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Play and Learn: Teachers' Perceptions About Classroom Video Games

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Abstract: The use of video games to support learning in the classroom became popular over the last two decades. Even though games have proved to be successful not only to improve the learning outcomes but also skills such as critical thinking and problem solving, it is still a challenge to adapt them to the classroom routine. Issues such as the lack of video games that cover the school curriculum, limited time to cover curriculum content and lack of technological resources are some of the barriers that influence teachers' decisions not to adopt video games. In order to look for solutions that may facilitate the implementation of classroom video games, we collected information of what teachers think about these games. Data was collected through a survey answered by 714 primary and secondary school teachers, which gathered participants' demographic information and their perceptions about learning through video games. Using Logistic Regression and Decision Tree models, we identified factors that influence or inhibit the adoption of video games by teachers. The results suggest that the adoption of video games is influenced by students' primary language (English or non-English speaking), motivational features of the video games, how the game relates to the curriculum and the pedagogical underpinning of the game. A significant group of teachers thinks games that are targeted for use in the classroom are pedagogically poorly designed and do not fit for purpose. Other barriers teachers face to using games in class are lack of time and lack of technological resources. These results are important as they indicate which features should be present in an educational game and how these games are used in classroom nowadays. Furthermore, identifying teachers' opinions and the challenges they face in the classroom video games implementation allow developers and researchers to look for solutions that may facilitate this process.

Keywords: classroom video games, game-based learning, games adoption, teachers

1. Introduction

Serious games are designed to make use of games elements in order to not only entertain but achieve an extra goal such as education or health, having pedagogy as a key element (Sawyer and Rejeski, 2002; Zyda, 2005; Dörner *et al.*, 2016). When designed to improve learning in the formal educational sector, they are part of a subfield called educational games, which concerns the use of computer games "from elementary schools to higher education, vocational training, and collaborative workplace training" (Dörner *et al.*, 2016, p.9). Besides supporting different levels of education, educational games improve learning outcomes in fields like science (Hwang, Wu and Chen, 2012), mathematics (Kiili, Moeller and Ninaus, 2018) and language learning (Yeh, Hung and Hsu, 2017). Furthermore, skills can be obtained through the implementation of video games in the classroom time, such as problem-solving (Sun, Chen and Chu, 2018) and critical thinking (Checa-Romero, 2016). The teacher has a fundamental part in the successful implementation of classroom interventions such as video games and plays crucial roles in technology integration in schools (Magliaro and Ezeife, 2008; Aremu, 2010). As stated by Kenny and McDaniel (2011), "if a teacher sees little or no value in an intervention, or is unfamiliar with its use, then the chances that it will be properly implemented are minimised" (p.199). Therefore, teachers' perceptions have an important role in the research about educational video games. Some surveys were designed to collect teachers' perceptions of games and the challenges they face when implementing those in the classroom. Through a questionnaire applied to almost 500 Korean teachers, Baek (2008) identified six main factors that inhibit teachers to use educational games: the inflexibility of the curriculum, negative effects of gaming, students' lack of readiness, lack of supporting materials, fixed class schedules, and limited budgets. In Europe, Wastiau, Kearney and Van den Berghe (2009) made a study with 528 teachers from 27 European countries. Although 70.6% of the respondents use games at school, they face obstacles such as cost and licensing of the video games, school timetable, and the difficulty in finding suitable games for teaching.

The present work is part of a Ph.D. project that aims to design and develop an educational game. To do that, it is important to understand what teachers consider when choosing to use a video game in the classroom. This paper aims to address the following research question: What are the factors that encourage or inhibit teachers

in using games in the classroom? To conclude, we will discuss how those factors may help to improve the development of classroom video games.

2. Methods

We designed a survey with three main sections of questions based on the literature (Wastiau, Kearney and Van den Berghe, 2009; De Grove, Bourgonjon and Van Looy, 2012; Koh *et al.*, 2012; Fishman *et al.*, 2014; Takeuchi and Vaala, 2014). The first section aimed to collect demographic information such as the age and the gender of the teacher, if the teacher works in a private or public school and if it is a primary or secondary school. The second section focuses on the use of games in the classroom, questioning, for example, about the frequency of use. The third section evaluates teacher's perception of games: the respondent had to answer how much he/she agrees, rating from "Strongly disagree" to "Strongly agree", with the following statements:

Table 1: Likert Scale questions to measure teachers' perceptions about classroom games

Item	Statement	Reference
1	Games help students to achieve learning goals	(Koh *et al.*, 2012)
2	Games improve students' motivation and engagement in learning	(Wastiau, Kearney and Van den Berghe, 2009; De Grove, Bourgonjon and Van Looy, 2012)
3	Games make it easier to understand how concepts are applied in daily life	(De Grove, Bourgonjon and Van Looy, 2012)
4	Games improve interaction between students	(Takeuchi and Vaala, 2014)
5	There is sufficient time to involve games in classroom routine	(Koh *et al.*, 2012; Fishman *et al.*, 2014)
6	Low costs are involved in using games as a teaching tool	(De Grove, Bourgonjon and Van Looy, 2012; Koh *et al.*, 2012)
7	Games cover the curriculum content	(De Grove, Bourgonjon and Van Looy, 2012; Fishman *et al.*, 2014)
8	Game design is often too simple and games lack proper pedagogical design	(Koh *et al.*, 2012)
9	Games are an easy way of assessing my students' learning	(Fishman et al., 2014)

We then spread the survey to primary and secondary school teachers through social media and email, besides distributing printed copies. The online version was designed using the free website esurv.org and the survey was available in English, Italian, Portuguese, and Spanish. We collected answers from 714 teachers from 34 countries between April 2016 and November 2016. After cleaning the data by deleting responses out of scope, such as those from university teachers, we were left with 671 answers. To identify factors that influence teachers to adopt classroom games, we applied Logistic Regression and Decision Tree prediction models. The Logistic Regression was applied considering the following steps. One of the survey questions measured the frequency of use of classroom video games, so teachers were separated in two groups: those that use digital games at least once a month and those that do not use or rarely use. We tried to predict these variables based on the answers each teacher gave to the questions from Section 1 (demographic questions) and Section 3 (perceptions about games; Likert Scale questions), which were the independent variables. We estimated the internal consistency of the Likert Scale questions by applying Cronbach's alpha coefficient to the third section of questions. We also decided to classify country's primary language as English and non-English to identify if the language influenced the use of classroom video games.

We then tested the multicollinearity of all these factors to check if some were highly correlated, which would mean that two or more different variables were measuring the same feature, leading to unreliable results in the regression analysis. The analysis was carried out using Logistic Regression techniques with IBM SPSS Statistics software. We also used a Decision Tree classifier to predict which factors influence teachers to implement games in the classroom. This is a widely used supervised learning method for data exploration and examines the data by inducing a tree where each path represents a set of conditions predicting one of the outcomes of the target variable ("Uses games" or "Does not use games"). We trained the model using the algorithm J48, which offers a stability of precision, speed and result interpretability (Breşfelean, 2007). The data was analysed using the free machine learning tool Weka.

3. Results

The first section of the questionnaire provided demographic data such as whether the teacher worked in a public or private school, the educational level of their classrooms and the teacher's age and gender. Considering that most digital games are in English, we also computed the primary language of the country in which they work (English and non-English speaking). The following table shows the frequency of answers according to each category (Table 2):

Table 2: Descriptive statistics of survey demographic results

Categories		N	%
Primary language	English	302	55%
	Non-English	369	45%
Type of school	Public	544	81%
	Private	127	19%
School level	Primary and secondary	75	13%
	Primary	297	50%
	Secondary	226	38%
Age	More than 35 years old	322	48%
	Less than 35 years old	342	51%
Gender	Female	542	81%
	Male	129	19%

In the second section of questions, teachers answered about their use of digital games for education. 60.6% of the respondent teachers use digital games to support education at least once a month, while 39.4% do not use or rarely use games – see Figure 1.

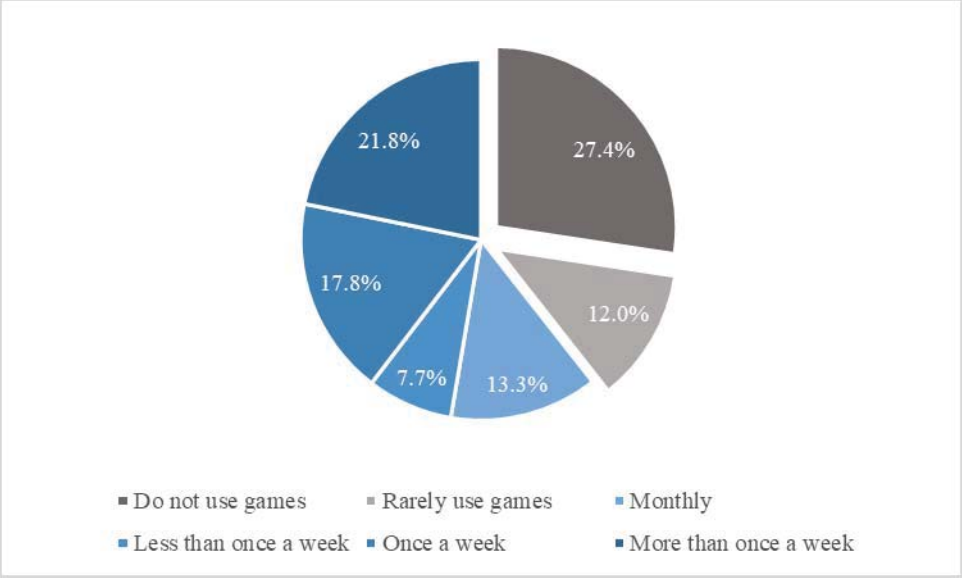

Figure 1: Frequency of use of video games in the classroom to support teaching and learning.

Both groups of teachers, those that use and do not use games, said how much they agree with 9 statements about the use of digital games for education. The results can be seen in Table 3:

Table 3: Teachers' level of agreement with statements about the use of video games for education

Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Games help students to achieve learning goals	**47%**	0%	9%	44%	0%
Games improve students' motivation and engagement in learning	**64%**	0%	4%	32%	0%
Games make it easier to understand how concepts are applied in daily life	40%	0%	15%	**45%**	0%

Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Games improve interaction between students	**58%**	0%	5%	36%	1%
There is sufficient time to involve games in classroom routine	12%	0%	20%	**60%**	8%
Low costs are involved in using games as a teaching tool	14%	0%	25%	**57%**	4%
Games cover the curriculum content	21%	0%	20%	**54%**	5%
Game design is often too simple, and they lack proper pedagogical design	4%	0%	30%	**59%**	8%
Games are an easy way of assessing my students' learning	21%	0%	21%	**55%**	2%

The respondents that do not use games in the classroom were asked to answer why they made this choice. This question generated text-based answers, which were analysed and coded. The results of this analysis are shown in Table 4 and are in line with previous studies (Koh *et al.*, 2012; Fishman *et al.*, 2014; Takeuchi and Vaala, 2014). Lack of time (19%), lack of technological resources (19%) and the lack of games appropriate for education (17%) were that hinder teachers of adopting video games into their classrooms.

Table 4: Analysis of the reasons cited by respondents' teachers for not using video games in the classroom

Reason to not use games in the classroom	Answers	Percentage
Lack of time	25	19%
Lack of technology resources	25	19%
Lack of good games	22	17%
Lack of knowledge (about the effects, how to use etc.)	17	13%
Games are not useful for teaching	8	6%
Too many students	8	6%
Do not apply to my case	6	5%
Students are not interested	6	5%
Lack of school support	5	4%
Learning is not about having fun	3	2%
Lack of opportunity	2	2%
Laziness	1	1%
Students already use too much technology at home	1	1%
Do not like technology	1	1%

As stated before, we asked teachers to determine their level of agreement with 9 statements about games for education using Likert Scale questions, varying from "Strongly disagree" to "Strongly agree". The reliability test shows that these 9 statements have a good internal consistency, with a Cronbach's alpha coefficient of 0.77. The answers to the 9 questions (statements) plus the participants' answers to the demographic questions, the public spending with education of each surveyed country and the primary language of the countries (English/non-English) were selected as independent variables to be used in a Regression and Decision Tree model to predict the target variable "use of video games in the classroom". To guarantee that these factors are reliable, we applied a multicollinearity diagnosis. Table 5 shows that the selected predictors have no multicollinearity problems (Tolerance > 0.1 and VIF < 10):

Table 5: Multicollinearity diagnosis of Likert scale questions.

Variables	Collinearity diagnostics	
	Tolerance	Vif
Primary language	0.70289	1.42269
Public or private school	0.88277	1.13279
School level	0.9147	1.09325
Age	0.90234	1.10823
Gender	0.95969	1.04201
Games help students to achieve cognitive learning goals	0.40323	2.47999

Variables	Collinearity diagnostics	
	Tolerance	Vif
Games improve students' motivation and engagement in learning	0.47035	2.12606
Games make easier to understand how concepts are applied in daily life	0.51929	1.92571
Games improve interaction between students	0.60155	1.66237
There is sufficient time to involve games in classroom routine	0.77926	1.28327
Low costs are involved in using games as a teaching tool	0.8715	1.14744
Games cover the curriculum content	0.71284	1.40283
Game design is often too simple and they lack proper pedagogical design	0.87504	1.14281
Games are an easy way of assessing my students' learning	0.7726	1.29434

Binary Logistic Regression was performed to assess the impact of the variables on teachers' decision to use games. The model is statistically significant (Chi-square= 119.521, $p<0.001$) and explained between 24.6% (Cox and Snell R square) and 33.4% (Nagelkerke R squared) of the variance in the use of digital games status, correctly classifying 72.4% of cases. The result is shown in Table 6 and five variables contribute significantly to the model. The strongest one is the language: teachers from countries that have English as a primary language are 3.7 times more likely to use digital games for education. Besides, respondents who teach primary school are around 3 times more likely to use digital games. The Likert Scale questions showed that teachers who use educational video games tend to consider that games motivate students (Odds ratio: 2.17; $p<0.05$) and cover the curriculum content (Odds ratio: 1.4; $p<0.05$). Those that agree that games for education do not have a good pedagogical design are 0.6 less likely to use digital games in the classroom.

Table 6: Logistic regression predicting the likelihood of digital game use in the formal environment

Variables	B	S.E.	Df	Sig.	Odds ratio	Odds ratio	
						Lower	Upper
Primary language	1.323	.281	1	.000	3.754	2.164	6.510
Public or private school	.064	.314	1	.838	1.066	.577	1.972
Primary school	1.070	.367	1	.004	2.914	1.418	5.988
Secondary school	-.015	.358	1	.966	.985	.488	1.986
Teacher's age	.344	.244	1	.159	1.411	.874	2.277
Teacher's gender	.036	.308	1	.906	1.037	.567	1.897
Games help students to achieve cognitive learning goals	.180	.257	1	.485	1.197	.723	1.982
Games improve students' motivation and engagement in learning	.776	.269	1	.004	2.173	1.284	3.679
Games make it easier to understand how concepts are applied in daily life	-.095	.211	1	.653	.910	.602	1.375
Games improve interaction between students	-.202	.207	1	.328	.817	.545	1.225
There is sufficient time to involve games in classroom routine	-.142	.116	1	.219	.867	.691	1.089
Low costs are involved in using games as a teaching tool	.041	.117	1	.729	1.041	.828	1.310
Games cover the curriculum content	.341	.123	1	.006	1.407	1.105	1.791
Game design is often too simple and they lack proper pedagogical design	-.419	.132	1	.001	.658	.508	.851
Games are an easy way of assessing my students' learning	-.155	.142	1	.275	.856	.648	1.132
Constant	-2.929	1.175	1	.013	.053		

We also trained a Decision Tree model using the well-known J48 algorithm and WEKA machine learning tool. The model used the same features as in the Logistic Regression – teachers were also divided into two groups: one is tagged as "Uses games" (teachers that use classroom games at least once a month), and the other one is tagged as "Does not use games", (teachers that do not use or rarely use games). We ranked the features by the value of the information gain. The information gain measures the quantity of information about the target

variable that each feature carries – the higher the information gain, the higher the capacity of the variable to predict if the teacher will use games in the classroom or not. Table 7 shows how the variable language (English / Non-English), the variable poor design (measuring the degree to which the design of the game is perceived pedagogically poor) and the variable effect on motivation are the most important factors for predicting the usage of digital games. These findings agree with the Logistic Regression model discussed before.

Table 7: Information gain of each feature. Target variable: use game (Y/N)

Rank	Information Gain	Feature
1	0.06375	Language
2	0.04886	Poor design
3	0.04674	Improve motivation
4	0.04263	School level
5	0.03913	Time is enough
6	0.03459	Cover curriculum
7	0.01427	Achieve learning goals
8	0.01115	Low cost
9	0.00827	Gender
10	0.00811	Age
11	0	Public or private
12	0	Model concepts of daily life
13	0	Improve interaction
14	0	Assessment

The summary of the model was obtained with a 10-fold cross-validation methodology, where for 10 times the dataset is split in a 90% training set and 10% testing, rotating the testing set over the entire dataset. In accordance once more with the logistic model, Decision Tree model has an accuracy of about 72% and around 28% of the instances were incorrectly classified. Table 8 shows the accuracy in detail.

Table 8: Detailed accuracy by class.

Class	Precision	Recall	F-Measure	ROC
Does not use games	0.66	0.603	0.63	0.716
Uses games	0.758	0.8	0.778	0.716
Weighted average	0.72	0.723	0.72	0.716

The confusion matrix shows how the predictions are better for the class “Uses games”, meaning that it is easier to predict when a teacher will use games than the opposite (Table 9).

Table 9: Confusion matrix of predictions.

	Predicted value: Does not use games	Predicted value: Uses games
Actual value: Does not use games	126	83
Actual value: Uses games	65	260

The resulting Decision Tree is displayed in Figure 2. The tree model provides further insights and a human-understandable visual representation of the factors driving teachers' choices. The numbers associated with terminal nodes have the format N/M, where N is the number of correctly classified cases and M the total number of instances falling in that specific branch of the tree. By looking at the tree structure, the language of the teacher is the first factor to consider. For English speaking teachers, is then important to consider the impact of games on students’ motivation. Teachers who agree that motivation is improved tend to use them. Interestingly, this represents the most numerous and easier to predict branch of the tree, covering about 33% of the total number of cases in the dataset with an accuracy of 86.4% (21 incorrect cases over 155 total cases). Teachers with an opposite view do not use games. Teachers with a neutral opinion on the matter tend to use games if they work in primary schools or if their age is below 35 years old. For non-English speaking teachers, the school level is the first factor to consider. For secondary level teachers, games are used if teachers believe games can cover the curriculum and are not used otherwise. This represents the second-largest branch of the tree, with about 30% of cases with an accuracy of 71%. For primary level teachers, games are usually used if they are considered pedagogically well designed or, even when games are considered poorly designed, when games are perceived

as low cost. The remaining branch of the tree contains teachers operating both at primary and secondary level. Here games are used only by teachers considering games well designed and useful for students' motivation and are not used otherwise.

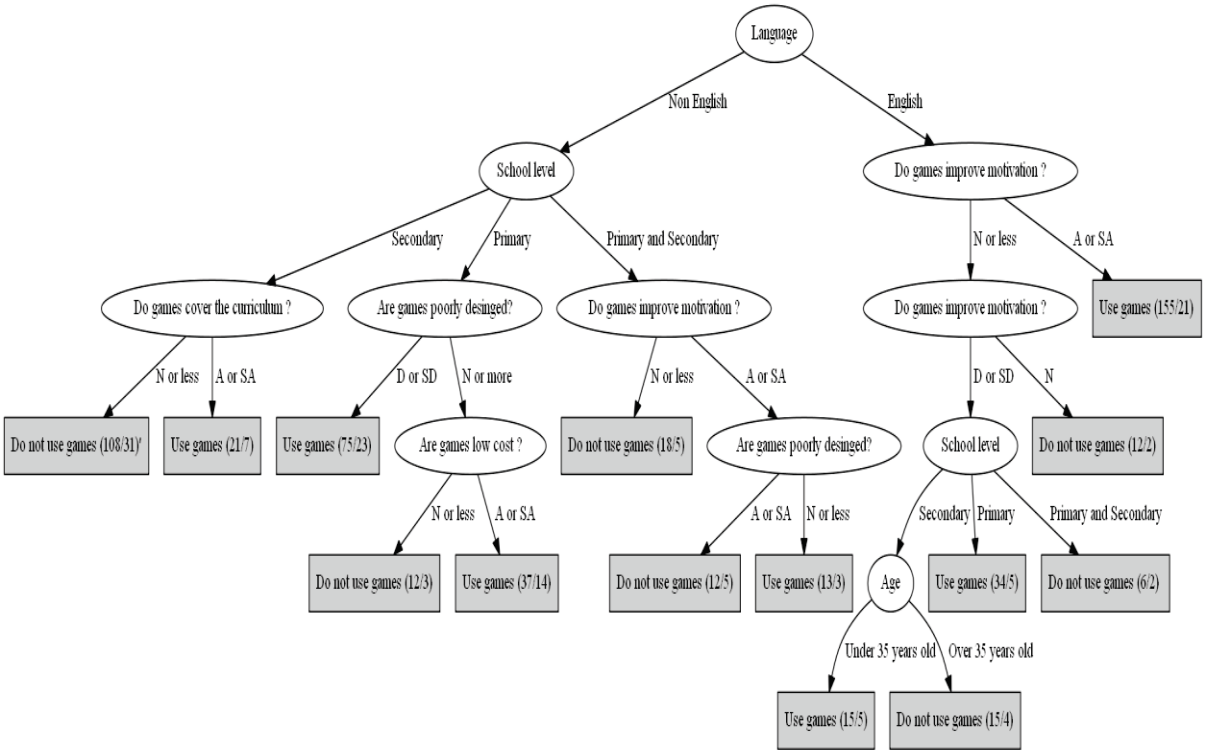

Figure 2: A decision tree model for predicting teachers' adoption of games.

4. Conclusions

This paper aimed to identify teachers' perceptions of video games use in primary and secondary classrooms. Results showed that most of the teachers believe that games may improve students' motivation to learn. Motivation can be related to the improvement of learning outcomes. A study with sixth graders showed a significant positive relationship between students' motivation scores and their science knowledge post-test scores (Liu *et al.*, 2011). However, the participants of our study consider that games cannot cover the school curriculum. They also disagree games can assess students' learning. These results are important for game designers as content and assessment are educational elements that should be present in classroom video games. As suggested by Gros (2016), one of the challenges in designing those games is to find the balance between the fun element and the educational content. Our survey also showed that while 47% of teachers agree games can improve learning, other 44% disagree. This result raises concerns as the usefulness of a game is a predictor factor for teachers to implement games in the classroom, and a teacher believes a game is useful when it improves students' learning (Sánchez-Mena, Martí-Parreño and Aldás-Manzano, 2018). We also identified the main factors that influence teachers to adopt games. The strongest one is the students' primary language: teachers from English speaking countries tend to adopt classroom games more than teachers from non-English speaking countries. In fact, children with a non-English background usually require adult support for translating games in English (Ke and Abras, 2013), which may be a challenge in the classroom. Our research also detected that primary school teachers tend to use games more than secondary school teachers. This is not well explored by literature, but after interviewing 15 teachers at primary and secondary levels, Watson et al. (2013, p.237) argue that "younger students usually have lower expectations of game quality than older students and thus are easy to deal with". We also identified that teachers who believe games have no proper pedagogical design tend not to implement those tools in their classroom. Seeney, Routledge & Vi (2014) argue that educational games need to be underpinned by pedagogy and game design, so classroom games could take advantage of game design theory aligned with pedagogical practices. Even though, as stated by Lowrie and Jorgensen, (2015), most of educational games do not use game design to promote higher-order thinking, but "rather visually appealing drill-and-practice games" (p. 5).

Our results also shed light on the reasons that inhibit teachers to implement games in the classroom, such as lack of time. Besides, 55% of the participants in our study disagree that games are able to assess students learning, so assessment should be an educational element considered in classroom games design. Those results are useful to improve the process of educational game design. The development of a game covering the official school curriculum and with a progress-monitoring system may save teachers' time and allow assessing students' learning. Progress-monitoring is a formative type of assessment – the student is assessed throughout the entire gameplay, and his/her progress and failures are continuously monitored (Carol, 2002). This type of assessment allows the teacher to adapt their teaching approach to individual needs of the students, besides saving time. Moreover, adaptive systems could help to deliver a game that not only has the curriculum content integrated into its gameplay but also considers students' differences while learning. This is an interactive system that adapts to individual users "on the basis of processes of user model acquisition and application that involve some form of learning, inference, or decision making" (Jameson, 2007, p.434).

This study was the first step in understanding how teachers deal with classroom video games. Future research should focus on interviewing teachers to evaluate how those games are applied in the classroom routine.

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