Narrative and aesthetics as antecedents of perceived learning in serious games

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Abstract

Purpose – This study uses a critically acclaimed digital game as an instructional tool to explore the role of emotional design elements on psychological flow and perceived learning.
Design/methodology/approach – The authors employ transportation theory to generate a set of antecedents of psychological flow and the theory of flow to connect the gaming experience to positive learning outcomes. The authors investigate the subjective learning experience of players with the use of a psychometric survey, and the authors employ structural equation modelling (SEM) to unearth the direct as well as the indirect effects amongst narrative, aesthetics, flow and learning outcomes.
Findings – The findings of this study demonstrate that narrative and aesthetics in serious games positively influence the perceived learning by facilitating a state of psychological flow.
Research limitations/implications – This study contributes to better understanding and theorizing the role of narrative and aesthetics on learning outcomes in the context of serious games.
Practical implications – The findings of this study bear valuable implications for the design of serious games as they highlight the importance of elements often disregarded as not directly related to the learning process and are typically absent from the design of serious games.
Originality/value – Prior studies have identified aesthetics and narratives as design elements that contribute to the perceived enjoyment of a game; this study empirically investigates the role of narratives and aesthetics in enhancing perceived learning through psychological flow.

Keywords Serious games, Game elements, Flow, Perceived learning, Narrative, Aesthetics
Paper type Research paper

Introduction

Serious games represent a promising instructional tool, bridging the gap between play and learning (Arnab *et al.*, 2012; Breuer and Bente, 2010; Gee, 2008). Serious games encapsulate

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the application of game elements in non-gaming contexts (Baptista and Oliveira, 2019), and they are not designed for entertainment (Djaouti *et al.*, 2011) but mainly for training purposes. Whilst their definition in the literature varies based on the elements that each study explores, the most common definition of serious games comes from Michael and Chen (2005, p. 21), who describe them as "games that do not have entertainment, enjoyment, or fun as their primary purpose". Whilst their main focus is in education, serious games have seen wide application in areas like service marketing and e-commerce (Huotari and Hamari, 2017); many studies have explored their various aspects extending from ethics to design (Deterding *et al.*, 2011), and they are used for training purposes by industries such as defence, healthcare, emergency management, city planning, engineering and politics (Tan, 2018). Prior studies show that serious games result in higher levels of learner commitment and satisfaction (Aparicio *et al.*, 2019), enhanced learning outcomes (Boyle *et al.*, 2012; Whitton, 2010), as well as a means to serve a generation that has had essentially grown up with a constant exposure to digital games (Brown and Thomas, 2008; Ghazali *et al.*, 2019; Petter *et al.*, 2018).

While commercial digital games have been successful at fostering and sustaining the intrinsic motivation of players, the outcomes of serious games have not been consistent, resulting oftentimes in *dry* or *tedious* experiences (e.g. van Eck, 2006). Prior studies have observed the failure of gamification to enhance learning outcomes (e.g. Dichev and Dicheva, 2017; Hanus and Fox, 2015; Wiggins, 2016) while addressing the role of digital games as instructional tools (e.g. Mayer, 2016). Digital games tap into the principles of emotional design (Park *et al.*, 2015; Parrish, 2009; Um *et al.*, 2012) and the literature identifies that *aesthetics* and *narrative* contribute to the perceived enjoyment of a game (e.g. Hua *et al.*, 2009; Hull *et al.*, 2019). In serious games, however, research and practice have overlooked the importance of aesthetics and narrative in stimulating the affective responses of players (Dickey, 2006; Rice, 2007).

To grasp the potential of serious games, it is key to understand the interplay between emotional and cognitive game elements, players' engagement and learning outcomes (Deterding *et al.*, 2011; Graesser *et al.*, 2009). To address that lacuna, we use a critically acclaimed digital game as an instructional tool to explore the role of aesthetics and narrative on psychological flow and perceived learning of players (Figure 1). Specifically, we suggest that narrative understanding, narrative-stimulated empathy and perceived aesthetics are three key drivers of psychological flow and in turn of perceived learning outcomes. We use transportation theory (Green and Brock, 2000, 2002) to investigate the role of narratives and aesthetics in enhancing psychological flow (henceforth *flow*) as well as the mediating role of flow between these game elements and perceived learning (Liu, 2017; Liu *et al.*, 2018). Transportation theory provides a lens for understanding media enjoyment through immersion and meaningful transformation and enlightens our understandings regarding the emotional underpinnings of players' engagement and enjoyment.

Our work aims to understand and theorize the role of different design elements in shaping the experience of players in serious games, contributing to the nascent discussion of how aesthetics and narrative can enhance the intrinsic motivation and engagement appeal of serious game (e.g. Deterding *et al.*, 2011; Lugmayr *et al.*, 2017; Nandhakumar *et al.*, 2013). Our work allows for novel theorization on the impact of information technology (IT) beyond utilitarian values, linking their use to positive outcomes such as enjoyment and learning and offers a novel approach to the design of serious games by stressing the role of emotional design on learning outcomes.

Theoretical background

Players' enjoyment – the key measure of success for commercial games – is primarily the product of a particular type of engagement, namely *flow* (Alexiou and Schippers, 2018; Alexiou *et al.*, 2012). According to Csikszentmihalyi (1982, p. 36), flow is a state of deep concentration defined as the "holistic sensation people feel when they act within total involvement (in any

activity)" and shares many qualities with peak experience and peak performance (Privette, 1983; Privette and Bundrick, 1991). Peak experiences, however, tend to be receptive and passive, while flow experiences require the active participation of individuals in the task at hand (Privette, 1983). Overall, flow represents a deeply rewarding experience and is a prominent model of intrinsic motivation (Keller and Bless, 2008), yet it involves aspects that are not mandatory for the experience of intrinsic motivation (e.g. a loss of self-consciousness or loosing track of time).

As flow is a holistic experience, it is a more expansive model of intrinsic motivation. Nakamura and Csikszentmihalyi (2002) have characterized flow experience based on the following aspects: (1) individuals are in a state of intense and focussed concentration on what they are doing; (2) a merging of action and awareness takes place; (3) individuals experience a loss of reflective self-consciousness; (4) individuals feel a deep sense of control; (5) individuals' temporal experience is distorted (hours seem to pass like seconds); (6) worries and ruminative thoughts disappear; (7) individuals enter a state of autotelic motivation indicated by the fact that engagement in the activity is perceived as rewarding in and of itself. At the same time, Csikszentmihalyi (1990) has identified certain requirements that help stage flow including the balance of skill and challenge of the activity (oftentimes referred to as the balance hypothesis), clear goals, sense of control and unambiguous feedback. These antecedents of flow have been widely researched in the contexts of digital games from a human–computer interaction, user experience and game design perspective (e.g. Takatalo *et al.*, 2010; Webster *et al.*, 1993). While flow was originally studied in the context of creativity and play, it was early on identified as an important theory for learning and educational contexts (Connolly *et al.*, 2012; Keys and Wolfe, 1990). Creating flow experiences in a learning context is crucial for knowledge acquisition and retention. Since flow experiences are intrinsically rewarding, people tend to seek out experiences that allow them to replicate such state, resulting in a psychological selection mechanism that leads to personal growth (Massimini and Fave, 2000).

Most studies addressing flow focus on the contingent relationship between challenge and skills (Fong *et al.*, 2015; Liu, 2017; Liu *et al.*, 2018), while several models of flow phenomenology focus on primary antecedents of flow such as goal clarity, feedback clarity, concentration and prior experience (Quinn, 2005), addressing primarily the cognitive underpinning of flow. Following the recent discussion in the literature regarding the various manifestations of flow in different environments (e.g. Tan, 2018; Zhang and Finneran, 2003), we highlight the ability of digital games to instigate strong affective responses that also contribute to achieving states of flow (Liu, 2017; Liu *et al.*, 2018). Narrative and aesthetics are two such elements of digital games, as suggested by transportation theory (Green and Brock, 2000, 2002).

Transportation theory provides a lens for understanding the concept of media enjoyment. According to Brock *et al.* (2004, p. 312), "[t]ransportation itself is a tripartite formulation (attention, imagery, feelings) of persuasive communication", which highlights the importance of individuals' identification with and empathy towards fictional characters and vivid imagery in fully immersing them into a media world. Brock *et al.* (2004) argue that the experience of transportation occurs predominantly in response to narrative communications. While transportation shares some of the qualities of flow (Green *et al.*, 2004, p. 315), its antecedents are well rooted in the affective domain and the *escapism* that narrative and aesthetics can offer (Green *et al.*, 2004). Transportation is also relevant to knowledge-related design as it links enjoyment to self-transformation through knowledge development. It facilitates openness to new information and creates room for identity play. Given that narrative worlds offer opportunities for simulating various personalities, realities and actions, transported individuals engage in higher experimentation and experience higher enjoyment through learning.

Both transportation theory and the theory of flow assist our investigation of how specific game elements facilitate intrinsically motivating experiences that lead to positive outcomes through emotional and cognitive engagement. The state of deep concentration that is

inherent to flow relates to meaningful learning (Montessori, 1967), the depth of cognitive processing and academic performance (Corno and Mandinach, 1983), while transportation theory allows us to trace such experience back to the affective affordances of digital games and in particular their narrative and aesthetic design. This helps to pinpoint the exact elements that may lead to the experience flow during game-based learning. Our theoretical model is depicted in Figure 1:

Hypotheses development

Serious games challenge traditional pedagogical paradigms that focus on "learning about" and introduce the dynamic of "learning to be" (Thomas and Brown, 2007), which associates with a behavioural and attitudinal change that springs from the experience of events and identification with in-game characters. The latter is difficult to capture with an objective measure of performance such as a score; however, it is as real and relevant as the former one. Perceived learning in the context of instructional design is defined as the "set of beliefs and feelings one has regarding the learning that has occurred" (Caspi and Blau 2008, p. 327) and it reflects the sense that new knowledge has been acquired and some new understanding has been achieved, although such subjective knowledge and understanding do not have to be in line with academic conventions (Caspi and Blau, 2011). Additionally, perceived learning can be a herald of technology acceptance (Bourgonjon *et al.*, 2010; Saadé and Bahli, 2005), learning motivation (Keller and Bless, 2008; Liaw and Huang, 2013), learner's satisfaction (Baturay, 2011; Sun *et al.*, 2008), enjoyment (Frenzel *et al.*, 2007) and overall learning gains (Lee and Lee, 2008; Liaw, 2008). Such outcomes are key to the success of serious games and should be considered in addition to the ability of serious games to deliver tangible cognitive and skill-based outcomes. Learners' satisfaction is particularly relevant to organizations that include such serious games in their training programmes on a voluntary basis (Newbery *et al.*, 2016). Thus, perceived learning is a more suitable outcome compared to other performance indicators.

The narrative–flow link

Stories represent a powerful tool to transfer knowledge (Fisher, 1987), and storytelling holds a prominent place in our culture because it facilitates sense-making (Bruner, 1990). At its core, storytelling is a device which triggers emotions and stimulates cognition (Lugmayr *et al.*, 2017). As such, it is particularly relevant to serious games design as it is directly linked to user engagement (e.g. Pourabdollahian *et al.*, 2012), sense-making (e.g. Newbery *et al.*, 2016) and the facilitation of knowledge transfer (e.g. Allal-Chérif and Makhlouf, 2016). Narrative, in its turn, can be considered as an element of storytelling created based on story's objects and

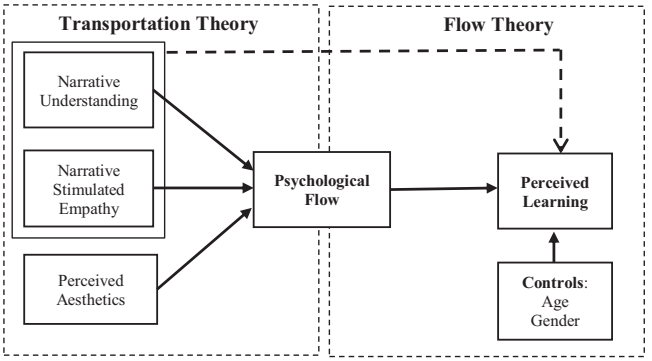


Figure 1.
The theoretical model

narrative components (Langellier and Peterson, 2004). As such, and following recent views of narrative in digital media, we theoretically distinguish narrative from story (Toledo Palomino *et al.*, 2019). As the rise of digital media during the last decades provided with novel possibilities for storytelling (e.g. through interactivity), the process of storytelling has become far more complex in digital platforms than in traditional media, such as films. We, thus, consider narrative in the context of serious games to not be limited to the element of story but to have both a *story* element as well as an *experience* element, which emerges from players' interaction (e.g. Rowe *et al.*, 2010).

In our study, we are particularly interested in the mechanism through which narrative enables players to encode and decode knowledge. Building on the premises of transportation theory, we argue that the narrative involvement of players in the game is a cognitive, emotional and imagery experience (Green *et al.*, 2004). Specifically, narrative stimulates the emotional and cognitive engagement of players via its story and experience dimensions (Marsh *et al.*, 2011; Reeve, 2009). The emotional experience of storytelling is manifested through narrative empathy generated mainly through the identification of players with in-game characters (including the use of artificial intelligence) (Lee, 2014). Players are exposed to the spatiotemporal perspective of the in-game character and process the emotional implications of narrative events from this standpoint (Gernsbacher *et al.*, 1992). As a result, players imaginatively adopt the character's emotional state, reinforcing their suspension of disbelief (Bowman *et al.*, 2012). While research on the link between character identification and flow is in its infancy (Soutter and Hitchens, 2016), early evidence on the field of transportation theory has shown that identifiable characters affect narrative transportation (Slater and Rouner, 2002; Escalas *et al.*, 2004). Consequently, narrative transportation affects critical thought, beliefs, attitudes and intentions (van Laer *et al.*, 2014). We, thus, argue that character identification is an important component of narrative design, leading to flow and higher perceived learning.

The cognitive component of storytelling is narrative understanding. Narrative understanding represents the design of a believable storyline (embedding factual knowledge and wisdom in serious contexts) without inhibiting sense-making (Coplan, 2004; Soutter and Hitchens, 2016). In other words, we are interested in the *verisimilitude* of the narrative. In the context of transportation theory, early findings indicate that fiction *versus* non-fiction manipulations show little effect on narrative transportation (Green and Donahue, 2011); what matters more is verisimilitude, i.e. the likelihood that the specific story events may actually happen. Bal *et al.* (2011, p. 362) colourfully argue that the central focus of verisimilitude "is on believability and not on consistency and noncontradictions. [. . .] Truth in fiction is not about empirical evidence". Therefore, a "life-like" (but not necessarily factual) storyline enhances the story receivers' suspended reality. In the context of interactive narratives and games, however, conflicting or convoluted storylines could be argued to create confusion regarding the game goals, thus raising the challenge levels of the game. Consequently, the state of flow would break since the higher challenge would outweigh players' skills, introducing frustration and disrupting progress (Csikszentmihalyi, 1990). In other words, narrative *understanding* involves the "lifelikeness" of events as well as a straightforward narrative, aimed at the retention of flow. Building on these premises, the first set of hypotheses of our study is as follows:

H1a. Narrative-stimulated empathy will be positively related to flow.

H1b. Narrative understanding will be positively related to flow.

The aesthetics–flow link

The aesthetic experience involves a state of higher concentration on the subject and is intrinsically motivating (Jennings, 2000). In the context of our study, aesthetics is defined as "the visual appearance of the interface as it conforms to design principles (i.e., symmetry,

balance, emphasis, harmony, proportion, rhythm, and unity)" (Brien and Toms, 2008, p. 939). Aesthetics are an increasingly important dimension in IT (Tractinsky, 2004) and have been on the forefront of design science (e.g. Baskerville *et al.*, 2018). Aesthetics has also started attracting attention in commercial interface designs as it links to positive emotional responses in consumers (Cyr *et al*, 2006, 2009; Lavie and Tractinsky, 2004; Porat and Tractinsky, 2012).

In digital games, aesthetics typically refer to the in-game sensory phenomena that the player encounters (visual, aural, haptic, embodied), while aesthetic experience refers to an expression of the game experienced as pleasure, emotion or sociability (Niedenthal, 2009). While existing empirical findings suggest that well-perceived audio and visual presentation in games positively influences players' engagement (Laffan *et al.*, 2016), we argue that these emotional responses do not necessarily result from cutting edge realistic graphics. The prototypical aesthetic experience stimulates intense feelings or emotions and fixates the attention of the participant upon the components of a visual pattern making them lose awareness of external objects or events (Kubovy, 2000). The aesthetic representation in a game (e.g. the colour palette, the choice and look of environments, character representation style), regardless of the level of fidelity, can stimulate powerful emotions on players in the same way an impressionist painting does for an enthusiast. Adopting *aesthetics* rather than a *fidelity* perspective in graphical design allows us to explore alternative approaches to graphics design and their effect on psychological flow and learning. When it comes to emotionally and cognitively engaging the players, in-game aesthetic choices that convey clarity, originality and set a tone fitting to the theme of the game can be equally effective. Thus, the second hypothesis of our study is as follows:

H2. Game aesthetics will be positively related to flow.

Flow and learning outcomes

The capacity of digital games to engage and motivate players enhances their potential as learning vehicles. Motivation is a strong source of learning and achievement (Ryan and Deci, 2000) and can be systematically influenced by teaching practices (Ryan and Stiller, 1991). Developers strive to engage the players by incorporating the right elements and mechanics in their game-based learning applications. In accordance with the main premises of self-determination theory, Ryan *et al.* (2006) show that digital games can, in fact, satisfy the basic needs for competence, autonomy and sociability and, therefore, enhance intrinsic motivation. Flow, in turn, being a prominent model of intrinsic motivation inherits its ability to facilitate knowledge development and creative accomplishment (Csikszentmihalyi *et al.*, 1993; Csikszentmihalyi, 1997; Hektner and Csikszentmihalyi, 1996). In an educational context, such deep levels of engagement can lead to optimal learning experiences and outcomes (Barzilai and Blau, 2014; Chang *et al.*, 2012; Hung *et al.*, 2015; Liu *et al.*, 2011). In the context of serious games in particular, prior studies have shown a direct link between flow and learning outcomes (e.g. Hamari *et al.*, 2016; Kiili, 2005). However, there are a limited number of studies on flow in a serious games context (Perttula *et al.*, 2017). We advance our third hypothesis:

H3. Flow will be positively related to perceived learning.

Flow as a mediator between game elements and perceived learning

Narratives, as part of our cognitive repertoire, can craft our sense of self (Clark and Rossiter, 2008; Jonassen and Hernandez-Serrano, 2002) and enhance the mental organization of information (Falk and Dierking, 2000), knowledge and experiences (Mandler, 1984). Consequently, narratives are a powerful means of shaping people's perceptions, beliefs, attitudes, intentions and behaviours,

having an effect on perceived learning (Braddock and Dillard, 2016). We expect, thus, a positive relationship between narrative and perceived learning on the premise that the more the players relate to the in-game characters and unfolding events, the more knowledgeable about the context, the story and the overall meaning of the exercise they would feel. This, however, is an indirect relationship since the involvement and connectedness with the narrative translates to flow experiences, leading consequently to higher perceived learning. A confusing or uninteresting narrative would fail to motivate the player to invest cognitive and emotional resources to follow the story, something that would eventually be translated to limited perceived learning. Building on these, our fourth set of hypotheses is as follows:

H4a. Flow mediates the positive relationship between narrative-stimulated empathy and perceived learning.

H4b. Flow mediates the positive relationship between narrative understanding and perceived learning.

The aesthetics of a digital game have a similar effect on perceived learning. The more intuitive an in-game environment is, the better the player can navigate it, and the more consistent and life-like a virtual environment is, the better the player can guess different properties based on knowledge of its real-world counterpart. In this sense, we argue that aesthetics have a similar need for verisimilitude, as narrative does. This means that although graphics do not need to be high-resolution or non-fiction, their "life-likeness" allows for a more accurate representation and manipulation of virtualized real-world objects or places. Such elements enhance the learning facilitation of digital games, influence the perceptions of players regarding their effectiveness and can enhance the knowledge transfer to the real world due to the similarity between the two environments. The positive emotions elicited by the aesthetic experience are expected to have a similarly positive impact on learning outcomes as they support comprehension and transfer of knowledge (Um *et al.*, 2012). Such impact, however, is partly enabled by the experience of flow, which is stimulated by the emotional design of the game (e.g. Park *et al.*, 2015). Given the above, we expect game aesthetics to positively and indirectly influence perceived learning. Such a relationship, like in the case of narratives, is mediated by flow since the higher the aesthetic appeal, the more engaged the player would be (Wood *et al.*, 2004). Experiencing flow results in a larger investment of resources to explore and experiment with the game, consequently leads to a higher perception of learning achievement. Therefore, we also hypothesize that

H4c. Flow mediates the positive relationship between aesthetics and perceived learning.

Based on the above discussion, our research model for the study is graphically depicted in Figure 2:

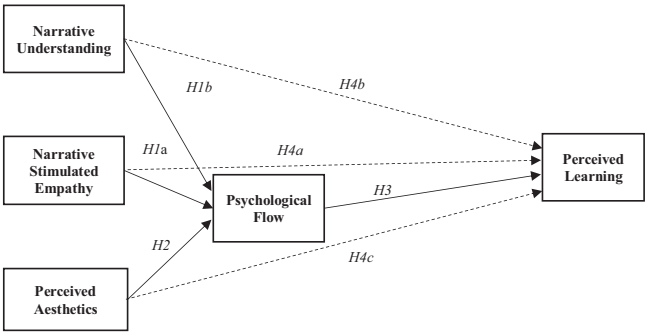


Figure 2.
The research model

The research methodology

Papers, Please*: a game for enforcing immigration policies*

Papers, Please (2013) is critically acclaimed for its aesthetic and gameplay qualities while it has been designed in a retro, low-resolution format. The game deals with the issues of enforcing immigration policies in an ever-changing political environment and focusses on the work-life of a border officer at a fictional country during a period of political turmoil. The player reviews arrivals' documents and uses a list of guides to either allow through the borders those with proper documents, reject those without proper documents or detain those with fake documents. The player has a limited amount of time to process as many arrivals as possible and receives a stipend based on how many people were processed correctly through the borders while being fined for any mistakes. The salary is used to pay for the rent, food, medicines and heat of the player's in-game family, the conditions of which are provided (e.g. the player knows whether the in-game family members are sick or cold). The player is presented with ethical challenges, such as approving entry for the pleading wife of a citizen, despite her lacking proper documents.

Data collection

We empirically test our research model and hypotheses via a psychometric survey (e.g. Nunnally, 1978), for which we recruited as participants 133 students from a major university in The Netherlands, who have not had an experience with *Papers, Please*. Such a population provided us with a multinational sample with exposure to digital games (Brown and Thomas, 2008; Carstens and Beck, 2005) – as a generation that has grown up with a exposure to them (Brown and Thomas, 2008; Ghazali *et al.*, 2019; Petter *et al.*, 2018) – that will soon join the workforce. The mean age was 22 years, with 58% being male. All the participants were asked to join a game session and fill out the survey immediately after. Each game session lasted 45 min, allowing the participants to get absorbed in the characters and the events that unfolded without causing fatigue that could influence their responses during the 15-min surveying session that followed. The sessions took place in a dedicated room at the university campus with a minimalistic interior. Participants' computers were positioned in such a way that they never faced each other and they all used headphones. One of the researchers was always present during the session without interfering, and the participants were not allowed to ask questions during the game session or the survey. All participant information was treated confidentially.

Operationalization of variables

All the variables were measured using multi-item scales (see Appendix). Age and gender were used as control variables. More specifically on the operationalization of our variables:

Flow was measured by an adapted version of Agarwal and Karahanna's (2000) cognitive absorption (CA) construct, which assesses players' experience in a holistic way (temporal dissociation, focussed immersion, heightened enjoyment, control, curiosity); flow is reflected in the construct of CA through the dimensions of *temporal dissociation* and *focussed immersion*. This follows the operationalization of flow in the studies by Barzilai and Blau (2014) and Oksanen (2013), who also studied flow in the context of serious games. We, thus, measured flow via a latent variable of the two aforementioned dimensions of CA. All items were scored on a seven-point scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"). Cronbach's alpha values were 0.91 and 0.83, respectively. *Perceived aesthetics* was measured in line with Lee and Koubek (2010) and Cronbach's alpha was 0.88. *Narrative understanding* and *empathy* were measured using the respective narrative understanding and narrative emotional engagement scales (Busselle and Bilandzic, 2009) and Cronbach's alpha values were 0.77 and 0.90, respectively. Finally, *perceived learning* was measured using

four items that relate to the cognitive aspects of perceived learning, adapted from Barzilai and Blau (2014) and Cronbach's alpha was 0.95.

The data analysis and results

We performed an exploratory factor analysis to assess the psychometric properties of the scales in our model in terms of adequacy, convergent and discriminant validities and reliability. All measures indicated no issues, and thus, we employed structural equation modelling (SEM) to test the validity and assess our model for common method bias (CMB) before proceeding with testing the hypothesized relationships. For our analysis, we used maximum likelihood (ML) SEM in AMOS 22. ML-SEM has been chosen over generalized least squares structural equation modelling (GLS-SEM), although the latter provides better empirical fit, this comes at the cost of theoretical misfit with respect to both model structure and parameter bias (Olsson *et al.*, 2000). ML-SEM, on the other hand, provides more realistic indexes and overall fit and less biased parameter values for paths that overlap with the true model in cases of misspecification (Olsson *et al.*, 2000).

The measurement model

We assessed the model in terms of convergent and discriminant validities as well as internal consistency by checking the composite reliability (CR), average variance extracted (AVE), maximum shared variance (MSV) and average shared variance (ASV) scores. CR was consistently above the 0.7 threshold, indicating no reliability concerns, AVE was consistently above the 0.5 threshold, raising no convergent validity concerns and finally, MSV and ASV were found consistently lower than AVE, suggesting no discriminant validity concerns. The aforementioned thresholds follow the suggestions of Hair *et al.* (2010). The results are presented in Table 2, while Table 1 presents the descriptive statistics of the variables.

The common method bias analysis

Due to concerns that the single method used to collect the data may have introduced systematic response bias that could either inflate or deflate responses, we tested our model for CMB. Since capturing a social desirability bias was not an issue in the context of our questionnaire, we opted to employ a common latent factor method to address any CMB issues. By comparing the standardized regression weights between all observed items in the model while the common latent factor (CLF) was present and not, we concluded that none of our factors were affected by CMB as the differences between items were consistently kept at a level lower than 0.2. The measurement model including the variables narrative empathy, narrative understanding, perceived aesthetics, flow, perceived learning, age and gender fit well to the data, with minimum discrepancy CMIN/DF = 1.38, comparative fit index CFI = 0.98, PCLOSE = 0.79 and root mean square error of approximation RMSEA = 0.04.

The structural model

The analysis explained in the previous section enabled the construction of the structural model, which we graphically depict in Figure 3, along with the results of SEM.

As can be seen from the standardized regression weights, both narrative design dimensions as well as the aesthetic value of the digital game are positively and significantly related to flow. As a result, H1a and H1b as well as H2 are accepted. Concurrently, flow experience is positively and significantly related to perceived learning as predicted by H3.

We test for mediation via bootstrapping. We resample 2,000 times and obtain the estimates and the confidence intervals for the indirect effects. The analysis resulted in a

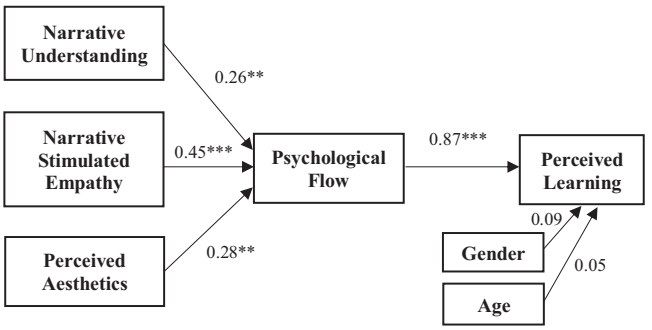
	Mean	SD	1	2	3	4	5	6	7
1. Age	22.44	2.63							
2. Gender	1.42	0.49	−0.345**						
3. Flow: focussed immersion	4.85	1.23	−0.220*	0.026					
4. Flow: temporal dissociation	4.24	1.47	−0.098	0.024	0.654**				
5. Narrative understanding	4.22	1.38	−0.121	−0.055	0.240**	0.088			
6. Narrative-stimulated empathy	3.36	1.37	−0.149	0.001	0.485**	0.388**	0.065		
7. Perceived Aesthetics	3.48	0.98	0.044	−0.28**	0.398**	0.330**	0.416**	0.481**	
8. Perceived Learning	4.01	1.59	−0.109	0.014	0.608**	0.515**	0.374**	0.514**	0.525**

Note(s): **Correlation is significant at the 0.01 level
*Correlation is significant at the 0.05 level

Table 1.
Means, standard deviations and correlations of model variables, $N = 133$

	α	CR	AVE	MSV	ASV
Flow: focussed immersion	0.83	0.84	0.58	0.33	0.19
Flow: temporal dissociation	0.91	0.92	0.73	0.32	0.17
Perceived aesthetics	0.88	0.88	0.51	0.23	0.16
Narrative-stimulated empathy	0.90	0.90	0.63	0.24	0.16
Narrative understanding	0.77	0.78	0.55	0.15	0.07
Perceived learning	0.95	0.95	0.82	0.33	0.23

Table 2.
Convergent and discriminant validities and reliability tests



Note(s): ***Significant at 0.001, **Significant at 0.01

Source(s): Fit indices X^2 (df) = 53.6 (39), CMIN/DF = 1.38, CFI = 0.98, PCLOSE = 0.79, RMSEA = 0.04

Figure 3.
Structural equation modelling results

significant positive indirect effect of narrative understanding on perceived learning mediated by flow ($\beta = 0.23$, CI = 0.11, 0.35, $a = 0.05$), a significant positive indirect effect of empathy on perceived learning mediated by flow ($\beta = 0.42$, CI = 0.29, 0.55, $a = 0.05$) and finally, a

significant positive indirect effect of aesthetics on perceived learning mediated by flow ($\beta = 0.24$, CI = 0.10, 0.37, $a = 0.05$). The above-mentioned results support H4a, H4b and H4c.

Discussion

We develop and test a novel model to assess the impact of narrative and aesthetics in facilitating flow experience as well as the mediating role of flow between these game elements and perceived learning. These two game dimensions are chosen because they are related to the often-neglected emotional dimension of player engagement. We incorporate a psychometric survey approach and employ SEM to investigate the relationships between narrative, aesthetics, flow and learning outcomes. Our findings demonstrate that both dimensions positively influence the perceived learning of players via high levels of engagement (i.e. flow). Player immersion and flow are the main engines of the gameplay experience and help facilitate a variety of positive outcomes, learning included. This highlights the significance of emotional design elements, which are often disregarded as not directly related to the learning process and are typically absent from popular training simulations.

Our study contributes to transportation theory by linking narratives and aesthetics to learning outcomes. While transportation theory is focussing on media enjoyment, our results indicate that the media qualities that are important to media enjoyment and consumption can be also linked to learning. This opens new opportunities for research and design. In particular, we deem transportation theory as highly relevant to knowledge-related design literature as it provides with the mechanisms through which enjoyment stimulants can also be linked to self-transformation through knowledge. Concurrently, we expand the theoretical ecosystem of flow theory by introducing narratives and aesthetics as antecedents of flow in the context of designed experiences. This finding shifts the focus away from cognitive antecedents of flow such as challenge levels, immediate feedback and proximal goals and introduces emotional antecedents such as empathy and aesthetics as a prosperous area for research and design.

Second, our study contributes to existing literature exploring the relationship between different game elements and flow experience (Hamari *et al.*, 2016; Hsu and Lu, 2004; Westwood and Griffiths, 2010). Whilst narrative is an inherent part of gameplay (e.g. Busselle and Bilandzic, 2008; Dickey, 2006), empirical evidence and the mechanisms through which narrative can influence learning-related attitudes on players had not been satisfactorily studied to date. Our mediation results demonstrate that narrative understanding and empathy positively influence perceived learning via flow. Transportation theory posits that a narrative can cause absorption through imagery and affect and can influence the beliefs and evaluations of participants regarding the story and its protagonists. Fantasy is an integral part of the gameplay experience and narrative elements, in essence, stimulate the imaginative involvement of the player, leading to higher immersion (Kenny and Gunter, 2008; Murray and Maher, 2011). We consider the blend of transportation and flow theory to be valuable for the design of dual systems, as serious games in particular, and gamified systems in general, are considered as dual IS.

Our third contribution lies in theoretically distinguishing *aesthetics* from *fidelity* and linking aesthetics to psychological flow and perceived learning. Our results indicate that even in low-fidelity settings, higher perceived aesthetics enhance players' engagement and consequently learning. This finding takes the spotlight away from the more objective element of fidelity towards the more subjective element of aesthetics. Thus, by using a game with low graphical fidelity, we focussed on capturing differences in the perceptions of aesthetic appeal and contributed to the very sparse existing evidence that graphical fidelity is not a necessity for a better player experience and related outcomes (e.g. Joeckel and Bowman, 2012). This has

implications for the design of learning environments as higher graphical fidelity is associated with higher development costs and higher requirements for the computers that will be running the software.

Our findings also give rise to practical implications, especially for software companies that develop serious games. Our study confirms that immersing players and creating the conditions to learn are indeed key elements in serious games. In particular, our findings point out to the effect of narratives and aesthetics in players' engagement and learning. We, therefore, propose that as narrative is key to achieving learning, serious game developers need to examine multiple possibilities to narrate the game story in order to facilitate learning. Within this range, serious games developers can adopt both a fictional and a real storytelling, as well as allowing the player to take an active role by shaping the narrative in a way that will increase *flow* and consequently the learning extracted from playing a serious game. Yet, with greater flexibility with narratives developed into the game, serious game developers need to consider how aesthetics, as a factor that enhances learning, could amplify the narrative. In doing so, serious games developers should facilitate a sustained flow by creating interactions between narratives and aesthetics by, for instance, woven changes in audio-visual representations (e.g. movement, sound, lights) when the narrative presents a complication of some sort as a learning opportunity. Aesthetics are, thus, a representation of learning opportunities and those should be invoked to create condition for learning as the narrative triggers the player to seek new solutions.

Limitations

Whilst we used mainly a self-report survey design, with specific inherent limitations, the extra steps taken during the analysis in regard to CMB, the establishment of theoretical causal mechanisms that govern the relationships in our model and our focus on studying the *perceptions* of players during their game experience render the survey method a fitting approach for studying the phenomena of interest. Additionally, our sample is exclusively comprises university student participants, and thus, it might not be fully representative of the general population. These individuals, however, are destined to become part of the future workforce and are representative of the virtual generation whose dispositional characteristics bear research-worthy implications for organizations worldwide (Beck and Wade, 2004).

Future research

Many questions remain unanswered, especially on the contingent effects of narrative and aesthetics on flow and learning. One promising direction is to investigate the role of individual differences. As the technology-enhanced training effectiveness model (TETEM) suggests (Landers and Armstrong, 2017) that instructional performance may be hindered if people are not comfortable and experienced with the particular technology. Additionally, dispositional characteristics such as learning goal orientation could also be playing a role (Alexiou and Schippers, 2018). Our study focussed on perceived learning because it was deemed a predictor of technology acceptance, self-efficacy and learner satisfaction. What remains to be explored is the translation of these outcomes to tangible gains in the work environment via *learning transfer*. Experimental and longitudinal designs would be an ideal avenue to explore this relevant and pressing question. Finally, emotions have been identified as an important predictor of creativity (e.g. Forgeard, 2011). Future research could aim at uncovering the role of narrative devices and aesthetic representation in facilitating creative thinking and behaviour.

Conclusion

Our study investigated the role of narrative and aesthetics in enhancing players' flow experience in serious game and the mediating role of flow between these game elements and

perceived learning. Our findings demonstrate that narrative and aesthetics influence positively the perceived learning of players through high levels of psychological flow. The findings of our study have implications for the design of game-based learning environments as they highlight the importance of elements often disregarded, as not directly related to the learning process and are typically absent from popular training simulations. Our findings contribute to better understand and theorize the components and implications of the gameplay experience and open avenues for further research and development in the area of gamification and serious games.

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Appendix

Table A1.
Variables

Variables		Loading
Game elements	*Narrative understanding (Busselle and Bilandzic, 2009)*	
	NU.1: At points, I had a hard time making sense of what was going on in the programme	0.714
	NU.2: I had a hard time recognizing the thread of the story	0.900
	NU.3: It was difficult to understand why the characters reacted to situations as they did	0.560
	Narrative-stimulated empathy (Busselle and Bilandzic, 2009)	
	NE.1: I was worried for some of the characters in the game	0.731
	NE.2: When a main character succeeded, I felt happy and when they suffered in some way, I felt sad	0.772
	NE.3: The story affected me emotionally	0.911
	NE.4: I felt sorry for some of the characters in the game	0.819
	NE.5: At important moments during the game, I could feel the emotions the characters felt	0.767
	Perceived aesthetics (Lee and Koubek, 2010)	
	PA.1: Overall, I am satisfied with the appearance of this game	0.825
	PA.2: I feel the design of this game is aesthetic	0.741
	PA.3: I feel the design of this game is pleasant	0.791
	PA.4: I feel the design of this game is clear	0.708
	PA.5: I feel the design of this game is clean	0.698
	PA.6: I feel the design of this game is systematic	0.605
	PA.7: I feel the design of this game is creative	0.606
	PA.8: I feel the design of this game is sophisticated	0.581
Flow	*Temporal dissociation (Agarwal and Karahannal, 2000)*	
	TD.1: Time appears to go by very quickly during the game	0.886
	TD.2: Sometimes I lost track of time during the game	0.880
	TD.3: Time flies during the game	0.948
	TD.4: Most time during the game, I ended up spending more time than I planned	0.688
	Focussed immersion (Agarwal and Karahannal, 2000)	
	FI.1: During the game, I was able to block out most other distractions	0.607
	FI.2: During the game, I was absorbed in what I was doing	0.885
	FI.3: During the game, I was immersed in the task that I was performing	0.900
	FI.4: During the game, my attention did not get diverted very easily	0.585
Outcome	*Perceived learning (Barzilai and Blau, 2014)*	
	PL.1: I learned a lot from the game	0.917
	PL.2: The game added to my knowledge	0.930
	PL.3: I learned new things from the game	0.924
	PL.4: The game will help me remember the things I learned	0.848

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