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How do the Experiences of Virtual Presence and Flow Differ? Evidence from Engineering and ICT Online Education*

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Virtual presence and flow are usually presented as two core facets of the individual's immersion in online education settings, yet their delimitation is still unclear. We seek to address this issue by theoretically explaining, and empirically showing, their different extents. From a sample of students of engineering and ICT programmes in a pure-online education setting, we have found that although virtual presence and flow are both triggered by focused attention (which in turn is prompted by a similar feeling of perceived control), virtual presence is directly activated by the challenges perceived in the online environment—and its activation facilitates flow states. The findings also support the impact of challenge and skill on perceived control. These results shed light on the complexity of immersive experiences in virtual education environments, and offer implications for higher education institutions and instructors.

Keywords: virtual presence; flow; online education; human-computer interaction

1. Introduction

Online education has become a crucial element to the higher education institutions' strategy [1] that can offer equivalent learning outcomes to those using face-to-face instruction [1, 2]. Consistent with this, online engineering and ICT programmes have flourished rapidly in recent years [3].

Despite this, the formation of immersive experiences within virtual education environments is still an intriguing issue for scholars and managers in higher education institutions.

On the one hand, studies in the field of Human-Computer Interaction (HCI) have paid a lot of attention to the concept of virtual presence (for example, see [4]). HCI literature has presented virtual presence as a 'subjective feeling of immersion' [5, p. 2275] in a environment evoked by the technology, which translates into an intense feeling of being 'inside' the said environment [6]. As a result, the medium's content becomes the individual's reality, and his or her sense of self is fully engulfed by the virtual, alternative world [7]. Previous HCI virtual presence research has drawn interest in the individual's cognitive factors underlying the sense of virtual presence (e.g. [4, 8]), and in explaining why this phenomenon occurs (e.g. [9, 10])—although it has ignored its links with flow.

On the other hand, educational, and marketing and consumer behaviour research has largely turned to Csikszentmihalyi's Theory of flow [11] to study the individual's immersive experiences online. Here, flow is understood as a state of immersion in the activity at hand [11], which leads the individual to merge himself or herself with the activity, and lose his or her own sense of self-consciousness [11, p. 38]. In modelling within this particular line of research, flow plays a central role while possible connections between flow and virtual presence are also taken into consideration—essentially to explain the flow phenomenon (e.g. [12]). However, this group of studies have faced a difficulty that has not yet been solved, namely: a lack of agreement about the potential link between flow and other user behaviour constructs like virtual presence [13]. So in some models virtual presence is conceived as a mere component of flow [14–16], whereas in others virtual presence is an independent construct that—among many other factors—precedes and facilitates flow [12, 17].

To the best of the authors' knowledge, only two previous empirical investigations [18, 19] have attempted to study, specifically, the connection

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between virtual presence and flow. In the aforementioned papers, it was shown that: (a) virtual presence and flow are two different user behaviour constructs; and (b) a positive correlation between virtual presence and flow exists.

We aim to shed some additional light on virtual presence and flow by investigating the precise nature of the virtual presence-flow connections, and the (similarities and) differences between these two constructs. To do so, we build an integrating conceptual model (rooted in HCI and Flow Theory) and we test this model with data from a sample of online students in engineering and ICT programmes. The analytical model is new in the literature, and provides new insights into the university students' immersive experiences online. We conclude with a discussion of the results, and their implications for scholars and university's staff managers.

2. Conceptual model and hypotheses

Figure 1 lays out our conceptual model about virtual presence and flow. The model stems from [18, 19]'s observations that virtual presence and flow are distinct consumer behaviour constructs. And on the basis of integrating virtual presence HCI literature, and Flow Theory, the model includes four additional constructs (challenge, skill, perceived control, focused attention) that impact, either directly or indirectly, on virtual presence and flow. Furthermore, it considers a positive direct relationship between virtual presence and flow.

Previous research has suggested that the individual's perceived control, understood as a perception of domain over the interaction with the virtual environment (e.g. [20]), is triggered by both high challenge, and skill [21]. Challenge is conceived as the individual's effort to achieve an end [22]. Skill is conceived as a self-perceived capacity, and internal concern to meet the requirements presented by the environment [23]. Even though the studies that have dealt with these potential relationships are very few and somewhat contradictory [24], there is some evidence that points out the direct causal link to perceived control from challenge [25], and skill [26]. This gives ground to formulate the following hypotheses:

H1a. Challenge has a positive influence on perceived control.

H1b. Skill has a positive influence on perceived control.

A handful of flow studies [27] have supported the existence of a link between the individual's perceived control, and his or her focussed attention—understood here as intense concentration on the events in the virtual environment [28]. Additionally, it might be reasonable to expect that the greater the challenge posed by the action occurring in the virtual environment, the more the individual will be concentrated in such an environment [12]. This rationale gives rise to hypothesise a positive direct effect of challenge on focused attention.

H2. Perceived control has a positive influence on focused attention.

H3. Challenge has a positive influence on focused attention.

For the individual's immersion to manifest—either in the form of a 'spatial' sense of being in the virtual environment (virtual presence), or translated into states of entire immersion in the online activity (flow)—, the individual's full concentration is required on the stimulus coming from the technological system. The potential link of focused attention with flow is well documented in flow literature (see e.g. [27, 29]). And although focused attention has received relatively less scrutiny in HCI litera-

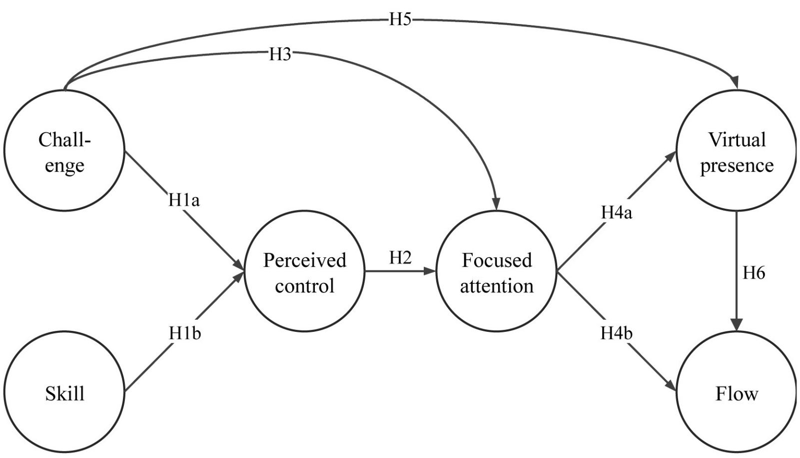

Fig. 1. Conceptual virtual presence-flow model.

ture, there is a reasonable foundation for assuming that deep concentration in the virtual environment leads the individual to emphasise his/her experience there, at the expense of reducing the awareness of the immediate realm [4].

H4a. Focused attention has a positive influence on virtual presence.
H4b. Focused attention has a positive influence on flow.

In the course of preparing this paper we only found one study that considers the facilitating effect of challenge on presence [30]. Nevertheless, it seems reasonable to presume that, when the individual faces a strong challenge within the virtual environment, his or her actions with the technology will be many more—and the feedback he/she receives will be greater. In turn, this will awaken more intense feelings of presence. Therefore:

H5. Challenge has a positive influence on virtual presence.

So far, the literature has not offered a definitive explanation about the potential influence of presence on flow (see, e.g. [18, 19]). A group of studies has presented presence as a predictor of flow (e.g. [12, 17]), yet other investigations—contrary to expectations—did not obtain such results [31]. On top of this, some studies have dealt with presence as a dimension of flow [14–16], whereas others have shown that virtual presence and flow are distinct, although correlated constructs [18, 19]. Despite these mixed findings, it seems likely that virtual presence feelings, insofar as they transport the individual to a virtual environment, provide opportunities that plunge he or she into the activities taking place in that virtual realm.

H6. Virtual presence has a positive influence on flow.

3. Methodology

3.1 Data collection and sample

Fieldwork was performed in a pure-online education environment in order to assess the hypotheses that configure the conceptual model. Within this particular setting chosen for the investigation, an online survey was addressed to all individuals who were studying undergraduate and graduate Engineering and ICT programmes (7,433 individuals in total). The questionnaires were dispatched in one wave by the University's office. A total of 657 students returned them fully answered. This sample was found to show very good representativeness in terms of marginal error (3.651%, assuming a level of confidence of 95% and maximum of uncertainty $p = q = 0.5$).

3.2 Measurement of constructs

After a careful review of the pertinent literature, scales to measure the constructs included in the model we selected. In all cases (see Table 1), scales previously validated in empirical research were adapted.

Except for the second item of the scale of flow, every scale item asked individuals to indicate their agreement or disagreement with a particular state-

Table 1. Measurements

Construct		Scale items
Challenge[1]	CH1	Using the campus[4] challenges me
	CH2	Using the campus challenges me to perform to the best of my ability
	CH3	Using the campus provides a good test of my skills
	CH4	I find that using the campus stretches my capabilities to my limits
Skill[2]	SK1	I am very skilled at using the campus
	SK2	I consider myself knowledgeable about good search techniques on the campus
Perceived control[1]	PC1	When I use the campus, I feel influential
	PC2	When I use the campus I feel dominant
Focused attention[3]	FA1	When using the campus I have a feeling of concentration
	FA2	When using the campus I am totally absorbed in what I am doing
	FA3	When using the campus I am able to block out most other distractions
Virtual presence[1]	VP1	I forget about my immediate surroundings when I use the campus
	VP2	Using the campus makes me forget where I am
	VP3	After using the campus, I feel like I come back to the 'real world' after a journey
	VP4	When I use the campus, I feel I am in a world created by the technology
	VP5	When I use 'the campus', the world generated by the technology is more real for me than the 'real world'
Flow[1]	FW1	I have (at some time) experienced 'flow' on the campus
	FW2	In general, how frequently would you say you have experienced flow when you use the campus?
	FW3	Most of the time I use the campus I feel that I am in flow

[1] Adapted from [12]. [2] Adapted from [12], [24]. [3] Adapted from [15], [20]. [4] Individuals of the sample frame named the virtual education system as 'campus'.

ment by using a Likert scale of seven points (from 1 'strongly disagree' to 7 'strongly agree'). By contrast, the response scale for the second item of flow ranged from 1 'never' to 7 'very frequently'.

4. Results

4.1 Measurement model

Although half of the constructs have item-to-total correlations greater than 0.60 (the recommended level for field studies) there are three constructs with values lower than that level: perceived control, focused attention, and virtual presence (see Table 2). Nevertheless, taking into account that those values are pretty close to 0.60, and that Cronbach's α values for every construct surpasses the requested 0.7 level, the internal reliability of the self-reported constructs is considered adequate.

The analysis of the convergent validity shows that all factor loadings are above the recommended level of 0.60, and that the composite reliability (CR) values surpass the lower bound of 0.70. Additionally, the average variance extracted (AVE) measures are greater than the required value of 0.50 in all constructs except VP. Nevertheless, since this value is very close to the minimum recommended level, and it is lower that the corresponding CR value, we deem that the convergent validity of the model is fulfilled.

And given that the AVE measure for each construct is greater than the associated maximum shared squared variance (MSV), and its average shared squared variance (ASV), we obtain that discriminant validity of the model is also accomplished.

4.2 Analytical model

Fit indices obtained from the model estimation show that the model has a very good adjustment to the data (see Table 3). Although the $\chi 2$ statistic does not have an associated *p*-value greater than 0.05, this test almost always rejects the model when large samples are used [32], and all the other absolute fit measures satisfy the recommended inequalities. If we adjust the $\chi 2$ statistic to the degrees of freedom of the model, we get a good result: the $\chi 2$/d.f measure is lower than 5.00. Additionally, the goodness of fit index (GFI) is greater than the recommended value of 0.80, which shows that 91.4% of the variance in the variance-covariance matrix of the data is captured by the model. And the standardized root mean square residual (SRMR), and the root mean square error of approximation (RMSEA) both satisfy the required inequality: the two yield values below 0.08.

Incremental and parsimonious fit measures show the good fit of the model to the data. The adjusted GFI (AGFI) is greater than 0.80. And the normed fit index (NFI), and the Tucker-Lewis index (TLI) are both above the lower bound of 0.90. Although the comparative fit index (CFI) is not greater than the recommended value of 0.95, it is pretty close to that value. Hence, and since all the other measures satisfy the required inequalities, we consider that (compared to the null model) our model is adequate.

The parsimonious GFI, the parsimonious normed fit index (PNFI), and the parsimonious comparative fit index (PCFI) are clearly greater than 0.50—the recommended cut-off value—which indicates a good parsimonious fit of the model [33].

Table 2

Construct	Variable	Cronbach's α	Item-total correlation	Factor loading	CR	AVE	MSV	ASV
Challenge	CH1	0.879	0.675	0.819	0.883	0.654	0.318	0.175
	CH2		0.822	0.864				
	CH3		0.790	0.851				
	CH4		0.669	0.701				
Skill	SK1	0.749	0.602	0.870	0.752	0.602	0.127	0.059
	SK2		0.602	0.868				
Perceived control	PC1	0.739	0.586	0.796	0.769	0.634	0.194	0.147
	PC2		0.586	0.890				
Focused attention	FA1	0.744	0.593	0.774	0.759	0.517	0.356	0.193
	FA2		0.564	0.726				
	FA3		0.660	0.798				
Virtual presence	VP1	0.811	0.576	0.619	0.813	0.486	0.452	0.244
	VP2		0.575	0.758				
	VP3		0.612	0.608				
	VP4		0.635	0.797				
	VP5		0.609	0.652				
Flow	FW1	0.885	0.777	0.815	0.895	0.740	0.452	0.251
	FW2		0.843	0.826				
	FW3		0.737	0.794				

Table 3

Fit measure	Value	Recommended values
χ^2	572.464	The lowest
P	0.000	> 0.05
χ^2/d.f.	4.003	< 5
GFI	0.914	> 0.80
SRMR	0.065	< 0.08
RMSEA	0.068	< 0.08
AGFI	0.886	> 0.80
NFI	0.906	> 0.90
TLI	0.913	> 0.90
CFI	0.927	> 0.95
PGFI	0.688	> 0.50
PNFI	0.758	> 0.50
PCFI	0.776	> 0.50

Table 4

Hypotheses and pathways		β	SE	CV	*p*
H1a	CH → PC	0.400	0.044	9.099	***
H1b	SK → PC	0.489	0.072	6.780	***
H2	PC → FA	0.212	0.042	5.045	***
H3	CH → FA	0.206	0.040	5.128	***
H4a	FA → VP	0.369	0.052	7.071	***
H4b	FA → FW	0.577	0.076	7.625	***
H5	CH → VP	0.399	0.042	9.476	***
H6	VP → FW	0.780	0.077	10.194	***

β: estimates; SE: standard error of the regression weight; CV: critical ratio value for regression weight; *** = 0.000.

Given the results obtained with the analysis of the fit indexes, we can consider that the structural is acceptable, so that it can be used to test the validity of the hypotheses. Since all estimates (β) are significantly positive, with *p*-values lower than 0.001 (see Table 4), we can assert that all hypotheses are supported.

5. Conclusions and further research

VP and FW are emerging as central elements in the understanding of individuals' interaction within virtual education environments. However, the delimitation of these phenomena is still elusive. In this paper we propose a closer integration of the lines of research on VP and FW in order to bring some insight to the connections and differences between these two constructs, and to expand current theories.

In line with [18]'s, we note that VP and FW are distinct user behaviour constructs, yet they represent conceptual similarities related to immersive feelings. Firstly, VP and FW show to be different because, as seen in the validation of the measurement model, items associated with VP and with FW belong to, respectively, a distinct component—with an eigenvalue greater than 1 and with factors loadings above 0.60 (see Table 2). Additionally to this, CH is a direct antecedent of VP whereas it has an indirect effect on FW. Secondly, VP and FW show resemblances because the results have brought evidence about two common antecedents of them (i.e. PC and FA), and both are conceptually related to the individual's immersion in a virtual environment.

We have gone one step further than [18, 19], by showing that the connection between VP and FW consists of a causal relationship from VP to FW. Moreover, we have detected that VP is directly triggered by CH presented by the education virtual environment, which was only observed in one previous study [30]. Also, we have provided empirical evidence about the link between CH and SK with PC, which only some studies have previously examined, and with mixed results.

For future research, we hope to complement these insights with evidence related to the positive consequences of VP on FW, in terms of academic performance and permanence in online education. The size of the sample used in this investigation, and the consistency of the results with previous research, tend to support the study's validity. Nevertheless, it would be desirable if further research compares these results with those in a variety of university programmes that are different from Engineering and ICTs'.

6. Management implications

The findings have implications for scholars, and management staff in higher education engineering and ICT colleges and departments, insofar as they contribute to explain the complexity of relationships gravitating around two central immersive subjective experiences with online education programmes: VP and FA.

Our results suggest that online engineering and ICT students undergo experiences of VP and FA when the learning activities raise CH, and induce them to fully use their SK online. CH and SK both activate the online students' perception that they are in control of the virtual learning environment, which further facilitates their FA in that learning environment. In turn, an FA in the learning activities triggers experiences of VP and FW. In addition to this, VP is positively and directly prompted by the CH faced by students online.

Online instructors and management staff can play a relevant role in facilitating VP and FW. By means of the resources they design, the learning tasks they prepare, and many other relevant components of the virtual education environment, they can unleash the virtuous processes that lead students to feel they are part of a true educative environment, and to fully immerse in the learning activities at hand.

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