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Abstract

Proponents of the Maker Movement encourage young people to actively engage in the process of learning using constructionist principles. A local nonprofit organization, Pixel Arts, creates model makerspaces at local schools and in local libraries. Pixel Arts particularly aims to nurture at-risk youths' non-cognitive learning skills. The purpose of this research is to evaluate the effectiveness of one Pixel Arts program. Given their unique curricular structure, it was hypothesized that Pixel Arts' nine-week after-school camp would more likely enhance students' self-efficacy, motivation, and metacognition than a comparable after-school program. In total, forty-two middle school students completed pre-test surveys; twenty-seven middle school students completed post-test surveys. Between-subjects and within-subjects comparisons showed no changes in non-cognitive learning skills. However, post-hoc analyses revealed while Pixel Arts students with autonomous reasons for joining scored almost significantly higher on pre-test self-efficacy and metacognition, camp-goers with controlled reasons for joining caught-up to their intrinsically-inclined peers at post-test. Altogether, qualitative responses indicated youth are meeting Pixel Art's directives by translating their love of gaming into opportunities for cultivating STEM educational initiatives. Future research should continue improving measures of students' reasons for joining, as well as case studies and statistical norms.

Keywords: game education, constructionism, makerspace, self-efficacy, motivation, metacognition

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Repairing the Leaky Pipeline

In his *Educate to Innovate* campaign, President Obama implored both researchers and educators alike to "think about new and creative ways to engage young people in science and in engineering, whether it's science festivals, robotics competitions," or even, "fairs that encourage young people to create and build and invent." The call was to encourage youth "to be *makers* of things, not just *consumers* of things" (e.g., Sheridan, Halverson, Litts, Brahms, Jacobs-Priebe, & Owens, 2014). This call contrasts sharply with the longstanding emphasis on high-stakes testing and the "language of learning" (Petrich, Wilkinson, & Bevan, 2013) that follows from it. The language of learning here is one that centers on leaders' abilities to reproduce fragmented information (i.e., misplaced facts) without necessarily assessing students' mastery in subjects (Petrich et al., 2013).

It is clear this standardized approach or language of learning reinforces an ideology that educators ought to teach to a systematized test. Though, despite the stated intent of such high-stakes testing atmospheres, many students are unfortunately left behind. In particular, students are oftentimes disenfranchised by socioeconomic status (SES) and/or by gender biases (e.g., stereotypes). For example, many minority learners have less access to advanced placement courses. Here, course accessibility problems foreshadow a possible future segregated by confidence in certain academic spaces (Bidwell, 2015). In tandem, displaced confidence stymies student involvement in extracurricular activities. Particularly, disadvantaged youth are less likely to sign up for after-school programs, and when in attendance, are more likely to drop out of after-school programs (Berry & LaVelle, 2013).

It could also be said a gender divide (Buchholz, Shively, Peppler, & Wohlwend, 2014) generates disparities for female students too. Most notably, females are subjected to stereotype threats in conventionally masculine fields (e.g., “girls are bad at math” or “programming”; Good, Rattan, & Dweck, 2012). Stereotypes present major repercussions for girls: women earned only 24% of doctoral degrees in mathematics and just 17% of doctoral degrees in engineering during 2003 (National Science Foundation, 2006). In addition, women continue to see no employment growth within these disciplines. In 2014, only 1 in 7 engineers are female and little more than 25% of computer scientists are women (Parke, 2014).

In this way, underserved students are becoming proverbial “leaks” in the “scientific pipeline” when they transition from education to employment (Hernandez, Woodcock, Shultz, Estrada, & Chance, 2013). It is likewise clear these “leaks” are generating a demographic (e.g., SES, gender) achievement gap: science, technology, engineering, or mathematics (STEM) workers are predominantly male, white (e.g., “white male nerd dominance”; Halverson & Sheridan, 2014), and from a higher SES background (Trivedi, 2014). In order to increase integrative integrity, researchers and educators must ultimately find better methods of engaging such youth in STEM early on.

Serendipitously, a solution to this problem exists. In the United States we are experiencing a rise in what is being called the “Maker Movement,” which presents us with an opportunity to address the inequalities just discussed. This movement partly seeks to bring “making” into K-12 education (Martin, 2015). It was during the mid-2000s in the San Francisco Bay area that the movement germinated from a “do-it-yourself” culture to a national agenda by the inspired work of Dale Dougherty, the founder of *MAKE* magazine (Brady, Salas, Nuriddin, Rodgers, & Subramaniam, 2014). In this context, “do-it-yourselfers” or “makers” react to disposable, pre-fabricated consumerism; enabling folks to produce physical or digital artifacts through tinkering, hacking, designing, or inventing (Bevan, Gutwill, Petrich, & Karen, 2014; Halverson & Sheridan, 2014). The movement aims to transform local communities and schools therein.

In divergence from a traditional standardization (“language”) of education, the maker does not aim to reproduce fragmented facts from a dated textbook. Rather, the maker strives to actively participate in the process of learning by making. Importantly, these making activities are multidisciplinary, ranging from digital design (e.g., building a robot with simple materials; e.g., Brady et al., 2014) to traditional art (e.g., sketching trading card characters) or music composition (e.g., programming songs on open-source software; Sheridan et al., 2014). More often than not, makers’ nontraditional pedagogy (e.g., building robots and so forth) operates within an educational philosophy framework and illustrates the aims of *constructionism.*

Building Knowledge: Constructionism

The broad notion of *constructivism* can be confused with constructionism. Put plainly, constructivism and constructionism share a root commonality: *construct*. That said, constructivists study how mental representations on the individual level are formed. Constructivists scrutinize “the learner’s contribution[s] to meaning” and furthermore, “learning through both individual and social activity” (Bruning, Schraw, & Ronning, 1999 as cited in Woolfolk, 2004). It is sometimes simplified as the phrase “learning-by-doing” (Halverson & Sheridan, 2014; Reder, Anderson, & Simon, 1996; Sheridan et al., 2014). As such, constructionists observe the way public knowledge in disciplines like STEM is materialized through everyday or common beliefs.

This is not a new idea. Many years ago, developmental psychologist Lev Vygotsky described knowledge as a manifestation of social experience with the outside world (Woolfolk, 2004). It is organized (or again, constructed) based on our prior knowledge or personal beliefs. To rephrase, researchers Papert and Harel (1991) suggest constructionism raises important issues concerning how students ought to "construct" knowledge. In particular, they articulate how information is both constructed and reconstructed through internal (mental) and through external (environmental) means (Papert & Harel, 1991).

Henceforth, constructionists like Vygotsky recommend embedding learning in relevant environments that reflect real situations (i.e., *situated learning*), or comparably, real problems (i.e., *problem-based learning*). Doing this encourages student leaners to have a stake in the educational process by helping them see relevance (Woolfolk, 2004). This aim of constructionist theory is embraced by makers and is clearly apparent in *makerspaces* (e.g., Brady et al., 2014; Dougherty, 2013; Halverson & Sheridan, 2014; Sheridan et al., 2014). In general, makerspaces are informal "spaces" (e.g., classrooms, libraries, or museums) borrowed for creative exploration and for technical development (Sheridan et al., 2014). It is evident that makerspaces also orchestrate situated or problem-based learning as well. In point of fact, students in makerspaces adopt scientific or artistic methods using deliberate practice: defining problems and designing solutions (e.g., building prototypes, testing inventions, and revising creations; Martin, 2015).

It is in these makerspaces that student learners can collaborate with peers and with adult volunteers or field experts to *appropriate* (e.g., internalize; Woolfolk, 2004) modeled skills and to test these ideas with their hands (Petrich et al., 2013). Such tactical engagement – the act of using our hands to experience the world – serves as an example of the *embodied cognition* perspective in context. Embodied cognition refers to the complex interaction between brain, body, and physical universe (Abrahamson et al., 2012; Leduc-Mills, 2013). The complexity of such interaction is observed in daily routines, handwriting serves as a notable example (e.g., taking notes, outlining lists, etc.). Handwriting necessitates precise geometric movements, which "links" our "mind[s] and hand[s]" (Keim, 2013). In short, this "linkage" is a form of embodiment established both because handwriting is a visual activity (i.e., interpreting written characters) and a motor activity (i.e., producing written characters) – unifying eye and hand (Keim, 2013).

In the theoretical realm of cognitive science, embodied cognition is presented as a replacement paradigm for *information-processing* posed in the late 1960s. Information-processing was centered on a computer metaphor where stimuli (e.g., sights, sounds, or smells) were considered inputs. Inputs had to be temporarily lodged within the "central processing unit" (i.e., working memory) and eventually stored onto the "hard drive" (i.e., long-term memory; Schwartz, 2014a). Thus, emergent terminology like *encoding* and *retrieving* were used to explain how information was "installed" and how information was "obtained" from our organic hard drives (Schwartz, 2014a). In spite of this and as alluded earlier based on constructionist conclusions, the computer metaphor is corporeally isolating. It cannot account for the nuanced relationship between the brain and the body documented (quite literally) by handwriting.

In another attempt to exemplify this compounded notion of embodiment, recent studies conducted by Kontra, Lyons, Fischer, and Beilock (2015) paired physics students to an "action group" or to an "observation group," in which both "groups" studied the difficult concept of angular momentum. In the action group, students tilted a set of wheels to simulate the physical properties of angular momentum. In the observation group, students observed the tilting and the path of a red laser dot on a wall. It was clear students in the action group displayed higher homework grades (12% higher), and additionally, higher quiz grades (7% higher; Kontra et al., 2015). In later replications, neuroimaging scans also revealed students in the action group had greater activation in several brain regions during learning, including: primary motor cortex, somatosensory cortex, and supplementary motor area (Kontra et al., 2015).

Illustrated by these widespread neural activation patterns, tactical engagement or embodiment employs more modalities at encoding (i.e., construction), generating extensive and rich knowledge representations (Abrahamson et al., 2012). In an influential reflection on contemporary learning theory, Gee (2008) calls this *distributed cognition* or *distributed knowledge*. Gee (2008) further applies this concept to, to the surprise of many: videos games. It seems many video games engender some sensation that our bodies and our minds are extending into virtual space (e.g., Gee, 2008). In this way, “gamers” can integrate individual knowledge with situated meanings defined by contexts built into game environments, technologies, and even other players (Barko & Sadley, 2013; Gee, 2008). Such experience is often described as a dynamic interaction called *enactivism*, as it is cognition that arises from an organism acting in an environment (Li & Tsai, 2013).

In fact, using video games as “learning machines” (Ashinoff, 2014) in academic environments serves a common aim as makerspaces. It appears these mediums both have the potential to bridge the divide between “formal” and “informal” learning (Halverson & Sheridan, 2014). In other words, both making and gaming promote opportunities for learners to critically experience, practice, and reflect on ideas in ways not conventionally regarded among educational sectors: inviting students to situate meaningful ideas in relatively low-risk environments. In such “game-based learning environments” (Barko & Sadley, 2013), many students who may have felt removed or disenchanted by school can become interested (or re-interested) in a variety of

STEM disciplines (Mayo, 2009). Ergo, video games serve as routes into STEM fields, and particularly, as entry points into technology disciplines (Sheridan, Clark, & Williams, 2013).

In researchers' continued interests to merge making and gaming, game design programs organized through makerspaces have facilitated high scores on subscales related to self-efficacy (i.e., belief in ability to succeed), interest, and attitude towards STEM (Clark & Sheridan, 2010). In addition, similar undertakings have mediated significant gains in problem-solving skills, like decision-making, through programing and debugging (e.g., troubleshooting) video games (Akcaoglu, 2014). In a unique three-program endeavor, Games (2010) showcased these encouraging outcomes too. Games (2010) used an online multiplayer game called *Gamestar Mechanic*, which was designed to teach students how to think and how to communicate like video game designers. It ultimately permitted students to develop game design principles, to repair dysfunctions, and to create games from scratch (Games, 2010).

As such, one can say that constructionist applications in makerspaces and/or in game designing activities endow student learners with unique opportunities to "learn how to learn" as scientists and engineers learn (Petrich et al., 2013). That is, by participating in such programs, youth can become better learners by virtue of the fact that makerspaces nurture their mindsets about confidence, motivation, and metacognition. When done correctly, the skills youth acquire should generalize to the classroom as well.

Mindset

In the same way meaning can be derived from situations, meaning can also be interpreted based on how our perceptions of ability and success are labeled. In fact, whether educators "praise for intelligence" (i.e., *person praise*) or "praise for effort" (i.e., *process praise*) impacts students' self- and performance- judgments (Mueller & Dweck, 1998). It is clear "praise for intelligence” encourages students to adopt *performance goal orientations,* wherein students act to appear smart and to avoid risk that might threaten a “smart perception” (e.g., refusing to challenge themselves in potentially unfamiliar situations where failure is a possibility; Dweck, 2007; Mueller & Dweck, 1998). In contrast, “praise for effort” leads students to attribute their performance to hard work, rather than a fixed trait (Dweck, 2007; Mueller & Dweck, 1998). Students praised for intelligence develop a *fixed mindset*, whereas students praised for effort develop a *growth mindset* (Mueller & Dweck, 1998).

In the domain of game design programs (e.g., makerspaces), growth mindsets are often referred to as *maker mindsets* (Dougherty, 2013; Martin, 2015). The proponents of maker mindsets champion experimental play (e.g., deliberate practice), muscle-like understanding of intelligence (i.e., adaptive learning patterns), failure-positivity (i.e., celebration of failure), and collaboration (i.e., exchanging information or feedback; Martin, 2015). In particular, collaboration brings about *knowledge-building communities* or *communities of practice* (e.g., Halverson & Sheridan, 2014; Reder et al., 1996; Woolfolk, 2004), which provide an audience with whom to share completed work (Martin, 2015).

In point of fact, as adolescents transition through developmental stages of identity formation (e.g., “crises”), such communities become fundamental for shaping their mindsets, and more specifically, their identities as makers (Gee, 2008). Karwowski (2014) recognizes creative personal identity (e.g., maker or maker mindset) as important for generating a creative self-concept, and furthermore, for promoting incremental (i.e., growth) theories of intelligence. In a related study, fixed mindsets correlated negatively with problem-solving, and by contrast, growth mindsets were moderated by fixed mindsets: lower aptitudes for fixed mindsets meant greater self-efficacy during problem-solving (Karwowski, 2014).

Fundamentally, self-efficacy is belief in the ability to succeed. It contributes to growth or to maker mindsets, which may accordingly avert the forewarned confidence divide accelerating structural pipeline problems (e.g., Bidwell, 2015). Despite that, 80% of parents still believe it is *necessary* to praise for intelligence (rather than effort) in order to impart their children with feelings of confidence (Dweck, 2007). In fact, these misguided efforts shed light on why many talented students do not engage in or possess high attrition rates in after-school programs (Berry & LaVelle, 2013). That is, they may be convinced anything less than immediately perfect performance is inadequate, and as the next section will suggest, lack motivation to pursue their more challenging interests or goals.

Motivation

According to *self-determination theory* (SDT), motivation is an "organismic" principle, which is to say that it necessitates the fulfillment of three "psychological needs" to be actualized, namely: (1) autonomy, (2) competence, and (3) relatedness (Ryan & Deci, 2000). When all three are satiated, we are "mobilized" to act at a high level (Ryan & Deci, 2000). Variation in satiation lends to variation in the quality of our actions. In one instance, a person might be mobilized to act because they value an activity. In another instance, a person might be mobilized to act because there is strong external coercion (e.g., grades; Ryan & Deci, 2000). In light of this, the former is called *autonomous motivation*; the latter is called *controlled motivation* (Ryan & Deci, 2000).

In thinking about motivation from an organismic perspective like this, controlled motivation may transition into autonomous motivation on a dimensional scale, ranging from: *external regulation* (i.e., work for reward), *introjected regulation* (i.e., work to avoid anxiety or guilt), *identified regulation* (i.e., work for perceived value), and finally, *integrated regulation* (i.e., work to enhance self concept; Ryan & Deci, 2000). It ought to be stated, however, sometimes a person might not be mobilized to act at all, or *amotivated* (as could be the case with fixed mindsets, addressed above). In the state of amotivation, one can still develop more autonomy over time, or similarly, over the course of need-fulfillment. In other words, autonomy is an internally-perceived locus of causality (Ryan & Deci, 2000), which can be developed through awareness and through practice.

In contrast to amotivation or controlled motivation, it is clear “authentic” motivational aims (i.e., autonomous motivation) manifest as enhanced or improved performance, persistence, creativity (e.g., Deci & Ryan, 1991), self-esteem (e.g., Deci & Ryan, 1995), and well-being (e.g., Berry & LaVelle, 2013; Ryan, Deci, & Grolrock, 1995). For example, Berry and LaVelle (2013) discuss how after-school programs can offer opportunities for student choice (i.e., autonomy), relationships with mentors (i.e., relatedness), and self-assurance with activities (i.e., competence). These opportunities enhance program engagement for students who may have joined for *external* reasons (e.g., controlled motivation stemming from parents pressuring children to join).

In turn, whether students join after-school programs for external reasons or for *internal* reasons (e.g., autonomous motivation stemming from youths’ interest in learning more about activities) reinforces their achievement goal orientations (Long, Monoi, Harper, Knoblauch, & Murphy, 2007). In a nutshell, achievement goal orientations include: learning goal orientations (i.e., willingness to master skills necessary for academic tasks), performance goal orientations (i.e., desire to gain favorable judgment from others), or work-avoidant goal orientations (i.e., intention to finish assignments with minimum amount of effort; Long et al., 2007). It is evident the first, learning goal orientations, are a reflection of autonomous motivational efforts, and therefore, optimal.

If student learners are to sustain autonomous motivation, then plainly, cultural and developmental influences (i.e., educational practices) must satisfy the aforementioned psychological needs. Makerspaces and similarly inspired educational programming enable realization of these needs through video gaming, and furthermore, through game designing: microcontrol (Gee, 2008), self-efficacy (e.g., Ashinoff, 2014; Long et al., 2007; Mayo, 2009), and sense of belonging (Good et al., 2012). First, giving students active control over learning experiences (“small-scale control”) is achieved by nature of video gaming where virtual space is manipulated, and additionally, by nature of game designing where virtual space is constructed (Gee, 2008). Second, playing video games provides a steady stream of positive rewards (Mayo, 2009), but further: designing video games lends itself to player feedback (Martin, 2015). Third, such feedback is crucial for establishing strong communities (e.g., knowledge-building communities; communities of practice). In particular, strong communities not only reinforce maker mindsets (Dougherty, 2013), but also, build an audience “with whom to share” (Martin, 2015).

Metacognition

Learning environments that foster mindsets and motivation can also enhance *metacognition*. Metacognition is higher-order knowledge or awareness about our individual cognition (Cetin, Sendurur, & Sendurur, 2014). It can be taught to learners by having students attend to the processes of learning, or put differently, to “self-regulate” (Schwartz, 2014b). Thus, the concept is translated to educational terms as *self-regulated learning* (Zepeda, Richley, Nokes-Malach, & Ronevich, 2015), where students plan (goal identification and ways to achieve the goal), monitor (tracked progress towards the goal) and evaluate (assessment of whether the goal was attained) problems encountered during academic tasks.

Zepeda et al. (2015) designed a “metacognitive instructional intervention” to improve students’ metacognitive knowledge. In a middle school math class, students who received the metacognitive instructional intervention were more likely to adopt mastery goal orientations (i.e., learning goal orientations; e.g., growth mindset; Long et al. 2007) rather than performance goal-orientations (e.g., fixed mindset; Zepeda et al., 2015). In addition, students who did receive instruction outperformed students who did *not* receive instruction on a learning packet, and concomitantly, discovered newfound metacognitive skills transferred to other, novel learning activities unrelated to math (Zepeda et al., 2015).

In computer science disciplines as well, program planning and debugging are major sources of difficulty for students (Cetin et al., 2014). Cetin et al. (2014) found computer science students who received metacognitive training rated higher on measures related to programming achievement than computer science students who had *not* received metacognitive training. In respect to video game programming, students are challenged to be metacognitive or to be reflective about how these games work (Clark & Sheridan, 2010). It seems, as Annetta, Frazier, Folta, Holmes, Lamb, and Cheng (2012) assert, students become engaged in *guided discovery* through game design – monitoring their own thinking, and additionally, revising existing schemata.

In short, the revision process associated with metacognition mediates greater achievement in computer programing (e.g., Cetin et al., 2014), and moreover, in other subjects like mathematics (e.g., Zepeda et al., 2015). It could be said these metacognitive successes are attributed to how skillsets like mindset and motivation are organized in relation to personal experiences. That is to say, metacognition constructs knowledge as something personal. Knowledge becomes networked or associated with different brain regions (e.g., Keim, 2013; Kontra et al., 2015), personalized or contextualized to learners' situated meanings. Henceforth, makerspaces and equivalent programs provide excellent opportunities for learners to practice incorporating the self into the act of learning.

The Present Study: Assessment of Pixel Arts' Effectiveness

The purpose of this study is to evaluate the effectiveness of a model makerspace created and maintained by a nonprofit organization called Pixel Arts. Pixel Arts exhibits a unique pedagogy with urban game camps. In their words, Pixel Arts serves to "bridge digital divides" (akin to the leaky pipeline analogy) by reducing barriers of access to technology education through game creation. It is the goal of Pixel Arts to reach out to aforementioned SES-disadvantaged youth and other disenfranchised minorities (e.g., females) with their after-school programs and also with their intersession camps centered on game design. Here, adult volunteers called "mentors" are industry professionals equipped to teach different game-based activity modules, including: game-logic (e.g., narrative prototyping; i.e., *Twine*), computer programming (e.g., introductory game coding; i.e., *Scratch*), and graphic art (e.g., creating pixelated characters; i.e., *Pixlr*).

In the interest of accommodating this program's aims, mentors are acclimated to the makerspace environment before arriving on site. Mentors attend pre-camp training sessions, which introduce correct conduct in makerspaces and fundamental constructionist concepts through a series of role-playing activities. Role-play topics range from prompting an amotivated student to continue working to supporting an advanced student who has accelerated through material (Kleinknecht, 2015). In either scenario, mentors observe and try to implement positive messages about learned skills. Through training, the mentors become versed in how to establish growth mindset trajectories (e.g., process praise), how to help satiate basic psychological needs required for motivational achievement (e.g., Ryan & Deci, 2000), and how to orchestrate self-regulatory interventions (i.e., metacognition; e.g., Zepeda et al., 2015).

In order to nurture maker mindsets, mentors reinforce individual accomplishments. In other words, mentors praise students' accomplishments as products of hard work, not as products of innate intelligence (e.g., Mueller & Dweck, 1998). In fact, Pixel Arts establishes a community of practice where failure is viewed as a "step forwards" or as a "launch pad" for improvement, and additionally, supported by a collaborative peer network (available to offer feedback or to provide constructive critique). It operates as an environment where, as Sheridan et al. (2014) describes in tandem with a similar community-funded program at Mt. Elliot, students become responsible for teaching or for sharing what they have learned. In the end, this sort of community infrastructure is imperative for overcoming youth-hesitancy in STEM, and concomitantly, valuable for bolstering delicate self-confidence and self-efficacy.

By design, Pixel Arts aims to effectively use video games as instructional tools. Video games produce a higher level of student motivation than more STEM topics because the content piques students' intrinsic interest (Molins-Ruano, Sevilla, Santini, Haya, Rodríguez, & Sacha, 2014). Pixel Arts also sustains youths' motivated attitude through "hands-on" student control of the computer, and by converse, "hands-off" mentor control of the computer (e.g., *guided participation*; Woolfolk, 2004); through "feeding" healthy mindsets (addressed earlier on by means of effort-based praise); and finally, through supporting a powerful, growing community of practice (e.g., Halverson & Sheridan, 2014; Reder et al., 1996) that situates these messages and that catalyzes relatedness (e.g., sense of belonging; Good et al., 2012).

It lastly follows that Pixel Arts seeks to nurture guided discovery by tracking students' metacognitive progress. This is achieved using journals uniquely tailored to their programs. The intent is that youth will complete daily journals or portfolios, inviting them to monitor their own thinking. In order to fit with themes of making, the portfolios are referred to as "keeper journals," which contain prompts regarding: what each student is working on now, what each student worked on prior, and what each student plans to work on next. In general, this process prepares youth for problem-solving in new situations – what might be called *transfer* to cognitive scientists (Evans, Norton, Chang, & Kirby, 2013). It is apparent transfer has important implications for future learning (e.g., Zepeda et al., 2015) by transforming such learning process into something *not wholly* tied to a specific context, but further, to novel possible-future events as well (e.g., Reder et al., 1996).

Program Evaluations of Pixel Arts

Pixel Arts follows empirical practices to assess whether their aims are being met. They intend with each camp session to enhance youths' maker mindsets through nurturing self-efficacy, motivation, and metacognition. Through multiple phases, the assessment processes are continually fine-tuned and improved.

Pixel Arts' original prototype camp documented the ways in which youth developed clearly-stated learning goals, gained confidence in computing skills, increased their interest in game design, and became more comfortable working in a multigenerational environment (e.g., asking peers or adults for help; Kleinknecht, Sens, & Lewis, 2014). Building on that framework, the next phase of assessment has since been reformed and restructured to account for changes from the original prototype camp. In the original prototype camp, the biggest challenge was implementing fidelity in portfolio and in assessment execution (Kleinknecht et al., 2014). That is, many mentors did not see much value in assessment (e.g., daily journaling) as it siphoned time away from activity modules.

To remedy this, portfolios and assessments were updated based on identified needs during the first camps, and further, mentor training was improved using scenarios to directly address program goals (by explicitly describing aims to boost youths' non-cognitive learning experiences; Kleinknecht et al., 2014). This first wave of evaluations included data from eight camps at alternative schools and at local libraries. Here, students' self-efficacy and motivational quality was charted (Kleinknecht, Gilmore, & VanderZanden, 2015). Assessment results suggested that students transitioned away from amotivation, gravitating toward a more internally-perceived manifestation of controlled motivation called integrated regulation (Kleinknecht et al., 2015). In addition, Kleinknecht et al. (2015) also found growth in metacognition for one subset of at-risk youth. Therefore, it seems mentor "buy-in" did much to ameliorate hesitation, resulting in better work documentation and in more favorable learning outcomes.

In this second wave of evaluations, two research pathways have been incorporated into the assessment process: involvement of a comparison group, and additionally, evaluation of non-cognitive differences between repeat students (i.e., youth who have attended a game camp before) and non-repeat students (i.e., youth who have *not* attended a game camp before). The present study evaluates the first pathway, improving pre-post program appraisals via tracking a nine-week after-school venture alongside a comparison group (i.e., book club). By adding a comparison group, we are able to assess whether Pixel Arts' class is more effective at supporting youths' non-cognitive learning skills than another after-school program. We hypothesize that students participating in Pixel Arts' camp will gain greater confidence using technology to design games (mediated by maker mindsets and by subsequent incremental theories of intelligence), achieve increased autonomous motivational quality (intended to inform learning or mastery goal orientations), and develop metacognitive strategies imperative for future learning (e.g., transfer). In other words, Pixel Arts strives to generate “optimal learning experiences” (Evans et al., 2013), where mentors are more likely enforce the mindsets necessary for youths’ development of non-cognitive learning skills (i.e., self-efficacy, motivation, and metacognition) than facilitators in a comparable after-school program.

Method

Participants

In the school district, 77% of youth are reportedly from low-income backgrounds (Oregon Department of Education, 2015a). Notably, the student population is primarily Caucasian (33%), Hispanic American (27%), Asian American (16%), and African American (15%; Oregon Department of Education, 2015a). For this sample, see Figure 1 for self-reported ethnicities from the experimental condition; see Figure 2 for self-reported ethnicities from the comparison condition.

Forty-two middle school students (N = 42; 8 females, 34 males) completed some or all of the pre-test assessment questions at the start of the comparison program (N = 16; 6 females, 10 males) or at the start of the experimental program (N = 26; 2 females, 24 males). The students’ ages averaged 11.88 (0.86) years, with a range of 10-13 years. At the end of these after-school programs, twenty-seven middle school students (N = 27; 2 females, 25 males) completed some or all of the post-test assessment questions in the comparison program (N = 8; 0 females, 8 males) or in the experimental program (N = 19; 2 females, 17 males). Here, the students’ ages averaged 11.78 (0.91) years, with a range of 10-13 years.

In the experimental condition, 10 students reported having previously attended a Pixel Arts after-school program (i.e., repeat students); 14 students reported having *not* previously attended a Pixel Arts after-school program (i.e., non-repeat students). However, 2 students did not specify whether or not they have previously attended a Pixel Arts after-school program.

Materials

The Student Survey. In both conditions, students completed a questionnaire before their programs and after their programs. This questionnaire contains four sections. The four sections are introduced as interests and work habits, self-efficacy, motivation, and metacognition (see Appendix A for a full copy).

Interests and Work Habits. In the first section, youth self-report on demographic information (i.e., gender, age, and ethnicity), on whether they have attended this program before, and on their reasons for joining. Following the work of Berry & LaVelle (2013), the response items used to assess reasons for joining are based on whether students joined the after-school program for autonomous reasons, denoted as *self-joined* (e.g., “I wanted to join”), or conversely: based on whether students joined the after-school program for controlled reasons, denoted as *other-joined* (e.g., “My parents wanted me to join”).

The next four items are open-response questions. These questions prompt students to think about what they most hope to learn while participating in the program, what (if any) aspect of the program makes them nervous, and who they are most comfortable going to for help (e.g., peers, mentors or teachers). The last item further requires youth to complete a sentence regarding long-term goals before the program and after the program (e.g., “When I leave this program, I most want to be able to…”).

Self-Efficacy. The self-efficacy measure is a subscale of the *Manual for Patterns of Adaptive Learning Scales* (PALS; Midgley et al., 2000). PALS includes survey assessments intended for school-aged children ranging from fourth-grade to middle school, operating under the theoretical backdrop of achievement goal orientation theory (e.g., Long et al., 2007). Accordingly, the five items used here tap into students' confidence, for example, efficacy-related statements like "I'm certain I can master the skills taught in this program" are measured on a 5-point scale (1 = *Not at all True* to 5 = *Very True*).

Achievement Motivation. Students' achievement motivation is assessed with a modification of the *Academic Self-Regulation Questionnaire* (SRQ-A; Ryan & Connell, 1989). The SRQ-A includes 32 questions rated on a 4-point scale (1 = *Not at all True* to 4 = *Very True*). It was developed for students in late elementary school and in middle school. The eight items selected here are headed with the question "Why do I work on my classwork?," followed by answers either representative of autonomous motivation (e.g., "Because I want to learn new things") or answers more representative of controlled motivation (e.g., "Because I want the teacher to think I'm a good student").

Metacognition. Students' metacognition is measured using a significantly modified *Metacognitive Awareness Inventory* (MAI; Schraw & Dennison, 1994). The original 52-item MAI was reduced by Craft (2010) to 16 items through selecting those items with the highest factor loadings. Seven from this were adopted here, and revised using the *Flesch-Kincaid Reading Level Index* to accommodate middle and high school literary comprehension (e.g., "I try to use strategies that have worked in the past"), as the unedited MAI was designed for adults. As with the original MAI, the scale for responding is a graphic rating scale numbered zero to one hundred (0 = *Completely False* to 100 = *Completely True*).

Procedure

Student Survey Implementation. Prior to implementation, activity coordinators from the experimental group and from the comparison group agreed to participate in evaluations. In both comparison and experimental conditions, the student surveys were administered at the start (i.e., pre-test) of each program and at the end (i.e., post-test) of each program (after nine weeks). These surveys took between 10 to 20 minutes to complete. Following completion, a researcher explained that students' answers would remain confidential and that results could be made available for those interested.

Coding of Qualitative Student Surveys. In keeping with a mixed-method concurrent triangulation approach (e.g., Creswell, 2009a), the last four questions from the student survey were analyzed separately and qualitatively. This was achieved by initially transcribing qualitative data into a tabular format, followed by independent raters reading through and noting potential patterns in youths' responses (e.g., quality shifts in self-efficacy, motivation or metacognition). To ensure reliability, raters compared their noted patterns. Then, both raters returned back to the dataset to draw examples from agreed-upon patterns (Creswell, 2009b).

Results

In total, the analytic strategy for this program evaluation involved both quantitative data and qualitative data (i.e., qualitative student surveys), based on a mixed-method concurrent triangulation process. The quantitative data incorporated between-subjects analyses to ascertain whether conditions differed from each other at pre-test and at post-test. It also used within-subjects analyses to determine whether students' scores in the experimental condition and whether students' scores in the comparison condition changed from pre-test to post-test. Finally, post-hoc analyses were performed to examine how autonomous or controlled reasons for joining influenced pre-post test scores and to examine how post-test completion influenced pre-test scores.

Descriptive Statistics: Non-Cognitive Learning Profiles, Reasons for Joining, and Skill Correlations

In both the experimental condition (i.e., game camp) and the comparison condition (i.e., book club), students completed pre-tests that measure non-cognitive learning skills: self-efficacy (M = 4.26, SD = 0.60), controlled motivation (M = 2.80, SD = 0.88), autonomous motivation (M = 3.09, SD = 0.56), and metacognition (M = 68.12, SD = 21.23). In addition, these students completed post-tests: self-efficacy (M = 4.28, SD = 0.66), controlled motivation (M = 2.89, SD = 0.66), autonomous motivation (M = 3.17, SD = 0.64), and metacognition (M = 62.41, SD = 19.85).

In regard to whether students were self-joined or whether students were other-joined, see Figure 3 to view reasons for joining in the experimental condition, and also, reasons for joining in the comparison condition. Likewise, see Table 1 for correlations between non-cognitive learning skill scales: self-efficacy, controlled motivation, autonomous motivation, and metacognition. For pre-test measures, self-efficacy and metacognition [$r(37) = 0.34$, $p < 0.05$]; self-efficacy and autonomous motivation [$r(40) = 0.37$, $p < 0.05$]; and metacognition and autonomous motivation [$r(37) = 0.40$, $p < 0.01$] were significantly correlated. For post-test measures, only self-efficacy and metacognition [$r(26) = 0.43$, $p < 0.05$] were significantly correlated.

Inferential Statistics: Youths' Non-Cognitive Skills as a Function of After-School Program

Between-Group Comparisons: Did Youth Differ at the Start of the Programs? A one-way between-subjects ANOVA found students in the experimental condition did not significantly differ from students in the comparison condition on pre-test measures of self-efficacy [$F(1,40) = 0.04$, $p = 0.84$], controlled motivation [$F(1,39) = 1.74$, $p = 0.20$], autonomous motivation [$F(1,38) = 0.78$, $p = 0.39$], or metacognition [$F(1,35) = 0.23$, $p = 0.63$]. This means that students in the experimental condition and students in the comparison condition started their respective after-school programs with similar, baseline non-cognitive learning skills. The means and standard deviations for each condition are displayed in Table 2.

Between-Group Comparisons: Did Youth Differ at the End of the Programs? A one-way between-subjects ANOVA found students in the experimental condition did not significantly differ from students in the comparison condition on post-test measures of self-efficacy [$F(1,24) = 0.89$, $p = 0.35$], controlled motivation [$F(1,24) = 1.89$, $p = 0.18$], autonomous motivation [$F(1,25) = 1.22$, $p = 0.28$], or metacognition [$F(1,24) = 1.87$, $p = 0.19$]. This means that students in the experimental condition and students in the comparison condition ended their respective after-school programs with similar non-cognitive learning skills. The means and standard deviations for each condition are displayed in Table 3.

Within-Group Comparisons: Did Game Camp Students' Skillsets Change from Pre-Test to Post-Test? In the experimental condition, a within-subjects paired-samples *t*-test found no significant changes from pre-test to post-test for self-efficacy [$t(14) = 0.41$, $p = 0.69$], controlled motivation [$t(14) = -0.49$, $p = 0.63$], autonomous motivation [$t(14) = -0.41$, $p = 0.69$], or metacognition [$t(13) = 0.37$, $p = 0.71$]. It seems students in the experimental condition did not change their learning skillset profiles over the course of this after-school program. The means and standard deviations for the experimental condition are displayed in Table 4.

Post-Hoc Analysis: Game Camp Students' Reasons for Joining and Pre-Test Learning Skills. A one-way between-subjects ANOVA found students in the experimental condition with autonomous reasons for joining scored slightly higher on pre-test measures of self-efficacy [$F(1,22) = 3.06$, $p = 0.09$] and metacognition [$F(1,21) = 3.25$, $p = 0.09$] than students in the experimental condition with controlled reasons for joining. However, the students with autonomous reasons for joining did not significantly differ from the students with controlled reasons for joining on pre-test measures of controlled motivation [$F(1,22) = 0.17$, $p = 0.68$] or autonomous motivation [$F(1,22) = 0.08$, $p = 0.78$]. The means and standard deviations for students in the experimental condition with self-joined reasons and for students in the experimental condition with other-joined reasons are displayed in Table 5.

Post-Hoc Analysis: Game Camp Students' Reasons for Joining and Post-Test Learning Skills. A one-way between-subjects ANOVA found students in the experimental condition with controlled reasons for joining did not significantly differ from students in the experimental condition with autonomous reasons for joining on post-test measures of self-efficacy [$F(1,13) = 0.16$, $p = 0.70$] and metacognition [$F(1,13) = 0.59$, $p = 0.46$]. This implies students with controlled reasons for joining improved their self-efficacy scores and their metacognition scores, and thus, achieved skills characteristic of students with autonomous reasons for joining. As with before, the students with controlled reasons for joining did not significantly differ from students with autonomous reasons for joining on post-test measures of controlled motivation [$F(1,13) = 0.12$, $p = 0.73$] or autonomous motivation [$F(1,13) = 0.10$, $p = 0.76$]. However, both sets of students did not necessarily strengthen their controlled or autonomous motivational qualities. The means and standard deviations for students in the experimental condition with self-joined reasons and for students in the experimental condition with other-joined reasons are displayed in Table 6.

Within-Group Comparisons: Did Book Club Students' Skillsets Change from Pre-Test to Post-Test? In the comparison condition, a within-subjects paired-samples *t*-test found no significant changes from pre-test to post-test for self-efficacy [$t(5) = 0.42$, $p = 0.70$], controlled motivation [$t(6) = -0.69$, $p = 0.52$], autonomous motivation [$t(6) = -0.93$, $p = 0.39$], or metacognition [$t(4) = 0.99$, $p = 0.38$]. It seems students in the comparison condition did not change their learning skillset profiles over the course of this after-school program. The means and standard deviations for the comparison condition are displayed in Table 7.

Post-Hoc Analysis: Post-Test Completion and Pre-Test Learning Skills. Further, post-hoc analyses were explored to determine if students who did complete the post-test differed in their pre-test scores compared to students who did *not* complete the post-test. A one-way between-subjects ANOVA found students who did complete the post-test were not significantly different in their pre-test scores when compared to students who did not complete the post-test: self-efficacy [$F(1,40) = 2.48$, $p = 0.12$], controlled motivation [$F(1,39) = 0.02$, $p = 0.90$], autonomous motivation [$F(1,38) = 0.13$, $p = 0.72$], or metacognition [$F(1,35) = 0.49$, $p = 0.49$]. Thus, there were no differences in learning skills between those who did complete the post-test and those who did not complete the post-test. The means and standard deviations for students who did complete the post-test and for students who did not complete the post-test are displayed in Table 8.

Qualitative Student Survey

Broadly speaking, the qualitative survey questions revealed three major trends. In particular, youth felt motivated to continue learning and improving their skills, were undeterred by mistakes (e.g., "failing forward"), and were comfortable seeking support in a variety of ways (with peers or with adult mentors). Fundamentally, these patterns suggest students translated their intrinsic video game interests into newfound technical abilities that foster STEM educational initiatives.

In regard to what students hoped to learn while participating in the program, most camp-goers initially described making games (e.g., “How to make games”) and learning to program (e.g., “To program better than before”). In post-test responses, students supplemented their original ambitions with more realistic expectations, specifically in regard to coding (e.g., “I wanted to learn programming, [but] there are still a few kinks”). It would seem youth engaged in self-regulated learning by evaluating more plausible plans for achieving long-term game design aspirations. In other words, youth displayed some metacognitive awareness – although youth did not specify what “kinks” hindered their original ambitions.

Further, this awareness was echoed by students’ self-reported learning goals. The students’ pre-test learning goals included: understanding how to program and understanding how to create games (e.g., “[I want to] make games and successfully program [them] to work”). In time, these students developed more specific and more attainable learning goals (e.g., “[I want to] program a simple game”). Notably, youth also wanted to continue learning and to continue pursuing such goals (e.g., “[I am going to] finish a game”; e.g., “[I am going to] make my own games at home”).

In these learning pursuits, students were either not nervous about the program, or unfortunately, were concerned about “messing-up” from the get-go. In contrast, post-test responses were characterized by a general lack of worry. It might be inferred that students’ fears concerning failure were lessened through a supportive community of practice, which embraces learning with trial-and-error experimentation.

In this community of practice, however, students' comfort levels when working with either peers or adult mentors did not change drastically from pre-test to post-test. It remained relatively stable. In fact, 16 of 26 students (61.53%) reported feeling comfortable when working with either peers or adult mentors at pre-test, and beyond this, 11 of 19 students (57.89%) reported still feeling comfortable when working with either peers or adult mentors at post-test. Thus, learners were consistently apt to request help from multi-generational support groups (from each other or from volunteers).

Discussion

In contrast to past program evaluations (e.g., Kleinknecht et al., 2014; Kleinknecht et al., 2015), at first blush, students who attended this particular after-school camp did not show significant improvement on the quantitative indicators of non-cognitive learning skills after nine weeks (see Figure 4), nor did they differ compared to their peers in the comparison program (see Figure 5). At a glance, this contradicts previous research, which suggests participating in "maker-based programs" contributes to growth mindsets (e.g., Dougherty, 2013; Martin, 2015) and to increased scores on measures of self-efficacy (e.g., Clark & Sheridan, 2010). However, the qualitative indicators *are* consistent with the literature, for example, youth still reported on open-response questions: engagement in learning (e.g., Li & Tsai, 2013), enthusiasm to explore STEM-oriented activities (e.g., Clark & Sheridan, 2010), and comfort working within a community of practice that reinforces learning through collaboration and through leadership (e.g., Sheridan et al., 2014).

Furthermore, youth in the experimental condition started and ended the after-school program with relatively high self-efficacy, with moderate autonomous and controlled motivation (i.e., identified regulation or integrated regulation), and with moderate metacognition (see Figure

4). Most notably, students with autonomous reasons for joining initially possessed greater self-efficacy scores and metacognition scores than students with controlled reasons for joining (see Figure 6). In the end, students with controlled reasons for joining caught-up to their intrinsically-inclined peers. Thus, other-joined students did appear to gain self-efficacy and metacognitive strategies as well (see Figure 7).

Moreover, lack of significant or even mild changes in students' autonomous or controlled motivations as a function of reasons for joining demonstrates how their motivations for attending after-school programs do not necessarily align with their motivations for doing schoolwork. In fact, schools may not be satiating youths' basic psychological needs (Ryan & Deci, 2000). These needs, characteristically found throughout makerspace camps (e.g., Good et al., 2012; Halverson & Sheridan, 2014; Reder et al., 1996), are essential for producing autonomously motivated students. If unaccounted for, then students may not feel inclined to engage in classroom material. Though, despite disengagement in traditional curricular design (e.g., teaching to a systematized test), youth were overwhelmingly autonomously motivated to take part in constructionist curricular design built around making games (see Figure 3).

Limitations

Regardless of motivation, all students entered the game camp with healthy learning skills and left the game camp with healthy – if not, then slightly refined – learning skills. This kind of ceiling effect might be attributed to the school where both experimental and comparison programs were held. In particular, on-campus social support advisors already reinforce metacognitive strategies to an extent. However, there is a large degree of variability in terms of how these strategies are implemented.

It is also possible that sample representativeness, among other factors, was a limitation. Aside from ceiling effects, the sample may not adequately represent the kinds of populations that Pixel Arts typically extends help towards. Pixel Arts tries to reach underserved, and by the same token, low-income youth. However, while the student population that comprised both the experimental group and the comparison group were 77% likely to be economically disadvantaged, Pixel Arts reaches out to another alternative program where student populations are 95% likely to be economically disadvantaged (Oregon Department of Education, 2015a, 2015b). It could be this 21% difference implies that the youth in this sample are not as “high need” as the youth in other Pixel Arts programs.

Similarly, the camp population featured more male students than female students. There are still gender disparities that bar young girls access into STEM (e.g., Buchholz et al., 2014), further evidencing deep-seated brokenness in the "scientific pipeline" (Hernandez et al., 2013). Regrettably, remedying this asymmetrical STEM landscape is an ongoing and interdisciplinary undertaking that cannot be fully addressed here. Put succinctly, while girls were underrepresented in this sample, female youth have historically been marginalized in these so-called masculine fields (Good et al., 2012). In time (having foreseeably vanquished the present-albeit-passé language of learning; Petrich et al., 2013), expanding communities of practice like Pixel Arts may enforce a greater “sense of belonging” for girls (Good et al., 2012).

In addition to sample representativeness, student attrition presented major problems. In the experimental condition, 26 students completed the pre-test questionnaire, but only 19 students completed the post-test questionnaire. In the comparison condition, 16 students completed the pre-test questionnaire, but only a mere 8 students completed the post-test questionnaire. Altogether, 15 students abandoned their after-school programs before completing post-test questionnaires. Here again, student attrition relates to reasons for joining: students with controlled reasons for joining might have been less motivated to complete their programs, and consequently, to finish their post-tests. This inability to shift or to account for other-joined students' motivations suggests a potential type II error.

Likewise, the measure used to ascertain students' reasons for joining (e.g., Berry & LaVelle, 2013) was compromised by sample size. In a handful of cases, some camp-goers would "check" multiple reasons for joining that reflected both autonomous and controlled intentions. It is not unusual for youth to have mixed reasons for joining, however this was not originally accounted for in the measure. Concurrently, not many students indicated solely other-joined reasons either. Thus, raters coded youth who indicated any controlled reasons for joining (despite such students potentially and concomitantly "checking" autonomous reasons for joining) as other-joined. This does not fully capture youths' expansive range of motivations for attending the program.

Future Directions

Ongoing research ought to build on students' reasons for joining. That is to say, mentors could use information about incoming motivational styles to shift students' controlled intentions to autonomous intentions. Mentors might allocate their attention toward satisfying controlled or amotivated camp-goers basic psychological needs. As well, this may be tracked by adding a post-test survey question about students' reasons for *staying* (Berry & LaVelle, 2013). In doing so, there is greater likelihood that extrinsically-inclined youth will not prematurely abandon their programs.

In contrast to students who leave, students who repeatedly return are candidates for longitudinal case studies. It seems case studies that follow repeat students' learning profiles would help characterize the long-term effects of game camps. By tracking changes in youth over longer periods, we might be able to begin establishing normative expectations. Though at present juncture, statistical averages for specific learning skills related to self-efficacy, motivation, and/or metacognition are not currently available for this age demographic. Thereby, future researchers should draw from archived evaluations to coalesce raw data into statistical norms.

Conclusion

This research marks the first program evaluation to recruit a comparison group in order to infer whether youths' non-cognitive improvements were merely products of attending after-school programs, or instead, products of Pixel Arts' maker-based curriculum. By tracking the development of higher-order cognitive processes (Borge, Shimoda, Yan, & Toprani, 2016), this evaluation addresses a lingering question: "it looks like fun, but are they learning?" (Petrich et al., 2013). The answer is highlighted by reasons for joining. Decidedly, students with controlled reasons for joining invigorated their self-efficacy and their self-regulation. This, alongside youths' qualitative remarks, suggests that Pixel Arts works as a means of enhancing learning skills. Pixel Arts is meeting its initiatives to "bridge digital divides" across STEM through game education. In closing, as model makerspaces like Pixel Arts can substantiate, the modern language of learning is evolving; "making" may soon eclipse "teach-to-test" curriculum.

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Appendix A
Student Survey

The Student Survey

Before Your Program Starts:

Before you start engaging in this after school program, we want to know about you as a student. The questions on this survey are about your learning. There are four kinds of question and responses. The survey is in four parts.

- In part one, the questions are about your interests and work habits
- In part two, the questions are about your confidence.
- In part three, the questions are about why you do what you do in the classroom (motivation).
- In part four, the questions are about how you think about learning and studying.

In parts 2-4, the number-scale is different for each part. Please read the scale carefully as you select the best answer for each question.

Please know that it is your choice to answer these questions. We promise that your answers to these questions will be kept private. Only staff will be able to see your answers.

Part 1: About You – Your Interests and Work Habits.

1. Gender: ______________________

2. Age: _________________________

3. How would you describe your family's ethnic background? (check all that apply)
    _____ African American
    _____ Pacific Islander (Hawaiian)
    _____ Asian American
    _____ Native American
    _____ Hispanic/ Latino American
    _____ Caucasian (White)
    _____ Other

4. I have participated in this after school program before:
    __________ YES __________ NO

    If YES is marked, when did you participate before?
    ____

5. Why did you join this program?
_____ My parents wanted me to join.
_____ My friends wanted to join.
_____ My teacher/principal wanted me to join.
_____ I wanted to join.
_____ There was nothing else better to do.

6. What do you most hope to learn while participating in this program?

7. What (if any) aspect of this program makes you nervous?

8. "When I am working on projects, I find that I am more comfortable going to _________ for help if needed."

_____Peers

_____Adult Mentors or Teachers

_____Either Peers or Adults, I am comfortable with both

_____Neither Peers nor Adults, I prefer to keep to myself

9. Please finish this sentence: "*When I leave this program, I most want to be able to* …"

Part 2: Confidence. In this part, you use the numbers on the scale to tell us whether each sentence is true of you. For example, for practice, please circle the number that best matches you:

I'm certain I like strawberry ice cream.

1	2	3	4	5
Not at all True		Somewhat True		Very True

Please circle the numbers that best match how you feel.

1. I'm certain I can master the skills taught in this program.

1	2	3	4	5
Not at all True		Somewhat True		Very True

2. I'm certain I can figure out how to do the most difficult things in this program.

1	2	3	4	5
Not at all True		Somewhat True		Very True

3. I can do almost all the work here if I don't give up.

1	2	3	4	5
Not at all True		Somewhat True		Very True

4. Even if the work is hard, I can learn it.

1	2	3	4	5
Not at all True		Somewhat True		Very True

5. I can do even the hardest work in this program if I try.

1	2	3	4	5
Not at all True		Somewhat True		Very True

Part 3: "Why Do I Work On My Classwork?". In this part, each sentence is an answer to the question "***Why do I work on my classwork?***". You use the numbers on the scale to tell us whether the answers match your feelings. For example, for practice, please respond to this question:

Why do I work on my classwork? **Because if I do, I will get strawberry ice cream.**

1	2	3	4
Not at all True	Not Very True	Sort of True	Very True

6. Why do I work on my classwork? **So that the teacher won't yell at me.**

1	2	3	4
Not at all True	Not Very True	Sort of True	Very True

7. Why do I work on my classwork? **Because I want the teacher to think I'm a good student.**

1	2	3	4
Not at all True	Not Very True	Sort of True	Very True

8. Why do I work on my classwork? **Because I want to learn new things.**

1	2	3	4
Not at all True	Not Very True	Sort of True	Very True

9. Why do I work on my classwork? **Because I'll be ashamed of myself if it didn't get done.**

1	2	3	4
Not at all True	Not Very True	Sort of True	Very True

10. Why do I work on my classwork? **Because it's fun.**

1	2	3	4
Not at all True	Not Very True	Sort of True	Very True

11. Why do I work on my classwork? **Because that's the rule.**

1	2	3	4
Not at all True	Not Very True	Sort of True	Very True

12. Why do I work on my classwork? **Because I enjoy doing my classwork.**

1	2	3	4
Not at all True	Not Very True	Sort of True	Very True

13. Why do I work on my classwork? **Because it's important to me to work on my classwork.**

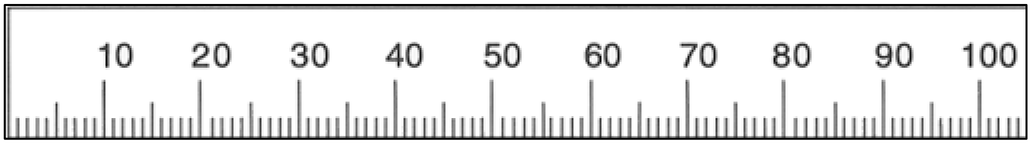
1	2	3	4
Not at all True	Not Very True	Sort of True	Very True

Part 4: Thinking About Learning. In this part, we ask that you answer by marking a spot on the ruler to show whether the statement about learning and studying is true of you. Once you've marked your spot, please put the number in the "score" line.

14. I try to use strategies that have worked in the past.

Score: ______

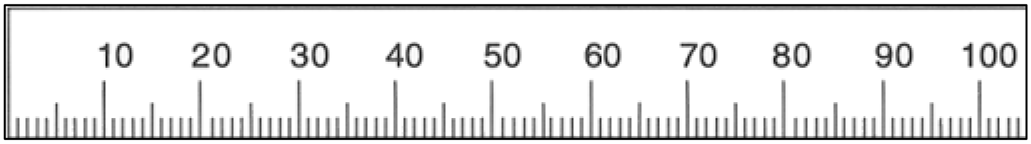
0=Completely False 100=Completely True



15. I understand my strengths and weaknesses in learning.

Score: ______

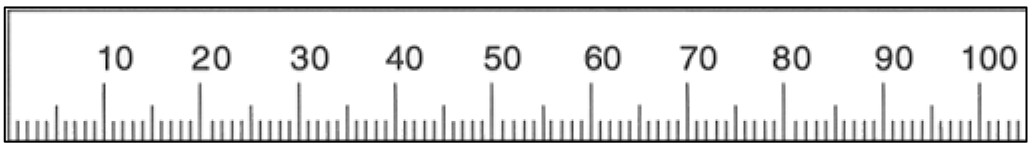
0=Completely False 100=Completely True



16. I think about what I really need to learn before I start to study.

Score: ______

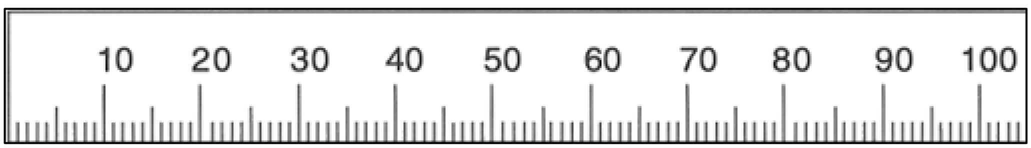
0=Completely False 100=Completely True



17. Before starting to study I ask myself questions about what I have to learn.

Score: ______

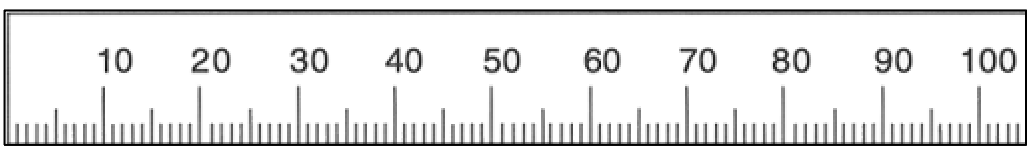
0=Completely False 100=Completely True



18. I think of different ways to do my work and choose the best one.

Score: ______

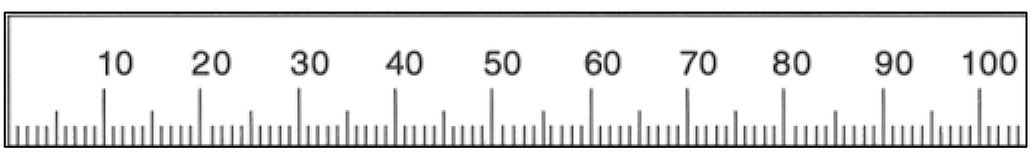
0=Completely False 100=Completely True



19. When I am done with my work I think about what I learned.

Score: ______

0=Completely False 100=Completely True



20. When what I am learning is new, I think about what it means.

Score: ______

0=Completely False 100=Completely True

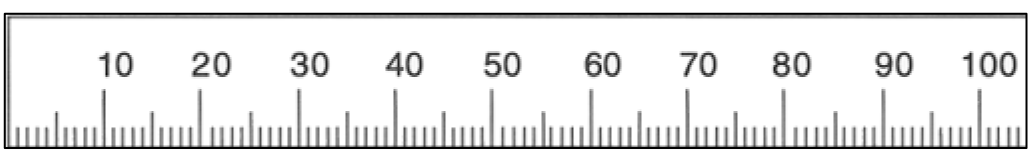


Table 1.

The Correlations Between Self-Efficacy, Controlled Motivation, Autonomous Motivation, and Metacognition for the Pre-Test and for the Post-Test

Learning Skills	Pre-Test			Post-Test		
	N	*r*	*p*	N	*r*	*p*
SE & MC	37	**0.34**	**0.04 ***	26	**0.43**	**0.03 ***
SE & AM	40	**0.37**	**0.02 ***	26	0.21	0.30
SE & CM	41	-0.03	0.83	25	-0.03	0.88
MC & AM	37	**0.40**	**0.01 ****	26	0.36	0.07
MC & CM	37	-0.05	0.78	25	0.02	0.92
AM & CM	40	-0.01	0.95	26	-0.29	0.16

Note. Self-Efficacy (SE); MC (Metacognition); AM (Autonomous Motivation); CM (Controlled Motivation).

***** $p < 0.05$

****** $p < 0.01$

Table 2.

The Means and Standard Deviations of Pre-Test Learning Skills for the Experimental Condition and for the Comparison Condition

	Experimental Condition		Comparison Condition	
Pre-Test Learning Skills	N	*M* (*SD*)	N	*M* (*SD*)
Self-Efficacy	26	4.28 (0.53)	16	4.24 (0.71)
Controlled Motivation	25	2.65 (0.92)	16	3.02 (0.78)
Autonomous Motivation	25	3.02 (0.61)	15	3.19 (0.47)
Metacognition	23	66.80 (22.88)	14	70.30 (18.81)

Table 3.

The Means and Standard Deviations of Post-Test Learning Skills for the Experimental Condition and for the Comparison Condition

	Experimental Condition		Comparison Condition	
Post-Test Learning Skills	N	*M* (*SD*)	N	*M* (*SD*)
Self-Efficacy	19	4.21 (0.62)	7	4.49 (0.76)
Controlled Motivation	18	2.78 (0.67)	8	3.16 (0.60)
Autonomous Motivation	19	3.08 (0.71)	8	3.38 (0.38)
Metacognition	19	59.24 (20.67)	7	71.02 (15.54)

Table 4.

The Means and Standard Deviations of Pre-Post Test Changes in Learning Skills for the Experimental Condition

	Pre-Test		Post-Test	
Learning Skills	N	*M* (*SD*)	N	*M* (*SD*)
Self-Efficacy	15	4.27 (0.53)	15	4.21 (0.65)
Controlled Motivation	15	2.76 (0.92)	15	2.83 (0.68)
Autonomous Motivation	15	3.03 (0.48)	15	3.08 (0.74)
Metacognition	14	62.27 (25.35)	14	59.90 (21.94)

Table 5.

The Means and Standard Deviations of Pre-Test Learning Skills for Students with Autonomous Reasons and for Students with Controlled Reasons in the Experimental Condition

	Autonomous Reasons		Controlled Reasons	
Pre-Test Learning Skills	N	*M* (*SD*)	N	*M* (*SD*)
Self-Efficacy	19	**4.36 (0.51) ***	5	3.92 (0.44)
Controlled Motivation	19	2.67 (0.94)	5	2.47 (0.96)
Autonomous Motivation	19	3.05 (0.59)	5	2.96 (0.82)
Metacognition	18	**71.11 (22.58) ***	5	51.26 (18.07)

***** $p = 0.09$

Table 6.

The Means and Standard Deviations of Post-Test Learning Skills for Students with Autonomous Reasons and for Students with Controlled Reasons in the Experimental Condition

	Autonomous Reasons		Controlled Reasons	
Post-Test Learning Skills	N	*M* (*SD*)	N	*M* (*SD*)
Self-Efficacy	11	4.25 (0.67)	4	4.10 (0.68)
Controlled Motivation	11	2.80 (0.78)	4	2.93 (0.31)
Autonomous Motivation	11	3.05 (0.74)	4	3.19 (0.85)
Metacognition	11	64.31 (25.45)	4	54.25 (6.10)

Table 7.

The Means and Standard Deviations of Pre-Post Test Changes in Learning Skills for the Comparison Condition

	Pre-Test		Post-Test	
Learning Skills	N	*M* (*SD*)	N	*M* (*SD*)
Self-Efficacy	6	4.50 (0.64)	6	4.40 (0.79)
Controlled Motivation	7	3.05 (0.68)	7	3.18 (0.64)
Autonomous Motivation	7	3.17 (0.18)	7	3.29 (0.30)
Metacognition	5	68.77 (14.66)	5	65.06 (14.02)

Table 8.

The Means and Standard Deviations of Differences in Pre-Test Learning Skills Based on Post-Test Completion

	Completed Post-Test		Uncompleted Post-Test	
Pre-Test Learning Skills	N	*M* (*SD*)	N	*M* (*SD*)
Self-Efficacy	19	4.11 (0.61)	23	4.39 (0.56)
Controlled Motivation	18	2.78 (0.94)	23	2.81 (0.85)
Autonomous Motivation	17	3.05 (0.71)	23	3.11 (0.44)
Metacognition	16	70.93 (19.00)	21	65.98 (23.04)

Figure 1.

The Self-Reported Frequencies of Ethnicities for Students in the Experimental Condition

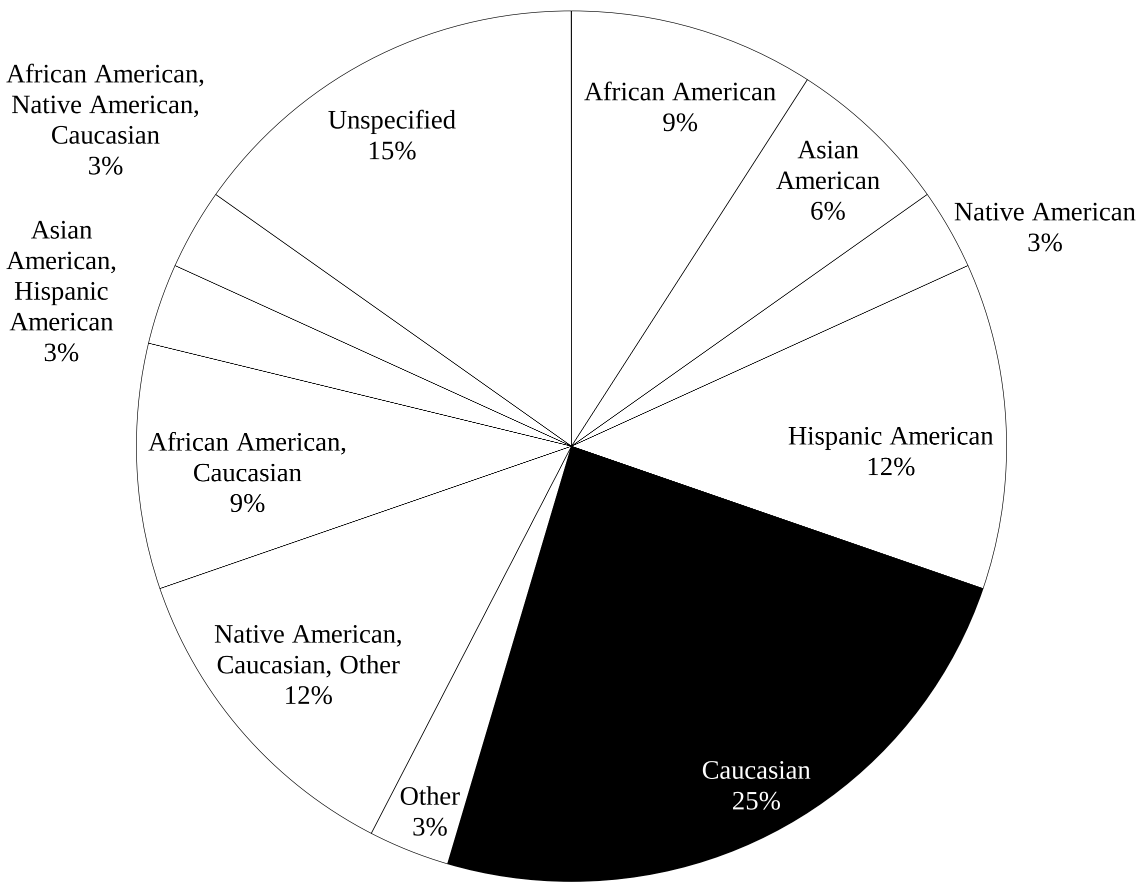


Figure 1. The students in the experimental condition (i.e., game camp) identified as Caucasian (25%); Hispanic American (12%); Native American, Caucasian, or Other (12%); African American (9%); African American or Caucasian (9%); Asian American (6%); African American, Native American, or Caucasian (3%); Asian American or Hispanic American (3%); Native American (3%); and Other (3%). The remaining 15% were unspecified.

Figure 2.

The Self-Reported Frequencies of Ethnicities for Students in the Comparison Condition

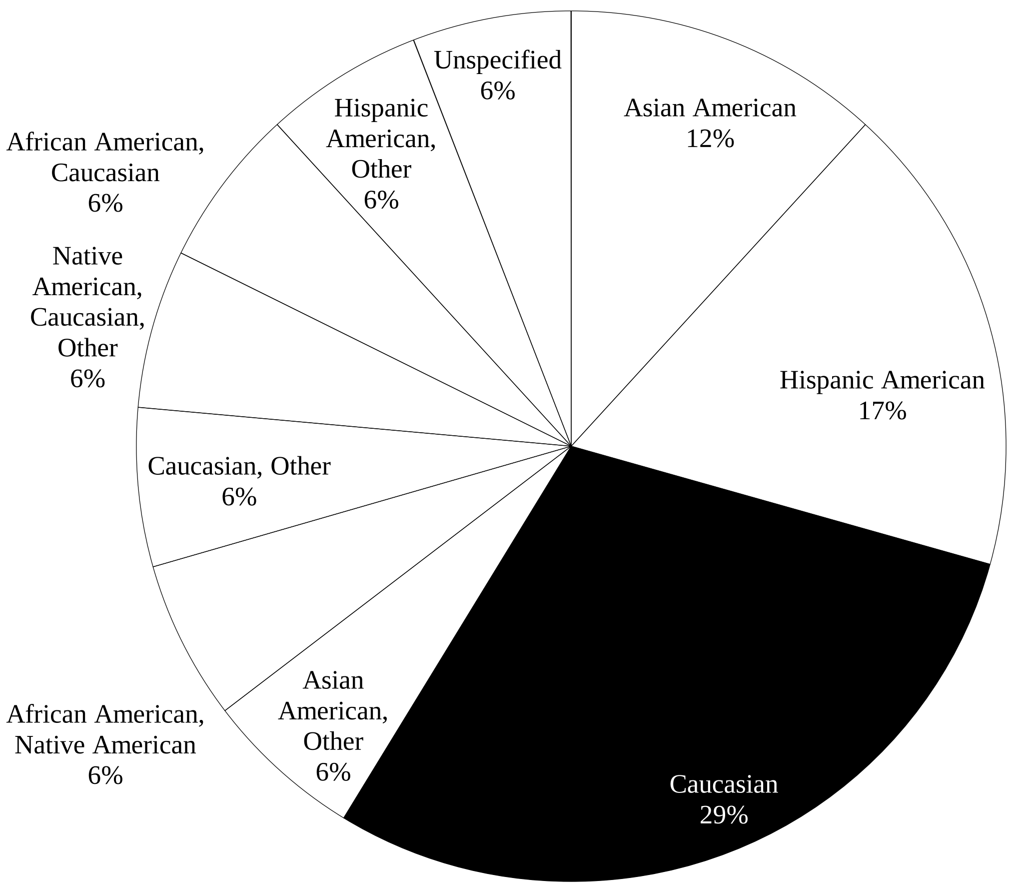


Figure 2. The students in the comparison condition (i.e., book club) identified as Caucasian (29%); Hispanic American (17%); Asian American (12%); African American or Caucasian (6%); African American or Native American (6%); Asian American or Other (6%); Caucasian or Other (6%); Hispanic American or Other (6%); and Native American, Caucasian, or Other (6%). The remaining 6% were unspecified.

Figure 3.

The Frequencies of Autonomous and Controlled Reasons for Joining in the Experimental Condition and in the Comparison Condition

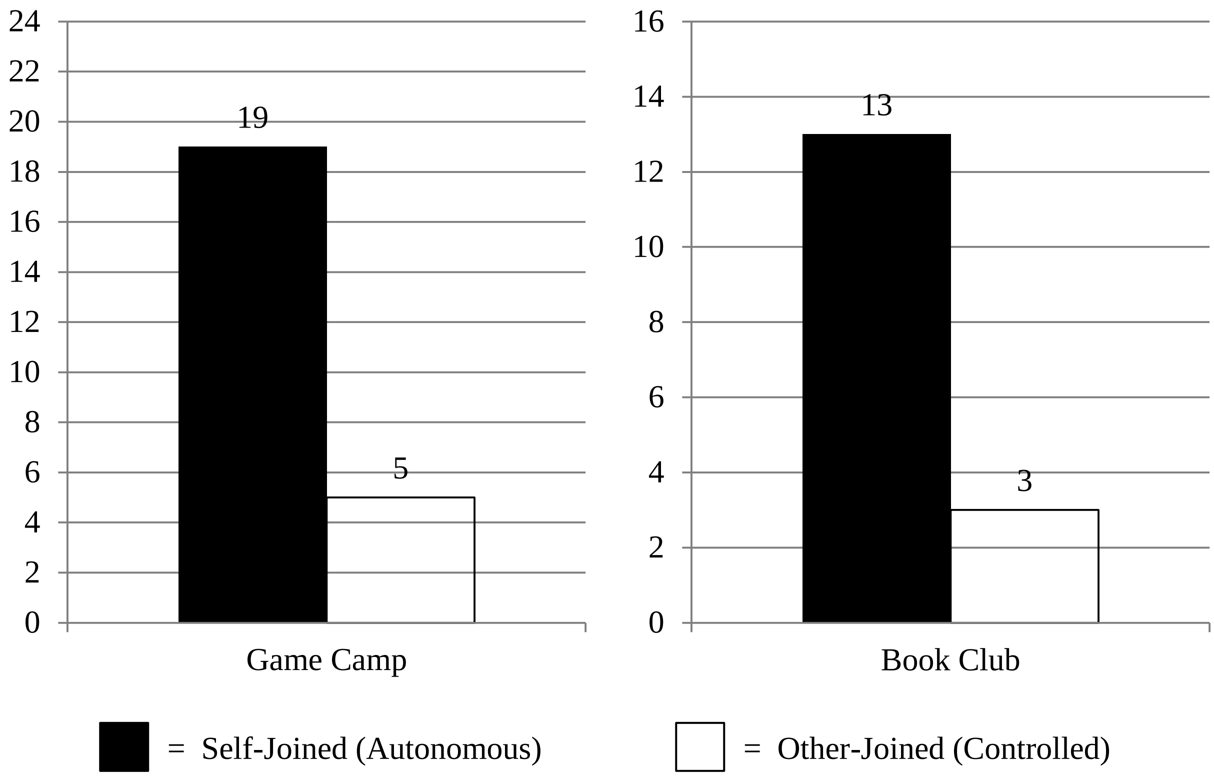


Figure 3. In the experimental condition (i.e., game camp), 19 students reported autonomous reasons for joining and 5 students reported controlled reasons for joining at pre-test. In the comparison condition (i.e., book club), 13 students reported autonomous reasons for joining and 3 students reported controlled reasons for joining at pre-test. Overall, students in the game camp and students in the book club were more likely to have autonomous reasons for joining (32 of 40), rather than controlled reasons for joining (8 of 40).

Figure 4.

The Means of Pre-Post Test Changes in Learning Skills for the Experimental Condition

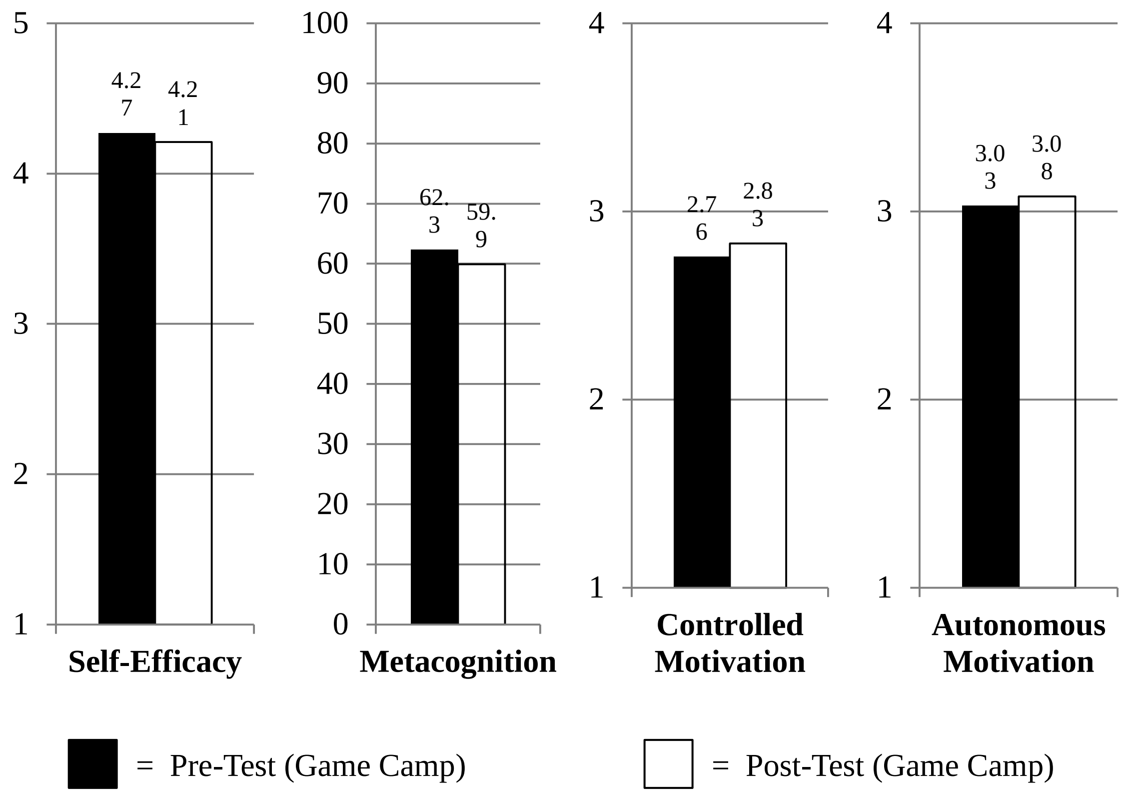


Figure 4. The students in the experimental condition (i.e., game camp) entered into their program with high self-efficacy scores (4.27), with moderate metacognition scores (62.27), with moderate controlled motivation scores (2.76), and with moderate autonomous motivation scores (3.03). In addition, students' scores on self-efficacy (4.21) remained high, and likewise, students' scores on metacognition (59.90), controlled motivation (2.83), and autonomous motivation (3.08) remained moderate.

Figure 5.

The Means of Post-Test Learning Skills for the Experimental Condition and for the Comparison Condition

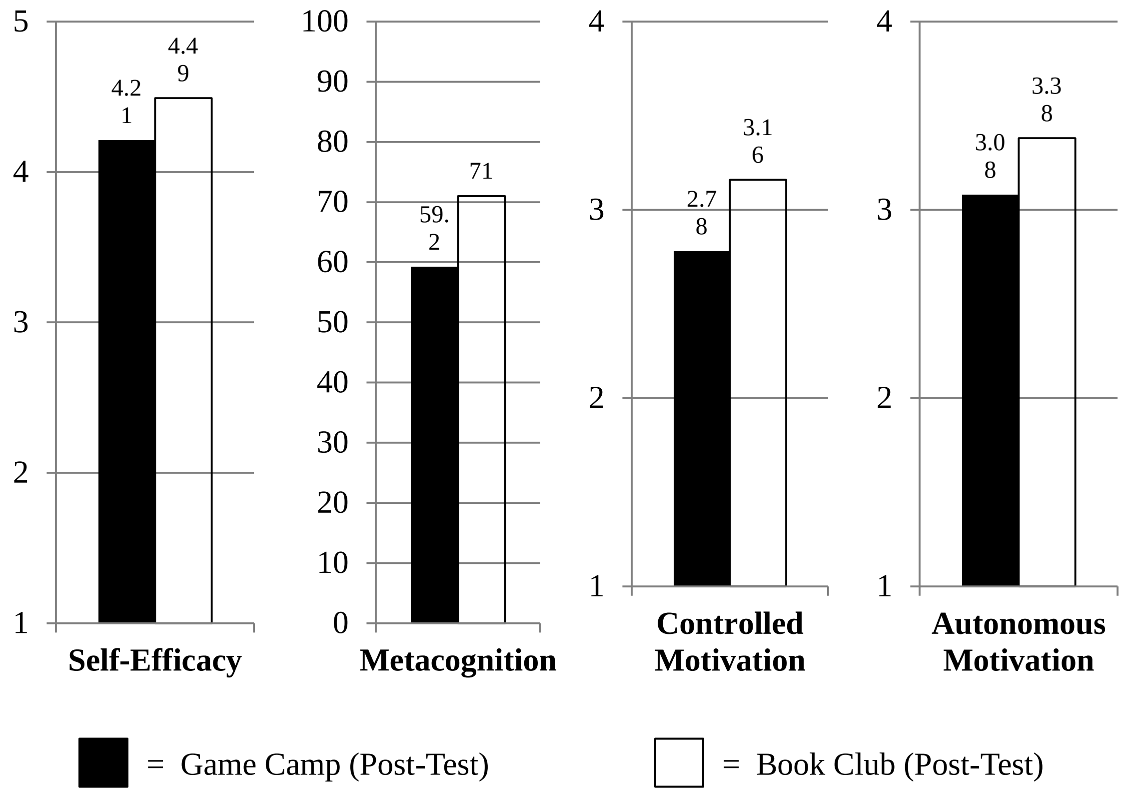


Figure 5. The students in the experimental condition (i.e., game camp) left their program with self-efficacy scores (4.21), with metacognition scores (59.24), with controlled motivation scores (2.78), and with autonomous motivation scores (3.08) that were not significantly different from students in the comparison condition at post-test.

Figure 6.

The Means of Pre-Test Learning Skills for Students with Autonomous Reasons and for Students with Controlled Reasons in the Experimental Condition

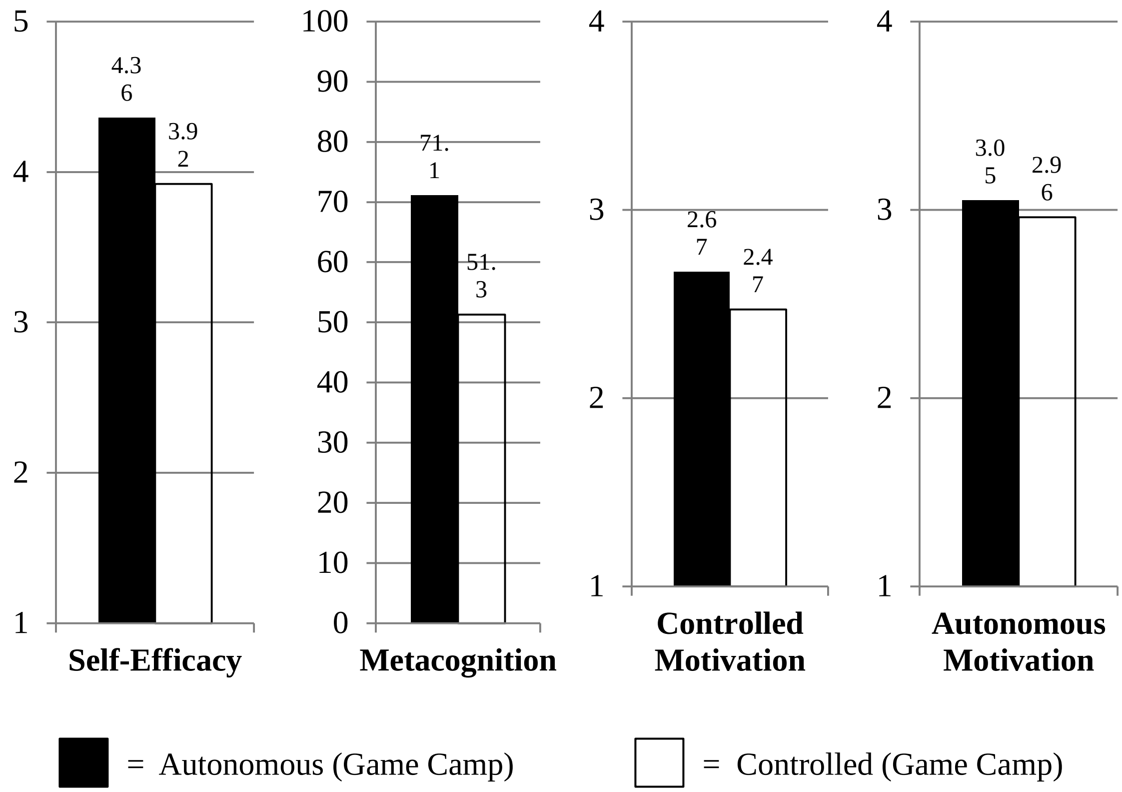


Figure 6. In the beginning, students in the experimental condition with autonomous reasons for joining displayed slightly more self-efficacy (4.36) and metacognition (71.11) than students in the experimental condition with controlled reasons for joining at pre-test.

Figure 7.

The Means of Post-Test Learning Skills for Students with Autonomous Reasons and for Students with Controlled Reasons in the Experimental Condition

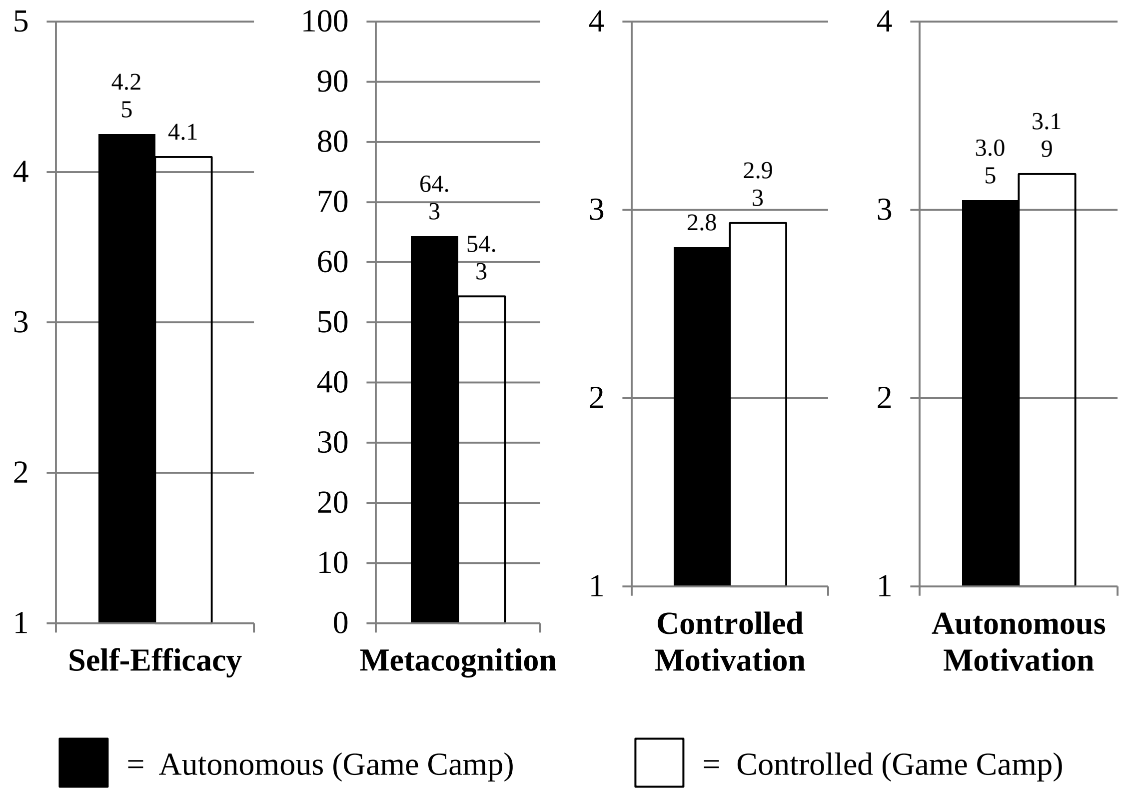


Figure 7. In the end, students in the experimental condition with controlled reasons for joining gained more self-efficacy (4.10) and metacognition (54.25), resembling or "matching" students in the experimental condition with autonomous reasons for joining at post-test.