioural and emotional engagement. It was revealed that "engagement predicts students' learning, grades, and achievement test scores; over the long term, it predicts patterns of attendance, retention, graduation, and academic resilience" (Skinner *et al.,* 2008, p. 765). Another study that explored engagement within the context of AR applications for science heritage found that satisfaction with AR applications led to an increased engagement with science heritage content (tom Dieck *et al.*, 2018). Considering the importance of satisfied learning experiences on the engagement of students, we propose:

H5: Learning satisfaction has a positive influence on student engagement

Kolb learning stage moderation

Experiential learning has the potential to influence students understanding, however, more research is needed to comprehend how immersive experiences contribute to an enhancement of students' learning (Morris, 2020). Hence, assessing the role of different types of learners is crucial for educational purposes, especially when adopting immersive AR experiences (e.g., Huang *et al.*, 2016, Moorhouse *et al.*, 2019). In line with prior literature (Li *et al.*, 2013) we used Kolb's learning stages as a moderator in our model. The Kolb experiential learning framework consists of two axis: active experimenters to reflective observers, horizontally, and, concrete experience to abstract conceptualisation, vertically (Kolb, 2014). Li *et al.* (2013) found that learners in the divergent stage moderates the relationship between international experience and cultural intelligence. Hence, we argue the role of Kolb's model moderating our framework:

H6: Kolb's learning model moderates the impact of gratifications to learning satisfaction and students engagement.

Please insert Figure 2 here

Methods

Study design

We delivered seminars and conducted surveys with students in higher education to analyse the proposed model. We received ethical approval prior to conducting this study and students were informed that their participation was entirely voluntary and that there were no pressures/consequences nor academic benefits in terms of grades or relationships with the unit leader if they decided not to participate.

As part of the study design, the researchers conducted online guest seminars with business and management university students in which they were tasked to explore different AR applications as part of the teaching activity. The guest seminars took place in eleven different undergraduate and postgraduate units to introduce students to AR. Each group from each unit was provided with one AR session. The aim of these seminars was to explore how the use of actual AR applications adds to the delivery of traditional seminars, facilitating an interactive online learning approach. Students were instructed to download the AR applications prior to the seminar to allow for a smooth running of the session. Sessions lasted 60 minutes and included an introduction to AR, various use cases, opportunities for businesses, marketing and branding as well as students hands-on experiences with the Ikea Place app, Wanna Kicks (AR shoe try-ons), Specsavers (AR virtual glasses try-on) and BBC Civilisations AR. Students explored

these applications for around 20 minutes as part of the seminar activities. These applications were chosen due to their relevance to the course material, and crucially to showcase a range of different AR uses, including both AR apps and desktops-based experiences.

Measures and data collection

Measurement items were measured on a five-point Likert scale from strongly disagree to strongly agree and were adapted from previous research (see Table 4). To explore students' learning style, the reduced Kolb's learning cycle was taken from Manolis *et al.* (2013) using a seventeen-item scale (see Table 5). Additionally, profile questions were asked categorically as shown in Table 2. Eleven seminars were delivered and a total number of 173 students completed the Qualtrics survey between December 2020 and March 2021. There was an equal distribution between male (49.7%) and female (50.3%) participants. The majority of participants were undergraduate students (73.45), between the ages of 18 to 30 (84.4%) (see Table 2). Data was collected from students studying within the business and management disciplines. Surprisingly, quite a large percentage of students (60.7%) had no previous AR experience (including Pokémon Go which was discussed within the seminar).

Please insert Table 2 here

Results

This section shows the three steps of the main findings of this study. We start presenting the Confirmatory Factorial Analysis (CFA) procedures, followed by the Structural Equation Modelling (SEM) analysis and hypothesis tests, and finally, we explore differences and similarities in this model when comparing learners' groups.

We have used the Partial Least Square Structural Equation Modelling (PLS-SEM) to analyse all these steps through SmartPLS software version 3.3.3. This technique has been chosen because of the number of parameters in our model, the goal of predicting key constructs toward learning satisfaction and students' engagement, and the exploratory nature of this research (Hair, Ringle and Sarstedt, 2011, Hair, Matthews, Matthews & Sarstedt, 2017). We proceed with a correlation analysis to check the association and directions of construct relations. According to Table 3, the constructs present a positive correlation among them.

Please insert Table 3 here

Confirmatory Factorial Analysis

As the items came from prior studies, we ran a CFA to assess the contributions of each item to the constructs as the first step. As suggested by prior research (e.g. Hulland, 1999), we did not include items with loadings below 0.7. Following this procedure, only one item (Novelty 4 - It was an unusual experience) has been removed from our model. After removing that variable, the model found a representative number of respondents per item (173 respondents divided per 36 items = 4.8 respondents per item) according to suggested by experts (5 respondents per item) (Hair, Black, Babin and Anderson, 2019).

After this purification procedure, we found satisfactory Cronbach's alpha (Alpha), Composite Reliability (CR) and Average Variance Extracted (AVE) indicators (see Table 4). Results suggest values higher than expected by prior literature (Hair, Black, Babin and Anderson, 2019), being >0.7, >0.7 and 0.5, respectively. Furthermore, the convergent validity has been measured by Average Variance Extracted (AVE) of which values higher than 0.50 indicate a good degree to which a construct explains the variance of its items (Fornell and Larcker 1981). The AVE found values from 0.609 to 0.824. Also, discriminant validity presents higher values than correlation among other constructs (see Table 3), suggesting a distinguished measurement feature among constructs when assessed by cross-loading criteria (Henseler, Ringle, Sarstedt, 2015).

Please insert Table 4 here

Next, we assessed the model fit according to suggestions from prior literature (Benitez *et al*.,2020) through Standardized Root Mean Square Residual (SRMR) and discrepancy of the squared Euclidean distance (d_ULS) indicators. While SRMR shows .091 (ideally <0.080 but acceptable < 0.10) (Henseler *et al*., 2014), d_ULS indicates a value of 21.986 with upper bound of confidence 28.781 (<bootstrapped HI 95% of d_ULS) (Dijkstra and Henseler, 2015). This reveals an acceptable model fit.

Structural Equation Modelling

After purifying our model, we proceed to the next stage of data analysis. This section presents results related to the inferential analysis by using PLS-SEM. We have used second-order items to measure hedonic, utilitarian, sensual and modality gratifications. According to Figure 3, all second-order constructs follow positive and significant relationships.

Our results indicate a positive effect of Hedonic gratifications on learning satisfaction (loading= 0.389, p-value=0.000), when measured by enjoyment and flow constructs. It provides empirical evidence to support our first hypothesis (H1: Hedonic gratifications have a positive influence on learning satisfaction). Similarly, when measured by information seeking and personalisation, utilitarian gratification appears to influence learning satisfaction positively (loading= 0.257, p-value=0.002). This result supports our second hypothesis (H2: Utilitarian gratifications have a positive influence on learning satisfaction).

The third hypothesis analyses the relationship of sensual gratifications and learning satisfaction. The immersion and presence constructs were used to measure sensual gratifications. Against our expectations, our study shows a negative effect of sensual gratification on learning satisfaction (loading= -0.248, p-value=0.001). Therefore, according to this result, we found support to reject the third hypothesis (H3: Sensual gratifications have a positive influence on learning satisfaction).

The fourth hypothesis tests the relation between modality gratifications and learning satisfaction, when measured by novelty. Our results indicate that higher modality gratifications lead to increased learning satisfaction (loading= 0.429, p-value=0.000). From this, we support our hypothesis (H4: Modality gratifications have a positive influence on learning satisfaction).

Our results also suggest that higher learning satisfaction is associated with higher students' engagement (loading= 0.752, p-value=0.000). Therefore, it provides support to confirm the fifth hypothesis (H5: Learning satisfaction has a positive influence on engagement). Finally, the R squared (R^2) are presented in the constructs. As shown, they reveal a higher explanatory power of dependent variables reaching values from 0.561 to 0.880. Particularly, these results are higher than expected by studies in the Social Science field and similar to customer satisfaction and loyalty research areas (Hair, Hult, Ringle, and Sarstedt, 2014).

Finally, we included three control variables to analyse variances in the dependent variable, named as gender (male and female), AR experience (low or high), and students' level (undergraduate, postgraduate, MBA). A new model has been created with dependent and control variables only, and as we did not perceive any statistical difference among control variables, therefore, these results similarly apply for gender, AR experience, and students' level. After that, these results were aggregated into Figure 3.

Please insert Figure 3 here

Multigroup analysis

We also proceeded with a multigroup analysis to explore similarities and differences among different learning styles based on Kolb's experiential learning cycle. Firstly, we ran an Exploratory Factorial Analysis (EFA) to identify main factors in our data. Kolb's model considers four types of learning styles; however, our data suggests only two factors with Eigenvalues greater than 1 as pointed out by prior studies (Hayton, Allen and Scarpello, 2004). Hence, we classified them as Active learner and Passive learner. While Active learners involves the Acommodators (AE/CE) and Divergers (CE/RO) styles of Kolbs' learning model, Passive learners are formed by Assimilators (RO/AC) and Convergers (AC/AE) styles. The grouping learning styles has been also perceived in prior literature as well (e.g., Manolis, 2013).

Please insert Table 5 here

Considering two groups - active and passive learners, we identified in our sample the trend of each respondent regarding their predominant learning style. In the sequence, we proceeded with the multigroup analysis. The multigroup analysis is used to compare differences between groups in the same sample and explore differences in group-specific estimates (e.g., loadings, path coefficients) (Mathew, 2017). The following table compares path coefficients of both groups and checks statistical differences.

Please insert Table 6 here

From the analysis it becomes clear that there are similarities between both groups in most relations. However, a significant difference was found in the relation from sensual gratification to learning satisfaction. This relation is perceived negatively in both groups, however, we found statistical support to confirm the negative effect on learning satisfaction for passive learners only. This reveals that sensual gratifications (immersion and presence) reduce learning satisfaction for passive learners. What could be potential reasons for this? We assume that passive learners do not like to be involved in these kinds of pedagogical activities (e.g., immersive experiences), so once it requires the exposition of these students, it reduces their satisfaction. Particularly, this explains the reason for the third hypothesis rejection, as students' learning style is an important characteristic to consider when measuring learning satisfaction attributes. In addition, we found a slight difference in the relation of utilitarian gratifications

towards learning satisfaction between groups. We found support to confirm only the positive effect of passive learners on learning satisfaction. It suggests that higher utilitarian gratifications (information and personalisation) increase the learning satisfaction of passive learners. Conversely, active learners appear to not require these features as an input to enhance their learning satisfaction. Therefore, we found partial support to accept hypothesis 6, where different learning styles appear to have similarities in terms of gratifications, learning satisfaction and engagement for immersive experience.

Discussion and Conclusion

Our paper has been designed to make a contribution that is both rigorous and relevant (Hodgkinson and Rousseau, 2009), by considering both a theoretical and applied problem when formulating the research focus and positioning the contributions via the implications stated (Nicholson *et al.* 2018). According to Nicholson *et al.*'s (2018) conceptual framework our paper makes an incremental and revelatory contribution around key outputs and implications aligned to the developed themes. Therefore, given the increased recognition and exploration of AR applications and their potential in learning environments the study aimed to address two research questions;

RQ1: What gratification factors influence AR learning experiences?

RQ2: How do learning styles influence the AR learning experience?

The first of these, RQ1, has been addressed through the creation of a number of hypotheses:

Hypothesis 1: Hedonic gratifications have a positive influence on learning satisfaction.

The results indicate that this is indeed the case and supports the work of Wang and Li's (2019) research into satisfaction with travel review websites. They found specifically that hedonic gratification is a strong predictor of user satisfaction. Interestingly, Nelson *et al.* (2014) and their work on determinants of player experience in digital games identified hedonic gratifications are defined as the user's immediate response of pleasure as part of an experience. There is perhaps then a temporal element to the gratification and satisfaction linkage, in addition to the context specific nature of the experience. Of course, elements of enjoyment and flow are often cited as common hedonic gratifications, for example as per the work of Rauschnabel (2018b) exploring AR smart glasses and the attempt to create a gratification framework.

Hypothesis 2: Utilitarian gratifications have a positive influence on learning satisfaction.

This hypothesis was also supported when measured by information seeking and personalisation. Regarding the first of these points, El-Maamiry (2017) explored the information seeking behaviour of higher education students and determined it to be increasingly important as a result of blended learning and online learning. Regarding the second point, according to Thongpapanl and Ashraf (2011) and their research into online retailers, reported that website content personalisation is essential to reduce complexity and enhance satisfaction. Is there then perhaps an element of design priority - for form to follow function (Gellerman, 1990)?

Hypothesis 3: Sensual gratifications have a positive influence on learning satisfaction.

This third hypothesis was actually rejected by the results. In constructing the hypothesis, we tried to explore the relationship of sensual gratification and learning satisfaction. Interestingly, there was a negative effect of sensual gratification on the reported learning experience. In adopting the term sensual gratification coined by Rauschnabel (2018a) we sought to assess variations in student senses based on changes in their immediate environment. There is obviously something very interesting to explore here, as identified by Themelis *et al.* (2020) who, in their work exploring the uses of video conferencing to support online learning and teaching sought to define aspects of the psychological state and subjective perception. We therefore propose this as an interesting are area for future research.

Hypothesis 4: Modality gratifications have a positive influence on learning satisfaction.

Our results indicated that higher modality gratifications led directly to increased learning satisfaction. In testing the relation between modality gratification and learning satisfaction we sought to test our belief that the novelty factor of using AR applications contributes directly to student satisfaction. This builds on the work of Wells *et al.* (2010) who examined the role of novelty of IT innovation adoption. From our research, there is a strong linkage to the perceptions identified by Sundar and Limperos (2013) who sought to explore the uses of the internet and aspects of gratification. Their research moved the debate forward by identifying out-of-date perceptions regarding gratification, and that concepts informed by older media needed challenging. They clearly identified that the novelty and coolness factor of up-to-date technologies influenced user behaviour. However, a word of caution from Hopp and Gangadharbatla (2016) proposed in their work on augmented reality advertising (ARA), that

whilst the novelty factor is strong with initial interactions of new technology it tends to decrease with continued usage.

Similarly, RQ2 was explored through the creation of two hypothesis:
First, we tried to explore if AR learning satisfaction has a positive impact on student engagement in general before moving on to testing individual learning styles.

Hypothesis 5: Learning satisfaction has a positive influence on engagement.
The fifth hypothesis was supported in as far as higher learning satisfaction appeared tangibly associated with greater student engagement. This is supported by the work of tom Dieck *et al.* (2018) who explored visitor engagement with AR applications at science festivals and found that satisfaction with AR applications lead to increased engagement with science heritage content. Furthermore, Jessen *et al.* (2020) reported that AR is clearly emerging as a strategic experience design tool; driving creative customer engagement through greater anticipated satisfaction and increased behavioural intentions. Finally, Pham *et al.* (2019), when exploring e-learning service quality in education, stated the obvious but necessary goal, that student satisfaction is most important for universities and that it was therefore essential to be innovative with learning techniques to increase satisfaction. They suggested that this had the potential to increase aspects of loyalty amongst the student body. An interesting aspect of causal additionality through the implementation of technology transfer and adoption.

A final element to consider is use of multigroup analysis that attempted to explore similarities and differences amongst learning styles based on Kolb's (2014) experiential learning cycle. This was explored through the final hypothesis:

Hypothesis 6: Kolb's learning model moderates the impact of gratifications to learning satisfaction and student engagement.

According to Kolb, learners move through experiences, reflective observation, abstract conceptualisation to active experimentation. Importantly, he identified that the stage learners see themselves at within the cycle also has an impact. Our research indicates that only two factors were apparent, active and passive learners. Of these, it was evident that for passive learners sensual gratifications (immersion and presence) reduce learning satisfaction, and that higher utilitarian gratifications (information and personalisation) increase learning satisfaction. Conversely, active learners appear to not require these features as an input to enhance their

learning satisfaction. According to Morris (2020), who performed a systematic review and a revision of Kolb's model, only having an experience is not enough; specifically in education we must consider involvement, engagement, challenges, problem-solving et cetera. Li *et al.* (2013), in their work on cultural intelligence and learning styles, supported the use of Kolb's theory. We do not disagree, but do recommend that more work is needed here to develop the concept along the lines outlined by Morris (2020), with regards to AR enhanced learning experiences.

Empirical/Theoretical contributions

Agerfalk (2014) suggested that rather than claiming a number of direct theoretical contributions, papers should perhaps consider discussion of the empirical contribution and to link them to possible implications for theory. In our paper, we proposed and tested a model on the gratification factors (c.f. Wang and Li, 2019) that influence students' AR learning satisfaction and engagement. AR has received limited attention within the context of higher education research and particularly the use of commercial AR applications to gratify students' wants and needs and consequently providing satisfying and engaging learning experience has been unexplored (c.f. Garcon and Acevedo, 2019). This study supported four gratifications within the AR learning context including hedonic, utilitarian, sensual and modality; providing future U&GT research (c.f. Rauschnabel *et al.*, 2017) with a roadmap of implementing gratifications within the learning context. Second, this study used a different approach to the majority of U&GT papers (for instance in Table 1) by using a second-order approach of gratifications through reflective measurements. In doing so, it allows amplification of the measurement of each gratification construct and explains key items accordingly. Third, this study added modality as a gratification which in recent years has only received limited attention as part of theoretical approaches (c.f. Lin *et al.*, 2017; Sundar and Limperos, 2013).

However, due to the novelty of using commercial AR applications for learning and education (c.f. Hopp and Gangadharbatla, 2016; Sundar and Limperos, 2013; Wells *et al.*, 2010); the modality gratification was in fact one of the strongest gratification factors within our model. Fourth, our study conducted a multigroup analysis using Kolb's (2014) experiential learning styles as a foundation. Agerfalk (2014) emphasised the importance of empirical contributions to advance theory of the future. In the context of our study, the combination of Kolb and U&GT has not been explored prior to this research and thus provide am important empirical contribution. Findings have shown that different learning styles (active vs. passive)

have significant differences with regards to gratification factors and their influence on learning satisfaction.

Practical implications

As a first practical implication of this study, we believe this study provides a strong case for using commercial AR applications as part of unit design and delivery within higher education settings. This fulfils the recent gap identified by Avila-Garzon *et al.* (2021) and Sırakaya and Sırakaya (2022) calling for further investigation of ARs as a learning tool in higher education settings. Technological innovations have long been shown as powerful tools for active learning experiences and this study proves the use of commercial AR as an enhancer of the learning experience, for both active and passive learners. This lends itself to collaborations between industry and academia with regards to designing AR enabled course materials. For higher education institutions, this encourages the design of enjoyable and interactive materials which result in high learning satisfaction and student engagement. For industry, this provides an opportunity for brand recognition, acquisition of future employees' through engagement and the potential of the development of new target markets. Therefore, businesses are advised to work hand in hand with higher education institutions by delivering guest seminars using the latest AR technologies in order to capitalise from the findings of this study. In doing so, this will improve learning experiences, as well as provide real-life examples to business and management students. This approach could be particularly valuable for courses such as apprenticeships degrees, whereby universities work hand in hand with employers to explore the effect and impact of their digital solutions. In addition, higher education institutions are advised to more actively use and develop AR applications in order to foster experiential learning. Our study has shown that there are some differences between active and passive learners with regards to the gratifications they receive and the influence on learning satisfaction. Therefore, universities and application developers should consider different learning styles and requirements when developing and implementing AR as part of the curriculum. While highly immersive applications which provide escapism were found to be attractive for active learners, passive learners required a provision of information and personalised approaches to learning. This study helps understand why and how students use AR applications and provides education providers with the understanding for developments of effective digital learning experiences.

Limitations and future research

Irrespective of the contributions identified, this study holds its own limitations. Since this study examined learners in business and management disciplines, it is suggested future research should extend to include other disciples such as medicine and chemistry, where visualisation of complex information (e.g., anatomy, molecular structures) is an even more integral element to the learning experience. In future it would be interesting to examine the impact of AR on learning satisfaction in these contexts, and whether the unique nature of the course materials elicits differences in terms of learning satisfaction comparing different cohorts of students. One limitation of the present study is that data only lends itself to two categories of learners, specifically active and passive. Therefore, we propose future research to explore differences among all four categories in Kolb's experiential learning cycle. This would provide important insights into how students at different phases of the learning cycle would react and respond to the use of AR. In addition, cultural differences may affect the adoption of AR as part of the learning experience. Considering that this study has been conducted in a UK higher education institution further research is advised to explore the model in other cultural settings. Another limitation results from the self-reported measures used to collect data from participants. Considering the link between commercial applications and the enhancement of the learning experience explored in this study, future research is recommended to explore the influence of students' learning experience on the behavioural intentions to engage with brands and businesses. Also, we do recommend further research to explore the impact and suitability of scales adopted in AR studies (for instance, five, seven, nine and eleven-points Likert scales). Finally, it is highly anticipated that the future of the metaverse will bring challenges and opportunities in various sectors (Dwivedi et al., 2022). New research will be needed to explore the creation of engaging, escaping, and immersive learning experiences. Future research is advised to explore this new and innovative way of learning using a U&GT perspective.

References

Ågerfalk, P. J. (2014), "Insufficient theoretical contribution: a conclusive rationale for rejection?" *European Journal of Information Systems*, Vol. *23 No.* 6, pp. 593-599.

Ahn, J. H. (2008), "Application of the experiential learning cycle in learning from a business simulation game", *E-Learning and Digital Media*, Vol. 5 No. 2, pp. 146-156. doi.org/10.2304/elea.2008.5.2.146

Akçayır, M. and Akçayır, G. (2017), "Advantages and Challenges associated with augmented reality for education: A systematic review of literature", Educational *Research Review*, Vol. 20, pp. 1-11. doi.org/10.1016/j.edurev.2016.11.002

Alimamy, S. and Nadeem, W. (2021), "Is this real? Cocreation of value through authentic experiential augmented reality: the mediating effect of perceived ethics and customer engagement", *Information Technology & People*.

Avila-Garzon, C., Bacca-Acosta, J., Kinshuk., Duarte, J. (2021). "Augmented Reality in Education: An Overview of Twenty-Five Years of Research", *Contemporary Educational Technology,* Vol 13, No 3.

Baasanjav, U. (2013), "Incorporating the experiential learning cycle into online classes", *Journal of Online Learning and Teaching*, Vol. *9 No.* 4, pp. 575-589.

Bamford, D., Karjalainen, K. and Jenavs, E. (2012), "An evaluation of problem-based assessment in teaching operations management", *International Journal of Operations & Production Management*, Vol. *32 No.* 12, pp. 1493-1514. doi.org/10.1108/01443571211284214

Barak, M. (2018), "Are digital native open to change? Examining flexible thinking and resistance to change", *Computers and Education*. Vol. 121, pp. 115-123. doi.org/10.1016/j.compedu.2018.01.016

Barhorst, J. B., McLean, G., Shah, E., and Mack, R. (2021), "Blending the real world and the virtual world: Exploring the role of flow in augmented reality experiences", *Journal of Business Research*, Vol. 122, pp. 423-436. doi.org/10.1016/j.jbusres.2020.08.041

Benitez, J., Henseler, J., Castillo, A. and Schuberth, F. (2020), "How to perform and report an impactful analysis using partial least squares: Guidelines for confirmatory and explanatory IS research", *Information & Management*, Vol. 57 No. 2, pp. 103168.

Bulu, S. T. (2012), "Place presence, social presence, co-presence, and satisfaction in virtual worlds", *Computers and Education*, Vol. 58 No. 1, pp. 154-161. doi.org/10.1016/j.compedu.2011.08.024

Cai, S., Liu, E., Yang, Y. and Liang, J.-C. (2019), "Tablet-based AR technology: Impacts on students' conceptions and approaches to learning mathematics according to their self-efficacy: Tablet based AR: Impacts in learning Mathematics", *British Journal of Educational Technology*, Vol. 50 No. 1, pp. 248–263. doi.org/10.1111/bjet.12718

Chae, H. and Ko, E. (2016), "Customer social participation in the social networking services and its impact upon the customer equity of global fashion brands", *Journal of Business Research*, Vol. 69 *No.* 9, pp. 3804-3812. doi.org/10.1016/j.jbusres.2015.12.072

Chae, H., Ko, E. and Han, J. (2015), "How do customers' SNS participation activities impact on customer equity drivers and customer loyalty? Focus on the SNS services of a global SPA brand", *Journal of Global Scholars of Marketing Science*, Vol. 25 No. 2, pp. 122-141. doi.org/10.1080/21639159.2015.1012809

Chen, Y.-H. and Wang, C.-H. (2018), "Learner presence, perception, and learning achievements in augmented–reality– mediated learning environments". *Interactive Learning Environments*, Vol. 26 No. 5, pp. 695–708.

Cheng, Y. and Jiang, H. (2020), "How Do AI-driven Chatbots Impact User Experience? Examining Gratifications, Perceived Privacy Risk, Satisfaction, Loyalty, and Continued Use", *Journal of Broadcasting and Electronic Media*, pp. 592-614. doi.org/10.1080/08838151.2020.1834296

Chiu, C. M., Wang, E. T., Fang, Y. H. and Huang, H. Y. (2014), "Understanding customers' repeat purchase intentions in B2C e-commerce: the roles of utilitarian value, hedonic value and perceived risk*", Information Systems Journal*, Vol. 24 No. 1, pp. 85-114. doi.org/10.1111/j.1365-2575.2012.00407.x

Dash, G., Kiefer, K. and Paul, J. (2021), "Marketing-to-Millennials: Marketing 4.0, customer satisfaction and purchase intention", *Journal of Business Research*, Vol. 122, pp. 608-620. doi.org/10.1016/j.jbusres.2020.10.016

de Melo Pereira, F. A., Ramos, A. S. M., Gouvêa, M. A. and da Costa, M. F. (2015), "Satisfaction and continuous use intention of e-learning service in Brazilian public organizations", *Computers in Human Behavior*, Vol. 46, pp. 139-148. doi.org/10.1016/j.chb.2015.01.016

Dixson, M. D. (2015), "Measuring student engagement in the online course: The Online Student Engagement scale (OSE)", *Online Learning*, Vol. *19 No.* 4, pp. 1-15.

Dwivedi, Y. K., Hughes, L., Baabdullah, A. M., Ribeiro-Navarrete, S., Giannakis, M., Al-Debei, M. M., ... and Wamba, S. F. (2022), "Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy", *International Journal of Information Management*, Vol. 66, pp. 102542.

El-Maamiry, A. A. (2017), "The information-seeking behaviour of students: A case of university of Dubai", *Global Journal of Computer Science and Technology*. Vol. 17 No. 1.

Elson, M., Breuer, J., Ivory, J. D. and Quandt, T. (2014), "More than stories with buttons: Narrative, mechanics, and context as determinants of player experience in digital games", *Journal of Communication*, Vol. 64 No. 3, pp. 521-542. doi.org/10.1111/jcom.12096

Engerman, J. A. and Otto, R. F. (2021), "The shift to digital: designing for learning from a culturally relevant interactive media perspective", *Educational Technology Research and Development*, Vol. 69 No. (1), pp. 301-305. doi.org/10.1007/s11423-020-09889-9

Fornell, C. and D. Larcker. (1981), "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error." *Journal of Marketing Research, Vol.* 18 No. 1, pp. 39-47.

Fu, F. L., Su, R. C. and Yu, S. C. (2009), "EGameFlow: A scale to measure learners' enjoyment of e-learning games", *Computers and Education*, Vol. 52 No. 1, pp. 101-112. doi.org/10.1016/j.compedu.2008.07.004

Gallego, M.D., Bueno, S. and Noyes, J. (2016), "Second Life adoption in education: A motivational model based on Uses and Gratifications theory", *Computers and Education,* Vol. 100, pp. 81–93. doi.org/10.1016/j.compedu.2016.05.001

Gan, C., and Li, H. (2018), "Understanding the effects of gratifications on the continuance intention to use WeChat in China: A perspective on uses and gratifications", *Computers in Human Behavior*, Vol. 78, pp. 306-315. doi.org/10.1016/j.chb.2017.10.003

Garzon, J., and Acevedo, J. (2019), "Meta-analysis of the impact of Augmented Reality on students' learning gains", *Educational Research Review*, Vol. 27, pp. 244-260. doi.org/10.1016/j.edurev.2019.04.001

Gellerman, S.W. (1990), "In organizations, as in architecture, form follows function", *Organizational dynamics*, Vol. 18 No. 3, pp. 57-69. doi.org/10.1016/0090-2616(90)90064-V

Ghazali, E., Mutum, D. S. and Woon, M. Y. (2019), "Exploring player behavior and motivations to continue playing Pokémon GO", *Information Technology & People*. Vol. 32 No. 3, pp. 646-667.

Groccia, J. E. (2018), "What is student engagement?" *New Directions for Teaching and Learning*, Vol. 154, pp. 11-20. doi.org/10.1002/tl.20287

Ha, Y. W., Kim, J., Libaque-Saenz, C. F., Chang, Y. and Park, M. C. (2015), "Use and gratifications of mobile SNSs: Facebook and KakaoTalk in Korea", *Telematics and Informatics,* Vol. 32 No. 3, pp. 425-438. doi.org/10.1016/j.tele.2014.10.006

Hair Jr, J. F., Matthews, L. M., Matthews, R. L. and Sarstedt, M. (2017), "PLS-SEM or CB-SEM: updated guidelines on which method to use", *International Journal of Multivariate Data Analysis*, Vol. 1 No. 2, pp. 107-123.

Hair, J. F., Ringle, C. M., and Sarstedt, M. (2011), "PLS-SEM: Indeed a Silver Bullet", *Journal of Marketing Theory and Practice,* Vol.19 No. (2), pp. 139-151. doi.org/10.2753/MTP1069-6679190202

Hair, J.F., Risher, J.J., Sarstedt, M. and Ringle, C.M. (2019), "When to use and how to report the results of PLS-SEM", *European Business Review*, Vol. 31 No. 1, pp. 2-24. doi.org/10.1108/EBR-11-2018-0203

Hair Jr., J.F., Hult, G.T.M., Ringle, C.M. and Sarstedt, M. (2014), "A Primer on Partial Least Squares Strucutral Equation Modelling (PLS-SEM)", *Handbook of Market Research*, Sage Publications, Los Angeles.

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J. and Edwards, T. (2016), "Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning", *Computers in Human Behavior*, Vol. 54, pp.170-179. doi.org/10.1016/j.chb.2015.07.045

Hayton, J. C., Allen, D. G. and Scarpello, V. (2004), "Factor retention decisions in exploratory factor analysis: A tutorial on parallel analysis", *Organizational research methods*, Vol. 7 No. 2, pp. 191-205. doi.org/10.1177/1094428104263675

Henseler, J., Ringle, C. M. and Sarstedt, M. (2015), "A new criterion for assessing discriminant validity in variance-based structural equation modelling", *Journal of the Academy of Marketing Science*, Vol. 34, pp. 115–135. doi.org/10.1007/s11747-014-0403-8

Henseler, J., Dijkstra, T.K., Sarstedt, M., Ringle, C.M., Diamantopoulos, A., Straub, D.W., Ketchen Jr., D.J., Hair, J.F., Hult, T.M. and Calantone, R.J. (2014), "Common beliefs and reality about PLS: Comments on Rönkkö and Evermann (2013)", *Organizational research methods*, Vol. 17 No. 2, pp. 182-209.

Hopp, T. and Gangadharbatla, H. (2016), "Novelty effects in augmented reality advertising environments: The influence of exposure time and self-efficacy", *Journal of Current Issues and Research in Advertising*, Vol. 37 No. 2, pp. 113-130. doi.org/10.1080/10641734.2016.1171179

Hossain, M. A. (2019), "Effects of uses and gratifications on social media use", *PSU Research Review*, Vol. 3 No. 1, pp. 16-28. doi.org/10.1108/PRR-07-2018-0023

Hu, P. J. H. and Hui, W. (2012), "Examining the role of learning engagement in technology-mediated learning and its effects on learning effectiveness and satisfaction", *Decision support systems*, Vol. 53 No. 4, pp. 782-792. doi.org/10.1016/j.dss.2012.05.014

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 and Education,* Vol. 96, pp. 72-82. doi.org/10.1016/j.compedu.2016.02.008

Huang, Q., Chen, X., Ou, C. X., Davison, R. M. and Hua, Z. (2017), "Understanding buyers' loyalty to a C2C platform: the roles of social capital, satisfaction and perceived effectiveness of e-commerce institutional mechanisms", *Information systems journal*, Vol. *27 No.* 1, pp. 91-119. doi.org/10.1111/isj.12079

Huang, L. Y. and Hsieh, Y. J. (2011), "Predicting online game loyalty based on need gratification and experiential motives", *Internet Research*, Vol. 21 No. 5, pp. 581-598. doi.org/10.1108/10662241111176380

Hui, W., Hu, P. H., Clark, T. H., Tam, K. Y. and Milton, J. (2008), "Technology-assisted learning: a longitudinal field study of knowledge category, learning effectiveness and satisfaction in language learning", *Journal of Computer Assisted Learning*, Vol. 24 No. 3, pp. 245-259. doi.org/10.1111/j.1365-2729.2007.00257.x

Hulland, J. (1999), "Use of partial least squares (pls) in strategic management research: a review of four recent studies", *Strategic Management Journal*, Vol. 20 No. 2, pp. 195-204. doi/10.1002/(SICI)1097-0266

Ibáñez, M.-B. and Delgado-Kloos, C. (2018), "Augmented reality for STEM learning: A systematic review," *Computers and Education*, Vol. 123, pp. 109–123. doi.org/10.1016/j.compedu.2018.05.002

Ibáñez-Sánchez, S., Orus, C. and Flavian, C. (2022), "Augmented reality filters on social media. Analyzing the drivers of playability based on uses and gratifications theory", *Psychology & Marketing*, Vol. 39 No. 3, pp. 559-578.

Jessen, A., Hilken, T., Chylinski, M., Mahr, D., Heller, J., Keeling, D. I. and de Ruyter, K. (2020), "The playground effect: How augmented reality drives creative customer engagement", *Journal of Business Research*, Vol. *116*, pp. 85-98. doi.org/10.1016/j.jbusres.2020.05.002

Jung, T., Chung, N. and Leue, M. C. (2015), "The determinants of recommendations to use augmented reality technologies: The case of a Korean theme park", *Tourism management*, Vol. *49*, pp. 75-86. doi.org/10.1016/j.tourman.2015.02.013

Katz, E., Blumler, J. G. and Gurevitch, M. (1973a), "Uses and gratifications research", *The public opinion quarterly*, Vol. *37 No.* 4, pp. 509-523.

Katz, E., Haas, H. and Gurevitch, M. (1973b), "On the use of the mass media for important things", *American sociological review*, pp. 164-181.

Kim, S, J. and Dey, A, K. (2015), "Augmenting human senses to improve the user experience in cars: applying augmented reality and haptics approaches to reduce cognitive distances", *Multimedia Tools Applie*d, Vol. 75, pp. 9587-9607.

Ko, H., Cho, C. H. and Roberts, M. S. (2005), "Internet uses and gratifications: A structural equation model of interactive advertising", *Journal of advertising,* Vol. 34 No. 2, pp. 57-70.

Kolb, D. A. (2014), "*Experiential learning: Experience as the source of learning and development",* (Second Ed.), FT press: Upper Saddle River.

Konak, A., Clark, T. K. and Nasereddin, M. (2014), "Using Kolb's Experiential Learning Cycle to improve student learning in virtual computer laboratories", *Computers and Education*, Vol. 72, pp. 11-22. doi.org/10.1016/j.compedu.2013.10.013

Li, M., Mobley, W. H. and Kelly, A. (2013), "When do global leaders learn best to develop cultural intelligence? An investigation of the moderating role of experiential learning style", *Academy of Management Learning and Education*, Vol. 12 No. 1, pp. 32-50.

Li, H., Liu, Y., Xu, X., Heikkilä, J. and van Der Heijden, H. (2015), "Modeling hedonic is continuance through the uses and gratifications theory: An empirical study in online games", *Computers in Human Behavior*, Vol. 48, pp. 261-272. doi.org/10.1016/j.chb.2015.01.053

Liaw, S. S. (2008), "Investigating students' perceived satisfaction, behavioral intention, and effectiveness of e-learning: A case study of the Blackboard system", *Computers and education*, Vol. *51 No.* 2, pp. 864-873. doi.org/10.1016/j.compedu.2007.09.005

Lim, K. and Lim, R. (2020), "Semiotics, memory and augmented reality: History education with learner-generated augmentation", *British Journal of Educational Technology, Vol.* 51 No. 3, pp. 673-691. doi.org/10.1111/bjet.12904

Lin, Y. H., Hsu, C. L., Chen, M. F. and Fang, C. H. (2017), "New gratifications for social word-of-mouth spread via mobile SNSs: Uses and gratifications approach with a perspective of media technology", *Telematics and informatics*, Vol. *34 No.* 4, pp. 382-397. https://doi.org/10.1016/j.tele.2016.08.019

Lai, C. H., Yang, J. C., Chen, F. C., Ho, C. W. and San Liang, J. (2009), "Mobile technology supported experiential learning", *International Journal of Instructional Media*, Vol. *36 No.* 1, pp. 41-54.

Lee, K. W. (2020), "Learning management knowledge: Integrating learning cycle theory and knowledge types perspective", *Academy of Management Learning and Education*, Vol. 19 No. 2, pp. 192-222. doi.org/10.5465/amle.2016.0029

Lemay, J. D., Doleck, T. and Bazelais, P. (2021), "Transition to online teaching during the COVID-19 pandemic", *Interactive Learning Environments*, pp. 1-12. doi.org/10.1080/10494820.2021.1871633

Luo, X. (2002), "Uses and gratifications theory and e-consumer behaviors: A structural equation modeling study", *Journal of Interactive advertising*, Vol. 2 No. 2, pp. 34-41. doi.org/10.1080/15252019.2002.10722060

Luo, M. and Remus, W. (2014), "Uses and gratifications and acceptance of Web-based information services: An integrated model", *Computers in Human Behaviour,* Vol. 38, pp. 281-295. doi.org/10.1016/j.chb.2014.05.042

Matthews, L. (2017), "Applying Multi-group analysis in PLS-SEM: a step-by-step process", Latan, H. and Noonan, R. (Eds), *Partial Least Squares Structural Equation Modeling: Basic Concepts, Methodological Issues and Applications*, Springer, Heidelberg, pp. 219-243.

Manolis, C., Burns, D. J., Assudani, R. and Chinta, R. (2013), "Assessing experiential learning styles: A methodological reconstruction and validation of the Kolb Learning Style Inventory", *Learning and individual differences*, Vol. 23, pp. 44-52. doi.org/10.1016/j.lindif.2012.10.009

Moorhouse, N., tom Dieck, M. C. and Jung, T. (2019), "An experiential view to children learning in museums with Augmented Reality", *Museum Management and Curatorship*, Vol. *34* No. 4, pp. 402-418. doi.org/10.1080/09647775.2019.1578991

Morris, T. H. (2020), "Experiential learning–a systematic review and revision of Kolb's model", *Interactive Learning Environments*, Vol. *28 No.* 8, pp. 1064-1077. doi.org/10.1080/10494820.2019.1570279

Nicholson, J. D., P. LaPlaca, A. Al-Abdin, R. Breese, and Z. Khan (2018), "What do Introduction Sections Tell Us about the Intent of Scholarly Work: A Contribution on Contributions?" *Industrial Marketing Management,* Vol. 73, pp. 206-219. doi.org/10.1016/j.indmarman.2018.02.014

Papacharissi, Z. and Rubin, A. M. (2000), "Predictors of Internet use. *Journal of broadcasting & electronic media"*, Vol. *44 No.* 2, pp. 175-196.

Pham, L., Limbu, Y. B., Bui, T. K., Nguyen, H. T. and Pham, H. T. (2019), "Does e-learning service quality influence e-learning student satisfaction and loyalty? Evidence from Vietnam", *International Journal of Educational Technology in Higher Education*, Vol. *16 No.* 1, pp. 1-26. doi.org/10.1186/s41239-019-0136-3

Raacke, J. and Bonds-Raacke, J. (2008), "MySpace and Facebook: Applying the uses and gratifications theory to exploring friend-networking sites", Cyberpsychology & behavior, Vol. 11 No. 2, pp. 169-174.

Rauschnabel, P. A. (2021), "Augmented reality is eating the real-world! The substitution of physical products by holograms", *International Journal of Information Management*, Vol. *57*, pp. 1-15. doi.org/10.1016/j.ijinfomgt.2020.102279

Rauschnabel, P. A. (2018a), "Virtually enhancing the real world with holograms: An exploration of expected gratifications of using augmented reality smart glasses", *Psychology and Marketing*, Vol. 35 No. 8, pp. 557-572. doi.org/10.1002/mar.21106

Rauschnabel, P. A. (2018b), "A conceptual uses and gratification framework on the use of augmented reality smart glasses", Jung T., tom Dieck M.C. (Eds) *Augmented Reality and Virtual Reality. Progress in IS. Springer*, Cham, pp. 211-227. doi.org/10.1007/978-3-319-64027-3_15

Rauschnabel, P. A., Felix, R. and Hinsch, C. (2019), "Augmented reality marketing: How mobile AR-apps can improve brands through inspiration", *Journal of Retailing and Consumer Services*, Vol. *49*, pp. 43-53. doi.org/10.1016/j.jretconser.2019.03.004

Rauschnabel, P. A., Felix, R., Hinsch, C., Shahab, H. and Alt, F. (2022), "What is XR? Towards a framework for augmented and virtual reality," *Computers in Human Behavior*, Vol. 133, 107289.

Rauschnabel, P. A., Rossmann, A. and tom Dieck, M. C. (2017), "An adoption framework for mobile augmented reality games: The case of Pokémon Go", *Computers in Human Behavior*, Vol. 76, pp. 276-286. doi.org/10.1016/j.chb.2017.07.030

Rubin, A. M. (2009), "The uses-and-gratifications perspective on media effects", In J. Bryant & M. B. Oliver (Eds.), *Media effects: Advances in Theory and Research*. Routledge, New York, pp. 165-184.

Rueda, L., Benitez, J. and Braojos, J. (2017), "From traditional education technologies to student satisfaction in Management education: A theory of the role of social media applications", *Information and Management*, Vol. 54 No. 8, pp. 1059-1071.

Ruggiero, T. E. (2000), "Uses and gratifications theory in the 21st century", *Mass communication & society*, Vol. *3 No.* 1, pp. 3-37.

Shin, S. I., Kim, J. B., Han, S. and Lee, S. (2020), "Exploring a mobile phone user's attitude toward watching TV content on a mobile phone–uses and gratifications perspective", *Information Technology & People.*

Sırakaya, M. and Sırakaya, D, A., (2022), "Augmented reality in STEM education: a systematic review", *Interactive Learning Environments,* Vol. 30 No. 8, pp. 1556-1569

Skinner, E., Furrer, C., Marchand, G. and Kindermann, T. (2008), "Engagement and disaffection in the classroom: Part of a larger motivational dynamic?" *Journal of Educational Psychology*, Vol. 100 No. 4, pp. 765–781. https://doi.org/10.1037/a0012840

Song, H. K., Baek, E. and Choo, H. J. (2019), "Try-on experience with augmented reality comforts your decision: Focusing on the roles of immersion and psychological ownership", *Information Technology & People*, Vol. 33 No. 4, pp. 1214-1234

Stafford, T. F., Stafford, M. R. and Schkade, L. L. (2004), "Determining uses and gratifications for the Internet", *Decision Sciences*, Vol. 35 No. 2, pp. 259-288.

Sundar, S. S. and Limperos, A. M. (2013), "Uses and grats 2.0: New gratifications for new media", *Journal of Broadcasting and Electronic Media*, Vol. *57 No.* 4, pp. 504-525. doi.org/10.1080/08838151.2013.845827

Themelis, C. and Sime, J. A. (2020), "From Video-Conferencing to Holoportation and Haptics: How Emerging Technologies Can Enhance Presence in Online Education?" In *Emerging technologies and pedagogies in the curriculum* (pp. 261-276). Springer, Singapore.

Thongpapanl, N. and Ashraf, A. R. (2011), "Enhancing online performance through website content and personalization", *Journal of computer information systems*, Vol. *52 No.* 1, pp. 3-13. doi.org/10.1080/08874417.2011.11645517

tom Dieck, M. C., Jung, T. H., and Rauschnabel, P. A. (2018), "Determining visitor engagement through augmented reality at science festivals: An experience economy perspective", *Computers in Human Behavior*, Vol. *82*, pp. 44-53. doi.org/10.1016/j.chb.2017.12.043

tom Dieck, M.C., tom Dieck, D. and Jung, T. (2021), "Exploring Usability and Gratifications for Virtual Reality Applications at Festivals", *Event Management,* doi.org/10.3727/152599521X16106577965152.

Uriarte-Portillo, A., Ibáñez, M. B., Zatarain-Cabada, R. and Barrón-Estrada, M. L. (2023), "Comparison of Using an Augmented Reality Learning Tool at Home and in a Classroom

Regarding Motivation and Learning Outcomes", *Multimodal Technologies and Interaction*, Vol. 7 No. 3, pp. 1-13.

van der Keylen, P., Lippert, N., Kunisch, R., Kühlein, T. and Roos, M. (2020), "Asynchronous, digital teaching in times of COVID-19: a teaching example from general practice", *GMS journal for medical education*, Vol. 37 No. 7, pp. 1-8. Doi.org/10.3205/zma001391

Vaterlaus, J. M., Frantz, K. and Robecker, T. (2019), "Reliving my childhood dream of being a Pokémon Trainer: An exploratory study of college student uses and gratifications related to Pokémon Go", *International Journal of Human–Computer Interaction*, Vol. *35 No.* 7, pp. 596-604. doi.org/10.1080/10447318.2018.1480911

Wang, P. and Li, H. (2019, July), "Disentangling the factors driving user satisfaction with travel review websites: content, social or hedonic gratifications". In PACIS (pp. 1-15).

Wells, J. D., Campbell, D. E., Valacich, J. S. and Featherman, M. (2010), "The effect of perceived novelty on the adoption of information technology innovations: a risk/reward perspective", *Decision Sciences*, Vol. *41 No.* (4), pp. 813-843. doi.org/10.1111/j.1540-5915.2010.00292.x

Wu, H.-K., Lee, S. W.-Y., Chang, H.-Y. and Liang, J.-C. (2013), "Current status, opportunities and challenges of augmented reality in education", *Computers and Education*, Vol. 62, pp. 41-49. doi.org/10.1016/j.compedu.2012.10.024

Yang, S. Mei, B. and Yue, X. (2018), "Mobile augmented reality assisted chemical education: Insights from elements 4D", *Journal of Chemical Education,* Vol. 95 No. 6, pp. 1060-1062. doi.org/10.1021/acs.jchemed.8b00017

Zhu, S., Gupta, A., Paradice, D. and Cegielski, C. (2019), "Understanding the impact of immersion and authenticity on satisfaction behavior in learning analytics tasks", *Information Systems Frontiers*, Vol. *21 No.* 4, pp. 791-814. doi.org/10.1007/s10796-018-9865-4

Tables

Table 1. Previous U&GT Research

Study	Media	Gratifications (constructs)	Methods/ Sample	Moderating Effect/Control Variables
Gan & Li (2018)	WeChat	**Hedonic** (Enjoyment, Passing time) **Social** (Social interaction, social presence) **Utilitarian** (Self-presentation, Information documentation, Information sharing) **Technology** (media appeal)	Survey, PLS/ 297 students	No
Ha et al. (2015)	Social media	**Cognitive** **Hedonic** **Integrative** **Social Interactive**	Survey, PLS/ 641 social media users	No/Age, Gender
Hossain (2019)	Social media	**Not classified into gratification categories** (Enjoyment, Passing time, Information seeking, Self-presentation, Social presence, Social interaction)	Survey, SEM/ 241 users	No/No
Huang & Hsieh (2011)	Online games	**Not classified into gratification categories** (Entertainment, Sociality)	Mixed methods, SEM/ 251 gamers	No/Gender, playing intensity
Ibanez-Sanchez et al. (2022)	AR marketing	**Hedonic** (entertainment, escapism, passing time) **Utilitarian** (convenience, curiosity) **Social** (interactivity, sense of belonging) **Personal** (trendiness, compatibility)	Mixed methods, PLS/ 251 users	No
Li et al. (2015)	Online games	**Hedonic** (Enjoyment, Fantasy, Escapism) **Social** (Social interaction, social presence) **Utilitarian** (Achievement, Self-presentation)	Survey, SEM/ 3919 gamers	No/ Gender, Age
Papacharissi, & Rubin (2000)	Internet	**Not classified into gratification categories** (Interpersonal utility, passing time, information seeking, convenience, entertainment)	Survey, Pearson correlations/ 279 students	No
Rauschnabel (2018a)	AR marketing	**Utilitarian (**Life-efficiency) **Hedonic** (Enjoyment)	Survey, SEM/ 228 students	No

		Sensual (Desired enhancement of reality, wearable comfort) **Social** (Socialising) **Symbolic** (Self-expression)		
Rauschnabel et al. (2017)	AR gaming	**Emotional** (Nostalgia, Enjoyment) **Hedonic** (Physical activity, Flow) **Social** (Socialising, Image)	Survey, SEM/ 642	No
Rauschnabel (2018b)	AR smart glasses	**Utilitarian (**Life-efficiency, usefulness, education) **Hedonic** (gaming, enjoyment, entertainment) **Social** (socialising, managing relationships) **Sensual** (escape, immersion, reality perceptions, wearable comfort) **Symbolic** (self-expression, coolness, status)	Conceptual	Proposed: Risks, demographics, knowledge, experience
Stafford et al. (2004)	Internet	**Process** **Content** **Social**	Survey, factor analysis, CFA, 915 consumers	No
Sundar & Limperos (2013)	New media	**Modality** (Realism, Coolness, Novelty, Being there) **Agency** (enhancement, community building, bandwagon, filtering, ownness) **Interactivity** (Interaction, activity, responsiveness, control) **Navigability** (browsing, scaffolds, play/fun)	Conceptual	No
Xu et al. (2012)	Social media	**Hedonic** (affection, disclosure, entertainment, escape, relaxation, and stylishness) **Utilitarian** (coordination, immediate access)	Mixed methods, PLS/ 148 students	No
Our study	*AR learning and marketing*	***Hedonic*** *(enjoyment, flow)* ***Utilitarian*** *(Information seeking, Personalisation)* ***Sensual*** *(Presence, Immersion)* ***Modality*** *(Novelty)*	*Experiments and surveys, PLS/ 170 students*	*Yes (Multi group analysis of learning styles)*

Source: The authors (2021)

Table 2. Participants' profile

Characteristics	N	%	Characteristics	N	%
Gender	**173**	**100%**	**Level**	**173**	**100%**
Male	86	49.7%	Undergraduate	127	73.4%
Female	87	50.3%	Postgraduate	33	19.1%
Age	**173**	**100%**	MBA	13	7.5%
18-30	146	84.4%	**AR experience**	**173**	**100%**
31-50	25	14.4%	Yes	68	39.3%
Over 50	2	1.2%	No	105	60.7%

Source: Research data (2021)

Table 3. Correlations and square roots of AVE

	Mean	SD	1	2	3	4	5	6	7	8	9
Enjoyment	4.279	0.784	**0.891**								
Flow	3.874	1.007	0.698	**0.823**							
Immersion	3.129	1.246	0.504	0.689	**0.871**						
Info Seeking	4.086	0.835	0.633	0.576	0.508	**0.856**					
Learning Satisfaction	4.218	0.783	0.701	0.620	0.406	0.663	**0.917**				
Novelty	3.726	1.099	0.459	0.581	0.518	0.519	0.477	**0.841**			
Personalisation	3.808	0.963	0.609	0.646	0.499	0.668	0.591	0.453	**0.841**		
Presence	3.439	1.303	0.580	0.651	0.699	0.566	0.482	0.553	0.641	**0.785**	
Student Engagement	4.007	0.959	0.658	0.630	0.540	0.665	0.752	0.442	0.589	0.511	**0.908**

Note: Square root of AVE is presented in the diagonal and bold

Source: The authors (2021)

Table 4. Factor loadings, Cronbach alpha, composite reliability and average variance extracted

Construct *(Source)*	Items	Loadings	Alpha	CR	AVE
Enjoyment *(Moon and Kim, 2001; Lis et al., 2018; van der Heijden 2003)*	The AR experiences were fun The AR experiences were pleasant The AR experiences were enjoyable The AR experiences were exciting	0.875 0.878 0.915 0.898	0.914	0.939	0.795
Flow *(Rauschnabel et al., 2017; tom Dieck et al., 2021)*	While experiencing the AR applications, I experienced a "flow" When experiencing the AR applications, my attention was totally focused Experiencing the AR applications excited my curiosity Experiencing the AR applications was intrinsically interesting	0.800 0.850 0.817 0.823	0.841	0.893	0.677
Information seeking *(Chae et al., 2015; Chae & Ko, 2016; Luo, 2002)*	The AR experiences were useful to get information about products or services The AR experiences were useful to get information I didn't know before The AR experiences were useful to learn about things related to my interests I think the information obtained from the AR experiences is helpful	0.844 0.881 0.825 0.874	0.879	0.917	0.733
Personalisation *(Smink et al., 2020)*	The AR experiences... Were tailored to my situation Felt like a personal experience Matched my needs Were personally relevant to me	 0.832 0.829 0.872 0.831	0.862	0.906	0.708
Immersion *(Fu et al., 2009; Hamari et al., 2016)*	I was completely immersed in the AR experiences I lost track of time while using the AR applications I became very involved in the AR applications forgetting about other things I became unaware of my surroundings while experiencing AR	0.834 0.878 0.909 0.861	0.894	0.926	0.759

Presence *(Gandy et al., 2010; Lis et al., 2018; Vorderer et al., 2004; Wirth et al., 2007)*	I felt like I was actually there in the AR environment It was as though my true location had shifted into the AR environment The objects in AR gave me the feeling that I could do things with them It seemed to me that I could do whatever I wanted in the AR environment I felt 'drawn in' to the experience I felt I could move or manipulate objects in the environment	0.814 0.753 0.825 0.798 0.788 0.728	0.875	0.906	0.616
Novelty *(Barhorst et al., 2021)*	It was a new experience for me It was a unique experience It was a different experience It was an unusual experience (excluded)	0.740 0.876 0.848 0.633 (excluded)	0.783	0.860	0.609
Learning satisfaction *(Hui et al., 2008)*	Using AR as part of my learning is a good idea My overall learning experience of using AR is positive As a whole, the AR experiences was effective for my learning	0.883 0.921 0.947	0.906	0.935	0.782
Student engagement *(Dixon, 2015; tom Dieck et al., 2019)*	These AR experiences have motivated me to learn more about AR These AR experiences have motivated me to participate in AR activities Using AR made the course material interesting to me Using AR enabled me to apply course material to my life	0.910 0.923 0.913 0.885	0.929	0.949	0.824

Source: The authors (2021)

Table 5. Varimax Rotated Factorial Analysis

Variable	Active learner	Passive learner	Communality
When I learn I like to watch and listen	0.145	0.829	0.708
When I learn I like to think about ideas	0.545	0.252	0.361
I learn best when I trust my hunches and feelings	0.424	0.315	0.279
I learn best when I listen and watch carefully	0.065	0.733	0.542
I learn best when I rely on logical thinking	0.596	0.177	0.386
When I am learning I have strong feelings and reactions	0.401	0.290	0.245
When I am learning I tend to reason things out	0.649	0.214	0.468
I learn by feeling	0.465	0.176	0.248
I learn by watching	0.132	0.889	0.808
I learn by doing	0.714	0.191	0.546
When I am learning I am an observing person	0.350	0.630	0.520
When I am learning I am a logical person	0.699	0.112	0.501
I learn best from observation	0.241	0.655	0.487
I learn best from a chance to try out and practice	0.769	0.128	0.608
I learn best when I can try things out for myself	0.764	0.073	0.589
When I learn I like to observe	0.319	0.643	0.515
When I learn I like to be active	0.668	0.157	0.470
Variance	4.57	3.70	8.28
% Var	0.269	0.218	0.487

Table 6. Multigroup Analysis

Relationships	**Path Coefficients (Active Learner)** **N= 81**	**Path Coefficients (Passive learner)** **N= 89**	**Difference (Active learner - Passive learner)**
Hedonic -> Enjoyment	0.960**	0.911**	0.049
Hedonic -> Flow	0.938**	0.867**	0.072
Hedonic -> Learning Satisfaction	0.332**	0.445**	-0.113
Learning Satisfaction -> Student's Engagement	0.814**	0.688**	0.126
Modality -> Learning Satisfaction	0.481**	0.366*	0.114
Modality -> Novelty	0.844**	0.793**	0.051
Sensual -> Immersion	0.898**	0.906**	-0.008
Sensual -> Learning Satisfaction	-0.103	-0.395**	0.291*
Sensual -> Presence	0.946**	0.934**	0.013
Utilitarian -> Info Seeking	0.919**	0.921**	-0.002
Utilitarian -> Learning Satisfaction	0.188	0.336**	-0.149
Utilitarian -> Personalisation	0.930**	0.878**	0.052

**P-value< 0.01; * p-value< 0.05.

Figures

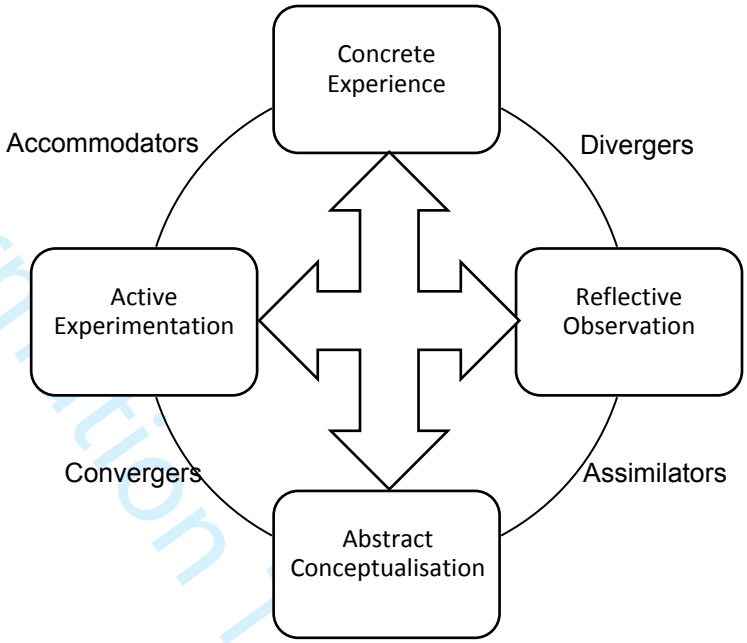


Figure 1. Kolb's Learning Cycle

Source: Kolb (2014)

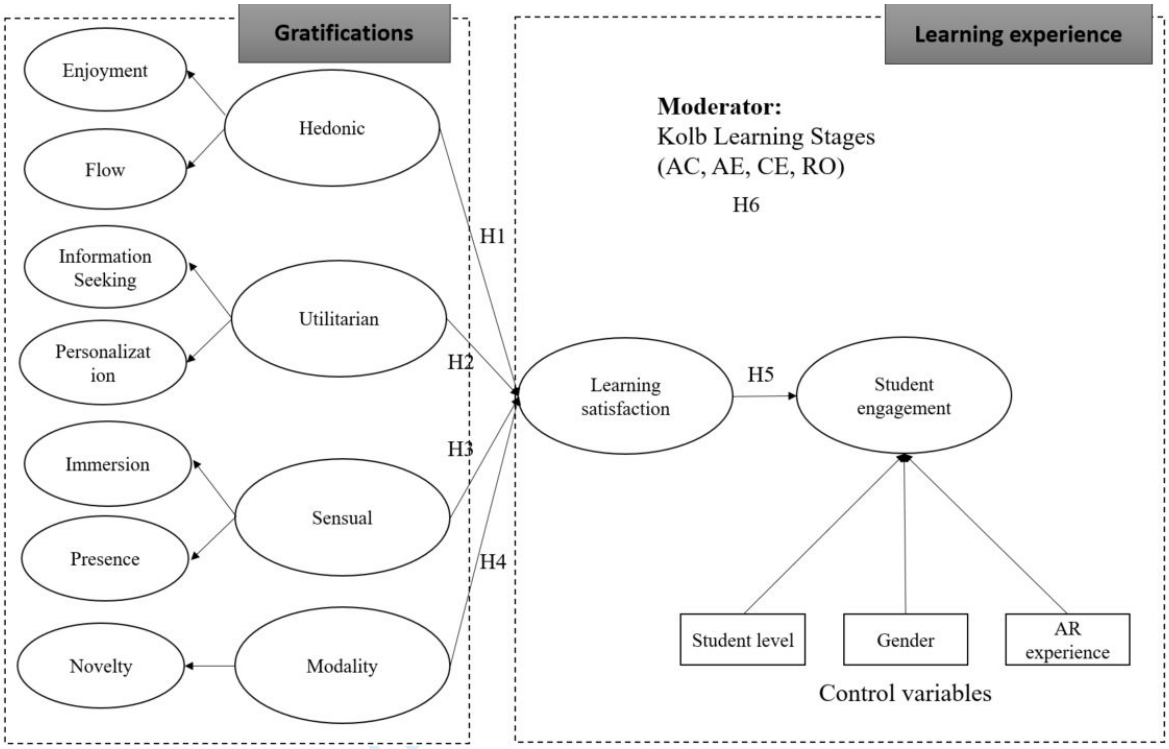
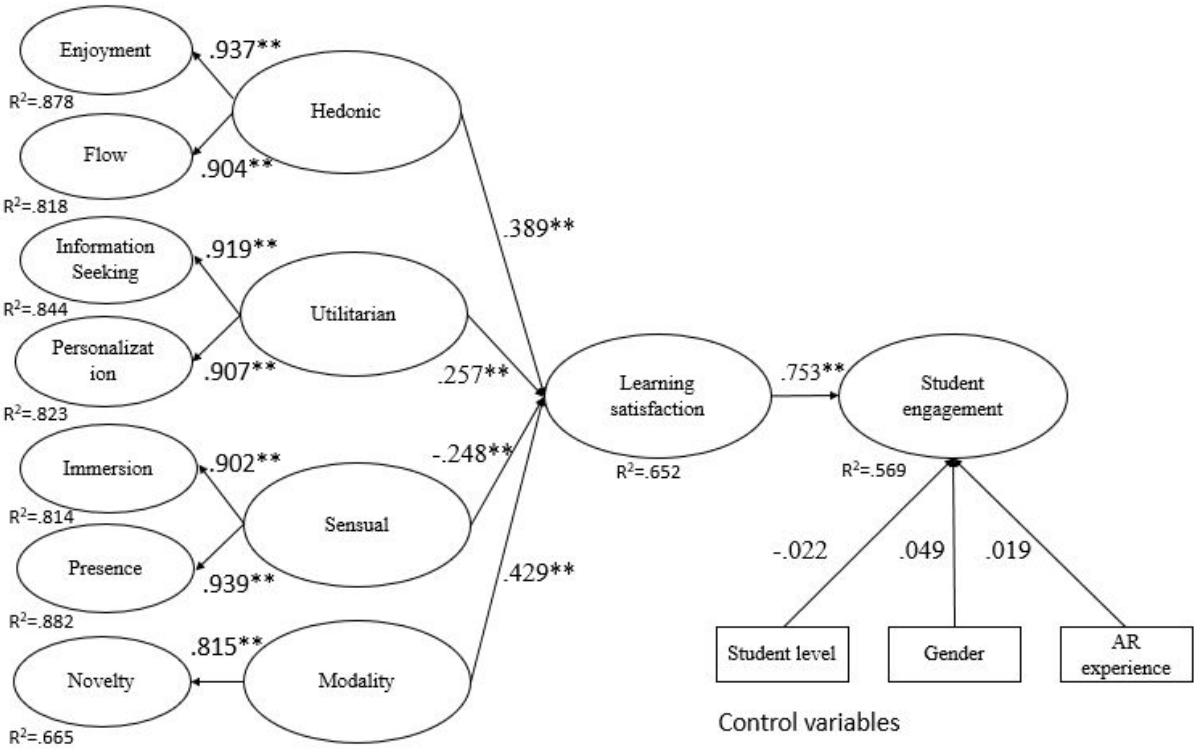


Figure 2. Proposed Model

Source: The authors (2021)



**P-value< 0.01; * p-value< 0.05.

Figure 3. Structural Equation Modelling