Collaborative Inquiry-Supported Game Design as a Context for Cultivating 'Constructionist Digital Literacy'

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Abstract

We propose a 6-dimensional practice framework as an instructional design to cultivate digital skills, centering on (a) student engagement in a central computational and creative technology task with software, and (b) students' task-driven supplementary inquiry activity and collaborative practices with web-based information and social media resources. The proposed framework offers an instructional theory of "constructionist digital literacy." Empirical support indicates how student engagement in each integrated activity contributes to the others, and how at-school design activity extends to voluntary at-home activity. Results offer support for the effectiveness of integrating collaborative inquiry, with creative design tasks, in instructional designs for digital literacy development, and can be built upon by other scholars of instructional design who are interested in pursuing this outcome

Keywords: digital literacy, contemporary learning, constructionism, technology, education

Introduction

The most recent versions of two sets of national education technology standards include outcomes related to creative technology uses and dispositions for productivity with technology tools (ISTE, 2007; AASL, 2008). However, the standards do not offer clear guidelines for practitioners on *how* to achieve the ends they specify. Implementation in U.S. public schools of substantive technology-based interventions necessary to elicit such outcomes is still relatively rare (Hutchison & Reinking, 2011, p. 312; Central Regional Educational Laboratory, 2003, p. 72).

This study investigates student learning in an educational technology program developed by a New York City-based non-profit organization that offers an innovative model of technology integration in schools, via game design. In this paper we present a 6-dimensional practice framework that we propose is generalizable as an instructional design to cultivate the digital literacy outcomes specified by such standards documents. The framework we present centers on (a) student engagement in a central computational and creative technology task with software, which is supported by (b) their task-driven supplementary inquiry activity and collaborative practices using an online learning management system containing both information and social media resources. We propose that the conceptualization of the framework of integrated activities offers an instructional theory for an effective design to cultivate students' "constructionist digital literacy," that can be built upon by other scholars of instructional design who are interested in pursuing this same student outcome.

Literature Review

The construct of "digital literacy" has been addressed in research by sociology and communications scholars who study technology diffusion trends within the general population. For instance, cross-sectional research in the general population indicates that even among those with moderate to high levels of technology access, more sophisticated forms of content creation, participatory engagement, and digital knowledge have been associated with higher socio-economic status and level of education (Pew Internet and American Life Project, 2007). Hargittai and Walejko (2008) find that creative activity and content sharing online are positively correlated with young persons' socioeconomic status as measured by parental schooling, indicating that greater socioeconomic resources allow for engagement in more sophisticated types of technology uses and their associated cultural benefits. Hargittai and Hinnant (2008) find that the higher the level of education, the greater the self-reported digital skill, and those with higher levels of self-reported skill are more likely to visit the types of Web sites from which their human and financial capital may benefit (2008). Using the outcomes she developed in 2005 and 2009, Hargittai (2010) also finds that those from more privileged backgrounds use Web-based technologies in more informed ways for a larger number of activities.

In the learning sciences scholarly discipline, scholars have also investigated the digital literacy construct. Barron (2004) has adopted the phrase "technological fluency" in her research that adopts a learning ecologies approach that aims to explain the interplay of a myriad of interactive learning resources in several different instances, including at school, in the home, the community, and within technologically mediated, distributed contexts (2004). Barron's (2004) study of high-SES, high technology access high school students in California's Silicon Valley region, for instance, addresses gender differences in participants' experience with technology and the role that various interactions within students' available learning ecologies play towards found differences in student skills.

Largely absent from the literature on digital literacy is research that explicates the specific instructional design features of digital literacy interventions that may be offered over longer timeframes (such as six months or a year), to yield student learning outcomes that, for instance, might mitigate known effects of the digital divide. Researchers need to build the evidence base for instructional design of digital literacy interventions. Practitioners need to know what works.

Game design intervention.

This study explicates a range of activities and practices that students engage in during a year-long game design intervention, and investigates how student engagement in particular activities contribute to their engagement in others. The study also investigates transfer of engagement from at-school to at-home settings. The program founders apply the theoretical instructional design principles of Constructionism and distributed cognition (Harel & Papert, 1991; Salomon, 1997). Students participate in collaborative inquiry-driven game design activities within a formal, in-school elective class offered daily, for credit and a grade. Students create games that address a social issue theme and/or academic content such as math or science. The primary goal from the students' perspective is to create a functioning interactive web game by the end of the school year.

To complete a game, students must engage in inquiry and collaboration in teams. The learning objectives are presented as a framework of six "contemporary learning abilities," or "6-

CLAs," which comprise the scope of expertise categories present in this context. We propose that the framework may offer a central organizing logic for thinking about the design of digital literacy interventions. Reynolds and Harel (2009) and Harel Caperton (2010) discuss the theoretical bases for this framework, which is expanded upon in Figure 1.

The first three CLAs are particularly reflective of constructionist influences, centering on the design and creation of a game in computational software, while CLAs 4-6 are indicative of inquiry and collaborative tasks using a web-based learning management system containing both information and social media resources, to support the central creative task. This study investigates the inter-relationships among the practices.

Research Questions and Hypotheses.

RQ1: In what ways does student engagement in each of the 6-CLA practice dimensions contribute to one another?

RQ2: In what ways does in-school engagement contribute to at-home engagement?

Additionally, previous research from prior school years has indicated that students who participate in the intervention have a greater extent of prior experience in CLA practices 4-6 than CLA practices 1-3 (Reynolds, 2012), and that increases in frequency are greater for CLAs 1-3. Thus, we hypothesize as follows.

H1. The magnitude of change in frequency of engagement from pre- to post-intervention will be greater for CLAs 1-3.

This study helps establish the groundwork for a proposal that collaborative inquiry-supported game design provides an effective instructional design means for cultivating middle and high school students' digital literacy, along the lines that the standards guidelines specify.

Methods

A full paper will provide expansive program implementation details. Data sources for the attitudinal results are as follows:

- Pre-program student survey data
- Post-program student survey data

Pre and post-program surveys were conducted online in August of 2010, January of 2011, and May/June 2011, depending on student participation modality (first semester only, second semester only, or full year). Links were distributed to students via each pilot location wiki, with educator administration. Educators were strongly encouraged to introduce the voluntary surveys prior and subsequent to student engagement with the program, with follow-through by non-profit staff to monitor completion. Research was conducted with full parental consent and child assent, and IRB approval.

Sample Characteristics.

Out of 1,356 middle and high school student participants, a total of 1,063 completed the pre-survey (78.4%), and approximately 670 completed the post-survey (49.4%). Findings reported in this study reflect those participants who completed both the pre-survey and post-survey assessments. A total of 282 middle school and 781 high school students did so. Drop off

from pre-survey to post-survey was due to a range of factors, including student voluntary opt-out, student absences at the end of the school year, and student discontinuations in the program, changing of schools, etc. The pre-intervention sample was 29.0% female and 71.0% male.

Parent Education.

Parent education was measured by asking respondents to identify the highest level of schooling each of their parents or guardians had achieved (1 = *did not complete high school*; 2 = *completed high school*; 3 = *completed high school, attended some college*; 4 = *completed college*; 5 = *completed college, attended some graduate school*; 6 = *completed graduate school*). To control for students who come from single-parent families, the education level of the parent with the highest attainment was used throughout the analysis. In the event that a student reported two parents with the same education level, only one was used in the analysis. The average parent education attainment was high school diploma.

Contemporary Learning Abilities.

Engagement in activities and practices indicative of the six dimensions of contemporary learning as articulated by the Globaloria intervention was measured through pre- and post-program survey items asking self-reported frequency of participation in twenty different activities that comprise the program intervention. Frequency of engagement was measured by asking students to gauge how often they performed a given behavior using a 6-point Likert scale (1= *never*, 6 = *several times a day*).

Results

Confirmatory factor analyses were conducted to validate the six dimensions of contemporary learning. The factorability of 20 indicators was examined across the six dimensions. Indicators were program-based practices and activities that were derived from existing research (e.g., Harel Caperton, 2010; Reynolds & Harel, 2009). All indicators for each dimension displayed factor loadings of at least .5 or above (Table 1). Confirmatory factor analyses and subsequent reliability analyses of frequencies of engagement at home support these results. The items specified for each factor hang together, and were thereby computed as composites (Table 3).

Pearson's product-moment correlation coefficients were computed to investigate the relationships between the six dimensions of contemporary learning at school and at home (Table 2).. At school, results indicated the strongest correlations between the more constructionist dimensions of contemporary learning, revealing the highest correlation between Manage and Publish followed by the correlation between Create and Manage and the one between Create and Publish. Socialize also indicated high degrees of correlation with the more constructionist dimensions of contemporary learning, although none were as high as those between Create, Manage, and Publish. Correlations between frequencies of engagement in the six dimensions of contemporary learning at home paralleled those at school, though they were overall lower (Table 4).

Results from a series of repeated measure ANOVAs reveal that the intervention resulted in increased frequencies of engagement at school and at home across numerous dimensions of contemporary learning (Table 5). Findings from both school and home demonstrate that the intervention had the largest overall effects on the more constructionist dimensions of contemporary learning, supporting Hypothesis 1.

Multiple regression analyses were used to investigate whether the change in students self-reported frequency of engagement in the six dimensions of contemporary learning at school contributed to the change in their self-reported engagement at home (Table 6). Aside from change in engagement at school, model parameters also included gender, grade level, and parent education. In each model, a number of of the at-school indicators are found to contribute to the at-home measures, with statistical significance.

Discussion

CLAs 1-3 displayed the highest degree of inter-correlation both at school and at home, with one another. CLAs 4-6 showed apparently lower magnitude of correlation, with both the more constructionist dimensions and among one another, but many were significant nonetheless. The practices contribute to one another in a way that aligns with the program conceptualization, in that the central constructionist activity is primary, and supported more peripherally by the inquiry and collaborative practices. This finding for RQ1 also appears to be supported by pre/post findings, which indicate that the pre-intervention mean was generally lower and the subsequent change was larger for the more central, constructionist creative dimensions.

The role of inquiry and collaborative activities, however, should not be underestimated. Findings on the whole for RQ2 indicate that several dimensions of student at-school engagement contributed to several at-home dimensions, even though homework was not assigned. Social exchange at school (CLA 4) was a significant predictor of increases in at-home engagement in the more constructionist dimensions, indicating that the more students engaged socially at school for productive purposes, the more motivated it appears they were to continue their design activity at home. Further, surfing at school (CLA 6) also played a similar role, indicating that inquiry-based surfing behaviors at school contribute to motivated transfer to home. Findings also indicate that change in at-school engagement for a given dimension, e.g. CLA 1, contributed to the change in at-home engagement for the same dimension in almost all cases.

Gender and parent education were not significant predictors of changes in at-home engagement, a finding that contradicts cross-sectional research findings about the nature of technology access and adoption such as those cited in the literature review but that supports a previous study of this intervention by Reynolds & Chiu (2013). Such interventions may be successful in imparting contemporary learning abilities to students who are traditionally less likely to report adoption of digital literacy skills.

This study demonstrates how a range of practices can contribute to one another when offered in a synergistic program that integrates a productivity task such as game design, with online learning management system usage for both social media and information resource purposes. The contemporary learning abilities framework centers on the *productive creative task* (CLAs 1-3) (in this case game design) as the primary activity, with *inquiry and collaboration* occurring in support of this task (CLAs 4-6). This broader conceptualization can be responsive to the constantly evolving nature of technology, which has posed issues in past theoretical and methodological studies of digital literacy where definitions center on specific technology tools. We propose that the factorability of the CLAs is based on these broader concepts: on the one hand -- creative engagement using computational productivity software as the central design task; and on the other – design-task-driven inquiry and use of information and social media resources, via an online learning management system featuring varying affordances. Future research along these lines must include more robust data than survey self-reports, including process and knowledge outcomes data. We propose that the present framework and

conceptualization offers a complement to ends-oriented digital skills standards guidelines issued by organizations such as ISTE and AASL, and provides greater explication of the means by which practitioners may achieve the benchmarked standards outcomes. More research is also needed to understand the longer-term influences of such an intervention upon student digital practices and participation, as well as effects on STEM career interests and life pathways.

References

Ackermann, E. K. (2004). Constructing knowledge and transforming the world. In M. Tokorn & L. Steels (Eds.), *A learning zone of one's own: Sharing representations and flow in collaborative learning environments* (pp. 15-37). Amsterdam, Netherlands: IOS Press.

American Association of School Librarians. (2007). Standards for the 21st-century learner. Retrieved from http://www.ala.org/ala/mgrps/divs/aasl/guidelinesandstandards/learningstandards/standards.cfm

Aviram, A., & Eshet-Alkalai, Y. (2006). Towards a theory of digital literacy: Three scenarios for the next steps. Retrieved from http://www.eurodl.org/materials/contrib/2006/Aharon_Aviram.htm

Bawden, D. (2001). Information and digital literacies: A review of concepts. *Journal of Documentation*, *57*(2), 218-259.

Barron, B. (2004). Learning ecologies for technological fluency: Gender and experience differences. *Journal of Educational Computing Research*, *31*(1), 1-36.

Barron, B., & Darling-Hammond, L. (2008). Teaching for meaningful learning: A review of research on inquiry-based and cooperative learning. Retrieved from http://www.edutopia.org/pdfs/edutopia-teaching-for-meaningful-learning.pdf

Bruckman, A., & Resnick, M. (1995). The MediaMOO Project: Constructionism and professional community. *Convergence*, (1)1, 94-109.

DiMaggio, P., Hargittai, E., Celeste, C., & Shafer, S. (2004). Digital inequality: From unequal access to differentiated use. In K. M. Neckermann (Ed.), *Social inequality* (pp. 355-400). New York, NY: Russell Sage Foundation.

diSessa, A., & Cobb, P. (2004). Ontological innovation and the role of theory in design experiments. *Journal of the Learning Sciences*, *13*(1), 77-103.

Harel, I. (1991). *Children designers: Interdisciplinary constructions for learning and knowing mathematics in a computer-rich school*. Norwood, NJ: Ablex.

Harel Caperton, I. (2010). Toward a theory of game-media literacy: Playing and building as reading and writing. *International Journal of Gaming and Computer-Mediated Simulations*, 2(1), 1-16.

Harel, I., Oliver, A., & Sullivan, S. (2008). Implementing Globaloria in West Virginia: Results from pilot year 1. Retrieved from worldwideworkshop.org/reports

Harel, I., & Papert, S. (1990). Software design as a learning environment. *Interactive Learning Environments*, *1*(1), 1–32.

Harel Caperton, I., & Sullivan, S. (2009). Students' Development of Contemporary Core Competencies through Making Educational Web Games. Paper presented at Games Learning and Society, Madison, WI.

Hargittai, E. (2005). Survey measures of Web-oriented digital literacy. *Social Science Computer Review*, *23*(3), 371-379.

Hargittai, E. (2009). An update on survey measures of Web-oriented digital literacy. *Social*

Science Computer Review, *27*(1), 130-137.
Hargittai, E. (2010). Digital na(t)ives? Variation in Internet skills and uses among members of the Net Generation. *Sociological Inquiry*, *80*(1), 92-113.
Hargittai, E. & Hinnant A. (2008). Digital inequality: Differences in young adults' use of the Internet. *Communication Research*, *35*(5), 602-621.
Hargittai, E. & Walejko, G. (2008). The participation divide: Content creation and sharing in the Digital Age. *Information, Communication and Society*. *11*(2), 239-256.
Hutchison, A., & Reinking, D. (2011). Teachers' perceptions of integrating information and communication technologies into literacy instruction: A national survey in the United States. *Reading Research Quarterly*, *46*(4), 312-333.
International Society for Technology in Education. (2007). NETS for students 2007. Retrieved from http://www.iste.org/standards/nets-for-students.aspx.
International Society for Technology in Education. (2008). NETS for teachers 2008. Retrieved from http://www.iste.org/standards/nets-for-teachers.aspx.
Kafai, Y. B. (1995). *Minds in play: Computer game design as a context for children's learning*. Mahwah, NJ: Lawrence Erlbaum, 1995.
Kafai, Y. B. (2006). Playing and making games for learning: Instructionist and constructionist perspectives for game studies. *Games and Culture*, *1*(1), 36-40.
Kafai, Y. B., & Ching, C. C. (2004). Children as instructional designers: Principles of learning with guided discoveries. In N. M. Seel & S. Dijkstra (Eds.), *Curriculum, plans, and processes in instructional design: International perspectives* (pp. 115-130) Mahwah, NJ: Lawrence Erlbaum Associates, Inc., Publishers.
Kafai, Y.B., Peppler, K., & Chiu, G. (2007). High tech programmers in low income communities: Seeding reform in a community technology center. In C. Steinfield., B. Pentland, M. Ackerman, &. N. Contractor (Eds.), *Communities and technologies 2007* (pp. 545-564). New York, NY: Springer
Kafai, Y. B., & Resnick, M. (Eds.). (1996). *Constructionism in practice: Designing, thinking, and learning in a digital world.* Mawhaw, NJ: Lawrence Erlbaum Associates.
Kline, R. B. (1998). Principles and practices of structural equation modeling. New York, NY: Guilford.
Klopfer, E. (2008). *Augmented learning: Research and design of mobile educational games*. Cambridge, MA: MIT Press.
Knight Commission. (2009). Informing communities: Sustaining democracy in the digital age. Retrieved from www.knightcomm.org/wpcontent/uploads/2010/02/Informing_ Communities_Sustaining_Democracy_in_the_Digital_Age.pdf
Livingstone, S., Van Couvering, E., & Thumim, N. (2005) Adult media literacy: A review of the research literature. Retrieved from stakeholders.ofcom.org.uk/binaries/research/media-literacy/aml.pdf
North Central Regional Education Laboratory & Metiri Group. (2003). enGauage 21st century skills: Literacy in the digital age. Retrieved from pict.sdsu.edu/engauge21st.pdf
Papert, S. (1980) *Mindstorms*. New York, NY: Basic Books.
Papert, S., & Harel, I. (Eds.). (1991). *Constructionism.* Norwood, NJ: Ablex Publishing.
Pew Internet and American Life Project. (2007). Teens and social media. Retrieved from http://www.pewinternet.org/Reports/2007/Teens-and-Social-Media.aspx
Reynolds, R. (2008). Reconstructing "digital literacy" in a Constructionist computer club: The Role of motivation, interest, and inquiry in children's purposive technology use Doctoral

dissertation (unpublished). S. I. Newhouse School of Public Communications, Syracuse University.

Reynolds, R. (2011). *Children's game design learning in discovery-based contexts: Contribution of intrinsic and extrinsic motivational orientations to student outcomes*. Presented at the International Communication Association annual conference, May 2011, Boston, MA.

Reynolds, R., & Chiu, M. (2013). Context matters: The effect of formal and informal context differences upon pre- to post-program changes in student engagement in a program of game design learning. *Journal of Learning, Media & Technology*.

Reynolds, R & Harel Caperton, I. (2009). Development of High School and Community College Students' Contemporary Learning Abilities in [a game design program]. Presented at the annual conference of the *American Educational Research Association*, San Diego, CA, April, 2009.

Reynolds, R & Harel Caperton, I. (2011). Contrasts in student engagement, meaning-making, dislikes, and challenges in a discovery-based program of game design learning. *Educational Technology Research and Development*, 59(2):267-289.

Stager, G. (2001). *Computationally-rich constructionism and at-risk learners*. Retrieved from http://www.stager.org/wcce/index.html

Urrea, C. (2001). Designing robotic artifacts: Rural school-community collaboration for learning. Retrieved from web.media.mit.edu/~calla/curriculum/RURAL1.pdf

U.S. Department of Education. (2010, November). National education technology plan. Retrieved from http://www.ed.gov/sites/default/files/netp2010-execsumm.pdf

Table 1. Indicator descriptions, factor loadings, and reliability analyses of contemporary learning abilities at school

	Contemporary Learning Abilities					
Indicator	Create	Manage	Publish	Socialize	Research	Surf
Think up an idea for a creative technology project	.85					
Think up an idea for an interactive game	.84					
Make computer games	.79					
Program a computer	.80					
Make graphics/animations on a computer		.88				
Make digital music/video on a computer		.89				
Work on digital design project with team members in person		.91				
Use online tutorials to help with digital design projects		.92				
Post digital design projects online			1.00			
Exchange messages in email about a technology project				.90		
Exchange messages in IM/chat about a technology project				.95		
Exchange messages on sites like Facebook about a technology project				.87		
Use Wikipedia					.82	
Search online when you have a question					.83	
Search online when you need technology help					.82	
Surf online to find new websites						.58
Play internet games						.79
Play software games						.84
Play games on a video game console						.79
Play multiplayer games with others through the internet						.82
Cronbach's α_{pre}	.84	.92	1.00	.89	.76	.81
Cronbach's α_{post}	.84	.88	1.00	.92	.78	.82

Note: All Eigenvalues > 1.00.

Table 2. Correlations between contemporary learning abilities at school

	Create	Manage	Publish	Socialize	Research	Surf
Create	1.00					
Manage	.78***	1.00				
Publish	.74***	.89***	1.00			
Socialize	.58***	.58***	.55***	1.00		
Research	.54***	.47***	.42***	.42***	1.00	
Surf	.54***	.45***	.41***	.47***	.55***	1.00

Note: ***$p < .001$.

Table 3. Indicator descriptions, factor loadings, and reliability analyses of contemporary learning abilities at home

	Contemporary Learning Ability Factors					
Indicator	Create	Manage	Publish	Socialize	Research	Surf
Think up an idea for a creative technology project	.83					
Think up an idea for an interactive game	.83					
Make computer games	.76					
Program a computer	.76					
Make graphics/animations on a computer		.82				
Make digital music/video on a computer		.83				
Work on digital design project with team members in person		.86				
Use online tutorials to help with digital design projects		.88				
Post digital design projects online			1.00			
Exchange messages in email about a technology project				.87		
Exchange messages in IM/chat about a technology project				.91		
Exchange messages on sites like Facebook about a technology project				.87		
Use Wikipedia					.83	
Search online when you have a question					.83	
Search online when you need technology help					.82	
Surf online to find new websites						.68
Play internet games						.83
Play software games						.84
Play games on a video game console						.70
Play multiplayer games with others through the internet						.76
Cronbach's α_{pre}	.80	.86	1.00	.86	.77	.82
Cronbach's α_{post}	.87	.91	1.00	.88	.78	.84

Note: All Eigenvalues > 1.00.

Table 4. Correlations between contemporary learning abilities at home

	Create	Manage	Publish	Socialize	Research	Surf
Create	1.00					
Manage	.75***	1.00				
Publish	.64***	.80***	1.00			
Socialize	.46***	.45***	.42***	1.00		
Research	.49***	.41***	.32***	.39***	1.00	
Surf	.55***	.37***	.30***	.38***	.53***	1.00

Note: ***$p < .001$.

Table 5. Repeated measure ANOVAs for CLA engagement at school and at home

	Pre-Intervention Mean	*Post-Intervention Mean*	*Change*	*F*	*p*	n^2	*N*
Create Frequency at School	1.95	2.84	+0.89	221.62	< .001	.25	663
Manage Frequency at School	1.57	2.89	+1.32	403.04	< .001	.38	664
Publish Frequency at School	1.52	2.90	+1.38	345.23	< .001	.34	668
Socialize Frequency at School	1.46	1.80	+0.34	36.03	< .001	.05	671
Research Frequency at School	2.62	3.09	+0.47	63.35	< .001	.09	677
Surf Frequency at School	2.32	2.37	+0.05	0.86	.355	.00	663
Create Frequency at Home	1.99	2.16	+0.17	11.10	< .001	.02	665
Manage Frequency at Home	1.56	1.85	+0.29	30.67	< .001	.04	667
Publish Frequency at Home	1.39	1.72	+0.33	33.20	< .001	.05	672
Socialize Frequency at Home	2.39	2.43	+0.04	0.54	.463	.00	672
Research Frequency at Home	2.99	3.10	+0.11	4.71	.030	.01	674
Surf Frequency at Home	3.44	3.48	+0.04	0.81	.370	.00	663

Table 6. Regression models predicting change in frequencies of engagement in CLA-based activities at home

	Model 1		***Model 2***		***Model 3***		***Model 4***		***Model 5***		***Model 6***	
	Δ *Create Freq. at Home*		**Δ *Manage Freq. at Home***		**Δ *Publish Freq. at Home***		**Δ *Socialize Freq. at Home***		**Δ *Research Freq. at Home***		**Δ *Surf Freq. at Home***	
	b	***β***	***b***	***β***	***b***	***β***	***b***	***β***	***b***	***β***	***b***	***β***
Constant	-.32		-.29		-.13		.90*		-.19		.78*	
	(.28)		(.30)		(.35)		(.45)		(.33)		(.31)	
Gender (*male* = 1)	.10	.04	.18	.07	.18	.06	-.16	-.05	.02	.02	-.13	-.04
	(.09)		(.10)		(.12)		(.15)		(.11)		(.11)	
Grade Level	.02	.03	.02	.03	.01	.02	-.06	-.07	.01	.01	-.07*	-.11
	(.02)		(.03)		(.03)		(.04)		(.03)		(.03)	
Parent Education	-.02	-.02	.00	.00	-.01	-.01	-.10	-.08	.01	.01	-.02	-.03
	(.03)		(.04)		(.04)		(.06)		(.04)		(.04)	
Δ Create Freq. at School	.39***	.45	.06	.06	.11	.11	.06	.05	-.05	-.06	.12*	.15
	(.05)		(.05)		(.06)		(.08)		(.06)		(.06)	
Δ Manage Freq. at School	-.10	-.12	.16**	.20	.04	.05	-.13	-.13	-.06	-.06	-.10	-.11
	(.06)		(.06)		(.07)		(.09)		(.07)		(.06)	
Δ Publish Freq. at School	-.04	-.07	-.07	-.09	-.02	-.03	.07	.08	.06	.08	.02	.03
	(.04)		(.05)		(.05)		(.07)		(.05)		(.05)	
Δ Socialize Freq. at School	.26***	.31	.38***	.43	.39***	.42	.40***	.35	.06	.07	.04	.08
	(.04)		(.04)		(.05)		(.06)		(.04)		(.04)	
Δ Research Freq. at School	.03	.04	-.03	-.03	-.01	-.01	.07	.06	.42***	.46	.08*	.11
	(.03)		(.04)		(.04)		(.05)		(.04)		(.04)	
Δ Surf Freq. at School	.15***	.17	.18***	.20	.12**	.12	.13*	.11	.09	.11	.26***	.32
	(.04)		(.04)		(.04)		(.06)		(.04)		(.04)	
F	38.68***		34.00***		22.66***		13.14***		20.63***		12.28***	
R^2	.43		.40		.30		.20		.28		.19	
Adj. *R^2*	.42		.39		.29		.19		.27		.18	

Note: *$p < .05$; **$p < .01$; ***$p < .001$. Standard errors are in parentheses.

Contemporary Learning Ability (CLA)	Practices Representing Each CLA & How They Are Articulated/Integrated in Globaloria
1 Invention, progression, and completion of an original digital project idea for an educational web-game or interactive simulation	Brainstorming and developing game and simulation ideas and storylines using Web2.0 tools Writing an original game narrative and a proposal to explain it Generating creative ideas for designs to express the subject of the game and the user experience Planning/programming/completing a game demo that illustrates the original game design and functionality Developing knowledge of the game's domain or topic through game invention/creation/research
2 Project-based learning through online project management in a wiki-based networked environment	Coordinating and managing the design/creation/programming of game elements Managing the project's execution by creating/organizing a wiki and by sharing project assets and progress updates Managing team work by defining and assigning team roles/coordinating tasks/executing roles Project troubleshooting for self and others Gaining leadership experience through the project management of all game production elements
3 Publishing and distribution of self-created digital media artifacts (using wikis, blogs, websites)	Creating a wiki profile page and project pages Integrating and publishing text/video/photos/audio/programming code/animations/digital designs on wiki pages Posting completed assignments/game design iteration and assets/notes and reflections about projects to wiki Developing a blog
4 Social-based learning, participation and exchange in a networked environment	Collaborating by using Web2.0 tools such as posting to wikis/blogs/open source help forums/instant messaging Exchanging/sharing feedback and resources by posting information/links/source code questions/ answers Reading and commenting on others' blogs and wiki pages Presenting final digital projects for others both virtually in game galleries and in person in live game demonstrations
5 Information-based learning, purposeful search, and exploration	Searching the Web for answers and help on specific issues related to programming games Searching and finding resources on MyGLife.org network, website, and wiki Searching the Web for new Flash design, animation and programming resources Searching for information in support of the game's educational subject and storyline
6 Surfing websites and experimenting with Web applications and tools	Surfing to MyGLife.org starter kit site and other game sites and playing games online Keeping track of and bookmarking surfing results that are relevant to projects Browsing Web2.0 content sites such as YouTube, Flickr, blogs, Google tools

Figure 1. Globaloria learning objectives: Promote development of six contemporary learning abilities (CLAs)