MEASURING STUDENT SUCCESS SKILLS: A REVIEW OF THE LITERATURE ON SELF-DIRECTED LEARNING

March 31, 2020

21st CENTURY SUCCESS SKILLS

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1. Center for Assessment completed this work on behalf of PBLWorks (Buck Institute for Education) in its effort to provide tools and resources to school and district partners as they assess student success skill performance in Gold Standard Project Based Learning.

BUCK INSTITUTE FOR EDUCATION
PBLWorks

2. I acknowledge the terrific feedback on previous drafts from my colleagues at the Center for Assessment. Any errors and omissions are my own.

4. Brandt, W. C. (2020). *Measuring student success skills: A review of the literature on self-direction.* Dover, NH: National Center for the Improvement of Educational Assessment.

MEASURING STUDENT SUCCESS SKILLS: A REVIEW OF THE LITERATURE ON SELF-DIRECTED LEARNING

INTRODUCTION

The illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn, and relearn. (Alvin Toffler, 1991)

Self-directed learning is vital in today's world. People in developing countries now have access to massive amounts of data and virtually ubiquitous access to information. This creates conditions for rapid societal change and presents challenges for educational institutions to fully prepare students for demands in the workforce. These demands extend beyond content knowledge to include skill-based competencies such as problem-solving, curiosity and reflection, creativity, written and verbal communication, collaboration, accepting and applying critical feedback, applying knowledge to real-life problems, and managing and supporting constant change (Toit-Brits, 2019). To survive in today's workforce, individuals must know how to take charge of their learning—to plan, develop, adapt, and change in a digital, interactive and global society.

To survive in today's workforce, individuals must know how to take charge of their learning—to plan, develop, adapt, and change in a digital, interactive and global society.

Although the concept of self-direction dates back to the mid-1800s, it has emerged as a major research area over the past 50 years (Hiemstra, 1994). Most research on self-directed learning as a wholistic concept comes from the fields of adult education and the study of informal and experiential learning. Research in the fields of K-12 education and psychology focuses much less on self-direction per se, although these fields do provide important contributions toward understanding key dimensions of self-directed learning (e.g., self-regulation, motivation). Self-directed learners have a heightened ability to adapt to changing social and contextual conditions (Jossberger, Brand, Gruwel, Boshuizen, & Van de Wiel, 2010; Morris, 2019), feel more empowered to take action when oppressed (Bagnall & Hodge, 2018), and are more likely to reach self-actualization (Arnold, 2017). As adults, they are better equipped to learn new skills (Barnes, 2016), remain employed (Morrison & Premkumar, 2014), and nurture their own long-term career success (Seibert, Kraimer, and Crant, 2001).

Self-directed learning represents a process of learning that is individual, purposeful, and developmental. The *individual* nature of self-directed learning emphasizes autonomy, choice, and self-actualization. Learners are viewed as autonomous and capable of smart decision-making, have a sense of responsibility to themselves and others, are inherently good-natured, have a desire to reach self-actualization, and have a unique and unlimited potential for growth (Elias & Merriam 1995; Morris, 2019). By applying self-direction, these learners empower themselves to take personal responsibility, choosing how they use information in the construction of meaning.

Self-directed learning is also *purposeful*: Individuals initiate self-directed learning to find solutions to concrete goals or real-world problems. For example, many real-world learning opportunities are initiated for highly practical reasons, such as making a good decision, building something, or carrying out a task related to one's job, home, family, sport, or hobby (Tough, 1971). The learner assumes responsibility for setting their learning objectives, managing tasks, and controlling the methods and resources used to achieve personal goals, solve problems or meet perceived demands (Morris, 2019).

Finally, self-directed learning is *developmental*: it is a vehicle for personal growth (Groen & Kawalilak, 2014). Individuals develop deep conceptual understanding, solve problems, and achieve goals by cyclically testing their ideas in real-world contexts, and applying personal reflection and external feedback to develop and further refine these ideas (Morris, 2019). Using this process, learners can solve problems, achieve goals, develop knowledge and skills, innovate, and realize their potential. Moreover, a learner's development is highly influenced by the environment, including social interactions and other context-based factors (Tan, 2017). The learning process happens as the individual interacts with, experiences, and interprets events occuring in the world (Merriam et al., 2007).

The primary goals of this literature review are to (a) provide a working definition of self-directed learning, (b) describe how self-directed learning develops, (c) examine different conceptions of how self-directed learning is taught, (d) discuss specific instructional practices that support the development of self-directed learning strategies, and (e) analyze how self-directed learning has been assessed by researchers and practitioners. Additionally, we consider the corresponding implications for the design and use of assessments of self-directed learning in K-12 schools. We conclude by offering best practices for documenting and evaluating self-directed learning skills over time.

DEFINITIONS

What is Self-Directed Learning?

Malcolm Knowles (1975) provided one of the earliest, and most widely adopted, definitions. In his view, self-directed learning comprises a five-step process:

> *Individuals take the initiative, with or without the help of others, in (1) diagnosing their learning needs,(2) formulating learning goals, (3) identifying human and material resources for learning, (4) choosing and implementing appropriate learning strategies and (5) evaluating learning outcomes. (Knowles, 1975, p. 18)*

Self-directed learning gives learners the freedom and autonomy to choose the what, why, how, and where of their learning.

Self-directed learning gives learners the freedom and autonomy to choose the what, why, how, and where of their learning (Francis, 2017). The research literature reveals four dimensions[1] of self-directed learning:

1. ***Self-Regulation*** is the ability to plan, direct, and control one's emotions, thoughts, and behaviors during a learning task. The most prominent model of self-regulation comprises four phases: (a) setting learning goals, (b) monitoring and regulating the learning progress, (c) making adjustments, or changing strategies, to achieve goals, and (d) reflecting on the task to generate

[1] These dimensions of self-directed learning represent a synthesis of prominent self-directed learning models, including those from Bouchard, 2009; Brockett and Hiemstra, 1991; Candy, 1991; Garrison, 1997; and Knowles, 1975. Additionally, the role of mindset (Dweck, 2006; Duckworth, 2016), intrinsic motivation and engagement (Pink, 2009; Ryan and Deci, 2000), and self-regulation/self-management (Claro and Loeb, 2019; NRC, 2012; Yarbro and Ventura, 2018) on students' ability to self-direct their learning is considered.

new knowledge (NRC, 2012; Pintrich, 2004). Characteristics of self-regulation include executive functioning (i.e., working memory, inhibitory control, and cognitive flexibility), metacognition, self-monitoring, grit/persistence, discipline/self-control, and self-reinforcement. Self-regulation also encompasses self-evaluation, which represents self-efficacy, emotional stability, and locus of control (NRC, 2012).

2. ***Motivation*** is the desire to engage in an activity that emerges from the inherent enjoyment of an activity or a sense of obligation to engage in a task (Pink, 2009; Ryan & Deci, 2000). Growth mindset is a major factor influencing intrinsic motivation: believing that intelligence, personality, and abilities are flexible and dynamic, shaped by experience, and changing over the life span. Learners with a *growth mindset* tend to be more curious, open-minded, and persistent in their learning (Duckworth, 2016; Dweck, 2006).

3. ***Personal Responsibility*** (also called responsibility, initiative, and ownership) is a willingness to take full responsibility for one's actions. Learners who demonstrate personal responsibility operate with integrity and act in concordance with clear ethical principles (Battelle for Kids, 2019). Personal responsibility emerges from an intrinsic desire to act in ways that benefit oneself, one's local environment, and the greater society. Personal responsibility develops on a continuum and is inextricably affected by the social context in which learning occurs (Banz, 2009; Brocket & Hiemstra, 1991).

4. ***Autonomy*** is the ability to recognize available choices and take charge of one's learning, control choices through ongoing reflection and evaluation. Acting autonomously does not happen in social isolation, but rather requires an awareness of one's environment and social dynamics. Autonomous learners decide how to manage their lives and create a personal identity as they engage with their environment and with other people (OECD, 2005). Autonomy develops as learners work independently or collaboratively to set goals, plan learning, select resources and learning strategies, and monitor and evaluate progress (Reinders, 2010).

The multi-faceted definition of self-directed learning illustrates its complexity, encompassing cognitive, intrapersonal, and interpersonal skills. Moreover, different fields of study take different perspectives and use different terminology when defining, delineating, and measuring these skills, which can cause confusion across related terms and definitions. In the research literature, for example, self-directed learning often is used synonymously with self-regulated learning. Self-regulation is a narrower concept, however, representing just one dimension of self-directed learning. To make matters worse, terms such as self-management, conscientiousness, and self-control have definitions overlapping with self-regulation, creating confusion across these terms.

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Such confusion has been called the jingle-jangle problem. The *jingle* problem surfaces when a concept is defined differently across research traditions (Duckworth, Taxer, Eskreis-winkler, & Gross, 2019). For example, the education literature characterizes self-direction as an intrapersonal process

associated with self-regulation and autonomy, whereas the cognitive science and psychology literature portrays self-direction as a cognitive process involving inhibitory control, cognitive flexibility, working memory, and other executive functions (NRC, 2012). The *jangle* problem is where different terms are used to refer to the same construct. Terms used interchangeably with self-direction include conscientiousness, self-management, self-regulation, self-control, and effortful control, to name a few (Claro and Loeb, 2019). It would not be unusual to find experts in business, psychology, economics, and education each using a different vocabulary to describe a self-directed learner. Given the confusion in terminology between self-directed learning, self-determined learning, self-regulation, and self-regulation's closest relatives, these nuances deserve further attention.

Self-Regulation

Self-regulation (also known as self-management, conscientiousness, self-control, self-discipline, willpower, effortful control, ego strength, and inhibitory control, among other terms; Claro & Loeb, 2019) represents a narrower construct than self-directed learning. However, both constructs overlap considerably, their differences are nuanced, and they often are used interchangeably in the literature. The overlapping, and often tangled, references to self-regulated learning and self-directed learning largely reflect their origins. The construct of self-directed learning originated in the 1970s from adult and experiential/informal education. Self-regulation is a more recent construct from cognitive science and psychology.

Definitions and dimensions of self-regulated learning vary in the literature. Pintrich (2004) developed the most prominent model of self-regulation, which describes learners' engagement in four phases: (a) setting learning goals, (b) monitoring and regulating the learning progress, (c) making adjustments or changing strategies to achieve goals, and (d) reflecting on the task to generate new knowledge about oneself or the learning task. Although this definition is strikingly similar to self-directed learning, the latter generally is considered a broader construct that encompasses self-regulated learning (Jossberger et al., 2010). Unlike self-regulation, self-directed learning addresses the learner's autonomy and personal responsibility to manage learning activities and the degree of learner control. For instance, a self-regulated learner may rely on the teacher for support, whereas a fully proficient self-directed learner is able to take control of the learning process from start to finish. Saks and Leijen (2014) rely on a prior definition from Jossberger et al. (2010) to clarify the differences between the self-directed learner and the self-regulated learner:

Unlike self-regulation, self-directed learning addresses the learner's autonomy and personal responsibility to manage learning activities and the degree of learner control.

> *A self-directed learner decides what needs to be learned next, diagnoses his learning needs, formulates learning goals, finds suitable resources for learning, monitors and reflects on his learning activities. The first step in learning to self-direct one's learning is the skill to self-regulate learning activities and task performances (Jossberger et al, 2010). Self-regulated learning...concerns processes within task execution. Self-directed learning may include self-regulated learning but not the opposite (Jossberger et al, 2010). In other words, a self-directed learner is supposed to self-regulate, but a self-regulated learner may not self-direct. (in Saks & Legion, 2014, p. 192)*

Providing learners with opportunities for self-directed practice can improve their self-regulation (Jossberger et al, 2010). This is because learners, in a self-directed learning environment, have more freedom to generate and pursue their own goals, and to plan, select, and critically evaluate the materials and resources they use to reach these goals.

Self-Determined Learning

Self-determined learning extends the self-directed learning continuum. *Teacher-directed* learning represents teacher-led instruction. In pedagogical environments, teachers determine what students will learn and how they will learn it. Students rely on their teacher to learn topics as they are presented. *Self-directed* learning represents student-directed learning, in which teachers serve as facilitators or consultants, but students ultimately are responsible for finding solutions to pre-determined content and tasks. *Self-determined* learning, in contrast, encourages students to find their own problems to solve, questions to answer, and subjects to study. Teachers become partners and mentors, providing support and opportunities for students to fully explore subjects (Davis, 2018).

Whereas self-directed learning can occur with or without help from a teacher, mentor, or tutor, self-determined learning occurs independently of formal teaching. In a self-determined learning environment, the learner is at the center of the learning process, rather than the teacher, curriculum, or learning standards. Most researchers consider self-determined learning an informal learning process that parallels how people learn in natural settings, rather than a process that could practically occur in a formal learning setting, like a K-12 public school (Hase and Kenyon, 2000).

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Table 1 organizes the array of terms and definitions associated with the multi-faceted dimensions of self-directed learning. This table presents a list of common terms associated with each dimension of self-directed learning, unpacks each dimension into its relevant sub-dimensions and components, and provides operational definitions that can be used to measure each dimension and its sub-component parts.

Table 1.
Dimensions and Sub-Dimensions of Self-Directed Learning

Dimension	Common Associated Terms	Sub-Dimension	Components	Operational Definition
Self-Regulation	Self-Management Conscientiousness Self-Control Self-Discipline Willpower Effortful Control Ego Strength Inhibitory Control	Cognitive Processing	Working Memory Inhibitory Control Cognitive Flexibility Metacognition	Diagnose learning needs; set learning goals; choose appropriate resources and strategies; monitor progress; make adjustments; reflect and evaluate; generate new knowledge.
		Core Self Evaluation	Self- Efficacy Locus of Control Emotional Stability	Execute strategies to manage emotions and maintain self-control.
		Grit	Resilience Ambition Self-Control	Exercise resilience, ambition, and self-control to maintain passion and persist in the face of challenge.

Table 1.
Dimensions and Sub-Dimensions of Self-Directed Learning (continued)

Dimension	Common Associated Terms	Sub-Dimension	Components	Operational Definition
Motivation	Desire Interest	Intrinsic		Develop and sustain motivation for learning. Operate with a fundamental belief that intelligence and personality is malleable and can change.
		Extrinsic		
		Growth Mindset		
Personal Responsibility	Responsibility Initiative Ownership	Ownership		Recognize and accept the consequences associated with a given set of actions on self, others, and the environment.
		Ethics and Integrity		Act in accordance with a strong set of moral values and principles.
Autonomy	Agency Independence	Agency		Take charge and manage the learning process from start to finish.
		Choice		Exercise choice when making decisions.
		Challenge		Select and engage in challenging tasks that are difficult but not impossible.

What is the Relationship Between Self-Directed Learning and Other Success Skill Concepts?

The construct of self-directed learning is operationalized differently across different success skill frameworks, making its relationship with other success skills a tangled web. For example, according the National Research Council report, "Education for Work and Life" (NRC, 2012), self-direction is one of several distinct skills associated with conscientiousness. Most other widely cited frameworks *do not* include self-directed learning as its own success skill, but they *do* include important aspects of self-directed learning, such as personal responsibility, ethics, initiative, and productivity (Battelle for Kids, 2019; NRC, 2012; OECD, 2018). The NRC report concluded that research on 21st century skills would benefit from efforts to achieve common definitions of competencies and their associated skills and activities (pp. 66-67).

Although counterintuitive, collaboration is intricately related to self-directed learning. Learners develop self-directed learning skills as they engage with others. The *intra*personal dimensions associated with self-directed learning develop through opportunities to engage in *inter*personal activities requiring collaboration, teamwork, communication, and conflict resolution. The NRC report references several school-

based interventions that improve dimensions of self-directed learning, such as motivation and self-regulation skills, by tapping into social communities that are meaningful to study participants (NRC, 2012; Yeager & Walton, 2011). This report also referenced studies demonstrating that personal responsibility and autonomy were fostered through collaboration, working in groups, and seeking help from peers or teachers (e.g., NRC, 2012, p. 97). Moreover, learners who rarely engaged in self-directed learning tasks initially experienced anxiety and fear when presented with tasks requiring substantial self-direction (Williamson, 2007). And students often resisted self-direction when they did not have experience applying self-directed learning skills in formal learning settings (Hiemstra and Brockett, 1994).

Although counterintuitive, collaboration is intricately related to self-directed learning. Learners develop self-directed learning skills as they engage with others.

Are Self-Directed Learning Skills Generic or Discipline-Specific?

Self-directed learning skills are both generic and discipline-specific. The research literature generally posits that self-directed learning skills are generic: they transfer across content area disciplines (Budge, 2000; NRC, 2012), facilitating student success in any discipline (Claro & Loeb, 2019; NRC, 2012). Self-directed learning rests on a continuum and therefore is present in individuals to some degree. Moreover, competencies required for self-direction can be practiced and developed across contexts and content domains. For example, individuals develop autonomy by engaging in activities that require autonomy and by experimenting with autonomous behaviors.

However, an individual having a high level of readiness for self-direction in one context does not necessarily have the same readiness in a new and unfamiliar context (Fisher, King, & Tague). In a similar vein, an individual's knowledge and perceived ability in a content area *does* affect self-directed learning (Abdullah, 2001; O'Shea, 2003). In this way, self-direction also is discipline specific. For example, an individual's perceived ability in a content area influences their motivation to self-direct. Novice learners demonstrating fixed mindsets may perpetuate the belief that they can't learn specific content (e.g., "I'm bad at math"), which, in turn, affects their willingness to demonstrate initiative and persist in achieving content-specific goals (Dweck, 2006; Duckworth, 2016). A growth mindset can be an effective method for encouraging self-direction and deeper learning, particularly in content areas where students may struggle.

Additionally, a certain level of content knowledge is necessary for an individual to be self-directed and influences a self-directed learner's propensity to achieve deeper learning (Dweck, 2006; Fisher, King, & Tague, 2001; NRC, 2000). For example, self-directed learners having limited content-knowledge can implement cognitive strategies for gathering information, but they may lack the content expertise to effectively integrate new information with existing knowledge. In this case, too much independence combined with insufficient content-specific instruction may limit deeper learning. This phenomenon is *the sensemaking paradox:* learners may be self-directed, yet still struggle to achieve deeper learning in a content area (Butcher and Sumner, 2011). This suggests that teachers must carefully balance intensive content-specific instruction and learning strategies with opportunities for students to practice self-direction.

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DEVELOPMENT

How Do Self-Directed Learning Skills Develop?

Empirically based milestones exist for dimensions of self-directed learning, but not for self-directed learning as a wholistic construct.

Developmental milestones are skills that most children can perform by a certain age. Empirically based milestones exist for dimensions of self-directed learning, but not for self-directed learning as a wholistic construct. Piaget's cognitive stage theory includes empirically based milestones for aspects of self-regulation and personal responsibility. By age five, for example, most children can begin to self-regulate their behaviors and emotions (including the ability to think metacognitively and control impulses). And between ages five and ten, they begin developing personal responsibility through a sense of right and wrong. Moreover, Erikson's stages of psychosocial development suggest that children begin experimenting with autonomy at age two. Skills associated with self-directed learning continue to develop as individuals progress through early adolescence into adulthood (Wilmshurst, 2013). The tenets of socio-cultural theory underlie the development of self-directed learning skills, with a central belief being that learners construct meaning through interactions with others and active engagement with the world. An individual's environment and social interactions play a critical role in shaping the learning process and the development of self-directed learning skills. Although specific developmental trajectories across the dimensions and sub-dimensions are beyond the scope of this paper, most children growing up in nurturing and caring environments during their formative years have the cognitive, social, and emotional readiness for self-directed learning by the time they enter preschool.

There does not appear to be any empirically validated developmental trajectories for self-directed learning. Some researchers have created performance scales describing different levels of self-directed learning or aspects of self-directed learning, based on hypothetical underlying sequences of development or learning. For example, the Essential Skills & Dispositions Developmental Frameworks (Lench et al., 2015) and Deep Learning Progressions (Fullan et al., 2017; Quinn, McEachen, Fullan, Gardner, & Drummy, 2020) provide analytic, multi-dimensional progressions of how students demonstrate less to more sophisticated forms of self-directed learning (among other success skills). These learning frameworks are analytic and multi-dimensional, with four or five levels of student performance. They are K-12 frameworks, broken down neither by grade level nor by grade span.

Other researchers have developed scales for measuring self-directed learning readiness. Fisher, King, and Tague (2001) define readiness as the degree to which an individual possesses the attitudes, abilities, and personality characteristics necessary for self-directed learning. (Several of the most common self-directed learning readiness scales are described in the assessment section below.)

Grow (2009) developed a continuum of self-direction. Figure 1 illustrates this continuum for both students and teachers as they interact in a formal classroom environment (Blaschke, 2012; Grow, 2009). For the student, this continuum ranges from dependent on the low end (with the teacher as authority/coach) to self-determined at the high end (with the teacher as mentor/partner). The amount of student control and freedom over the learning process increases as one moves along the continuum (Fisher, King, & Tague, 2001).

Figure 1.
Self-Directed Learning Continuum [2]

Stages of Self-Direction	Student	Teacher	Examples
5 Beyond	Self-Determined	Mentor/ Partner	Action research Self-developed project
4 High	Self-Directed	Consultant/ Delegator	Open-ended performance-, problem-, or project-based task Internship, senior project, term project Dissertation
3 Intermediate	Involved	Facilitator	Teacher-approved group projects Seminar with teacher as participant (e.g., Socratic seminar)
2 Moderate	Interested	Motivator/ Guide	Teacher-led discussion Lecture followed by guided discussion Guided practice in applying learning stategies (e.g., goal-setting) Skill-building exercises
1 Low	Dependent	Authority/ Coach	Teacher-led drill Informational lecture Coaching with immediate feedback

INSTRUCTION

What Instructional Approaches are there for Facilitating Self-Directed Learners?

Self-direction is best viewed as a continuum that exists in every person and learning situation (Morris, 2019). Moreover, a learner's readiness and propensity to engage in self-directed learning activities varies from person-to-person and is influenced by factors such as prior formal and non-formal learning experiences, metacognition, motivation, self-efficacy, and subject area interest. Some learners in a formal classroom setting will be ready to engage in self-directed learning strategies; others will not. Consequently, teachers play an important role helping learners develop and apply self-directed learning skills (Lunyk-Child, 2001).

Some learners in a formal classroom setting will be ready to engage in self-directed learning strategies; others will not. Consequently, teachers play an important role helping learners develop and apply self-directed learning skills (Lunyk-Child, 2001).

[2] Figure adapted from Grow, G. (2009). Teaching Learners to be Self-Directed. Retrieved from http://longleaf.net/wp/articles-teaching/teaching-learners-text/

Schools that promote self-directed learners embrace practices that encourage student choice, agency, and responsibility. Teachers must be able to facilitate and scaffold the learning process in addition to teaching content. Additionally, teachers must carefully balance the type and amount of support provided to students as they learn to take responsibility of their own learning with the goal of being independent learners (Morris, 2019). Instructional approaches promoting self-directed learning typically support choice and personalization, agency, responsibility, collaboration, and peer support. Common approaches include:

Instructional approaches promoting self-directed learning typically support choice and personalization, agency, responsibility, collaboration, and peer support.

- Experiential Learning
- Problem-Based Learning
- Project-Based Learning
- Inquiry-Based Learning
- Personalized Learning
- Competency-Based Learning
- Self-Assessment
- Online and Distance Learning

Under these approaches, teachers expand their role from authority figure to consultant as students carry out personalized activities to demonstrate competencies (see Figure 1). Evidence-based models have been developed to support the self-directed learning process in a personalized learning environment (English & Kitsantas, 2013; Sale, 2018; Shogren, Wehmeyer, Burke, & Palmer, 2017). Models generally support activities across three instructional phases: plan; monitor and adjust; and reflect and evaluate. Table 2 highlights classroom resources/activities, teacher responsibilities, and student responsibilities for developing self-directed learners.

Table 2.
Instructional Activities and Responsibilities to Develop Self-Directed Learning

Instructional Phase	Primary Teacher Responsibilities	Classroom Resources/ Activities	Primary Student Responsibilities
Plan	Facilitate a process for students to reflect on their learning needs and set learning goals	• Well-crafted big-idea questions to frame learning goals • Know/want to know/need to learn (KWL) sessions • Handouts that outline project objectives and key milestones • Explicit instruction, scaffolding, and modeling based on students' knowledge and readiness for ill-structured or open-ended tasks • Final product exemplars	• Set challenging goals • Identify personal interests/ choose among options • Reflect on learning needs • Develop a strategy for completion

Table 2.
Instructional Activities and Responsibilities to Develop Self-Directed Learning (continued)

Instructional Phase	Primary Teacher Responsibilities	Classroom Resources/ Activities	Primary Student Responsibilities
Monitor and Adjust	Model how to monitor learning and adjust using feedback and metacognitive thinking aloud	• Teacher and peer feedback • Student self-assessment • Whiteboards to write down ideas (i.e., making students' thinking visible) • Journaling • Prompts for student explanation	• Manage strategy use • Engage in self-observation • Monitor progress toward the goal • Maintain attention on important information related to the goal • Practice autonomy
Reflect and Evaluate	Model reflective behaviors, provide feedback and evaluate student work relative to the learning goal and standards	• Final product showcases and presentations • Teacher and peer feedback • Student self-assessment • Teacher evaluation and feedback relative to learning goal and standards	• Reflect on process and learning • Self-evaluate/compare performance to standards • Identify learning adjustments to be made • Set new goals

Plan

In this phase, teachers facilitate a process for students to reflect on their learning needs and set realistic yet challenging learning goals. Using a project-based learning approach, for instance, teachers may frame the process with big-idea questions focused on a major topic, problem or issue such as power. The topic/issue becomes a focal area to organize questions that guide instruction and learning. In a unit on World War II, essential questions might include, "How did Germany acquire and use power to expand their empire in the 1930's?" Or, "Why was the United Nations (U.N.) created, and how did the U.N. affect the distribution of power after WWII?" These questions can serve as the catalyst for identifying people, events, and issues that students are familiar with. It also allows students to explore their "need to knows," which might include understanding how the war started; what countries became involved in the war, what events influenced their involvement, and why; and events after the war that were designed to prevent future wars. Other practices shown to be effective in the planning phase include launcher activities (e.g., connecting real world practices with authentic tasks, such as using the movie Apollo 13 to introduce the scientific process)[3] and handouts that outline the project/performance task structure and key milestones. Teachers should vary the structure, explicit instruction, and modeling they provide so it matches students' existing content knowledge and familiarity with ill-structured tasks. Below are additional strategies teachers can use to develop students' self-directed learning skills:

- ***Set goals:*** Goal-setting influences motivation by making a desired future event clear and concrete. When developed to be specific, measurable, attainable, realistic and timebound (SMART), goals create an intended target to guide a teacher's instruction and motivate learner action. Goals also

[3] See Kolodner, J. L., Camp, P. J., Crismond, D., Fasse, B., Gray, J., Holbrook, J., Puntambekar, S., & Ryan, M. (2003). Problem-based learning meets case-based reasoning in the middle-school science classroom: Putting Learning by Design™ into Practice. Journal of the Learning Sciences, 12(4), 495–547. http://dx.doi.org/10.1207/S15327809JLS1204_2

promote persistence; development and modification of creative plans, and strategies to carry them out; and reference points that provide feedback on a learner's performance. After clarifying the task, teachers can support learners' personalized goals by explicitly teaching how the goal-setting process works and why it is important (Marzano, 2007).

Goal-setting influences motivation by making a desired future event clear and concrete. When developed to be specific, measurable, attainable, realistic and timebound (SMART), goals create an intended target to guide a teacher's instruction and motivate learner action.

- ***Identify personal interest and value:*** Commitment and effort toward achieving a goal are influenced by the student's interest in the associated tasks, perceived value of goal achievement, effort required, mindset (growth vs. fixed), and self-efficacy. Teachers promote self-direction by facilitating tasks that address students' personalized interests, and by helping learners balance effort required with the perceived value of achieving a goal (Csikszentmihalyi, 1997). Additionally, teachers who implement strategies for promoting a growth mindset and scaffolding the learning process improve students' learning beliefs and capabilities.
- ***Identify learning gaps:*** To succeed in a task, learners need to understand the knowledge and skills they currently have, as well as the knowledge/skill gaps that need to be addressed to achieve the goal. Formative assessment plays an integral role in helping both teachers and learners identify and attend to these gaps. Important formative assessment strategies include self-assessment, peer-assessment, teacher-led assessment, and external assessment (Tholin, 2008).
- ***Develop a strategy:*** To achieve a challenging goal, learners must exert appropriate effort, select strategies that will produce success, and adjust strategies when they are not working. These skills require metacognition – the ability to think about, and learn from, one's thinking process. Teachers facilitate metacognition by explicitly teaching students how metacognition works, modeling it, and providing opportunities for learners to use metacognitive strategies while engaging in tasks.

Monitor and Adjust

In this phase, teachers scaffold students' learning by modeling how to monitor and adjust using ***feedback***, and metacognitive thinking aloud. The role of teacher and peer feedback is essential for developing self-directed learners in this phase. Students need regular and timely feedback on the process they use and product they produce to achieve a goal. Decades of research support the idea that more feedback, *when delivered effectively*, produces greater learning (Black & William; Hattie, 2008; Marzano, Pickering & Pollack, 2001). Feedback is defined as specific information about how students are doing in their efforts to reach a goal. According to Wiggins (2012) effective feedback must be goal-referenced, tangible and transparent, actionable, specific and personalized, timely, ongoing, and consistent. Moreover, because feedback is most effective when it references a well-defined, long-term goal (e.g., see phase 1), providing frequent feedback against the goal is essential for improvement. Teachers should provide targeted, detailed and timely feedback to individuals and student groups as they engage in the learning process. They can encourage students to develop their ability to reflect and provide effective feedback using a variety of peer- and self-assessment tools.

The role of teacher and peer ***feedback*** is essential for developing self-directed learners.

Metacognitive thinking aloud is another important teacher responsibility in phase 2. As students engage in a learning task, they tap into cognitive, metacognitive, and motivational strategies to test strategies, change direction, and make progress toward goal achievement. The teacher's role is to support the learning process by making these invisible processes visible. Teachers do this by sharing how they approach a problem, applying what they already know, keeping themselves on task, and wondering aloud. Additionally, whiteboards can be an effective means of making students' thinking visible. Students can use whiteboards to document ideas, solve problems with others, and keep track of progress. They can also use whiteboards to brainstorm ideas and think about their thinking (e.g., test how processes play out by writing them out). Moreover, whiteboards and activities such as journaling and writing prompts allow teachers to identify and address students' misconceptions (English and Kitsantas, 2013).

Reflect and Evaluate

In this final phase, teachers provide opportunities for students to share work, collect and process feedback, and compare their work to other students' work and to standards. As students share their work, teachers should model reflective behaviors, provide feedback against the learning goal and standards, and evaluate final products. Time for students to showcase and gather feedback on their work is occasionally given short shrift; however, it is important because it enables students to develop self-regulation skills (Zimmerman, 2008). Moreover, research studies have found that when teachers skip or minimize the conclusion process, students learn less (Gertzman & Kolodner, 1996; Hmelo, Holton & Kolodner, 2000). As students share their work, teachers should facilitate discussion and reflection to prompt students to examine what resources were most useful, what strategies were most effective, where they struggled, and what might have worked better.

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What Do We Know About the Effects of Self-Directed Learning on Achievement?

Several studies associate self-directed learning skills with improved student achievement. These studies tend to address dimensions of self-directed learning rather than the construct in full. For example, some studies focus on related constructs (e.g., motivation and autonomy/agency), other studies focus on processes (e.g., self-regulation/self-management). Below is a summary of the research on the effects of three core dimensions of self-directed learning: self-regulation, autonomy, and motivation.

Self-Regulation

Numerous studies demonstrate the importance of self-regulation for improving student performance. For example, Duckworth et al. (2019) cited several experimental and descriptive studies that found self-control—a key dimension of self-regulation—predicted educational persistence; course grades and improvement in course grades at all levels of schooling; and successful graduation from both high school and college. Self-control also predicted achievement test scores even after controlling for measured intelligence and family socio-economic status. Similarly, conscientiousness—one of the Big Five personality traits related to self-regulation, dependability, and grit, among others—predicts academic success. In a meta-analysis involving 70,000 students from primary school through college, the relationship between conscientiousness and grades (r = .19) was not dissimilar to that between grades and measured intelligence (*r* = .23)

Numerous studies demonstrate the importance of self-regulation for improving student performance.

(Poropat, 2009, cited in Duckworth et al., 2019, p. 380). Claro and Loeb's (2019) study of 221,840 students in grades 4-7 supported prior evidence linking self-regulation to academic achievement. They reported student growth in English language arts of roughly one tenth of a standard deviation (equivalent to almost three months of learning) due to changing from a low to a high level of self-regulation. Finally, Yarbro and Ventura (2018) reported numerous studies that found significant positive effects of self-regulation skills on academic, social, and emotional outcomes.

Autonomy

Autonomy has been described as a subdimension of engagement. Whereas self-regulation focuses on what students *do* to generate and sustain engagement, autonomy focuses on *how* independently and efficaciously they do it (Toshalis & Nakkula, 2012). Therefore, strategies that promote student autonomy are those that emphasize student engagement and independence. Common strategies include (a) giving students choices in how they want to demonstrate competency or achieve a goal and (b) encouraging personal agency (Lawson & Lawson, 2013).

Personal agency in education is generally defined as the belief that an individual has control over how they respond to circumstances and events (Zimmerman, B.J., Schunk, D.H., & DiBenedetto, 2015). It encompasses notions of possibility (e.g., the power to change) and orientation (e.g., the will and skill to change), and it is influenced by innumerable personal and social factors (Klemenčič (2015). Toshalis and Nakkula's (2012) literature review on motivation, engagement, and student voice found that factors influencing agency—including student choice, control, challenge and collaborative opportunities—also influenced motivation and engagement in school and raised academic achievement in marginalized student populations (p. 27). Moreover, in recent studies on bullying, individuals were much more likely to intervene on behalf of a victim when they believed their actions would make a difference.

Learning approaches that emphasize agency and choice, such as problem-based, project-based, and inquiry-based instruction, are associated with improved academic and nonacademic outcomes. Although research on competency-based and personalized learning approaches are sparse (Pane, Steiner, Baird, & Hamilton, 2018), a strong research base supports a link between (a) problem-project, project-based, and inquiry-based learning approaches and (b) key educational outcomes. For example, Barron and Darling-Hammond's (2008) empirical review of inquiry-based learning approaches found significant effects on students' content knowledge, their ability to work in teams, solve complex problems, and apply knowledge to novel problems. More recent meta-analyses support these findings (Lazonder & Harmsen, 2016; Scott, Smith, Chu, and Freisen, 2018). Notably, Lazonder and Harmsen's (2016) synthesis of 72 empirical studies suggest that inquiry-based approaches are only more effective than teacher-directed approaches when students are given adequate support. Learners acted more skillfully during the task and scored higher on tests of learning outcomes when they had received guidance in the form of scaffolding, prompts, status updates, heuristics, and detailed explanations on how to perform tasks. Studies cautioned that such practices can be challenging to implement because they often require simultaneous changes in curriculum, instruction, and assessment practices that are new to both teachers and students (Barron & Darling-Hammond, 2008).

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Motivation

Motivation is a prerequisite to exercising both autonomy and self-regulation in learning. According to self-determination theory, a learner will act autonomously when they either enjoy the activity or they believe the activity is instrumental to attaining an important or valued outcome (Ryan & Deci, 2000). Without motivation, moreover, the learner relinquishes any perceived need to exercise self-control or to regulate emotions and behavior to persist and endure. Thus, motivation is an essential mediator of both engagement and self-directed learning (Duckworth et al., 2019).

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A large body of evidence demonstrates that developing a growth mindset influences motivation and academic achievement. Blackwell, Trzesniewski, and Dweck (2007) conducted an experiment involving 373 grade seven low-income students. Students in the experimental group were taught that intelligence is malleable and can be developed by engaging in challenging tasks, and students in the control group received a lesson on memory. Results indicated that students in the experimental group were more likely to believe that effort mattered, and more often selected effort-based strategies in response to failure. They also demonstrated higher mathematics achievement scores. Similarly, Claro, Paunesku, & Dweck (2016) used a nationwide sample of high school students from Chile to examine how growth mindset influences academic achievement at various levels of socioeconomic status. Claro et al. found that student mindset explained 11.8% of variance ($r = 0.343$) in a composite average of mathematics and language scores after controlling for all commonly observed predictors of achievement (e.g., family income, parents education). Though students from lower-income families were less likely to hold a growth mindset than their wealthier peers, students from the lowest 10th percentile of family income who did hold a growth mindset showed academic performance as high as that of fixed mindset students from the 80th income percentile. Other studies have found that students with a growth mindset tend to see difficult tasks as opportunities to increase their abilities and, in turn, seek out challenging learning experiences that enable them to do so, leading to higher academic achievement (Blackwell et al., 2007; Dweck, 2000; Dweck, 2006).

MEASUREMENT/ASSESSMENT

How is Self-Directed Learning Typically Assessed?

To assess an individual's readiness for self-directed learning, researchers tend to use questionnaires and surveys comprising categorical (e.g., basic to advanced) or numerical (e.g., 0-10) scales. Educators typically employ classroom assessments for this purpose—e.g., performance tasks, portfolios, behavioral checklists, anecdotal records, and self- or peer-assessments—which both inform instruction and complement evidence collected from questionnaires and surveys. We describe these categories of assessment in more detail below.

Questionnaires and surveys typically entail the quantification of self-directed learning readiness. Three prominent self-report surveys of self-directed learning include the Self-Directed Learning Readiness Scale (SDLRS; Guglielmino, 1978), the Oddi Continuing Learning Inventory (OCLI; Oddi, 1987), and the Personal Responsibility Orientation Self-Directed Learning Scale (PRO-SDLS; Stockdale & Brockett, 2011). Although these instruments originally targeted adult populations, several studies support their use with high school and vocational education students (Morris, 2019). Additionally, Guglielmino & Associates, LLC, now offers a version of the SDLRS for children, called the SDLRS-Elementary.

The SDLRS is a 58-item student survey using a 5-point Likert scale to measure eight factors: (a) openness to learning opportunities, (b) self-concept as an effective learner, (c) initiative and independence in learning, (d) informed acceptance of responsibility for one's own learning, (e) love of learning; (6) creativity, (f) positive orientation to the future, and (g) ability to use basic study skills and problem-solving skills. The SDLRS reports reliability coefficients greater than .85 and documents evidence of construct and concurrent validity evidence (Delahay & Choy, 2000; Timothy, Seng Chee, Chwee Beng, Ching Sing, Joyce Hwee Ling, Wen Li, and Horn Mun, 2010). The SDLRS now includes versions for non-native English speakers/emerging readers and elementary students.[4]

Comprising 24 items, the OCLI uses a 7-point Likert scale for measuring three domains: proactive/reactive learning drive, cognitive openness/defensiveness, and commitment/aversion to learning. Although studies report reliabilities greater than .80, the results of recent factor analyses suggest the OCLI leaves out important dimensions of self-directed learning, such as learner motivation, autonomy, and self-regulation (Timothy et al., 2010).

The PRO-SLDS measures four domains—initiative, control, self-efficacy, and motivation—using 25 items on a 5-point Likert scale. Reported scale reliability is greater than .85, and there is evidence of construct and concurrent validity.

Other K-12 surveys measure the narrower dimensions of self-directed learning such as project planning/monitoring, self-regulation/self-management, self-control, conscientiousness, socio-emotional regulation, persistence, metacognition, and motivation (Claro & Loeb, 2019; Yarbro & Ventura, 2018).

Performance tasks and portfolios of students' work are useful for assessing students' application of knowledge and skills to new or novel situations. High-quality performance tasks,in particular, require students to use self-direction in order to complete the task. Additionally, students can be given choices about how they demonstrate proficiency in either performance tasks or portfolios, which promotes meaningful and authentic engagement and further enhances self-direction. These assessments also allow the teacher and peers to provide formative feedback to support the learning process.

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Behavioral checklists enable educators to convey to students hard-to-observe dispositions associated with self-directed learning. Checklists most often are used during, or immediately after, instruction to monitor progress and make instructional or behavioral adjustments. For example, teachers may develop—or ask students to develop—a list of behaviors that could be evidence of self-directed learning skills, such as setting goals, staying on task, reviewing and revising work, finding alternatives when stuck, and editing with care. Teachers can use the checklists to provide feedback to students, or students can complete them as a self-assessment tool (Costa & Kallick, 2003).

Anecdotal records are brief, qualitative descriptions of student behaviors. Teachers can systematically record evidence of self-directed learning skills. For example, some teachers will tab sections of a notebook with students' names and document when a student demonstrates various skills. If done systematically, teachers will have a rich pool of data from which to write a summary of the students' self-directed learning

[4] For more information see http://www.lpasdlrs.com/

performance. Additionally, teachers can work with parents to collectively note when students demonstrate key behaviors at school and at home.

Self- and peer-assessments are useful feedback and reflection tools. Through *interviews*, for example, teachers and one's peers can help a student reflect on key skills targeted for development. Interviews provide opportunities for teachers or peers to provide feedback or recommend strategies that students can try out to improve responsibility, self-motivation, or other facets of self-directed learning. *Journals and logs* are another form of self-assessment for documenting behaviors when students are engaged in specific activities or content. Students can review logs to identify patterns of behavior that may emerge at certain times of day or during regular activities. They also can evaluate their success in using strategies to control their emotions or improve behavior. Teachers can provide support by offering *daily or weekly prompts* for students to respond to and setting aside time for meaningful student reflection. *Other self-assessments,* such as goal-setting worksheets or graphic organizers with process-oriented prompts, also can be useful tools for self-reflection.

What are the Assessment Issues Related to Self-Directed Learning?

Soland et al. (2013) provide three considerations when selecting or designing measures of 21st century competencies: instructional, practical, and technical. Instructional considerations focus on the use of the assessment information. For example, is the measure intended to be used formatively or summatively? Does it provide actionable information to teachers, or useful feedback to students? Is the measure grade, context, or culturally appropriate? Practical considerations relate to cost and ease of administration, delivery, and scoring. And technical issues center on validity, reliability, and fairness.

The desired inferences that educators wish to make from assessment results will influence what evidence will be collected.

The desired inferences that educators wish to make from assessment results will influence what evidence will be collected (NRC, 2011; Wilson et al., 2012). The development of educational and psychological tests typically proceed as follows: define the targeted construct; create relevant tasks and item types to elicit responses; thoughtfully consider the various administration issues; determine the values, codes, or scores to be assigned to student responses; pilot the assessment, using a large and diverse sample of students; model and analyze responses, attending to technical issues such as validity, reliability, and test fairness.

What are the Implications of Prior Research for Assessment Design and Use?

Self-direction is best learned through observation (e.g., watching others self-direct), teacher modeling, and guided practice. Students therefore need ample opportunities to be taught self-directed learning skills and, further, to observe and practice these skills in their community. Schools that adopt constructivist and socio-cultural learning approaches, such as personalized and problem-based learning, are better equipped to facilitate self-directed learning. By adopting these approaches, furthermore, teachers have the flexibility to personalize the level of self-regulation, choice, and independence to which students are exposed as they work toward self-direction. However, scaling up these approaches requires systemic shifts in curriculum, instruction, assessment, and professional development. The major implications for assessment design and use are summarized below.

Assessment Design

Assessments can be designed to measure targeted dimensions of self-directed learning. The most useful assessments elicit observable evidence and allow students to demonstrate the highest forms of self-directed learning. Evidence-centered design (ECD) is a process for developing assessments of such hard-to-observe constructs as self-directed learning. ECD incorporates validity arguments into the design process, rather than seek validity evidence after administration. ECD views an assessment as an evidence-based argument, using things that students say, do, or create to make inferences about the extent of their knowledge, skills, and abilities (Mislevy & Haertel, 2006). Through the ECD process, assessment developers delineate the types of *evidence*—an interrelated set of knowledge, skills, and abilities—known to reflect a construct or competency. This collection of evidence is then structured to reflect the relative importance in demonstrating each competency. Rubrics can be designed to capture the intended evidence, and weight of that evidence, toward measuring the overall competency. Finally, cycles of iteration are typically needed to refine the assessment rubric/measure.

Additionally, assessment tasks should reflect how context and culture matter. Self-directed learning tasks that work well in one setting, context, or culture may not work equally well in another (Soland et al., 2013). Attending to cross-cultural validity is critical, although sparse in the literature (Ercikan & Oliveri, 2016). As Soland et al. argue, "Extra caution is warranted when considering measures of 21st century competencies, particularly interpersonal and intrapersonal competencies, because these may be more culturally and contextually dependent than traditional academic skills. To the extent possible, the validity of scores on a given measure should always be confirmed locally" (p. 41).

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Assessment Use

There are many challenges with assessment use regarding 21st century skills. First and foremost, there is no clear end of grade-level or grade-span standards that define proficiency for any of the success skills, including self-directed learning. There are at least a few research-based, hypothesized learning frameworks of how students demonstrate less to more sophisticated forms of self-directed learning (among other success skills) in the literature (e.g., Lench et al., 2015; Quinn, McEachen, Fullan, Gardner, & Drummy, 2020). These learning frameworks are analytic and multi-dimensional, typically with four or five levels of student performance, and describe performance in grades K-12, in that they are not broken down by grade level or grade span.

Empirically validated learning progressions do not yet exist for the success skills. Consequently, it is unclear how students develop competence in the domain of self-directed learning. There are no expected levels of self-directed learning at certain markers in time. It also is unclear what exactly (if anything) becomes more complex over time related to self-directed learning skills. For example, is it the case that diagnosing learning needs, choosing resources, or reflecting on learning tasks becomes more sophisticated over time, or is it that the assessment tasks and disciplinary content to which students apply self-directed learning skills become more complex or novel over time? Or is it a combination of both?

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An additional challenge with assessment use relates to the creation of rubrics to score and grade student performance in any particular student success skill. Rubrics imply scoring and grading, and grading can have negative effects on learning (Shepard, 2019). This is because grading can elicit comparisons among students, which can adversely affect student motivation. More, specifically, grading 21st century skills is fraught with potential unintended consequences, as the measures are not sufficiently accurate at the individual student level and distort the meaning of grades as indicators of academic achievement. That said, technical concerns are not the primary reason why educators and school systems should avoid grading student success skills.

> *Giving points for effort and collaboration leads to the commodification of these endeavors and invites a performance orientation, for example, working to please the teacher, rather than supporting students to develop a learning or mastery orientation. Factors that enable learning…are more appropriate as targets for formative feedback than for grading. (Shepard, 2019, p. 191)*

In this context, grading is especially problematic to the extent that student grades are dependent on valid student- and peer-assessments/ reflections on the quality of self-directed learning.

In this context, grading is especially problematic to the extent that student grades are dependent on valid student- and peer-assessments/reflections on the quality of self-directed learning. One can imagine a student being honest with what they thought they did well and how they could improve on their self-directed learning (e.g., self-regulating behavior, persisting through challenges, exercising autonomy) if they knew the information would only be used for formative purposes. However, student responses will likely suffer from response-set biases, such as social desirability bias, as soon as they realize their grades are dependent on their own and others' assessment of their self-directed learning skills. Additionally, there is a long and deep research base related to assessment for learning and how students learn more from written formative feedback than grades (Black & Wiliam, 1998).

For these reasons, we suggest not using the language of a rubric, but instead creating research-based continua to describe student performance from less to more sophisticated. These continua would be pilot tested on student work in local contexts to evaluate the extent to which they accurately reflect how students across socio-cultural contexts and conditions demonstrate competence in the domain.

Additionally, the continua would provide useful, formative information that teachers could use during self-directed learning activities to guide instruction and provide feedback to students on their level of self-directedness. The pilot testing could determine if the continua provide useful feedback to students, parents, and teachers for instructional purposes. Being provided specific behaviors to look for during self-direction activities would help teachers know what skills to teach. Further, students could keep these behaviors in mind as they aim to improve their self-directed learning skills over time. Annotated student work samples from across disciplines and types of assessment tasks would be especially useful in helping teachers to recognize markers for the essential dimensions of self-directed learning in student work products and artifacts.

Being provided specific behaviors to look for during self-direction activities would help teachers know what skills to teach. Further, students could keep these behaviors in mind as they aim to improve their self-directed learning skills over time.

CONCLUSION

This paper synthesized literature across multiple disciplines to conceptualize and describe self-directed learning, report on research findings, and discuss the corresponding implications for assessment design and use. Overall, this literature shows self-directed learning to be a multi-dimensional construct that is considered from varying perspectives across many disciplines. Original definitions focused on the process of self-directed learning and recognized the critical role of social context in its development. More recent definitions recognize the cognitive and intrapersonal dimensions associated with self-directed learning, and incorporate the role of mindset and motivation.

Self-directed learning develops along a continuum, from teacher-directed at one end to self-determined at the other. Students' readiness and willingness to move along this continuum depends on many factors. Among them are personality, ability to self-regulate, prior experiences, self-efficacy, domain-specific knowledge/skill, motivation, and existing context and circumstances. Though early research suggested that certain intelligence and personality traits were fixed, a large body of recent research refutes these findings, showing instead that such traits are malleable. Thus, one can develop and improve cognitive functions and intrapersonal skills associated with self-directed learning.

A growing body of research points to instructional approaches for improving self-directed learning, such as inquiry-, problem-, and project-based learning. These approaches are nested in constructivist and socio-cultural theories, which define learning as a socially constructed process. Using these approaches, self-directed learning develops through collective problem-solving, collaboration, and community engagement, as well as opportunities to make choices and practice independence, agency, and personal responsibility. Assessments well-suited to these approaches include performance and portfolio assessment that incorporate self-assessment prompts for gathering evidence about students' level of self-direction.

There appears to be no empirically validated developmental trajectories associated with self-directed learning skills. Moreover, many questions remain, such as how do self-directed learning skills develop and progress? Are there differential effects associated with levels of self-directed learning and achievement in specific content areas? How do motivation, personality, cognition, and context individually and collectively influence the development of skills associated with self-directed learning? Importantly, how do these individual skills build toward self-directed learning and, ultimately, self-determination? Are some skills more easily associated with age than others? And how can assessment be used with teachers, parents, and students to maximize both self-directed learning and performance? Continued research and reflective practice on these and other questions will influence districts' and schools' ability to develop the skills they need to thrive in the 21st century.

There appears to be no empirically validated developmental trajectories associated with self-directed learning skills. Moreover, many questions remain.

Assessing 21st century skills such as self-directed learning is challenging. Educators must attend to the way the assessment task design encourages all students to plan, manage, adjust, and reflect on the learning process; sustain motivation throughout the learning task; take responsibility for their actions; exercise integrity; and act independently. At potential odds with instructional goals is creating self-directed learning rubrics to score and grade students. Given the lack of empirical evidence related to how students should develop competence in the holistic concept of self-directed learning by the ends of certain periods of time

(end of grade, end of grade span, end of 12th grade), we recommend that draft self-directed learning continua be created to describe student performance from less to more sophisticated using shared markers of self-directed learning across the research literature. We recommend the pilot testing of these draft continua against student work to determine the accuracy of their descriptions of student performance and usefulness for teaching and learning purposes in K-12 classrooms.

Given the lack of empirical evidence related to how students should develop competence in the holistic concept of self-directed learning by the ends of certain periods of time (end of grade, end of grade span, end of 12th grade), we recommend that draft self-directed learning continua be created to describe student performance from less to more sophisticated using shared markers of self-directed learning across the research literature.

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