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APPROACHES TO LEARNING IN THE NON-ACADEMIC CONTEXT: CONSTRUCT VALIDITY OF LEARNING APPROACHES TEST IN VIDEO GAME (LAT-VIDEO GAME)

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ABSTRACT

The subject-object interaction of knowledge studied by the field of learning approaches has been evaluated exclusively in the school/academic context. However, the field does not assume that these interactions are manifested only in this context. This article studies the validity of the Video Game Approach Test (LAT-Video Game), with the novel proposal to evaluate approaches in a non-academic context. The structural validity and its generality were investigated, as well as the predictive and divergent validity of the LAT-Video Game in two independent samples. Three models were tested in the first sample and the constrained bifactorial model gave the best fit and parsimony. By comparing the two samples, this model proved to be invariant even to the scalar level. The LAT-Video Game predicts the self-declaration of people as gamer or non-gamer at 84% [65% -100%]. The deep approach in video games does not correlate with approaches in the academic context, measured by the Learning Approaches Scale (LAS). The motivation related to the practice of video games correlates positively with the superficial approach and negatively with the deep approach. The LAT-Video Game shows structural validity, invariance, predictive and divergent validity.

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INTRODUCTION

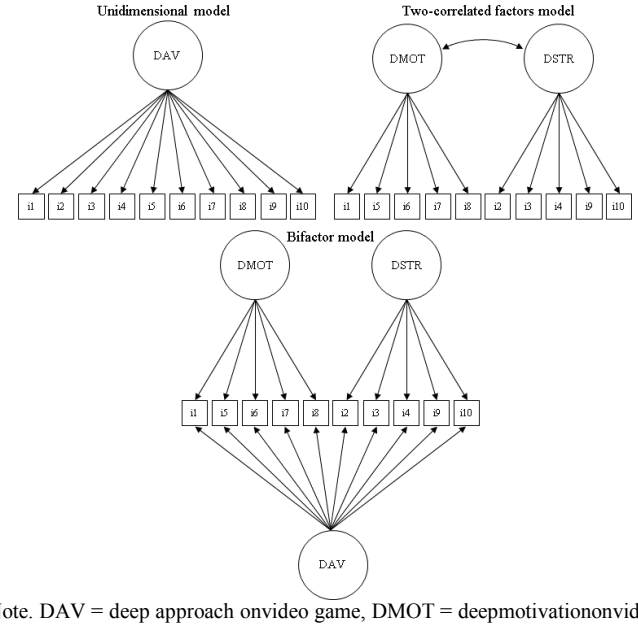
The main contribution of the theory of learning approaches to the field of studies on teaching and learning is the theoretical proposition and empirical identification that people interact with the objects of knowledge through two broad and antagonistic forms of cognitive processing and motivation: superficial and deep approach (Justicia, Pichardo, Cano, Berbén, & Fuente, 2008; López-Aguado & Gutiérrez-Provecho, 2018; Soler-Contreras, Cárdenas-Salgado, Fernández-Pina, & Monroy-Hernández, 2017). The theory points out that in the superficial approach the student is motivated for reasons outside of the interaction with the object, such as studying only to not fail, and uses low-level processing strategies, such as memorization with poor meaning. In the deep approach, the student is motivated for reasons inherent of his own interaction with the object, such as studying to increase his knowledge. In this approach, the student uses high-level processing strategies, such as the construction of meanings and the formation of relationships (López-Aguado & Gutiérrez-Provecho, 2018). In addition to highlighting the existence of two approaches, the theory also provides evidence that the deep approach is associated with a learning of better quality, as opposed to the superficial approach which is associated with a learning of worse quality. Furthermore, investigations of the theory on the relationship between teaching and the promotion of approaches have enabled the development of pedagogical practices that provide better student learning (Rosário, *et al*., 2010; Soler-Contreras *et al*., 2017). The main role of the active subject highlighted by the students` approaches to learning theory is corroborated by the evidence found in the predictive studies of academic achievement. Most of the main predictors presuppose, explicitly or implicitly, the role of the active subject (Cardoso, Seabra, Gomes, & Fonseca, 2019; Gomes, Golino, Santos, & Ferreira, 2014; Pereira, Golino, M. T. S., & Gomes, 2019), which is in accord with the constructivist theories (Golino, Gomes, Commons & Miller, 2014; Gomes, 2007; Gomes & Borges, 2009a; Gomes, 2010a; Pires & Gomes, 2018), as well

the neuropsychological field (Dias *et al*., 2015; Reppold *et al*., 2015). This prominent role of the active subject has been found in students` approaches to learning (Gomes, 2010c, 2011; Gomes, Golino, Pinheiro, Miranda, & Soares, 2011; Gomes & Golino, 2012; Gomes, 2013), metacognition (Gomes & Golino, 2014; Gomes, Golino, & Menezes, 2014), the students` beliefs about the teaching-learning processes (Alves, Flores, Gomes &Golino, 2012; Gomes & Borges, 2008a), motivation for learning (Gomes &Gjikuria, 2018), academic self-reference (Costa, Gomes, &Fleith, 2017), learning styles (Gomes, Marques, & Golino, 2014; Gomes & Marques, 2016) and intelligence (Alves, Gomes, Martins, & Almeida, 2016, 2017, 2018; Gomes, 2010b, 2011, 2012; Gomes & Borges, 2007, 2008b, 2009b, 2009c; Muniz, Gomes, & Pasian, 2016; Valentini *et al*., 2015). The theory does not assume that learning approaches occur only in the school/academic context. However, the instruments that measure the approaches have been developed to evaluate them in this context (Romero *et al*., 2013; Soler-Contreras *et al*., 2017). Exclusive evaluation in the academic setting is a limitation, as it prevents empirical research and understanding about approaches in other contexts. In turn, video games are a non-academic context conducive to studying the subject's interaction with objects of knowledge. Video games are part of people's daily lives (Adachi & Willoughby, 2013). In addition, there is evidence from meta-analyzes that playing video games causes positive changes in inhibitory control and in motor, visual and spatial skills (Powers, Brooks, Aldrich, Palladino, & Alfieri, 2013). Supporters of the use of video games argue that their practice enhances effective learning because they are interactive, provide support/help and react to the subject's actions, allowing the player to identify his mistakes, regulate his actions and have an active performance. Besides, video games present challenges that promote an intrinsic motivation to the interaction with the game itself (Zap & Code, 2009). In short, these arguments allow us to assume that the game context is a favorable environment for studying learning approaches. For that reason, in 2017, authors Cristiano Mauro Assis Gomes and Jhonys de Araujo from Laboratory for Cognitive Architecture Mapping [*Laboratório de Investigação da Arquitetura Cognitiva - LAICO*] at the Federal University of Minas Gerais created the Video Game Approach Test (LAT-Video Game), with the purpose of measuring approach in a non-academic context, that is, the practice of playing video games. This instrument has the same structure as the self-report questionnaires in the academic context. It has 10 statements describing behaviors of deep approach that the player can manifest in the practice of video games. These behaviors can be deep strategies or motivations related to video games (see Table 1).

Table 1. ***Items of LAT-Video Game***

Item
• Video game is one of my priorities.
• I have already completedmany games or became very good at many games.
• I try to combine different strategies to help achieve a certain goal in the game.
• I have already completed at least one game or I am very good at it.
• Playing video games is passion for me.
• Video game is my main source of leisure.
• I invest money in games or gaming equipment.
• I play video games for hours, whenever I can.
• I try to understand the behavior patterns of the elements present in the game.
• When I start a new game, I tryto use what I already know to help me perform better in that game.
• I have already completed a lot of games or got really good at a lotof games

Given its unique and recent character, no study has yet been published or presented in congress about the validity of the LAT-Video Game. In this article we present evidence of the construct validity of the LAT-Video Game. Two independent samples from Brazil are used. In the first sample, three models are tested: one-dimensional model, two correlated factors model and bifactor model. The one-dimensional model assumes that the LAT-Video Game has a single latent dimension, the deep approach in video games, which explains the variance of the test items. The correlated two-factor model assumes that the factors of deep motivation and deep strategy in video games explain the variance of the test items. The bifactor model integrates the previous models, with the presence of a general factor that represents the deep approach in video games and two specific factors, one of deep motivation and the other of deep strategy, all orthogonal (see Figure 1).



Note. DAV = deep approach onvideo game, DMOT = deepmotivationonvideo game, DSTR = deepstrategyonvideo game.

Figure 1. Testedmodels

After testing the structural validity of the LAT-Video Game, this study examines its invariance, by comparing, in samples 1 and 2, the parameters of the best model identified in the structural validity analysis. The external validity of the LAT-Video Game is analyzed through the predictive and divergent validities. Predictive validity is verified by examining the power of the LAT-Video Game to predict as gamers or non-gamers, from the person´s self-declaration. It makes sense to assume that the LAT-Video Game is highly capable of predicting this identification, because the fact of being a gamer implies the display of deep motivations and strategies related to the practice of playing (Neys, JeroenJansz& Tan, 2014). The divergent validity is studied through the analysis of the correlations among the variables measured by the LAT-Video Game and the deep and superficial approaches in the academic context. It is expected that weak correlations will be found, since the theory of learning approaches defines that the approaches are context dependent (Biggs, 1985).

METHODS

Participants: The participants in this study come from three independent samples. Sample 1 consists of 561 individuals

with complete or incomplete college education, with 541 (96.4%) coming from a public Brazilian university of Technological Sciences and 20 (3.6%) from other institutions. The average age of this sample is 22.67 years (5.30); it includes 352 (62.7%) males and 209 (37.3%) females; it consists mainly of students of Mathematical Sciences (n = 551, 98.2%) and includes people who were studying or already studied Humanities (n = 9, 1.6%) and Biological Sciences (n = 1, 0.2%). The majority did not declare themselves a gamer (n = 351, 62.6%). Sample 2 is composed exclusively of students from the same university of Technological Sciences. This sample includes 148 students, all from Mathematical Sciences and with an average age of 24.03 years (5.66), with 100 (67.6%) being male and 48 (32.4%) being female. The majority did not declare themselves a gamer (n = 89, 60.1%). Sample 3 is composed of 509 students from public (n = 122, 24.0%) and private (n = 387, 76.0%) universities, with an average age of 23.55 (7.13), including the areas of Mathematical Sciences (n = 148, 29.1%), Humanities (n = 285, 56.0%) and Biological Sciences (n = 76, 14.9%). The majority of this sample is composed of female students (n = 296, 58.2%).

Instruments

LAT-Video Game. The LAT-Video Game is a self-report instrument with the purpose of evaluating the deep approach in the context of the video game practice in people who have at least junior high school not yet completed. The test consists of 11 items representing behaviors of deep approach in video games. The instructions ask the respondent to mark the option "yes" if the statement of the item strongly represents their usual way of interacting with video games; otherwise, he must check the "no" option. Answers are recorded as 0 and 1 for "no" and "yes", respectively. Items 2 and 11 are identical. Item 11 was inserted exclusively to analyze the reliability of the responses. If the correlation between identical items is not high, this indicates that respondents have unreliable responses. There is evidence of content validity of the LAT-Video Game. Its items were elaborated taking as a conceptual reference the theory of learning approaches. Five self-declared gamers with at least 10 years of practical experience in video games were interviewed in a group when they were playing video games. The interviewer asked them what motivations and strategies were brought into play at the time they played. This interview was conducted in order to activate the previous knowledge that the interviewees had about their playing practice. The interview was recorded and items were created from it. Then, three judges were asked to assess the relevance and clarity of the items, suggesting changes when necessary. Small adjustments were made. A group of 10 representatives of the target population indicated that the items and instructions were easy to understand.

Learning Approach Scale (LAS [Escala de Abordagens de Aprendizagem – EABAP]). This article uses LAS to investigate the divergent validity of LAT-Video Game, taking into account that LAS is the instrument with evidence of validity and reliability in Brazilian samples (Gomes, 2010c, 2011, 2013; Gomes, Golino, Pinheiro, Miranda, & Soares, 2011; Gomes & Golino, 2012). LAS is a self-report instrument composed of 17 items, 9 of which measure a deep approach, and 8 measure a superficial approach, in the academic context. Each item has a statement that express motivations and strategies related to the study and the classroom. The respondent must assess how much each behavior presented in the item statements is present in his life, answering a Likert scale from 1 to 5, where 1 represents "not at all" and 5 represents "totally". LAS is applicable to people who have at least junior high school not yet completed.

Sampling procedures: The data in this study come from two independent samples. The samplings were carried out in 2018 and 2019, in order to produce an educational database. Different instruments were applied, including the LAT-Video Game and the LAS. Along with questions related to socio-demographic aspects, the question "Do you consider yourself a gamer?" has been applied in order to identify whether or not the participant identified himself as a gamer. The answer options for this question were "yes" and "no" and were coded as 1 and 0 respectively. The collections followed the ethical standards and had the approval of the Santa Catarina State University ethics committee (protocol 73453317.1.0000.0118). The people who participated in the survey took notice of it through disclosures made on social networks and e-mails. Those interested could access a link that redirected them to the SurveyMonkey platform, where the instruments were available. The data were collected virtually and automatically recorded in an Excel spreadsheet. Only those who consented to the conditions presented by the Free and Informed Consent Form participated in the study.

Data analysis

The analyzes were performed using the semTools packages, v. 0.5-3 (Jorgensen, Pornprasertmanit, Schoemann, &Rosseel, 2020), lavaan, vol. 0.6-6 (Rosseel, 2020), psych, v. 2.0.7 (Revelle, 2020) and polycor, v. 0.7-10 (Fox, 2019) of the R Project for Statistical Computing, v. 4.0.2 (R Core Team, 2020). The analyzes were divided into five stages. The first stage used sample 1, steps 2, 3 and 4 used samples 1 and 2, and the last stage used samples 2 and 3. In all stages, the tested models were estimated using the Weighted Least Square Mean and Variance Adjusted (WLSMV). The models fit was assessed using the Comparative Fit Index (CFI) and Root Mean Square Error of Approximation (RMSEA). Models with CFI $< .90$ or RMSEA $\geq .10$ were rejected (Putnick & Bornstein, 2016). In the first stage three models were tested in order to select the best fitting model. To select the best model, the likelihood ratio test was used. Regarding the best model, either items with a negative charge or values less than .10 in a given factor would be constrained to zero in that factor. In the second stage the generality of the best model selected in the first stage was tested, by analyzing its invariance between samples 1 and 2. The configural, metric and scalar invariance models were looked into. The configural invariance model looks into whether the factor structure valid for sample 1 is also valid for sample 2. The metric invariance model examines whether the factor loads identified in sample 1 are also present in sample 2. Finally, the model of scalar invariance examines whether both the factorial loads and the item thresholds are equivalent between samples. The configural model was evaluated, considering the CFI and RMSEA indexes. If the configural model were rejected, subsequent models would not be analyzed, as the model would prove to be non-invariant. Otherwise, the metric and scalar models would be compared to the configural model. These models would be rejected if they presented, in relation to the configural model, both a difference greater than .002 in the CFI (Putnick & Bornstein, 2016) and a p value referring to the comparison of chi-squares

and degrees of freedom less than .01 in favor of the configural model, through the likelihood ratio test using the Satorra method (2000) .The third stage of the analysis consisted in examining the difficulty of the LAT-Video Game items. This analysis was carried out in order to ascertain whether the items discriminate a wide spectrum of behaviors from the deep approach in video games. Since LAT-Video Game is a self-report instrument, items that showed less frequent behaviors were considered more difficult, and items that indicated more frequent behaviors were easier. The averages of the relative frequency of the items were calculated and then these averages were classified into five levels of difficulty: very difficult (.00–.20), difficult (.21–.40), medium (.41–.60), easy (.61–.80), very easy (.81–1.00). The fourth stage examined the predictive validity of LAT-Video Game through structural equation modeling. In this analysis, the variable gamer, which designates whether or not the individual identifies himself or herself as a gamer, was taken as a dependent variable, being explained by the latent variables of the best model of stage one, regarding the factorial structure of LAT-Video Game. The last stage studied the divergent validity of the LAT-Video Game through two steps. The first step examined the internal validity of LAS, in order to verify whether the model of two correlated factors, representing the superficial and deep approaches, already studied in Brazilian samples of primary and secondary education (Gomes, 2010c, 2011, 2013; Gomes &Golino, 2012; Gomes, *et al*., 2011), would show an acceptable adjustment in samples 2 and 3, composed of higher education students.

RESULTS AND DISCUSSION

The one-dimensional model fits the data well, as shown in Table 2. All of its factor loads were statistically significant ($p < .001$). The average load was .81, the minimum of .66 and the maximum of .95. The results support evidence of validity of the latent variable deep approach in video games, indicating that it is possible to empirically identify a general factor that explains the deep interaction of the player with the video game. The correlated two-factor model had good data fit, showing to be superior to the one-dimensional model, as indicated by the likelihood ratio test (Table 2).

Also, all of its factor loads were statistically significant ($p < .001$). The deep motivation factor showed an average load of .89, a minimum of .85 and a maximum of .96. The deep strategy factor had an average load of .78, a minimum of .69 and a maximum of .91. The deep strategy and deep motivation factors showed a correlation of .83, 95% CI [.76,.90]. These results support evidence of model validity, indicating the plausibility of differentiating the motivational and strategic components of the deep video game approach. There is a strong association between motivation and strategy in the context of video games, indicating the need for a general factor for the model. The bifactorial model yielded a good fit to the data and was better than the correlated two-factor model (Table 2). The general factor and the specific motivation factor exhibited all the statistically significant factor loads ($p<.001$).

Table 2. Results of confirmatory factor analysis of items, invariance analysis and structural equation modeling

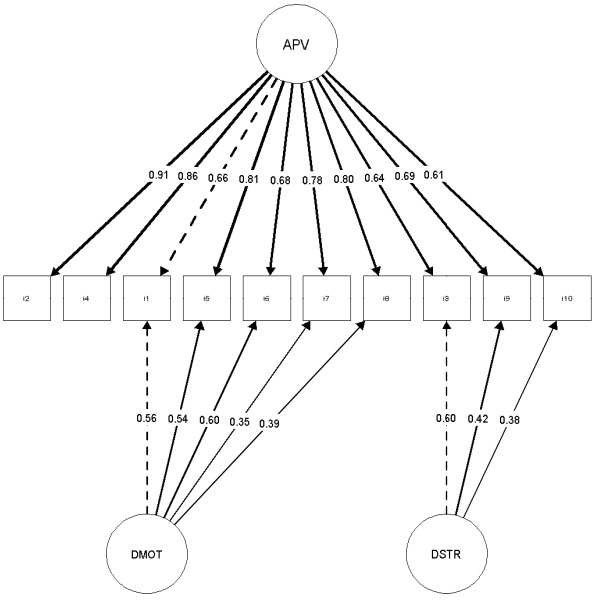
Model	$\chi^2(df)$	LRT	*p*	CFI	ΔCFI	RMSEA	IC 90%
Structuralvalidityanalysis (stage 1)							
Unidimensional (N1 = 561)	87.82 (35)	—	—	.993	—	.052	[.038, .066]
Twocorrelatedfactors (N1 = 561)	49.31(34)	19.09(1)	<.001	.998	—	.028	[.005, .045]
Bifactorial (N1 = 561)	17.92(25)	27.44(9)	.001	1.00	—	.000	[.000, .020]
Final (N1 = 561)	18.71(27)	0.77(2)	.682	1.00	—	.000	[.000, .017]
Invarianceanalysis (stage 2)							
Configural (N1 = 561, N2 = 148)	34.93(54)	—	—	1.00	.000	.000	[.000, .000]
Metric (N1 = 561, N2 = 148)	45.96(69)	12.07(15)	.673	1.00	.000	.000	[.000, .000]
Scalar (N1 = 561, N2 = 148)	40.72(66)	9.32(12)	.676	1.00	.000	.000	[.000, .000]
Predictiveanalysis (stage 4)							
Final + gamer (N1 = 561, N2 = 148)	20.40(34)	—	—	1.00	—	.000	[.000, .000]
Divergentanalysis (stage 5)							
EABAP (N2 = 139, N3 = 509)	520.86(118)	—	—	.968	—	.073	[.066, .079]
Final + EABAP (N2 = 139)	331.48(306)	—	—	.995	—	.025	[.000, .042]

Note. N1 = sample 1, N2 = sample 2, N3 = sample 3, χ^2 = chi-squared, *df* = degreesoffreedom, LRT = likelihoodratiotest, Δ = difference, IC = confidenceinterval.

The second step analyzed the correlation between the latent variables measured by the best model of stage one, concerning the factorial structure of tLAT-Video Game and the LAS through structural equation modeling.

The strategy factor showed statistically significant loads ($p<.05$) in items 9 and 3, while the loads in items 2, 4 and 10 were not statistically significant. The general factor of in-depth approach in video games showed an average factor load of .75, a minimum of .62 and a maximum of .91. The deep motivation factor showed average loads of .49, minimum of

.36 and maximum of .60. The deep strategy factor showed average loads of .26, minimum of -.10 and maximum of .66. Since the bifactorial model yielded the best fit, the loads of the deep strategy factor in items 2 and 4 were constrained to zero and the final model was generated. This model fitted well the data (Table 2), not worse than the original bifactor model. All loads were statistically significant ($p < .05$), with the exception of item 10 in the deep strategy factor ($p = .078$). The general factor yielded an average load of .74, a minimum of .61 and a maximum of .91. The deep motivation factor yielded an average load of .49, a minimum of .35 and a maximum of .60. The strategy factor yielded an average load of.47, a minimum of .38 and a maximum of .60. It is important to note that all items that carry specific factors have higher loads on the general factor than on specific factors (Figure 2). This suggests that the general factor (in-depth approach) is more relevant to explain the player's interaction with video games than the specific factors. In relation to reliability, the deep approach in video games yielded Cronbach's alpha of .94, the deep motivation an alpha of .95 and the deep strategy an alpha of .84. The McDonald's omega values were.74, .21 and .20 for these respective factors. The Cronbach's alpha values were acceptable, nevertheless, the McDonald's omega values were very low for the factors of strategy and deep motivation, indicating that the LAT-Video Game reliably measures the factor of deep approach in video games. The correlation between identical items (items 2 and 11) was .99, this shows that the participants' responses were highly consistent. There is evidence that the final model is invariant (Table 2). The configural model was not rejected as can be seen in Table 2, both CFI and RMSEA are acceptable, by which we can conclude that the factorial structure of the final model represents the structure in samples 1 and 2. The metric and scalar models were not rejected, as both showed a similar fit to the one of the configural model, both in the ΔCFI and in the likelihood ratio test. These results show that the final model is robust in terms of generalization, so that the factorial scores produced in independent samples (samples 1 and 2) are fully comparable.



Note. DAV = deep approach onvideo game, DMOT = deepmotivationonvideo game, DSTR = deepstrategyonvideo game.

Figure 2. Final model

The 10 items of the LAT-Video Game cover a wide spectrum of the deep approach in video games: 2 items are very difficult, 2 items are difficult, 2 items are average, 1 item is easy and 3 items are very easy (Table 3). Very difficult items represent behaviors with a strong deep approach in video games. For example, the item "The video game is one of my priorities" is very difficult, as only 12% of the participants answered that this behavior represents their usual way of interacting with video games. This means that the behavior of prioritizing video games differentiates high-level players from others. The opposite are the very easy items. For example, the item "When I start a new game, I try to use what I already know to help me perform better in that game" is very easy, since 94% of the participants responded that they usually manifest this behavior when interacting with video games. This means that using prior knowledge to perform well when playing video games discriminates against people with a lower level of profound approach to video games compared to other players.

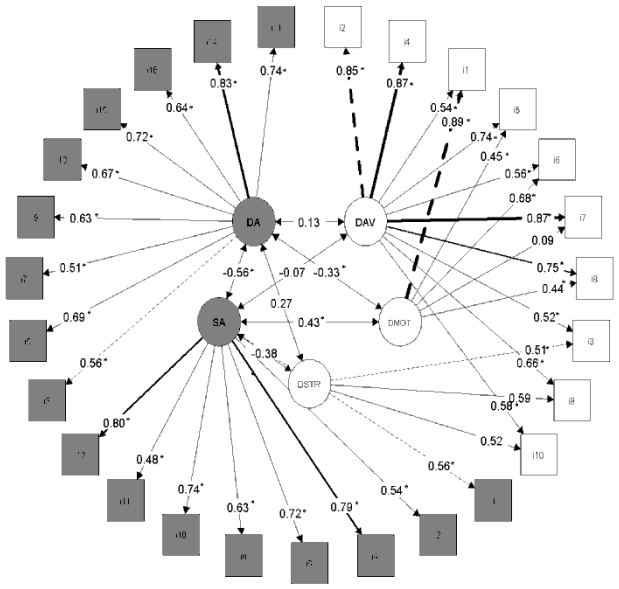
Table 3. ***Difficulty of items in the LAT-Video Game***

	Item	Difficulty%
1.	Video game isoneofmypriorities.	12
2.	I havealready completed many games or became very good at many games.	50
3.	I tryto combine different strategiesto help achieve a certaingoal in the game.	80
4.	I have already completed at leastone game or I amverygoodat it.	87
5.	Playingvideo games ispassion for me.	34
6.	Video game ismymainsourceofleisure.	20
7.	I investmoney in games orgamingequipment.	33
8.	I play video games for hours, whenever I can.	47
9.	I try to under stand the behavior patterns of the elements present in the game.	81
10.	When I start a new game, I tryto use what I already knowto help me performbetter in that game.	94

The final model proved to be a great predictor of people's self-assessment as a gamer. Table 2 indicates the fit of the final model plus the gamer variable as an outcome. The latent variable deep approach in video games predicts 68%, 95% CI [57%, 79%] of the variance of the gamer variable. The latent variable of deep motivation predicts 16%, 95% CI [8%, 28%], while deep strategy had no statistically significant prediction ($p = .814$). Taken together, the latent variables of the LAT-Video Game predict the gamer variable by 84%, 95% CI [65%, 100%] of its variance. These findings support the predictive validity of LAT-Video Game showing with it the relevance of the deep approach in video games.

The superficial and deep approaches model, as measured by LAS, showed an acceptable fit, according to the CFI and RMSEA (Table 2). All the factorial loads of the LAS were statistically significant ($p < .001$). The superficial approach factor yielded an average factor load of .65, a minimum of .46 and a maximum of .80. The deep approach factor showed an average of .64, a minimum of .52 and a maximum of .77. The factors of superficial and deep approach exhibited a correlation of -.60, 95% CI [-.67, -0.52]. The factorial scores of the deep approach ($\alpha = .86$ and $\omega = .86$) and the superficial approach ($\alpha = .85$ and $\omega = .83$) proved to be reliable. These results areevidence that LAS has structural validity and reliable scores for samples from higher education.

The model used to analyze divergent validity of the LAT-Video Game fitted well the data (Table 2). The results did not show statistically significant correlations between the deep approach in video games and the deep (p = .209) and superficial (p = .510) approaches in the academic context (Figure 3). This result suggests that the approaches that are manifested in the academic context and in the practice of video games are independent, that is, some students may interact superficially with academic knowledge objects, but interact superficially or deeply with video games. This finding is in line with Biggs' model (omen, process and product) 3-P (1985), which assumes that the context has strong impact on the student's motivations and strategies. There were also no statistically significant correlations between the deep strategy factor in the video game and the deep (p = .098) and superficial (p = .203) approach in the academic context. On the other hand, the video game deep motivation factor had a correlation of .43, 95% CI [.19, .68] with the academic superficial approach and of -.33, 95% CI [-.56, -.10] with the academic deep approach. Although modest, these associations are relevant, as they suggest that students with greater deep motivation in video games have less deep approach and more superficial academic approach.



Note. DAV = deep approach onvideo game, DMOT = deepmotivationonvideo game, DSTR = deepstrategyonvideo game, DA = deep approach, SD = superficial approach. * = valuesthat are statisticalsignificant (p< .05).

Figure 3. Final modelplus EABAP

Conclusion

In this article some relevant contributions to the field of learning approaches and to the understanding of the relationship between video game practice and cognition were brought out into discussion. The results indicate novel evidence that the approaches also manifest themselves in non-academic contexts, more specifically, in the context of the practice of video games. This finding supports the notion that the field of video games can be very pertinent to the investigation of the subject's interaction with objects of knowledge. This study only examined university students. More studies should be carried out with a more diverse samples, using, for instance, non-university students.

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Declaration of Conflicting Interests
The Authors declare that there is no conflict of interest

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