Title: Motivation and Culturally Responsive Technology for COMPUGIRLS

Kimberly A. Scott, Jenefer Husman, & Jieun Lee Arizona State University

Problem Statement

Explanations for why girls from underrepresented groups (e.g. African American, Hispanic, and Native American) do not enter and/or persist in STEM fields in general and technology disciplines in particular, consider a multitude of factors. Among the suggested reasons, lack of motivation continues to shape much of the discourse and programmatic efforts. Although we come from different disciplines (social justice studies and educational psychology) our training and individual research, as well as our combined efforts on the COMPUGIRLS project have provided us with significant evidence that the above description is a misrepresentation of our girls' lived experience and the motivational psychological constructs often cited as part of this discussion. Specifically, we argue that the taken-for-granted view of motivation is problematic for two reasons.

Motivation and Self-Concept

First, it is commonly believed that motivation is an innate construct. Such a perspective describes motivation as an immutable entity that some individuals inherently lack. In contrast, some education psychology research maintains that motivation is a process related to future beliefs (Oyserman & James, 2009), self-concept (Marsh, Gerlach, Trautwein, Lüdtke, & Brettschneider, 2007), and self-efficacy (Usher & Pajares, 2006). Of these three motivational beliefs system all are highly influenced by context, and amenable to change – in some cases very rapid change.

The concept of "the self" is central to social and educational psychology. The self not only represents what we know of ourselves from our past experiences, but also holds what we expect from ourselves in the future (Husman & Lens, 1999; Markus & Nurius, 1990; Nuttin & Lens, 1989). The study of humans understanding of themselves in the present, and in the context of educational achievement has been dominated by Herbert Marsh and his colleagues (Marsh & Craven, 2006; Marsh, Gerlach, Trautwein, Lüdtke, & Brettschneider, 2007; Marsh, Tracey, & Craven, 2006; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2006). Much of this research has focused on the validation of the Academic Self Description Questionnaire II as a high quality measure of domain specific self-concept (Marsh, 1990). Marsh has successfully used this measure with adolescent students from various academic and personal backgrounds. Due to the widely known success of this measure, and its domain specificity we chose to use this instrument to measure our students' academic, technological, and general self-concepts; and to track changes in their self-concepts over time.

One aspect of students' motivation for engagement in the present and the future is their understanding of the connection between present behaviors and future goals. This connection has been called Perceptions of Instrumentality, the perception that some tasks are instrumental to achieving important future goals. Perceptions of Instrumentality have been shown to influence students' achievement, motivation, and learning (Husman, Derryberry, Crowson, & Lowmax, 2005; Turner & Schalertt, 1999). We were interested to find out how instrumental adolescence girls' of color beliefs of learning technology was for their future goals. Wwe also wanted to know how instrumental the students' found working on the types of projects we provided. To measure student's perceptions of instrumentality we used a measure which has been used frequently and successfully with late(Turner & Schallert, 2001) and early (Van Calster, Lens, & Nuttin, 1987) adolescences.

Another aspect of humans' projection of themselves into the future has been researched in adolescence in high-needs areas under the description of Future Possible Selves (Oyserman, Brickman, & Rhodes, 2007; Oyserman & James, 2009). Oyserman and her colleagues have successfully used the Academic Possible Selves measure to examine the possible selves of students from high-risk, high-poverty areas in the Detroit metro area(Oyserman & Fryberg, 2006). We chose to use her measure both because of the strong validity and reliability evidence, but also because we felt the measure would provide us with the greatest amount of information about the future expectations of the students in our study.

Students' expectations of their future selves and their perception of their current selves greatly influence the value students have for activities (both academic and non-academic). Although critical to engage students and encourage them to value STEM activities (in formal and informal settings), students who value an activity but doubt their ability to successfully reach their goals or perform in those tasks may (often referred to as self-efficacy) create a situation where they experience high anxiety and negative emotions. This situation is likely to result in disengagement in their value of the activity (Brophy, 2002). It is therefore important not only to track students' understanding of themselves but also their understanding of their self-efficacy for completing the specific STEM activities involved. In our case we were concerned that students feel competent doing computer and web-based activities. We used the Computer Interface Literacy Measure (CILM) (Turner, Sweany, Husman, 2000) which assesses students' self-efficacy for specific computer knowledge and skills as well as functions as an objective measure of their computer literacy. For our task we updated the CILM to emphasize the software and operating systems currently in use.

Within this understanding of motivation lies the argument shaping our efforts: The earlier youngsters receive nurturing experiences and frames that support particular adaptive motivational beliefs, the greater the likelihood for strengthening their future beliefs, self-concept, and self-efficacy. To deeply influence these self-belief and produce an effective process, we argue that these experiences need to be culturally relevant and resonate with the students' deeply seated understanding of themselves in relation to their community. Although this notion is rarely considered when examining disadvantaged populations, it leads us to our next critique.

Motivation in Cultural Contexts

Second, believing that students from high needs areas lack motivation too easily recalls the cultural deficit model (Solorzano,1991, Valencia, 1997). Often used to explain the achievement gap, cultural deficit thinking faults students' culture, motivation, and/or community for preventing academic success rather than noting the structural, institutionalized constraints impeding true progress. Similarly, some researchers and program developers maintain that certain population's lack of technological motivation is due to their community's lack of interest or belief in digital media. When such contexts do use technology, their employment is often marginalized or rarely valued (Everett, 2009). Such communities' purported technophobia (Monroe, 2004) leads to structural and individual implications. Contending that underrepresented groups' cultures preclude its individuals from being motivated and interested in technology allows high needs schools to not offer advanced technology classes (Goode 2007; Margolis, Estrella, Goode, Holme, & Nao, 2008), and a proliferation of enrichment programs that are culturally irrelevant (Scott, Aist, Hood, 2009; Scott, Clark, Sheridan, Mruczek, & Hayes, 2010). Culturally relevant practices (CRP; Howard, 2003; Ladson-Billings, 1995; Milner, 2010; Lee, 2007; Gay, 2002) stand in direct opposition to these beliefs and actions.

CRP maintains three key features**:** 1) Asset Building: a youngsters' cultural knowledge is an invaluable asset that should shape the learning process; 2) Reflection: Instructors involved in the learning process need to reflect upon their own positionality challenging what they know and how they gained knowledge about people and content; and 3) Connectedness: Students should feel that their learning should and can affect their communities insofar as they feel a sense of responsibility to something larger than themselves (i.e. peer group, community, ideals).

In combination with our understanding of motivation theory, we constructed COMPUGIRLS (NSF # 0833773) around the following assumptions: Although girls from high needs districts may not have access to mastery experiences or digital media that is culturally relevant, they may be highly motivated to interact with multimedia if provided the opportunity. The effects of such an opportunity will be more pronounced in a digital media experience that incorporates the above elements of culturally responsive practices. Programmatic implications of these assumptions caused us to create COMPUGIRLS as a six-course, culturally responsive, multimedia after school and summer program aimed at adolescent girls (ages 13-18) who rarely if ever have exposure to culturally relevant digital media.

The PI worked primarily with two Phoenix-metropolitan school districts to recruit a cohort of 40 girls to navigate the two-year program. Upon receiving over 100 applications, 50 girls were selected to participate based on their essay scores. The vast majority of the girls are Hispanic (76%) followed by a significant percentage of African American female participants (16%). During the Summer 2009, participants began the first COMPUGIRLS course at Arizona State University's Downtown Campus. This paper examines their future time perspective, self-concept, and self-efficacy during the first three courses.

Although the media product of each course varied, dependent upon the used software, two end results remained constant—a research paper and a digital media presentation of their results. Throughout the courses, carefully trained mentor-teachers led small and large group lessons around issues of social justice, software and hardware use, and the role of technology towards community advancement. Meetings required individuals to continuously reflect upon self-selected topics; consider how digital media could be used to answer the individually created research question; and analyze the results and ultimately present the findings while discussing implications to various audiences. The curricula encouraged the girls to demonstrate to their peer group their strengths (assets) by requiring girls to provide progress reports, verbally articulating what they learned, and posting ideas using Ning. Instructors were encouraged to monitor the girls' demonstrations, document them, and incorporate their cultural knowledge into subsequent lessons. Often this led to peer mentoring, girls presenting how they accomplished tasks, and interdependent group work integrated into lessons. From these exchanges, girls learned how to provide feedback to their peers. Importantly, as participants' became more connected with each other, instructors and girls' co-created rules, adjudication systems, and peer feedback loops. At the conclusion of each meeting, we required girls to reflect upon and share their progress, articulate short and long-term goals, and direct recommendations for future accomplishments. Equally important, each course concluded with a community-wide celebration organized by participants. At these events, girls showcased peer-selected projects to family, friends, school administrators, community advocates, and university affiliates.

Method

Participants

To contextualize our results, we created a matched comparison group. Based on work by staff and district personnel within the Roosevelt Elementary School District and the Phoenix Union High School District, the project PI worked closely with school and district level administrators to develop a procedure for identifying participants and administering the surveys. In Roosevelt, for instance, an assistant principal worked with the computer lab instructor to disseminate permission slips and arrange for the survey administration days and times. The students were allowed to come to the computer lab during a two-hour block and complete the surveys. Evaluation staff were on hand immediately or at a pre-arranged time to have students complete a compensation form receipt and to receive a $5 gift card. Two Phoenix Union High School District administrators (technology department and research department) worked together to develop the protocol for their survey administration. The technology administrator identified one key staff at a number of campuses who would be in charge of working with the evaluation team to recruit students and administer the survey. The high school district staff requested copies of all permission slips.

The arrangements for comparison group participants were not completed by summer, so their first survey administration occurred in conjunction with the fall administration for COMPUGIRL participants.

The analysis employed for the two groups was a two-way ANOVA with unequal sample sizes. This was used to evaluate the effects of two groups (COMPUGIRLS and comparison group), and time on the dependent variables PS, ASDQ-SC, ASDQ-TS, and CILM. To account for the differential in survey times, the analysis included the first and fourth semester results on the dependent variable for both groups.

The time periods used were the following:

- Time 1= First Semester
- Time 4= Fourth Semester

For COMPUGIRLS participants, that translates into Time 1 being their pre-summer 09 and Time 4 being their Post-fall 09 scores. For the comparison group, Time 1 is pre-fall 09 and Time 4 is their post spring 10 scores.

The COMPUGIRLS participants and members of a comparison group completed one or two rounds of surveys in 2009. The table below lists the total number of participants, by group, within each survey administration.

Table 1: Number of participants by group

Group	Pre Sum 09	Post Sum 09	Pre Fall 09	Post Fall 09	Pre Spring 10	Post Spring 10
COMPUGIRLS	**43**	**37**	**31**	**29**	28	23
Comparison Grp			**61**	**52**	44	39

Measures

Possible Selves & Plausible Strategies Questionnaire

This instrument was administered for the students to express *Expected Selves* ("next year, I expect to be…") and *Feared Selves* ("next year, I want to avoid…"). Additionally, the instrument asks if she is doing anything to accomplish this goal, and if yes, identify what she is doing now to facilitate this. Each survey is scored by 2 raters who coded the questionnaires for academic plausibility. The questionnaire author, Daphna Oyserman explained that "plausibility is meant as a general assessment of the usefulness of the achievement related visions and strategies the student describes as a 'road map to achieving in school' or a plan of action." (Oyserman, et al., 2004) Plausibility scores range from 0 (none or a single, vague academic possible self) to 5 (multiple academic possible selves and strategies that focus on both the academic aspects and social interpersonal aspects of attaining the academic goal).

Perceptions of Instrumentality Scale

The Perceptions of Instrumentality Scale (PI) (Husman et al., 2005) asks the students if they would use what they learned in the COMPUGIRLS program in the future and that the skills and information will be important to their future success. It was only used in the CG survey. The response categories ranged from *strongly disagree* (1) to *strongly agree* (5) Reported Cronbach's alpha =.86.

ASDQII

Three of the subscales from Academic Self Description Questionnaire II (Marsh, 1992) were utilized: Computer Studies/Technological, Stable Personal Preferences, and Academics. The ASDQII instrument measures multiple subject matter dimensions of academic self-concept and is designed for use with early adolescents. Reported coefficient alpha estimates of reliability varied from .89 to .95 for the scales.

Computer Interface Literacy Measure (CILM)

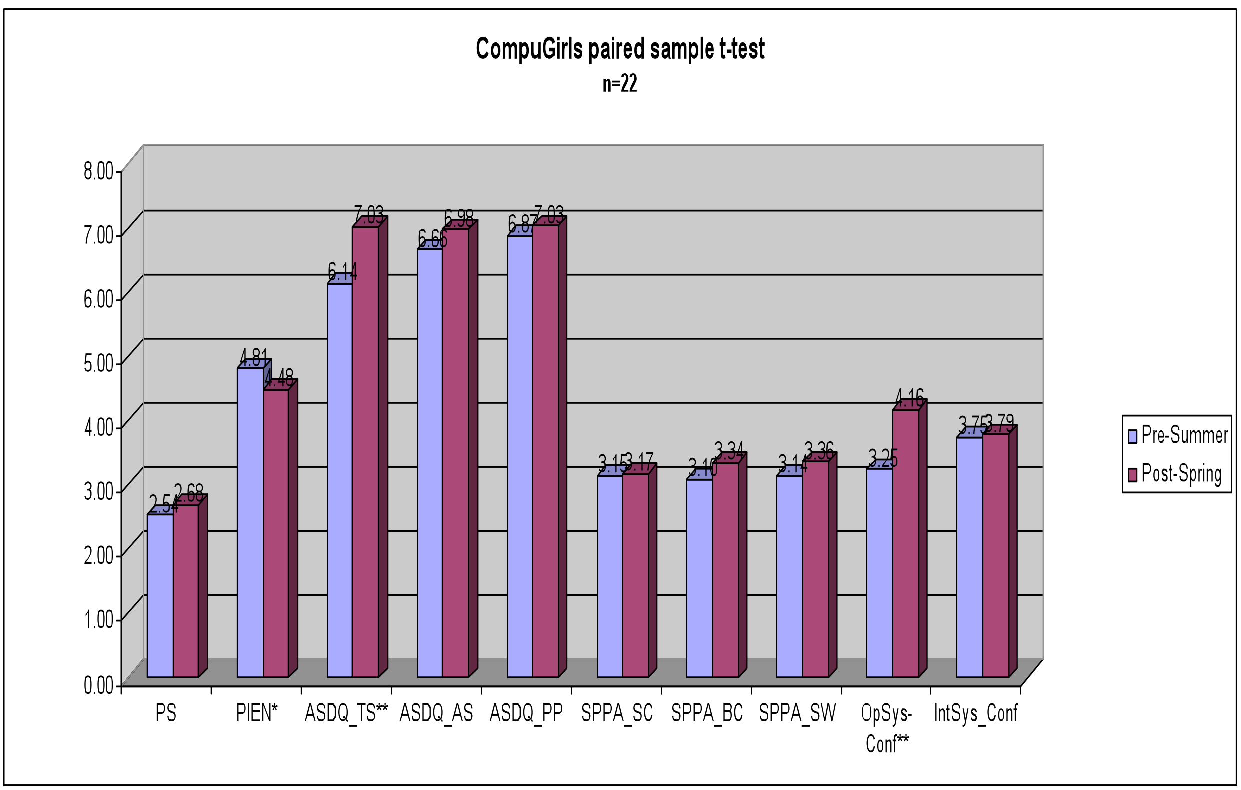
To measure participant change in technological skills, the CILM Measure (Turner, et al., 2005) survey was used. The items measured included confidence in using operating systems, skills and knowledge in using operating systems, confidence in internet use, and skills/knowledge in using the internet. The CILM is composed of both self-report (26 items □=.90) and knowledge application subscales (42 items; □=.85).

Results

In order to examine growth for the COMPUGIRLS participants, a paired sample t-test was conducted using the pre-summer to the post-spring scores on all commonly repeated measures. This included ASDQ, SPPA, PS, PIEN, and CILM measures.

COMPUGIRLS												
	Sum Pre Survey		Sum Post Survey		Fall Pre Survey		Fall Post Survey		Spring Pre Survey		Spring Post Survey	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
PS	2.36	1.495	2.92	1.26			2.79	1.264			2.61	1.12
PIEN_M	4.60	.54138	4.77	.328	4.7016	.350	4.62	.456			4.49	.576
ASDQ_TS_M	6.23	.97562	6.31	1.153	6.7073	.983	6.79	1.071	7.04	.869	6.95	.851
ASDQ_SP_M	6.81	.77230	6.86	.878							7.03	.801
ASDQ_AS_M	6.55	.92286	6.65	1.11			6.87	.913			6.98	.586
OpSys_Conf	3.25	.49461	3.90	.558			4.07	.356			4.15	.349
Internet_Conf	3.77	.43581	3.87	.387			2.73	.296			3.8	.381
	N = 41		N = 32		N = 31		N = 29					

The Perception of Instrumentality (significant decline $p < .05$). The growth in ASDQ-TS and Operating System Confidence was statistically significant ($p<.001$).

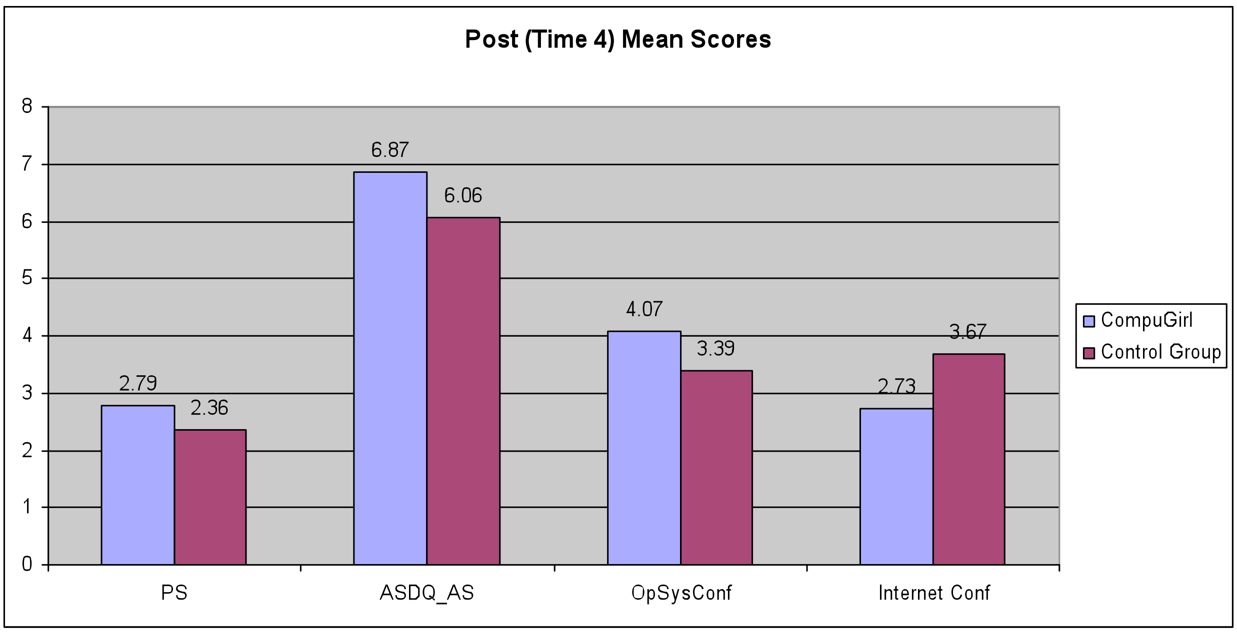


Note: n=22 *$p < .05$; **$p < .01$

Comparison Group and COMPUGIRLS

The ANOVA results reveal a significant interaction on a few measures between the groups (COMPUGIRLS, comparison) and Time of measurement on the possible selves measure and technological skills (operating system use confidence). Compared to the comparison group, the COMPUGIRL participants had higher scores in possible academic self-confidence and operating system use--scores that increased over time. However, the Internet use confidence measure was a significantly higher value for the comparison group over time.

Possible Selves (PS): F (1, 162) = 5.08, $p<.05$
CILM Internet confidence: F (1, 161) = 58.2, $p<.001$
CILM Ops Sys Use: F (1, 162) = 15.93, $p<.001$



A significant group main effect indicated that COMPUGIRLS tended to have greater academic self-concept and operating system confidence scores than the comparison group. The increase in average score between Time 1 and Time 4 was also significant for operating system use (p<.001).

ASDQ-SC: F (1, 162) = 7.38, $p<.05$
CILM Ops Sys Use: F (1, 162) = 15.93, $p<.001$

Discussion

The participants of the COMPUGIRLS participants did enter the program with less exposure to and confidence in their use of computers. The participants, however, did have strong stable self-concepts—that is, in general, they thought of themselves as strong capable girls. They did lack exposure to technology, however. Over the course of their participation in COMPUGIRLS, their technological self-concept grew, as did their academic self-concept, and their academic possible selves. The change in these scores was significantly greater than any change in the comparison group. This indicates that the participants' structured engagement with technology was significantly more than the girls' peers across the same period of time. Although, still less confident than their peers about their skills in working with the internet – the students' understanding of the selves in technology contexts did improve. We infer that students who lack exposure to technology and therefore lack confidence in their use of technology, can in a fairly short period of time, change how they see the role of technology in their own lives, and can develop a strong and healthy technological self-concept.

Our findings encourage three suggestions related to motivation, culturally relevant practices, and approaches to widening the pipeline for underrepresented girls.

Suggestion #1: Lack of exposure to mastery experiences and digital media do not necessarily translate into participants' self-concept as technophobic. Digital media enrichment programs may do well to initiate their efforts understanding that the populations they wish to serve do not necessarily see themselves as technologically or academically disadvantaged. The more immersed COMPUGIRLS became in the program and the more they interacted with technology they may have realized how much more they needed to learn. Interestingly, if this is the case, it did not affect their self-concept along other lines. Program developers need to consider that not knowing a concept may not deter such individuals but pique their interests in other areas.

Suggestion #2: In fact, curricula should draw on the participants' cultural knowledge positioning it as an asset seamlessly integrated into lessons. This requires a considerable amount of training for teachers and guidance for participants, as the approach is antithetical to most formal learning environments. Additionally, the lack of equal confidence in working with the Internet does not seem to depress the burgeoning confidence of seeing themselves as capable in other areas. For individuals in general, our self-concept includes how we perceive our identities over time and contexts. Elsewhere, we discuss how race, social class, and gender are significant features that shape identities for girls of color. Self-concept is fluid and mutable and culturally influenced. Capitalizing on this approach seems paramount.

Suggestion #3: Approaches need to be interdisciplinary. Combing educational psychology with concepts from social science (e.g. culturally relevant practices) provides much needed space for new approaches such as culturally relevant computing (Gilbert et al., 2009). Greater collaborations among researchers and practitioners need to be made when developing enrichment programs. Room needs to be left for modifications where participants' voices included in authentic ways.

Follow-up work should explore how these results change over time. Particularly after the sixth course when participants engage in a summer internship and apply their research and technology skills in a work setting, a longitudinal study could examine how their self-concepts develop in different contexts and the potential impact it may have on their selection of college majors.

In sum, COMPUGIRLS' participants may not have as much exposure to culturally relevant digital media but they are motivated and willing to engage in such a program even with limited understanding. Without sustained opportunity to a culturally relevant computing experience, we fear that the technology workforce will remain limited. Offering a culturally relevant computing experience seems to hold promise for diversifying the pipeline for how can one construct an idea of the future without identifying present possibilities?

References

Everett, A. (2009). *Digital diaspora: A race for cyberspace.* Albany: SUNY Press.

Gilbert, J.E., Eugene, W., Arbuthnot, K., Hood, S., Grant, M.M., West, M.L. & Swanier, C. (2009) Culturally Relevant Game Design: A Case Study for Designing Interactive Algebra Lessons for Urban Youth. *i-manager's Journal of Educational Technology,* 5,3, pp. 54-60

Goode, J. (2007) If you build teachers, will students come? The role of teachers in broadening computer science learning for urban youth. *Journal of Educational Computing Research, 36*(1) 65-88.

Howard, T. C. (2003). Culturally relevant pedagogy: Ingredients for critical teacher reflection. *Theory into Practice, 42*(3), 195-202.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal, 32*(3), 465-491.

Margolis, J., Estrella, R., Goode, J., Holme, J., Nao, K., (2008) *Stuck in the Shallow End: Education, Race and Computing,* Cambridge, MA: MIT Press.

Marsh, H. W., & Craven, R. G. (2006). Reciprocal effects of self-concept and performance from a multidimensional perspective: Beyond seductive pleasure and unidimensional perspectives. *Perspectives on Psychological Science, 1*(2), 133-163.

Marsh, H. W., Gerlach, E., Trautwein, U., Lüdtke, O., & Brettschneider, W.-D. (2007). Longitudinal study of preadolescent sport self-concept and performance: Reciprocal effects and causal ordering. *Child Development, 78*(6), 1640-1656.

Marsh, H. W., Tracey, D. K., & Craven, R. G. (2006). Multidimensional Self-Concept Structure for Preadolescents With Mild Intellectual Disabilities: A Hybrid Multigroup-MIMC Approach to Factorial Invariance and Latent Mean Differences. *Educational and Psychological Measurement, 66*(5), 795-818.

Marsh, H. W., Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2006). Integration of Multidimensional Self-Concept and Core Personality Constructs: Construct Validation and Relations to Well-Being and Achievement. *Journal of Personality, 74*(2), 403-456.

Monroe, B. (2004). *Crossing the digital divide*. New York: Teachers College Press.

Oyserman, D., Brickman, D., & Rhodes, M. (2007). School success, possible selves, and parent school involvement. *Family Relations, 56*(5), 479-489.

Oyserman, D., & Fryberg, S. (2006). The Possible Selves of Diverse Adolescents: Content and Function Across Gender, Race and National Origin *Possible selves: Theory, research and applications.* (pp. 17-39): Hauppauge, NY, US: Nova Science Publishers.

Oyserman, D., & James, L. (2009). Possible selves: From content to process *Handbook of imagination and mental simulation.* (pp. 373-394): New York, NY, US: Psychology Press.

Scott, K.A., Aist, G., Hood, D. (2009). COMPUGIRLS: Designing a culturally relevant technology program. *Educational Technology, 6*, 34-39.

Scott, K.A., Clark, K., Hayes, E., Mruczek, C., Sheridan, K. (2010). Culturally relevant computing programs: Two examples to inform teacher professional development. In D. Gibson & B. Dodge (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2010* (pp. 1269-1277). Chesapeake, VA: AACE.

Turner, J. E., & Schallert, D. L. (2001). Expectancy-value relationships of shame reactions and shame resiliency. *Journal of Educational Psychology, 93*(2), 320-329.

Solorzano, D. G. (1991). Mobility aspirations among racial minorities, controlling for SES. *Sociology & Social Research*, 75(4), 182.

Usher, E. L., & Pajares, F. (2006). Sources of academic and self-regulatory efficacy beliefs of entering middle school students. *Contemporary Educational Psychology, 31*(2), 125-141.

Valencia, R. R. (1997). *The evolution of deficit thinking: Educational thought and practice. The Stanford series on education and public policy* Falmer Press, Taylor & Francis Inc.

Van Calster, K., Lens, W., & Nuttin, J. R. (1987). Affective attitude toward the personal future: Impact on motivation in high school boys. *American Journal of Psychology, 100*(1), 1-13.