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Revised Computer Game Attitude Scale

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Abstract: In order to fit students' needs, an accurate computer game attitude scale is needed so teachers and researchers can know among their students who can really benefit from the use of educational games. In this paper, the research team analyzes 218 students' responses of a revised computer game attitude scale and finds their computer game attitude relationships and differences among gender, grade, preferred gaming way and game playing experience.

Keywords: Educational games, gender issue, elementary school students, post-secondary school students

1. Introduction

Most games are in some way educational, even if they have not been originally designed to be. When the games are played, the games can introduce new concepts or reinforce existing ones for players. Consider a deck of cards. There are literally thousands of card games that can be played. In most card games players need to know basic matching skills to match card denominations or suits; card denominations are often added together, requiring math skills. Often cards must be counted and matched, requiring counting (Cribbage, 2013; War, 2013), matching (Go Fish, 2013; Rummy, 2013) and more complex mathematical skills (Contract Bridge, 2013; Cribbage, 2013).

More and more games are designed for teaching and learning in the last decade (Fletcher & Tobias, 2006). Many researchers believe that students can learn in a leisure and friendly environment (i.e., game) if the game is designed for specific learning subject (Gee, 2003; van Eck, 2007). Furthermore, researchers also find out that educational games can help students learning complex contents such like activities of daily living (Kuo, Chang, Lyu, and Heh, 2013), algebra cognition (Corbett, Koedinger, & Handley, 2001), financial concepts (Jones, Chang and Kinshuk, 2014), history and culture (Ardito, Costabile, De Angeli, 2012; Chang & Chang, 2006; Garzotto, 2007), logic (Lanzilotti and Roselli, 2007), management information systems (Lu, Chang, Kinshuk, Huang, and Chen, 2014), programming language (Kahn, 1999; Kuo, Chang, Kinshuk, and Liu, 2010), and help elders with disabilities to improve selective attentions and to gain higher quality of life (Chen, Chiang, Liu, and Chang, 2012) as well as encouraging young females to do physical activity (Huang, Hung, Chang, and Chang, 2009). All experiments and pilots of educational games do show positive and encouraging outcome (Kapp, 2012; Prensky, 2007).

On the other hand, although many research find that there are gender differences on students' confidence in playing computer games and on how much students like computer games (Liu, Lee, and Chen, 2013; Lu, Chang, Kinshuk, Huang, and Chen, 2012), Lu and his colleagues (2012) have found that how students think about computer games and how comfortable they feel toward computer games are the two factors that significantly influence their voluntariness of using educational games. It is important to have an accurate measure for researchers and teachers getting clear idea of their students' attitude toward computer games, so proper supplemental learning tools like educational games can be offered to the right target – students who may really need and appreciate the alternative way of learning.

2. Computer Game Attitude Scales

Computer Game Attitude Scale (CGAS) is used to measure the player's attitude towards computer games. The scale was first introduced in 1997 and has proven to have strong validity and reliability in measuring attitudes (Chappell & Taylor, 1997). The CGAS has twenty items for testing two main subscales – comfort and liking. Liu and colleagues (2013) develop a New Computer Game Attitude Scale (NCGAS) by adopting items from Chappell and Taylor's CGAS and adding new items for new subscales and factors. There are sixty items proposed, in the NCGAS, for testing three subscales: cognition which includes two factors – learning and confidence; affection which includes liking factor; and, behavior which includes three factors – participation, leisure, and negative behavior). After validity and reliability tests, only twenty-two items kept in the final version of NCGAS questionnaire. The twenty-two items are used to examine three subscales (i.e., cognition, affection, and leisure) and five factors (i.e., learning and confidence in cognition subscale, liking in affection subscale, and participation and leisure in behavior subscale).

The research team further develops a revised CGAS based on NCGAS. As the NCGAS was developed for early adolescents, we remove some items according to the comments and suggestions made by research ethics review board and revise wordings of some items so the revised items can even be fully understood by Canadian children at ages 6 to 7 (i.e., 2nd grade elementary school students). There are seventeen five-point Likert-scale items (5 for "Strongly Agree" to 1 for "Strongly Disagree") proposed at beginning. The seventeen items are categorized into 4 factors listed below:

- Confidence: users' confidence in playing the computer game;
- Learning: users' perceptions of positive impact when computer games are used in learning;
- Liking: users perceived enjoyment for playing computer games;
- Leisure: users' thoughts on taking playing computer games as leisure activities.

Table 1: The proposed items of the revised Computer Game Attitude Scale.

Subscale	Factor	Item
Cognition	Confidence (CON)	1. I am good at playing computer games. 2. Playing computer games is easy for me. 3. I understand and play computer games well. 4. I am skilled at playing computer games.
	Learning (LRN)	1. I like taking courses that use computers. 2. Using computer games in school is a good way to learn. 3. Playing computer games improves my eye and hand coordination. 4. Playing computer games enhances my imagination.
Affection	Liking (LIKE)	1. I like it when people talk about computer games. 2. I feel comfortable while playing computer games. 3. I am very interested in solving quests/questions/missions in computer games. 4. I always try to solve the current quest/question/mission in the computer game.
Behavior	Leisure (LEI)	1. Playing computer games makes me happy. 2. Playing computer games is part of my life. 3. When I have free time, I play computer games. 4. I talk about computer games with my friends. 5. I am not alone in a computer game as I can make friends there.

Beside the seventeen items, in order to find out the differences among gender, grade, preferred gaming ways, and game play experience, additional twelve items are included – (1) one item for gender; (2) one item for grade; (3) three items for the preferred gaming ways include single player, limited multiplayer, and full functionality of multiplayer gaming; and, (4) seven items for amount of hours every day in a week the respondent usually spend on playing computer games.

3. Validity and Reliability of the Revised CGAS

Principal Component Analysis with varimax rotation is used to examine items' validity within the factors. Items with factor loading less than 0.6 were not good enough for presenting the factor (Hair, Anderson, Tatham, & Black, 1995). At the end, a valid and reliable revised computer game attitude scale with four factors and 17 items is determined and confirmed.

The cognition subscale is identified into Confidence and Learning factors. The reliability of the entire subscale is good as its Cronbach's alpha value is 0.882 (George & Mallery, 2010). Moreover, the reliability of Confidence factors is excellent (i.e., its Cronbach's alpha value is 0.936 and is larger than 0.9) and Learning factor is acceptable (i.e., its Cronbach's alpha value is 0.704 and is larger than 0.7). Table 2 lists the factor analysis results of the cognition subscale.

Table 2: Rotated factor loadings and Cronbach's alpha values of the cognition subscale of the revised Computer Game Attitude Scale.

Item	Factor 1: Confidence	Factor 2: Learning
Factor 1: Confidence (Cronbach's alpha = 0.967)		
CON3	0.936	
CON4	0.930	
CON2	0.921	
CON1	0.914	
Factor 2: Learning (Cronbach's alpha = 0.704)		
LRN2		0.795
LRN1		0.694
LRN4		0.670
LRN3		0.662
Eigenvalue	4.476	1.356
% of variance	55.955%	16.948%
Overall alpha = 0.882, Total variance explained is 72.903%		

The affection subscale only has one factor, Liking. The Cronbach alpha of the subscale is 0.748 and its reliability is acceptable. Table 3 lists the factor analysis result of the affection subscale.

Table 3: Factor loadings and Cronbach's alpha value for the affection subscale of the revised Computer Game Attitude Scale.

Item	Factor 1: Liking
Factor 1: Liking (Cronbach's alpha = 0.748)	
LIKE3	0.818
LIKE4	0.749
LIKE1	0.749
LIKE2	0.709
Eigenvalue	2.290
% of variance	57.242%

The last subscale, behavior, also has one factor, Leisure. The reliability of the subscale is also acceptable with its Cronbach alpha equals 0.754. The factor analysis results of the behavior subscale is listed in Table 4.

Table 4: Factor loadings and Cronbach's alpha value for the behavior subscale of the revised Computer Game Attitude Scale.

Item	Factor 1: Leisure
Factor 1: Leisure (Cronbach's alpha = 0.754)	
LEI2	0.829
LEI4	0.827
LEI5	0.802
LEI3	0.775
LEI1	0.744
Eigenvalue	3.167
% of variance	63.341%

The correlations among four factors are shown in the intercorrelation matrix in Table 5. All correlations in-between two factors are reached significance at level of 0.01. Moreover, the correlations in-between two subscales are also reached significance as the intercorrelation matrix in Table 6 shows. These two tables show that the three subscales and the four factors are coherent measurement in computer game attitude.

Table 5: Intercorrelation matrix of four computer game attitude factors.

Factor	CON	LRN	LIKE	LEI
CON	-	-	-	-
LRN	0.501**	-	-	-
LIKE	0.616**	0.569**	-	-
LEI	0.664**	0.649**	0.693**	-

**: Correlation is significant at the 0.01

Table 6: Intercorrelation matrix of three computer game attitude subscales.

Subscale	Cognition	Affection	Behavior
Cognition	-	-	-
Affection	0.683**	-	-
Behavior	0.753**	0.693**	-

**: Correlation is significant at the 0.01

Table 7 list the descriptive statistics of the three subscales and the four factors. The results show that students believe playing computer games is a good way for learning. Students are also enjoy in playing computer games and prefer playing computer games when they are free.

Table 7: Descriptive statistics of students' responses to the four factors and three subscales of the revised Computer Game Attitude Scale.

Subscale	Item Amount	Value Range	Mean	SD	Skewness
Cognition	8	1-5	3.950	0.889	-0.578
Affection	4	1-5	4.037	0.893	-0.863
Behavior	5	1-5	3.959	0.994	-0.779
Factor	Item Amount	Value Range	Mean	SD	Skewness
CON	4	1-5	3.798	1.236	-0.716
LRN	4	1-5	4.102	0.803	-0.532
LIKE	4	1-5	4.037	0.893	-0.863
LEI	5	1-5	3.959	0.994	-0.779

4. Differences among Gender, Grade, Preferred Gaming Way, and Game Playing

This research compares the scores of the four factors and the three subscales that students in different groups (e.g., gender, grade, preferred gaming way, and average hours of weekly game playing) respond. Table 8 shows the results of comparing male and female students' responses by using t-tests. Students' responses in all of the factors and the subscales show significant difference. The results show that male students have higher confidence in playing computer games and enjoy more on playing computer games when they are free. Male students also have higher perceptions of believing computer games can be a tool for learning.

Table 8: Gender differences to the factors in CGAS.

Factor	Gender	Mean	S.D.	t
CON	Female	3.348	1.356	-5.242**
	Male	4.194	0.965	
LRN	Female	3.985	0.844	-2.035*
	Male	4.206	0.753	
LIKE	Female	3.793	0.999	-3.818**
	Male	4.251	0.728	
LEI	Female	3.725	1.088	-3.275**
	Male	4.164	0.857	
Subscale				
Cognition	Female	3.668	0.942	-4.539**
	Male	4.199	0.760	
Affection	Female	3.793	0.999	-3.818**
	Male	4.251	0.728	
Behavior	Female	3.725	1.088	-3.275**
	Male	4.164	0.857	

*: Correlation is significant at the 0.05
**: Correlation is significant at the 0.01

We also divide data into two groups according to students' ages. The two groups are elementary school and post-secondary school. We use t-tests to check if there are differences in students' responses between the two groups. The results in Table 9 show that there are significant differences between the two. Elementary school students have more positive responses to all factors and subscales than post-secondary school students. The results show that elementary school students believes that they are good in playing computer games and treating playing computer games is an leisure activity. Elementary school students also believe that they can learn via the game-play of computer games. In other words, educational games may be appreciated much more for elementary school students.

In terms of preferred gaming way: there are 15.1% of students prefer to play computer games alone; 7.8% prefer to play computer games which have limited multiplayer features; 57.3% prefer to play multiplayer computer games; 1.8% prefer to play both of single player and limited multiplayer games; 0.9% prefer to play both of single player and full functionmultiplayer games; 3.7% prefer to play both of limited and full function multiplayer games; and, 2.3% enjoy all kinds of games. Table 10 lists the analysis results of the relations between preferred gaming way and the revised Computer Game Attitude Scale. The ANOVA and the Scheffe's tests results show that in terms of learning from playing computer games there is no significant difference among students' responses from different groups. On the other hand, we can find that students who prefer full function multiplayer games have more positive perceptions toward learning from playing computer games than their counterpart; for instances, group 3 vs. groups 1 and 2; group 4 vs. group 1; group 6 vs. group 2; and, group 7 vs. group 4.

Table 9: Grade differences to the factors in CGAS.

Factor	Gender	Mean	S.D.	t
CON	Elementary	3.954	1.281	3.301**
	Post-secondary	3.407	1.023	
LRN	Elementary	4.194	0.851	3.125**
	Post-secondary	3.871	0.614	
LIKE	Elementary	4.149	0.924	3.290**
	Post-secondary	3.754	0.745	
LEI	Elementary	4.055	1.062	2.647**
	Post-secondary	3.716	0.753	
Subscale				
Cognition	Elementary	4.074	0.917	3.673**
	Post-secondary	3.639	0.730	
Affection	Elementary	4.149	0.924	3.290**
	Post-secondary	3.754	0.745	
Behavior	Elementary	4.055	1.062	2.647**
	Post-secondary	3.716	0.753	

**: Correlation is significant at the 0.01

Table 10: Students who prefer different gaming ways have different responses toward the revised Computer Game Attitude Scale.

	CON	LRN	LIKE	LEI	Cognition	Affection	Behavior
Group 1 (1)	3.303 (1.536)	3.947 (0.922)	3.780 (1.121)	3.588 (1.184)	3.625 (1.108)	3.780 (1.121)	3.588 (1.184)
Group 2 (2)	3.559 (1.368)	4.147 (0.862)	4.000 (0.976)	3.882 (0.914)	3.850 (1.003)	4.000 (0.976)	3.882 (0.914)
Group 3 (3)	3.956 (1.057)	4.183 (0.726)	4.179 (0.740)	4.201 (0.830)	4.068 (0.752)	4.179 (0.740)	4.201 (0.83)
Group 4 (1)+(2)	2.563 (0.718)	3.375 (0.595)	2.896 (0.393)	2.863 (0.419)	2.969 (0.063)	2.896 (0.393)	2.863 (0.419)
Group 5 (1)+(3)	4.500 (0.707)	4.875 (0.177)	4.375 (0.884)	4.100 (1.273)	4.688 (0.442)	4.375 (0.884)	4.100 (1.273)
Group 6 (2)+(3)	4.469 (0.633)	4.531 (0.542)	4.563 (0.547)	4.400 (0.835)	4.500 (0.513)	4.563 (0.547)	4.400 (0.835)
Group 7 (1)+(2)+(3)	4.600 (0.894)	4.500 (0.707)	4.700 (0.671)	4.280 (0.820)	4.550 (0.758)	4.700 (0.671)	4.280 (0.820)
F	3.208**	1.910	3.345**	3.506**	3.429**	3.345**	3.506**
Scheffe test							

**: Correlation is significant at the 0.01

(1) prefer single player games; (2) prefer limited multiplayer games; and (3) prefer full function multiplayer games

Students spend time in playing computer games. Some of them spend less than two hours daily averagely and some may spend more than four hours a day. We divide the student responses to five groups according to how much time students spend on playing computer games daily. The five groups are: playing no computer game (8.3%), playing computer games less than 2 hours (33.5%), playing computer games 2 to 4 hours (25.7%), playing computer games 4 to 6 hours (12.8%), and playing computer games more than 6 hours (19.7%). The differences that students in different groups may have are also investigated in this research. Table 11 lists the results of comparing different group students' CGAS responses with ANOVA and the Scheffe tests. All of the factors and subscales have significant differences among the groups with level 0.01. Moreover, the Scheffe tests show that students spending more time in playing computer games may have higher score in Computer Game Attitude Scale.

Table 11: Students who spend different time daily in playing computer games have different responses toward the revised Computer Game Attitude Scale.

	CON	LRN	LIKE	LEI	Cognition	Affection	Behavior
Group 1 not playing	2.903 (1.632)	3.653 (0.879)	3.347 (1.287)	3.092 (1.158)	3.286 (1.073)	3.347 (1.287)	3.092 (1.158)
Group 2 less than 2 hours	3.26 (1.218)	3.894 (0.866)	3.817 (0.862)	3.641 (1.053)	3.575 (0.915)	3.817 (0.862)	3.641 (1.053)
Group 3 2 to 4 hours	4.232 (1.061)	4.304 (0.723)	4.296 (0.677)	4.224 (0.833)	4.268 (0.718)	4.296 (0.677)	4.224 (0.833)
Group 4 4 to 6 hours	4.152 (0.826)	4.241 (0.665)	4.089 (0.800)	4.121 (0.788)	4.198 (0.672)	4.089 (0.800)	4.121 (0.788)
Group 5 more than 6 hours	4.291 (0.965)	4.293 (0.705)	4.326 (0.837)	4.409 (0.735)	4.29 (0.698)	4.326 (0.837)	4.409 (0.735)
F	11.776**	4.626**	6.762**	10.134**	11.563**	4.626**	6.762**
Scheffe test	(3)>(1) (4)>(1) (5)>(1) (3)>(2) (4)>(2) (5)>(2)		(3)>(1) (5)>(1) (3)>(2) (5)>(2)	(3)>(1) (4)>(1) (5)>(1) (3)>(2) (5)>(2)	(3)>(1) (4)>(1) (5)>(1) (3)>(2) (4)>(2) (5)>(2)	(3)>(1) (5)>(1) (3)>(2) (5)>(2)	(3)>(1) (4)>(1) (5)>(1) (3)>(2) (5)>(2)

**: Correlation is significant at the 0.01

We also further investigate whether or not the time spent on playing computer games during weekdays and weekends have influence to the students' CGAS responses. During weekdays, there are 31.2% of students who do not play computer games, 38.5% of students spend less than 2 hours in playing computer games, 14.7% of students spend 2 to 4 hours in playing computer games, 7.3% of students spend 4 to 6 hours in playing computer games, and 8.3% of students spend more than 6 hours in playing computer games. Table 12 list the results of ANOVA and the Scheffe's tests. The results show that there is no significant difference in the responses to the Learning factor among groups. The Scheffe tests also show that less significant patterns among groups have found. However, in general speaking, the hardcore players do still have higher CGAS value than non-players (i.e., who play no computer games all the time no matter in weekdays or weekends) and leisure game players (i.e., who play computer games less or even not during weekdays but will play less than 2 hours or more in weekends).

For weekends, there are 22.9% of students who do not play computer games, 26.1% of students spend less than 2 hours in playing computer games, 17% of students spend 2 to 4 hours in playing computer games, 13.8% of students spend 4 to 6 hours in playing computer games, and 20.2% of students spend more than 6 hours in playing computer games. From the results of ANOVA and the Scheffe's tests listed in Table 13 we can see that all of factors and subscales have significant difference among the groups.

Table 12: Students who spend different time daily (during weekdays) in playing computer games have different responses toward the revised Computer Game Attitude Scale.

	CON	LRN	LIKE	LEI	Cognition	Affection	Behavior
Group 1 not playing	3.371 (1.331)	3.989 (0.798)	3.771 (1.055)	3.73 (1.09)	3.682 (0.949)	3.771 (1.055)	3.73 (1.09)
Group 2 less than 2 hours	3.628 (1.224)	4.012 (0.82)	3.976 (0.742)	3.805 (0.956)	3.818 (0.892)	3.976 (0.742)	3.805 (0.956)
Group 3 2 to 4 hours	4.359 (0.842)	4.32 (0.744)	4.292 (0.753)	4.166 (0.907)	4.341 (0.615)	4.292 (0.753)	4.166 (0.907)
Group 4 4 to 6 hours	4.531 (0.712)	4.505 (0.597)	4.281 (0.917)	4.388 (0.659)	4.515 (0.618)	4.281 (0.917)	4.388 (0.659)
Group 5 more than 6 hours	4.556 (0.942)	4.208 (0.871)	4.653 (0.67)	4.789 (0.533)	4.382 (0.679)	4.653 (0.67)	4.789 (0.533)
F	8.112**	2.338	5.046**	6.168**	6.910**	5.046**	6.168**
Scheffe test	(3)>(1) (4)>(1) (5)>(1)		(5)>(1)	(5)>(1) (5)>(2)	(3)>(1) (4)>(1) (5)>(1)	(5)>(1)	(5)>(1) (5)>(2)

*: Correlation is significant at the 0.05
**: Correlation is significant at the 0.01

Table 13: Analysis of average hour of daily game play in weekend and Computer Game Attitude Scale.

	CON	LRN	LIKE	LEI	Cognition	Affection	Behavior
Group 1 not playing	3.305 (1.323)	3.825 (0.708)	3.615 (0.976)	3.525 (0.92)	3.568 (0.883)	3.615 (0.976)	3.525 (0.92)
Group 2 less than 2 hours	3.272 (1.083)	3.904 (0.766)	3.73 (0.761)	3.597 (1.016)	3.588 (0.788)	3.73 (0.761)	3.597 (1.016)
Group 3 2 to 4 hours	3.696 (1.313)	4.088 (0.93)	4.187 (0.888)	4.041 (1.051)	3.887 (0.97)	4.187 (0.888)	4.041 (1.051)
Group 4 4 to 6 hours	4.5 (0.785)	4.408 (0.73)	4.425 (0.686)	4.187 (0.832)	4.452 (0.579)	4.425 (0.686)	4.187 (0.832)
Group 5 more than 6 hours	4.648 (0.767)	4.479 (0.694)	4.523 (0.715)	4.696 (0.545)	4.564 (0.604)	4.523 (0.715)	4.696 (0.545)
F	15.535**	6.478**	11.174**	13.187**	15.735**	11.174**	13.187**
Scheffe test	(4)>(1) (5)>(1) (4)>(2) (5)>(2) (4)>(3) (5)>(3)	(4)>(1) (5)>(1) (5)>(2)	(3)>(1) (4)>(1) (5)>(1) (4)>(2) (5)>(2)	(4)>(1) (5)>(1) (5)>(2) (5)>(3)	(4)>(1) (5)>(1) (4)>(2) (5)>(2) (5)>(3)	(3)>(1) (4)>(1) (5)>(1) (4)>(2) (5)>(2)	(4)>(1) (5)>(1) (5)>(2) (5)>(3)

**: Correlation is significant at the 0.01

5. Conclusion

This paper aims to provide researchers and teachers a valid and reliable revised Computer Game Attitude Scale which can be used even by children at their age of seven. Moreover, the findings of the differences among gender, grade, preferred gaming way, and game play experience, show that educational games may be appreciated by elementary school students and hardcore game players. Students who prefer to play full function multiplayer games seem to be more positive toward the idea of

learning from playing computer games. In the other words, an educational game may have higher usability and be accepted by students if it can have well-designed multiplayer functionality built-in. t

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