Journal of Research Initiatives

Volume 5 | Issue 2 Article 5

10-31-2020

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Keywords

self-regulated learning, social cognitive theory, socioeconomic status, STEM education, online learning

Cover Page Footnote

I would like to acknowledge Ms. Deiadra Modlin, undergraduate student in the Department of Graphic Design Technology at North Carolina A&T State University, for her contribution in formatting the figures for presentation in this manuscript.

DEVELOPING SELF-REGULATED LEARNING BEHAVIORS IN ONLINE LEARNING ENVIRONMENTS - A CONCEPTUAL FRAMEWORK FOR INCLUSION

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Abstract

This paper outlines an inclusion initiative's conceptual framework for programs serving secondary students from economically challenged communities. It proposes distance learning technologies to afford these students access to learning resources, experiences, and environments in STEM. This paper addresses concerns with a complex duality of environmental factors: the environments in which these students are reared and currently reside; and the alteration to the environments in which they "traditionally" learning. It outlines a process where components participating in online learning experiences contribute to developing motivational and learning strategies to overcome environmental conditions and achieve academic excellence.

Introduction

The 2015 National Science Board report contended that the ever-growing pervasiveness of technology in our society had made STEM fields central to our nation's economic growth across a significant portion of the U.S. workforce. Within the next decade, our nation will need one million more STEM professionals than it can produce (United States Congress, Joint Economic Committee, 2014). Identifying ways to engage and prepare students to attain their high school diplomas and pursue postsecondary education successfully is critical to our nation's future economic prosperity. To meet the projected workforce need of one million additional STEM graduates by 2022, the U.S. must do more to increase all students' academic achievement, particularly our high-need, minority students underrepresented in STEM majors career fields. The 2015 Program for International Student Assessment (PISA) found that U.S. students ranked 38th in math and 24th in science out of 71 advanced industrialized nations (OECD, 2015). Compared to these statistics, low-income students' success rate in science, technology, engineering, and mathematics disciplines is much lower than that of students who do not come from underrepresented backgrounds (Doerschuk et al., 2016).

Students from lower-income backgrounds are markedly less likely to enroll in a full sequence of high school STEM courses, partially because of low performance in those courses as they begin high school (Svoboda, Rozek, Hyde, Harackiewicz, & Destin, 2016). The other contributing factor is the lack of cultural capital present in these students' environments and schools. "The lack of social and cultural resources is highly likely to be associated with lack of knowledge of the nature of STEM majors, information about STEM occupation perspectives, and role models, leading to student's ill-informed decision" (Niu, 2017, p. 310).

Proposition | STEM Inclusion Initiative

Persons from disinvested communities stand out as a conspicuous and untapped resource for expanding and diversifying the pool of U. S. STEM professionals (National Science Foundation, 2013). Historically, underrepresented racial and ethnic groups continue to be part of the Science & Engineering workforce at rates lower than their presence in the U.S. population (National Science Board, 2018). To address concerns of inequity and lack of cultural capital, proponents of distance education, online learning, and computer-based tools used for learning suggest online learning environments can foster cultural inclusivity (Ziegahn, 2005), reduce barriers to technology integration (Kotrlik & Redmann, 2005), and incorporate distance education as a means to appeal to a particular group (Carney-Crompton & Tan, 2002). In geographic regions where qualified teachers do not live, learning opportunities are not available, [learning] experiences should be made available online (U.S. Department of Education, 2016).

To widen and lengthen the STEM pipeline, this conceptual idea intends to include secondary students whose family annual taxable income is at or below 150 percent of the poverty threshold—realizing that there are nearly three million students around the United States who face struggles keeping up with their studies because they are without home internet. Melia, Amy, and Fenn (2019) report that an estimated 17 percent of U.S. students do not have access to computers at home, and 18 percent do not have home access to broadband Internet. Students without Internet at home are more likely to be students of color, from low-income families, or in households with lower parental education levels. Recognizing that families who did not earn a high school diploma or who only earned a high school diploma had access to the Internet at a much lower rate compared to those with a college degree (National Telecommunication and Information Administration, 2014), this concept will be initiated in collaboration with programs providing educational opportunities to students and families participating in TRIO Programs.

TRIO Programs

TRIO Programs are federal outreach and student services programs designed to identify and provide services for individuals from disadvantaged backgrounds. TRIO includes eight programs targeted to serve and assist low-income individuals, first-generation college students, and individuals with disabilities to progress through the academic pipeline from middle school to post-baccalaureate programs (U.S. Department of Education, 2020). TRIO is a set of federally-funded college opportunity programs that motivate and support students from disadvantaged backgrounds to complete high school and pursue a college degree. Two-thirds of the students served come from families with incomes at 150 percent or less of the federal poverty level (see Table 1), and neither parent graduated from college. The remaining one-third either meet the income level or be a first-generation college student (Margret & Goodwin, 2014).

Table 1

Current Year Low-Income Levels

Size of Family Unit	48 Contiguous States, D.C., and Outlying Jurisdictions	Alaska	Hawaii
1	$19,140	$23,925	$22,020
2	$25,860	$32,325	$29,745
3	$32,580	$40,725	$37,470
4	$39,300	$49,125	$45,195
5	$46,020	$57,525	$52,920
6	$52,740	$65,925	$60,645
7	$59,460	$74,325	$68,370
8	$66,180	$82,725	$76,095

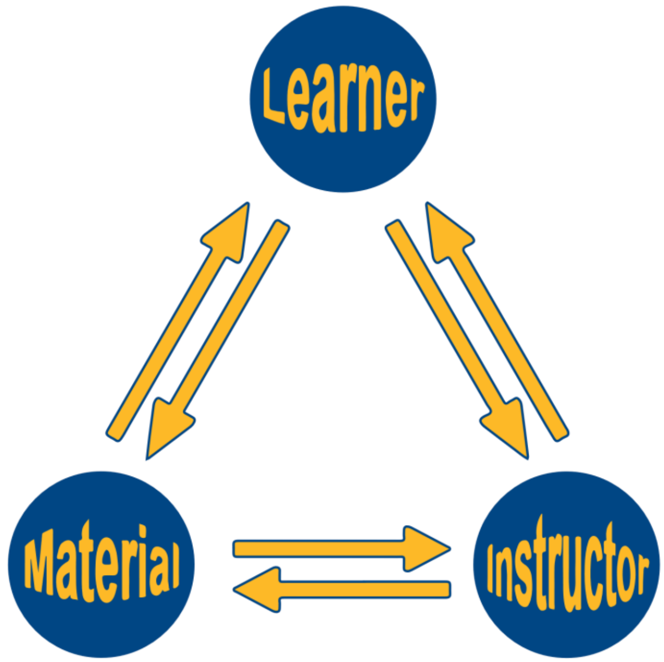
Source: *U.S. Department of Education, 2020*

These programs are hosted by centers, two-year or four-year institutions of higher education. Three of these programs (i. e., Upward Bound, Educational Talent Search, and Upward Bound/Math Science) serve secondary education students. Throughout the academic year and the summer, TRIO programs provide a battery of services to students and families including information about colleges and financial aid; academic and career counseling; and tutorial services.

During the summer residential program, the students spend four to six weeks on the host institutions' campus, where they participate in a rigorous curriculum. They take general education core courses (i. e., math, laboratory science, English/Literature, and social science), preparing them for the upcoming academic year. In some instances, students are given opportunities to "explore" interests in other disciplines through elective courses. While at the host institutions, the students have access to technological resources (i.e., computers, internet connectivity, software) that would support participation in online learning environments and experiences during the academic year and the summer. Due to their environmental conditions at home, they may (or may not) have access to these resources otherwise.

It is atypical for students from economically disadvantaged communities to engage in online learning experiences. Although the literature proclaims online learning would foster inclusivity (Ziegahn, 2005), Hansen and Reich (2015) discovered that online courses disproportionately attracted individuals already advantaged regarding access to resources. raising the question if Massive Open Online Courses (MOOCs) are "reinforcing the advantages of the 'haves' rather than 'educating' and the 'have nots.'" The students participating in this research initiative typically experience learning in face to face environments where the learners, materials, and instructor are in the same physical place. The exchange of information and the observation of changes in behavior happen in real-time. Interactions are direct and immediate (see Figure 1).

Figure 1
Interactions between environmental components in face-to-face environments



The environmental components in online learning environments are separated by time and physical space. The intimacy created by immediate and direct communication in "traditional" learning environments (see Figure 1) is "severed" and facilitated through networked devices (see Figure 2).

Figure 2
Interactions between environmental components in online learning environments

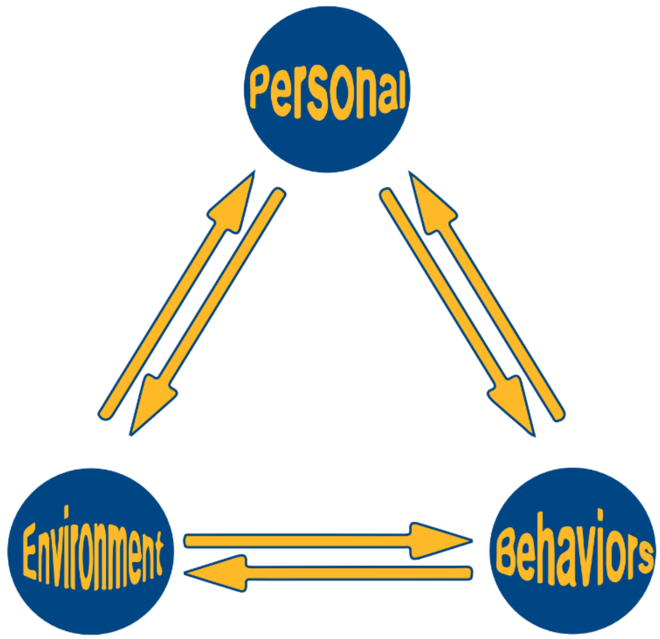
According to Social Cognitive Theory, such an environmental alteration may impact behaviors the learners employ to complete learning tasks and accomplish learning goals.

Social Cognitive Theory | Self Efficacy

The social cognitive theory posits an interdependent, bidirectional, and reciprocal relationship between environmental factors, behavioral factors, and personal factors. Triadic reciprocal determinism (TRD) is often utilized as a conceptual and analytical model in studies using social cognitive theory (SCT) as a theoretical framework, representing bidirectional relationships among an individual's behavior, personal factors, and the environment (see Figure 3).

Figure 3

Social Cognitive Theory



Source*: Bandura, 1986*

TRD describes how a person regulates relative to changing environmental circumstances to gain desired outcomes (Bandura, 1986). The social cognitive theory posits that factors such as economic conditions, socio-economic status, and educational and familial structures do not directly affect human behavior. Instead, they affect it to the degree that they influence people's aspirations, self-efficacy beliefs, personal standards, emotional states, and other self-regulatory influences.

At the very core of the social cognitive theory is self-efficacy beliefs. Self-efficacy is "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). The abrupt migration from face-to-face to online learning may be an overwhelming experience for some learners. Self-efficacy is a crucial self-regulatory cognition that drives the perception/belief in one's ability to manage environmental demands and effectively enact coping behaviors (Bandura, 1977). Self–efficacy is critical to the development and deployment of SRL strategies, and it [self-efficacy] is boosted by positive persuasion of, and learning experiences with, supportive mentors, particularly for students underrepresented in STEM (Stout, Dasgupta, Hunsinger, & McManus, 2011). The framework considers the interplay between environmental factors (created by socioeconomics and modifications in learning environments) that may have implications on the [learning] behavior factors (see Figure 3). This initiative's conceptual framework intends to perpetuate students from disadvantaged backgrounds to become self-efficacious in their development and implementation or self-regulated learning behaviors to complete learning tasks and accomplish learning goals in online learning environments.

Self-Regulated Learning

According to Zimmerman (1989), "self–regulated learning (SRL) is one's ability to be metacognitively, motivationally, and behaviorally active in one's learning process" (p. 329). Within the agentic framework of social cognitive theory, self-regulation operates through three generic subfunctions: self-monitoring, adaptation of proximal goals, and exercise of self-influences (Bandura, 1986). The social-cognitive perspective holds that successful self-regulated learners possess higher motivation levels, apply more effective learning strategies, and respond more appropriately to situational demands (Pintrich & Schunk, 2002). Academically capable students rely on strategies associated with self-directed and self-initiated processes, while less academically capable students prefer SRL strategies associated with social sources of help-seeking from peers, teachers, and adults (Effeney, Carroll, & Bahr, 2013). SRL behaviors have proven to contribute to social relationships and academic achievement (Boekaerts & Cascallar, 2006) and are common to career aspirations and employability (Yorke, 2004).

Self-regulated learning and socio-economic status. Self-regulatory behaviors are associated with parental socio-economic status. Students from lower socio-economic conditions exhibit lower rates of self-regulated learning (Evans & Rosenbaum, 2008). Students of low SES backgrounds often lack self-regulatory habits and metacognitive strategies to improve academic performance. Van der Veen and Peetsma (2009) found the decline in self-regulated learning behavior that applies specifically to students in the lowest academic level of secondary school can be derived from the context in which they grow up. However, Fouche (2013) found a difference in post-test scores on science assessment among low SES secondary students who used metacognitive and self-regulatory strategies compared to students who did not use these strategies. Zimmerman and Pons (1986) proved that self-regulated learning improved the prediction of English and mathematics achievement by 41 and 36 percent over the variables of gender and SES, suggesting that demonstration of high self-regulation overcomes the effects of low socio-economic status has on academic achievement.

Self-Regulated Learning and STEM. Students' development of SRL is essential when working on poorly structured problems, e.g., STEM engineering design tasks that are difficult to solve and require increased cognitive operations (Paris & Winograd, 1990). Lawanto & Santoso (2013) found higher-performing students scored significantly higher than their lower-performing counterparts on selecting SRL strategies to establish design means and monitoring/fix-up strategies to generate design alternatives in a secondary engineering/technology course. Gonzalez, Rodriguez, Olmos, Borham, and Garcia (2012) found that engineering students who were active learners achieved more significant levels of learning and motivation than did their peers. The design process is non-linear; students must identify, plan, act, evaluate, make necessary adjustments, and make necessary adjustments.

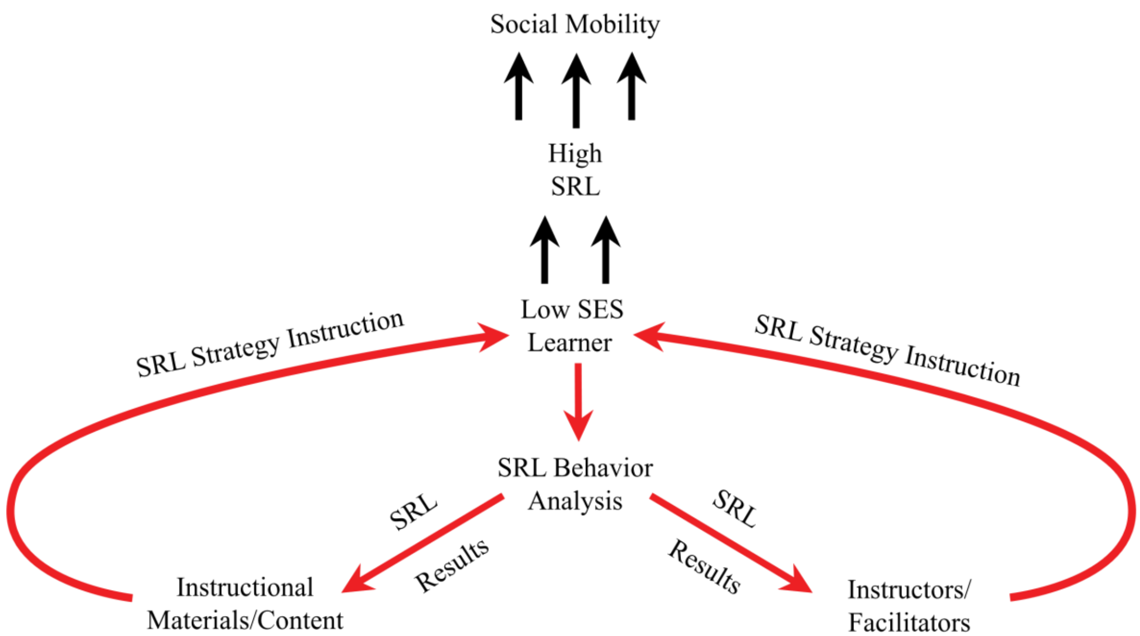
Self-Regulated Learning and Online Learning. Schunk and Zimmerman (1998) claim, "self-regulation seems critical in distance education due to the high degree of student independence deriving from the instructor's physical absence" (p. 231). In the absence of support and guidance from an instructor, the ability to self-regulate one's learning process is critical to achieving personal learning objectives. Prior work found that many learners struggle with self-regulation in online learning environments (Lajoie & Avezedo, 2006). Wang and Lin (2007) corroborate the social cognitive view of self-regulated learning: students who hold high levels of motivation apply better learning strategies and respond appropriately to environmental influences to improve performance in the web-based learning environment. Prior work in online learning environments demonstrated improvements in academic achievement from applying SRL strategies, especially time management, metacognition, and effort regulation strategies (Broadbent & Poon, 2015). Confidence in implementing self-regulated learning strategies can be attributed to learners understanding the contexts of behaviors being used.

The Conceptual Framework

The Learners. Learners from socioeconomically disadvantaged backgrounds are the focus of the conceptual framework (see Figure 4). To encourage them to engage in STEM, they are to enroll in the online STEM courses as one of their elective course options during their participation in one of the TRIO programs (i. e., Upward Bound, Educational Talent Search, or Upward Bound/Math Science) during the summer residential program. One of the goals of the TRIO programs is to prepare students from socioeconomically disadvantaged backgrounds to complete high school and attend and earn a degree from a postsecondary institution. In contrast to the 1960s (when the TRIO programs were conceptualized), preparing students for the college experience has drastically changed. Presently, there is a recognized shift towards technology-supported learning, commonly known as e-learning, with most institutions of higher learning adopting e-learning for fully online courses or complementary to the face-to-face sessions in blended learning approach (Hadullo, Oboko, & Omwenga, 2018; Luna, Castro, & Romero, 2017). This initiative intends to encourage these students to pursue an interest in college (specifically in STEM) while concurrently providing them the opportunity to participate in online learning environments to complement their readiness for experiences they may face at the postsecondary level.

Figure 4

Conceptual Framework



In this initiative, synchronous and asynchronous online learning technologies facilitate interactions between the students, content, materials, and instructors. This research initiative is concerned with the reciprocal, bi-directional, interdependent relationship between environmental factors and behavioral factors addressed by social cognitive theory (see Figure 3). This framework considers the "novel" online learning environment where the students are to engage in STEM education experiences (see Figure 2) that is different from the learning environments where they typically participate in learning (see Figure 1) and the socio-economic environments in which the students were reared and currently reside; the implications these environmental factors may have on the self-regulated behaviors developed and used to complete learning tasks and accomplish learning goals in STEM and online learning experiences.

Self-regulated learning behavior analysis. Before, during, and after the online learning experiences, the self-regulated learning behaviors (i. e., the motivational and learning strategies) the students demonstrated in the online environment are assessed. This is done by using self-report measures, interview protocols, and data extracted from the learning management system (i. e., Learner Analytics). The Online Self-Regulated Learning Questionnaire (OSLQ) is a self-report tool developed by Barnard et al. (2009) to assess students' use SRL strategies in online or blended learning environments. It contains 24 items under five categories that use a five-point Likert scale. It measures six SRL strategies: goal-seeking, help-seeking, time management, task strategies, environment structuring, and self-evaluation. The Self-Regulated Learning Interview Schedule (SRLIS) is an interview protocol (Zimmerman and Pons, 1986). In this framework, the SRLIS is used 14 classes of self-regulated learning behaviors by students of socioeconomically disadvantaged students participating in the STEM online environment.

Learner Analytics (L.A.) involves integrating and analyzing data collected from educational environments for insights and patterns on how students engage in various learning activities during online learning. Lodge and Corrin (2017) opine that L.A. provides an opportunity to monitor students' learning to understand their behavioral patterns and provide real-time interventions, especially in online learning environments. According to Naif, Ayman, & Saeed-ul (2019), the outcome from L.A. helps in understanding learners' behavior with a view of providing early intervention mechanisms that enhance learning engagement, which is positively correlated to academic performance. Similar to studies such as Cicchinelli et al. (2018), Davis, Chen, Jivet, Hauff, & Houben (2016), Lee and Recker (2017), and Nussbaumer, Hillemann, Gutl, & Albert (2015), this conceptual framework incorporates L.A. to identify SRL strategies from learners of low socio-economic status through the use of LMS data and provide this feedback to learner and teachers (Arnold & Pistilli, 2012). The quantitative and qualitative data collected from these measures are analyzed to develop and enhance the learners' self-regulated learning behaviors while participating in the online learning environment.

Self-Regulated Learning Intervention. The main objective is to support students by providing interventions to improve undesirable learning behaviors and reinforce positive learning (Lodge, Panadero, Broadbent, & De Barba, 2019). The information acquired from the SRL measures informs the integration of self-regulated learning strategy intervention in the online instructional materials, and the analysis informs online instructors and their professional development. The left side of Figure 4 illustrates taking the data from the learner analysis and redesigning the course materials by embedding prompts in the course materials to scaffold SRL development. Zheng (2016) revealed that 21 of 29 studies (72.4%) adopted prompts or hints to scaffold SRL and that SRL scaffolds had a medium but significant positive effect on academic performance in computer-based learning environments.

The right side of the conceptual framework (see Figure 4) illustrates the SRL behavior analysis results, informing professional development efforts for online instructors. Jayawardena, Van Kraayenoord, and Carrol (2017) posit teachers play a crucial role in promoting SRL; however, they found that few teachers prepare learners to learn independently and lack knowledge of how much and what types of support they should provide to enhance learners' SRL capacities. The professional development efforts would include but not limited to effective evidence found in Geduld (2017) such as equipping the online instructor to 1) develop goal setting, planning, and task analysis; 2) use questioning to check for prior knowledge; 3) teach learners to monitor their understanding; 4) allow learners to question, discuss, and to work with peers; 5) make learners aware of time management; and 6) directly model how to use alternative strategies to get the same results. Knowledge of these and other effective strategies, online instructors are equipped with abilities to encourage students of low socio-economic status to employ appropriate motivational and learning strategies as they engage in STEM and online learning environments.

"The social cognitive view of self-regulation is important (see Figure 3). Suppose teachers realize the reciprocal formulation of these influences (i. e., personal, behavioral and environmental). In that case, they are more likely to be capable of facilitating student learning through the alternation of environmental influences, student perceptions, and learning behaviors" (Wang & Lin, 2007, p. 606). Geduld (2017) concluded that teachers who were more knowledgeable about SRL, who were more positive about SRL, and who understood their SRL development roles demonstrated more observable teaching behaviors that develop SRL. The study indicated a severe need for interventions to make practicing teachers and student teachers aware of the importance [of self-regulated learning].

This initiative is a cyclical and iterative process where the analysis, design, development, implementation, and assessment of self-regulated learning behaviors will occur and accumulate over time. The environments in which students of low socio-economic status not only lacks resources to motivate and nurture in STEM; they also may lack resources to model and perpetuate SRL strategy use. The idea of the conceptual framework is for components that occupy learning environments such as students, instructional materials, and instructors to contribute to the development and improvement of self-regulated learning. The SRL interventions are informed by the data to provide an environment where continuous development of SRL behavior use is supported. The learners are provided physical or virtual access to STEM human, instructional and technological resources; the conceptual framework guides the development of learning environments to equip the human and instructional resources to develop SRL behaviors making the learning experiences and environment pedagogically accessible and equitable. Figure 4 illustrates the long-term benefit of the conceptual framework, which is to elevate the students' SRL profiles. Through SRL behavior development, learners of low socio-economic status will attain social mobility by preparing and motivating them to pursue and persist toward lifelong learning and career aspirations in disciplines (e. g., STEM) that generate income exponentially higher than their current annual taxable income.

Implications for Education Practice

Persons from disinvested communities stand out as a conspicuous and untapped resource for expanding and diversifying the pool of US STEM professionals (National Science Foundation, 2013); however, these communities may not have the cultural capital to encourage, nurture, motivate interest in STEM. Bandura (2002) states social models are a source of inspiration, competencies, and motivation, and seeing people similar to oneself succeed by preserving effort raises observers' beliefs in their abilities (i. e., self-efficacy)(Purdie-Vaughns, Steele, Davies, Ditlmann, & Crosby, 2008). Self-efficacy in STEM-related concepts has been identified as a major socio-cultural factor influencing minority students' decisions to pursue STEM fields (Wang, 2013).

This initiative proposes integrating distance learning technologies to "transport" human, instructional, and technological resources to the geographically disparate locations so persons in these communities can interact with STEM resources. The ability to select and use appropriate self-regulated learning strategies is essential to succeed academically in STEM disciplines (Lawanto, & Santoso, 2013) and online context (Azevedo & Aleven, 2013). Unfortunately, students from low socio-economic situations often lack self-regulated learning habits and metacognitive strategies that can improve academic performance in online environments, which supports the affirmation of Callahan and Sandlin (2007), who reported that "cyber education serves as a mechanism of symbolic violence because it provides the false perception (or creates misrecognition) of increasing access and, in turn, equality while instead maintaining inequalities" (p. 10).

Due to their environmental conditioning, children from low-income families may need explicit instruction in SRL strategies (Nisbett, 2007) to equip them with the motivational and learning strategies to succeed in STEM or online environments. SRL interventions effectively improve learners' SRL knowledge and activities, as well as their course performance and overall academic achievement (de Bruijn-Smolders, Timmers, Gawke, Schoonman, & Born, 2016). This project proposes self-regulated learning strategy instruction be embedded in the instructional materials and content, and the online instructors are equipped with the pedagogical tools to develop and encourage self-regulated learning strategy implementation.

Implications for Education Research

Bullock and Limbert (2009) noted that socio-economic status tends to remain invisible in psychological research. Martin (2004) pointed out that psychologists who conduct self-studies, such as self-regulation, construct models, and offer recommendations that are seemingly intended to apply across social classifications and realities without representation by all social classes. This project responds to the call for the next generation of SRL research to focus on socio-political context (Boekearts and Corno, 2005), informal learning contexts (Littlejohn et al., 2012), and online engineering contexts (Yukselturk & Top, 2013). Few studies include socioeconomically diverse samples that address the role of socio-cultural factors such as self-regulated learning and self-efficacy in disparities in STEM participation (Shaw & Barbuti, 2010).

This conceptual idea is expected to contribute to discussing the implications environmental factors have on self-regulated learning behavior development and deployment by students from low socio-economic communities in STEM online learning environments. The contribution is significant because it is expected to revolutionize online learning environments and experiences to develop discipline-specific skills and knowledge while simultaneously developing the self-regulated learning strategies to acquire the skills and knowledge to make STEM educational opportunities physically and pedagogically accessible to these students specifically. They offered theories for how best to include this population of students in STEM, which is viewed as sweeping the U.S., prompted primarily by the recent adoption of the Next Generation Science Standards. The surge in STEM education's interest is beneficial for local schools and communities and promises to positively impact students, teachers, school leaders, community members, and the future workforce (Avendano, Renteria, Kwon, & Hamdan, 2018). This initiative will equip them with strategies and behaviors transferable to various disciplines and contexts. Future longitudinal studies will test the hypothesis that self-regulated learning strategy implementation contributes to students' social mobility from low socio-economic conditions and negates the negative cycle of social reproduction.

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