Research Report

2022-07

Cross-Cutting Capabilities

Transferable Skills for the 21st Century

KRISTIN LANSING-STOEFFLER; NOLA DALEY, PhD

ACT®

Conclusions

As the global economy transforms into a knowledge-based society with an enhanced focus on information and innovation, success will depend on the ability of global citizens to work effectively with knowledge and technology (Drucker, 1993; Sawyer, 2006; Schwab, 2017). Working effectively with knowledge and technology requires thinking critically and creatively, solving problems collaboratively, using technology effectively, and understanding our capabilities as lifelong learners. ACT includes these cross-cutting capabilities (CCCs) in the ACT® Holistic Framework®. The goal of this inclusion is to ensure that students have the opportunity to learn these skills, to prove their proficiency with them, and to improve in their use of them.

So What?

The inclusion of these skills in the classroom requires the ability to continue to effectively define, teach, and measure these skills in a way that will allow us to track, cultivate, and share student proficiency. Defining and organizing the CCCs so they can be taught and measured is a critical first step that drives the design and development of learning and measurement tools. In the current paper, we provide ACT's construct definitions for these skills based on prior research, including research into how individuals use these skills in applied settings. We also provide an overview of the value and application of these skills in academic and workforce settings.

Now What?

We continue to make progress toward learning and measuring these essential skills in the classroom. We continue to refine our definitions of the constructs and the skills that reflect their use in the real world to build new bridges between academics and the workforce. We continue to improve our ability to measure these skills in order to ensure learners are gaining and sharing the capabilities that they will need to transform lives and drive economies in the real world.

About the Authors

Kristin Lansing-Stoeffler

Kristin is a Sr. Learning Solutions Designer focused on the learning and measurement of 21st-century skills.

Nola Daley

Nola is a Research Scientist in ACT's Center for Social, Emotional, and Academic Learning.

Introduction

As the global economy transforms into a knowledge-based society with an enhanced focus on information and innovation, success will depend on the ability of global citizens to work effectively with knowledge and technology (Drucker, 1993; Sawyer, 2006; Schwab, 2017). Working effectively with knowledge and technology requires thinking critically and creatively, solving problems collaboratively, using technology effectively, and understanding our capabilities as lifelong learners. These skills are referred to as 21st-century skills or cross-cutting capabilities (CCCs). Given the importance of CCCs for success in academics and the workforce, ACT includes these skills in the ACT® Holistic Framework® (Camara et al., 2015).

The ACT Holistic Framework was created to support a more comprehensive approach to defining the knowledge and skills required to succeed in education, careers, and beyond. The Holistic Framework includes core academic subjects (e.g., math, science, English language arts), social and emotional (SE) skills, skills required for successful navigation of education and career decisions, and CCCs. CCCs are a collection of domain-general skill sets that, when used in concert with core academic knowledge and SE skills, empower learners to fulfill their potential as effective and creative knowledge seekers, communicators, and problem solvers. The Holistic Framework uses the term CCCs to focus on the role that these skills play in supporting the acquisition and application of knowledge across domains.

CCCs have been identified as essential for success in the modern classroom and modern society (Organisation for Economic Co-operation and Development [OECD], 2018; Schleicher, 2020; United Nations Children's Fund, 2022; World Economic Forum [WEF], 2016). The 21st-century skills that we include as CCCs are both commonly emphasized as essential skills by leading organizations (National Research Council, 2012; OECD, 2009, 2013, 2017, 2018, 2019; WEF, 2019) and transferable across domains. ACT's five cross-cutting capabilities are critical thinking, creative thinking and innovation, collaborative problem-solving (CPS), information and communication technology (ICT), and self-directed learning.

In addition to receiving support from leading organizations, CCCs are also shown by research to contribute to important academic outcomes. Critical thinking skills are correlated with GPA (Facione, 1991; Sternberg, 1986). Similarly, creative thinking is linked with improved academic performance, particularly among lower performing and historically underserved students (Yang & Zhao, 2021). Likewise, collaborative problem-solving skills are related to student learning (Laal & Ghodsi, 2012; Terenzini et al., 2001). Regarding information and communication technology, the rise and role of technology in the classroom has become a pivotal issue in recent years (Timmers, 2018). Not only has technology in the classroom been found to improve student engagement and motivation (Mo, 2011), but the acquisition of ICT skills has been found to improve students' academic performance (Ben Youssef et al., 2022). Self-directed learning skills are related to academic performance (e.g., Dent & Koenka, 2016). Additionally, interventions that aim to improve students' self-directed learning skills can increase academic achievement (Dignath & Büttner, 2008; Jansen et al., 2019; Oz, 2021).

Ensuring that students learn cross-cutting capabilities and improve their proficiency with them requires that these skills be effectively measured and taught in classrooms. To measure and teach these skills effectively, we must clearly define them. The current paper provides ACT's construct definitions for these skills. In the future, ACT will continue to provide innovative, research-based insights regarding the learning and measurement of CCCs.

The Cross-Cutting Capabilities

The CCC skills included in the ACT Holistic Framework are (1) critical thinking, (2) creative thinking & innovation, (3) collaborative problem-solving, (4) information & communication technology, and (5) self-directed learning. (See Figure 1.)

Figure 1. ACT Holistic Framework Cross-Cutting Capabilities

Defining and organizing these CCCs so they can be taught and measured is a critical first step that drives the design and development of learning and measurement tools. In the following sections, we define each of the CCCs and its associated skills. We begin by providing the ACT definition for each skill, which is based on prior research, including research into how individuals use these skills in applied settings. We also provide an overview of the value of these skills in academic and workforce settings.
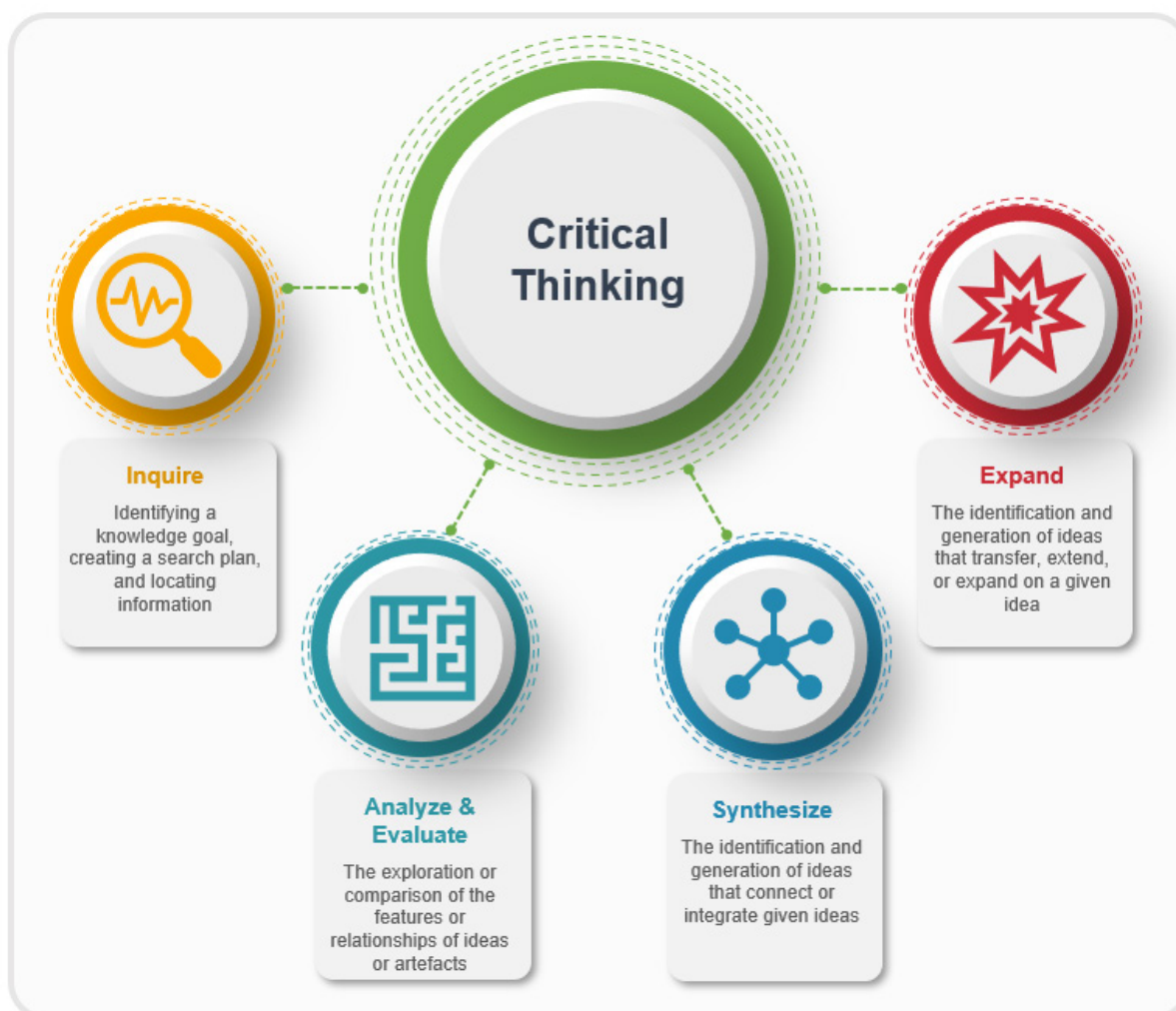
Critical Thinking

ACT's Definition of Critical Thinking

The ACT Holistic Framework's definition of critical thinking focuses on a set of critical thinking skills as they are applied in educational contexts and, often implicitly, in common classroom and assessment tasks. ACT's critical thinking skills are decontextualized and transferable across contexts and content. The Holistic Framework defines critical thinking as the skills and processes that support the critical consideration of ideas and information for the purpose of making a determination, decision, or judgment. These skills often build on each other to support more complex understanding and application of ideas and information.

The ACT critical thinking skills are inquire, analyze & evaluate, synthesize, and expand. (See Figure 2.)

Figure 2. ACT Holistic Framework Cross-Cutting Capabilities: Critical Thinking Skills and Definitions

While definitions of critical thinking vary across the fields of philosophy, psychology, and education, they all agree that critical thinking includes skills that support analysis; making inferences using reasoning; problem-solving; and making judgements, evaluations, and decisions (Lai, 2011). ACT's definition of critical thinking builds on the educational approach to critical thinking, which focuses primarily on the demonstration of higher-order thinking skills in an educational context (Lai, 2011).

Critical thinking skills are found in many contextualized applications across domains and curricula (Bailin et al., 1999; Case, 2005; Ennis, 1989; Pithers & Soden, 2000; Silva, 2008). For example, students are asked to locate information from various sources in classroom settings; to categorize information, differentiate between ideas, explain their thoughts or work, and compare information; to summarize information or their understanding, integrate ideas, and connect information; to extend information by identifying a likely outcome or the next steps in a process; and to transfer information to a different context.

Why Focus on Critical Thinking?

Educators and the workforce place high value on critical thinking skills, seeing these skills as necessary for success. Such skills have been highlighted by the World Economic Forum (WEF) as critically important for the current and future workforce (WEF, 2019). The Organisation for Economic Co-operation and Development (OECD) has also prioritized critical thinking skills by including critical thinking in its report *The Future of Education and Skills: Education 2030* (OECD, 2018). Employees in the workforce also recognize the importance of critical thinking for success in their work. Employees in the 2016 ACT National Curriculum Survey ranked critical thinking as the third most important skill for success, behind only content knowledge and conscientiousness (ACT, 2016). Similarly, high school, middle school, and elementary school educators in the ACT National Curriculum Survey all ranked critical thinking as the most important skill for success in the classroom. Postsecondary educators ranked critical thinking second, behind only study skills (ACT, 2016). Taken together, these endorsements demonstrate that critical thinking skills are viewed as important in the workforce and at all levels of schooling.

Creative Thinking & Innovation

ACT's Definition of Creative Thinking & Innovation

The ACT Holistic Framework's definition of creative thinking focuses on the skills and processes that support the development of a creative thinking and innovation skill set as it is applied in educational and workforce contexts. Beyond identifying effective creative thinkers, we focus on identifying and cultivating the skills that support the processes involved with creative thinking and innovation. To support the development and improvement of students' creative thinking and innovation skills, we include skills that support the creative thinking process, such as the ability to identify and generate unconventional ideas. Further, we also emphasize the importance of understanding the difference between an unconventional idea and an idea that is unique but implausible, not useful, or inappropriate. The Holistic Framework defines creative thinking and innovation as the skills and processes involved with the generation of ideas that are unconventional, original, or innovative. ACT's creative thinking & innovation skills include understanding conventions, identifying and generating diverse ideas, identifying and generating unconventional ideas, and evaluating and improving the unconventionality, plausibility, and usefulness of existing ideas. ACT's creative thinking & innovation skills are conventional thinking, diverse thinking, unconventional thinking, and evaluate & improve. (See Figure 3.)

Figure 3. ACT Holistic Framework Cross-Cutting Capabilities: Creative Thinking & Innovation Skills and Definitions

Conventional Thinking
The identification and generation of conventional ideas in compliance with given criteria

Unconventional Thinking
The identification and generation of unconventional or unique ideas in compliance with given criteria

Creative Thinking & Innovation

Diverse Thinking
The identification and generation of diverse ideas in compliance with given criteria

Evaluate & Improve
The identification and generation of ideas that iterate and improve on given ideas to improve creativity

Prior conceptualizations of creative thinking focused on its role in generating ideas that defy conventions while maintaining value as appropriate for the given context (Kaufman & Sternberg, 2010; Mumford et al., 2012; Sternberg, 1999). The PISA 2021 Creative Thinking Framework focuses on the processes required to generate an unconventional idea as well as the skills required to refine ideas with the intention of increasing their unconventionality (OECD, 2019). ACT's definition builds on these concepts to focus on skills and processes that support learning as well as measurement.

Students are often asked to use creative thinking and innovation skills in the classroom. For example, they might be asked to identify or follow certain rules or conventions that could be seen as stepping-stones to generating unconventional ideas. In addition, students are often asked to brainstorm different ideas or generate multiple solutions to a problem, which is considered key to the process of generating unconventional ideas. Students are also asked

to evaluate, critique, augment, and improve either their own ideas or the ideas of classmates. These are all aspects of the creative thinking and innovation process.

Why Focus on Creative Thinking and Innovation?

Creative thinking and innovation skills have the potential to be significant differentiators in academia and the workforce. These skills help students stand out among their peers and help workers contribute to the advancement of their industries. Colleges and universities have recognized the value of this impactful skill set in transforming content knowledge into innovative and potentially world-changing solutions. As a result, colleges and universities increasingly highlight these skills as differentiators for admissions (Adobe, 2020; Pretz & Kaufman, 2017).

Collaborative Problem-Solving

ACT's Definition of Collaborative Problem-Solving

The ACT Holistic Framework's definition of collaborative problem-solving focuses on the ways in which collaborative problem-solving skills are applied in educational and workforce contexts. In particular, students and employees frequently use these skills when they are asked to engage in peer-supported learning and group work. The Holistic Framework defines collaborative problem-solving as the social and cognitive skills and strategies required to collaborate with a group to work toward a common goal. The ACT collaborative problem-solving construct differentiates between two skill sets, team effectiveness and task effectiveness. These skill sets, used in concert, support effective and efficient collaborative problem-solving. Team effectiveness addresses interdependence through the distribution of resources or roles. The team effectiveness skills are inclusion; clarity of roles, goals, and tasks; commitment; and communication. Task effectiveness includes individual contributions to achieving group goals. The task effectiveness skills are problem orientation, strategy, execution, and monitoring & evaluation. (See Figure 4.)

Figure 4. ACT Holistic Framework Cross-Cutting Capabilities: Collaborative Problem-Solving Skills and Definitions

Prior conceptualizations of collaborative problem-solving by Hesse et al. (2015) and the PISA 2015 Collaborative Problem-Solving Framework (OECD, 2017) focus on the social and cognitive skills that support individuals' ability to work collaboratively toward a common goal. ACT's definition builds on these concepts to focus on task effectiveness and team effectiveness, employing ACT's social and emotional framework as a foundation for the social and emotional aspects of collaboration (Casillas et al., 2015).

The use of collaboration skills in supporting learning in the classroom has been well-established (Crouch & Mazur, 2001; Dillenbourg, 1999; Hmelo-Silver et al., 2013; Johnson et al., 2007; Stahl et al., 2006; Webb et al., 1995). In the classroom, students are often asked to work as a team to complete a task or project in which resources, roles, or activities are distributed among the team members, who are given a common goal. In addition, students are often asked to develop a strategy for achieving this goal and monitor their progress toward it. In these tasks, the team's success requires all team members' communication, negotiation, and coordination of effort, input, and contributions. These activities encompass both the cognitive and non-cognitive skills involved with collaborative problem-solving.

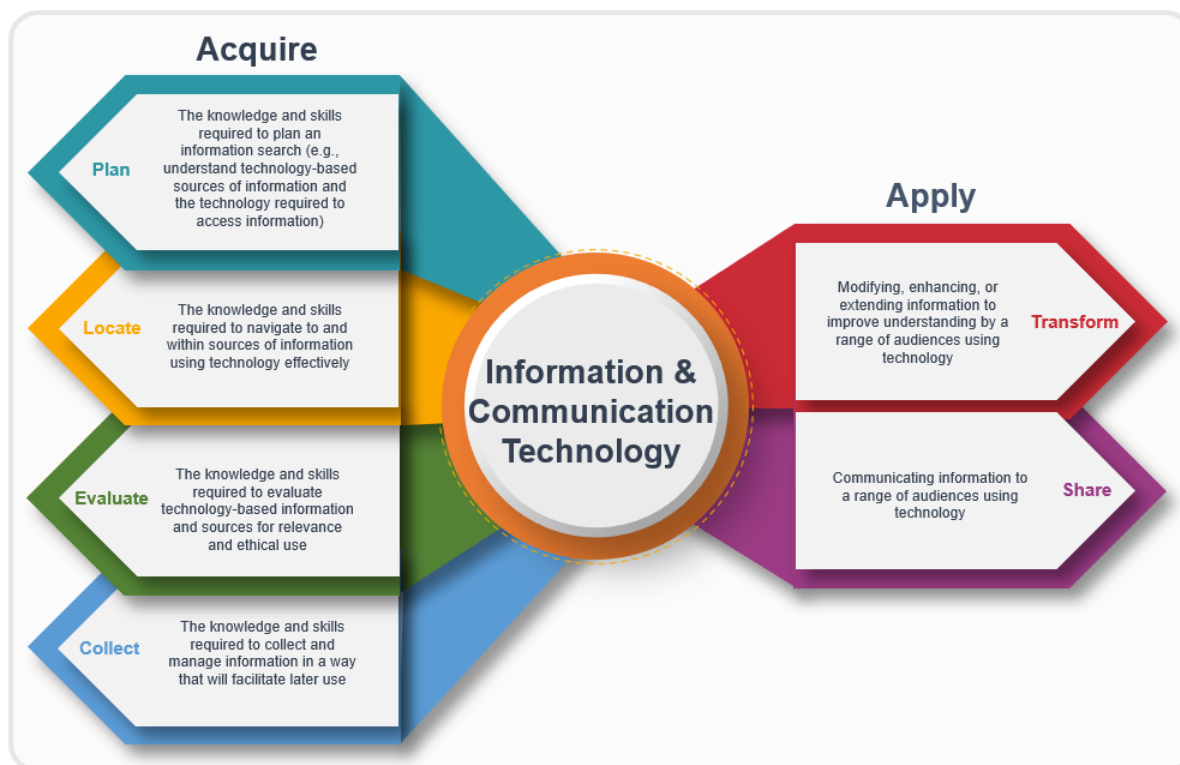## *Why Focus on Collaborative Problem-Solving?*

Modern society places a high value on innovation and problem-solving. The advanced nature of the problems to be solved and the innovation required to solve them often require coordinated expertise rather than simply an individual expert (Schwab, 2015). This coordination presents unique challenges. Individuals working in a team must use their expertise, problem-solving skills, collaboration skills, and aptitude for eliciting the expertise of others. For this reason, collaborative problem-solving skills are included in the major initiatives outlining the skills required for the education and workforce of the future (OECD, 2018; Schleicher, 2020; United Nations Children's Fund, 2022; WEF, 2016).

Information & Communication Technology (ICT)

ACT's Definition of ICT

The ACT Holistic Framework's ICT framework focuses on the ICT skills that support the ability to acquire and apply information using technology. The Holistic Framework defines ICT skills as the technology knowledge and skills required to effectively acquire and apply information. The ACT construct differentiates between two ICT skill sets: the skills needed to acquire information (acquire skills) and the skills needed to apply it (apply skills). Acquire skills focus on understanding sources of information, the technological tools required to navigate them, and the ways in which various forms and quantities of information can be collected for later use or reference. Apply skills focus on understanding how technology can be used to effectively transform and share information with a wide range of audiences. Acquire skills include the ability to plan, locate information, evaluate information, and collect information. Apply skills include the ability to transform and share information. (See Figure 5.)

Figure 5. ACT Holistic Framework Cross-Cutting Capabilities: Information & Communication Technology Skills and Definitions

The International Computer and Information Literacy Study (ICILS) provides one of the most widely accepted international definitions of information and technology skills. The ICILS defines computer and information literacy as "an individual's ability to use computers to investigate, create, and communicate in order to participate effectively at home, at school, in the workplace, and in society" (Fraillon et al., 2013, p. 17). ACT's definition of ICT builds on this definition with a focus on the foundational technology skills required for acquiring and applying information.

Few skills could be more impactful in the 21st century than the ability to effectively acquire and apply information using technology. ICT skills have become a critical component of both acquiring and applying knowledge in the classroom. For many students, ICT skills have become heavily embedded in daily tasks such as accessing class activities, searching for information, and accessing learning tools online regardless of school format (e.g., virtual, hybrid, in-person) (Project Tomorrow, 2021). ICT skills, including the use of multimedia, have also become essential tools for group collaboration and the production of classwork, documentation, and presentations. Defining ICT skills in a way that reflects their inclusion in educational contexts requires a focus on the frequency with which students are asked to engage with technology to complete even the most foundational of classroom activities.

Why Focus on ICT?

The role of technology in the classroom has been amplified by the worldwide COVID-19 pandemic, which pushed many schools and students to quickly adopt and adjust to

computer-mediated online learning. In the United States, students in Grades 3–12 have seen, on average, a 29% increase in the use of school-provided Chromebooks since pandemic-related school closures began. In 2020, over 80% of students in Grades 3–8 and 65% of students in Grades 9–12 used Chromebooks (Evans, 2020). With these and other technologies, students can learn effectively and apply that learning. Technology also plays a critical role in the workforce, and the expanding demand for the technology skills required in an increasingly international and technology-based economy makes ICT a critical skill for the future workforce (WEF, 2020). The value of this skill set is also highlighted by the inclusion of digital skills in the PISA 2025 Innovative Framework (OECD, 2022), which notes their importance for solving problems and acquiring new knowledge and skills.

Self-Directed Learning

ACT's Definition of Self-Directed Learning

The ACT Holistic Framework's definition of self-directed learning focuses on a set of skills used in formal and informal contexts to support independent student learning. The Holistic Framework defines self-directed learning as the active processes through which students monitor their learning, make adjustments, and use strategies to achieve their learning goals. ACT organizes self-directed learning into three phases and eight skills. These phases and skills were selected due to their inclusion in prior frameworks of self-directed learning and their importance to student learning. The three phases are prepare, execute, and evaluate. The eight skills are identify task, set goals, plan, implement, monitor, adjust, reflect, and adapt. (See Figure 6.)

Figure 6. ACT Holistic Framework Cross-Cutting Capabilities: Self-Directed Learning Skills and Definitions

Although conceptualizations of self-directed learning[1] vary based on different theoretical frameworks, these frameworks generally agree that self-directed learning is an active process through which students use strategies and monitoring to manage their learning (Greene & Azevedo, 2007). Additionally, many frameworks of self-directed learning suggest students proceed through three phases: a preparatory phase, a performance phase, and an appraisal phase (Jansen et al., 2019; Panadero, 2017). In addition to these common phases, eight skills are included in most of the frameworks commonly used in research on self-directed learning (e.g., Pintrich, 2000; Winne & Hadwin, 1998; Zimmerman, 2000). These skills include evaluating the task, goal setting, planning, implementing strategies, monitoring, adjusting, reflecting, and adapting. ACT's definition of self-directed learning builds on these prior concepts of self-directed learning and on empirical evidence linking these skills to student learning.

To illustrate how students use these skills in their everyday lives, take the example of a student studying for a vocabulary test. This student thinks of this as a multiday task and expects to do well on the test because they have high self-efficacy and strategy knowledge (evaluating the task). As such, they set the goal of getting an A on the test (goal setting).

---

[1] The research literature we refer to here uses the term self-regulated learning. We use the term self-directed learning for consistency with ACT's Holistic Framework.

Based on this goal and their strategy knowledge, they make the plan of creating flashcards to review the vocabulary terms (planning). They then make the flashcards and begin to go through each term the following night (implementing strategies). While going through the terms, they notice they are having difficulty remembering a subset of the words (monitoring). They decide to put those terms aside and devote additional study time to them the next day (adjusting). After revisiting these terms, they decide to stop studying based on the judgment that they have met their initial goal and are prepared for the upcoming test (reflection). They also decide that using flashcards worked well for them and continue using this strategy for future vocabulary tests (adaptation). This example highlights a relatively effective implementation of self-directed learning skills.

Why Focus on Self-Directed Learning?

In both formal and informal educational settings, students have control over at least some aspects of their learning experience and thus need the skills to effectively learn independently. Indeed, the use of self-directed learning skills relates to student learning (e.g., Geller et al., 2018; Thiede et al., 2003; Yusuff, 2018; Zimmerman & Kitsantas, 1996; Zimmerman & Martinez-Pons, 1992). For instance, using more effective study strategies is related to greater learning (Hartwig & Dunlosky, 2012; Zepeda & Nokes-Malach, 2021). Furthermore, more accurate monitoring is associated with more effective regulation and increased learning (Guo, 2022; Hartwig et al., 2012; Son & Metcalfe, 2000). Despite the importance of these self-directed learning skills, students are seldom taught these skills directly (Kornell & Bjork, 2007; Lawson et al., 2019). Thus, more direct instruction on self-directed learning skills is needed to support effective student learning. Consistent with this possibility, interventions that aim to improve students' self-directed learning skills can increase academic achievement (Dignath & Büttner, 2008; Jansen et al., 2019; Oz, 2021).

Summary

The goal of the inclusion of CCCs in the ACT Holistic Framework is to ensure that students have the opportunity to learn these skills, to prove their proficiency with them, and to improve in their use of them. To do that requires the inclusion of these skills in the classroom. This inclusion requires the ability to continue to effectively define, teach, and measure these skills in a way that will allow us to track, cultivate, and share student proficiency.

These skills are not only transferable, they are durable in the sense that they have long been required for success in academics, the workforce, and beyond, and will continue to be in the future (WEF, 2015). Inclusion of these skills in academics, admissions, and hiring practices allows learners to share a range of their strengths that go beyond traditional core academics. The skills also align with a broader range of education and workforce needs (Schleicher, 2020; Schwab, 2015; WEF, 2015) while—as in the case of creative thinking—mitigating gender and cultural testing biases as barriers to success (Kaufman, 2010; Kim & Zabelina, 2015). Future research will continue to explore the role these skills can play in improving equity and supporting all students.

We continue to make progress toward the learning and measurement of these essential skills in the classroom. We continue to refine our definitions of the constructs and the skills that reflect their use in the real world and build new bridges between academics and the workforce. We continue to build tasks that reflect the use of these skills in a range of real-world contexts. With these efforts, we continue to improve our ability to measure these skills in a way that is reliable and valid so that we can ensure students are gaining and sharing the capabilities that they will need to transform lives and drive economies in the real world.

References

ACT. (2016). *ACT national curriculum survey® 2016*.
https://www.act.org/content/dam/act/unsecured/documents/NCS_Report_Web_2016.pdf

Adobe. (2020). *The deciding factor: The case for a more holistic measure of student success*.
https://www.adobeforeducation.com/hubfs/Deciding_Factor_Sept_2020/pdf/adobe_deciding_factor_full_research_deck_ext_sept2020.pdf

Bailin, S., Case, R., Coombs, J. R., & Daniels, L. B. (1999). Conceptualizing critical thinking. *Journal of Curriculum Studies*, *31*(3), 285–302.

Ben Youssef, A., Dahmani, M., & Ragni, L. (2022). ICT use, digital skills and students' academic performance: Exploring the digital divide. *Information*, *13*(3), 129. https://doi.org/10.3390/info13030129

Camara, W., O'Connor, R., Mattern, K., & Hanson, M. A. (2015). *Beyond academics: A holistic framework for enhancing education and workplace success*. (ACT Research Report No. 2015 [4]). ACT.
https://www.act.org/content/dam/act/unsecured/documents/ACT_RR2015-4.pdf

Case, R. (2005). Moving critical thinking to the main stage. *Education Canada*, *45*(2), 45–49.

Casillas, A., Way, J., & Burrus, J. (2015). Behavioral skills. In R. O'Connor, W. Camara, K. Mattern, & M. A. Hanson (Eds.), *Beyond academics: A holistic framework for enhancing education and workplace success* (ACT Research Report No. 2015 [4]) (pp. 25–38). ACT.
https://www.act.org/content/dam/act/unsecured/documents/ACT_RR2015-4.pdf

Crouch, C. H., & Mazur, E. (2001). Peer instruction: Ten years of experience and results. *American Journal of Physics Teachers*, *69*(9), 970–977. https://doi.org/10.1119/1.1374249

Dent, A. L., & Koenka, A. C. (2016). The relation between self-regulated learning and academic achievement across childhood and adolescence: A meta-analysis. *Educational Psychology Review*, *28*(3), 425–474. https://doi.org/10.1007/s10648-015-9320-8

Dignath, C., & Büttner, G. (2008). Components of fostering self-regulated learning among students. A meta-analysis on intervention studies at primary and secondary school level. *Metacognition and Learning, 3*(3), 231–264. https://doi.org/10.1007/s11409-008-9029-x

Dillenbourg, P. (Ed.). (1999). *Collaborative learning: Cognitive and computation approaches* (2nd ed.). Emerald Group Publishing Limited.

Drucker, P. F. (1993). The rise of the knowledge society. *The Wilson Quarterly*, *17*(2), 52–72.

Ennis, R. H. (1989). Critical thinking and subject specificity: Clarification and needed research. *Educational Researcher*, *18*(3), 4–10.

Evans, J. A. (2020). *Digital learning during the pandemic: Emerging evidence of an education transformation* [National report]. Project Tomorrow. https://tomorrow.org/speakup/pdfs/2020%20Speak%20Up%20National%20Report.pdf

Facione, P. A. (1991). *Using the California critical thinking skills test in research, evaluation, and assessment.* California Academic Press. https://files.eric.ed.gov/fulltext/ED337498.pdf

Fraillon, J., Schulz, W., & Ainley, J. (2013*). International computer and information literacy study: Assessment framework.* International Association for the Evaluation of Educational Achievement. https://www.iea.nl/sites/default/files/2019-04/ICILS_2013_Framework.pdf

Geller, J., Toftness, A. R., Armstrong, P. I., Carpenter, S. K., Manz, C. L., Coffman, C. R., & Lamm, M. H. (2018). Study strategies and beliefs about learning as a function of academic achievement and achievement goals. *Memory*, *26*(5), 683–690. https://doi.org/10.1080/09658211.2017.1397175

Greene, J. A., & Azevedo, R. (2007). A theoretical review of Winne and Hadwin's model of self-regulated learning: New perspectives and directions. *Review of Educational Research*, *77*(3), 334–372. https://doi.org/10.3102/003465430303953

Guo, L. (2022). The effects of self-monitoring on strategy use and academic performance: A meta-analysis. *International Journal of Educational Research*, *112*, Article 101939. https://doi.org/10.1016/j.ijer.2022.101939

Hartwig, M. K., & Dunlosky, J. (2012). Study strategies of college students: Are self-testing and scheduling related to achievement? *Psychonomic Bulletin & Review*, *19*(1), 126–134. https://doi.org/10.3758/s13423-011-0181-y

Hartwig, M. K., Was, C. A., Isaacson, R. M., & Dunlosky, J. (2012). General knowledge monitoring as a predictor of in-class exam performance. *British Journal of Educational Psychology*, *82*(3), 456–468. https://doi.org/10.1111/j.2044-8279.2011.02038.x

Hesse, F., Care, E., Buder, J., Sassenberg, K., & Griffin, P. (2015). A framework for teachable collaborative problem solving skills. In P. Griffin & E. Care (Eds.), *Assessment and teaching of 21st century skills* (pp. 37–56). Springer Dordrecht. https://doi.org/10.1007/978-94-017-9395-7_2

Hmelo-Silver, C. E., Chinn, C. A., O'Donnell, A. M., & Chan, C. (Eds.). (2013). *The international handbook of collaborative learning*. Routledge.

Jansen, R. S., Van Leeuwen, A., Janssen, J., Jak, S., & Kester, L. (2019). Self-regulated learning partially mediates the effect of self-regulated learning interventions on achievement in higher education: A meta-analysis. *Educational Research Review*, *28*, Article 100292. https://doi.org/10.1016/j.edurev.2019.100292

Johnson, D., Johnson, R., & Smith, K. (2007). The state of cooperative learning in postsecondary and professional settings. *Educational Psychology Review*, *19*(1), 15–29. https://doi.org/10.1007/s10648-006-9038-8

Kaufman, J. C., & Sternberg, R. J. (Eds.). (2010). *The Cambridge handbook of creativity*. Cambridge University Press.

Kim, K. H., & Zabelina, D. (2015). Cultural bias in assessment: Can creativity assessment help? *The International Journal of Critical Pedagogy*, *6*(2).

Kornell, N., & Bjork, R. A. (2007). The promise and perils of self-regulated study. *Psychonomic Bulletin & Review*, *14*(2), 219–224. https://doi.org/10.3758/BF03194055

Laal, M., & Ghodsi, S. M. (2012). Benefits of collaborative learning. *Procedia - Social and Behavioral Sciences*, *31*, 486–490. https://doi.org/10.1016/j.sbspro.2011.12.091

Lai, E. R. (2011). Critical thinking: A literature review. *Pearson's Research Reports*, *6*(1), 40–41. Pearson.

http://images.pearsonassessments.com/images/tmrs/CriticalThinkingReviewFINAL.pdf

Lawson, M. J., Vosniadou, S., Van Deur, P., Wyra, M., & Jeffries, D. (2019). Teachers' and students' belief systems about the self-regulation of learning. *Educational Psychology Review*, *31*(1), 223–251. https://doi.org/10.1007/s10648-018-9453-7

Mo, S. (2011). Evidence on instructional technology and student engagement in an auditing course. *Academy of Educational Leadership Journal*, *15*(4), 149.

Mumford, M. D., Medeiros, K. E., & Partlow, P. J. (2012). Creative thinking: Processes, strategies, and knowledge. *Journal of Creative Behavior*, *46*(1), 30–47. https://doi.org/10.1002/jocb.003

National Research Council. (2012). *Education for life and work: Developing transferable knowledge and skills in the 21st century*. National Academies Press. doi:10.17226/13398

Organisation for Economic Co-operation and Development. (2009). *PIAAC problem solving in technology-rich environments: A conceptual framework* (OECD Education Working Papers No. 36). https://dx.doi.org/10.1787/220262483674

Organisation for Economic Co-operation and Development. (2013). Problem-solving framework. In *PISA 2012 assessment and analytical framework: Mathematics, reading, science, problem solving and financial literacy*. https://doi.org/10.1787/9789264190511-6-en

Organisation for Economic Co-operation and Development. (2017). *PISA 2015 assessment and analytical framework: Science, reading, mathematic, financial literacy and collaborative problem solving* (revised ed.). http://dx.doi.org/10.1787/9789264281820-en

Organisation for Economic Co-operation and Development. (2018). *The Future of Education and Skills: Education 2030*. https://www.oecd.org/education/2030/E2030%20Position%20Paper%20(05.04.2018).pdf

Organisation for Economic Co-operation and Development. (2019). *PISA 2021 creative thinking framework (third draft)*. https://www.oecd.org/pisa/publications/PISA-2021-creative-thinking-framework.pdf

Organisation for Economic Co-operation and Development. (2022). *PISA 2015 learning in a digital world*. Retrieved April 11, 2022, from https://www.oecd.org/pisa/innovation/learning-digital-world/

Oz, E. (2021). The effect self-regulated learning on students' academic achievement: A meta-analysis. *International Online Journal of Educational Sciences*, *13*(5), 1409–1429.

Panadero, E. (2017). A review of self-regulated learning: Six models and four directions for research. *Frontiers in Psychology*, *8*, 422. https://doi.org/10.3389/fpsyg.2017.00422

Pintrich, P. R. (2000). Multiple goals, multiple pathways: The role of goal orientation in learning and achievement. *Journal of Educational Psychology*, *92*(3), 544–555. https://doi.org/10.1037/0022-0663.92.3.544

Pithers, R. T., & Soden, R. (2000). Critical thinking in education: A review. *Educational Research*, *42*(3), 237–249. https://doi.org/10.1080/001318800440579

Pretz, J. E., & Kaufman, J. C. (2017). Do traditional admissions criteria reflect applicant creativity? *Journal of Creative Behavior, 51*(3), 240–251. https://doi.org/10.1002/jocb.120

Project Tomorrow. (2021). *Empowering and engaging student voice to create equity in education. Five questions every K–12 education leader should ask today. Findings from the 2020–21 Speak Up Research Project.* Blackboard. http://files.eric.ed.gov/fulltext/ED615843.pdf

Sawyer, R. K. (2006). Educating for innovation. *Thinking Skills and Creativity*, *1*(1), 41–48. https://doi.org/10.1016/j.tsc.2005.08.001

Schleicher, A. (2020). Developing twenty-first-century skills for future jobs and societies. In B. Panth & R. Maclean (Eds.), *Anticipating and preparing for emerging skills and jobs* (pp. 47–55). Springer Singapore. https://doi.org/10.1007/978-981-15-7018-6_7

Schwab, K. (2015, May 14). *The new key to growth is unlocking latent talent*. The Globe and Mail. https://www.theglobeandmail.com/report-on-business/rob-commentary/the-new-key-to-economic-growth-is-unlocking-latent-talent/article24424439/

Schwab, K. (2017). *The fourth industrial revolution*. Currency.

Silva, E. (2008). *Measuring skills for the 21st century* [Report]. Education Sector. http://www.educationsector.org/usr_doc/MeasuringSkills.pdf

Son, L. K., & Metcalfe, J. (2000). Metacognitive and control strategies in study-time allocation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *26*(1), 204. https://doi.org/10.1037/0278-7393.26.1.204

Stahl, G., Koschmann, T., & Suthers, D. (2006). Computer-supported collaborative learning: An historical perspective. In R. K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (pp. 409–426). Cambridge University Press.

Sternberg, R. J. (1986). *Critical thinking: Its nature, measurement, and improvement.* National Institute of Education. http://eric.ed.gov/PDFS/ED272882.pdf

Sternberg, R. J. (Ed.). (1999). *Handbook of creativity*. Cambridge University Press.

Sternberg, R. J. (2003). Creative thinking in the classroom. *Scandinavian Journal of Educational Research*, *47*(3), 325–338. https://doi.org/10.1080/00313830308595

Terenzini, P. T., Cabrera, A. F., Colbeck, C. L., Parente, J. M., & Bjorklund, S. A. (2001). Collaborative learning vs. lecture/discussion: Students' reported learning gains. *Journal of Engineering Education*, *90*(1), 123–130.

Thiede, K. W., Anderson, M., & Therriault, D. (2003). Accuracy of metacognitive monitoring affects learning of texts. *Journal of Educational Psychology*, *95*(1), 66. https://doi.org/10.1037/0022-0663.95.1.66

Timmers, K. (2018). Evolution of technology in the classroom. In *Teaching in the fourth industrial revolution* (pp. 106–123). Routledge.

United Nations Children's Fund. (2022). *The 12 transferable skills from UNICEF's conceptual and programmatic framework*. https://www.unicef.org/lac/media/32441/file/The%2012%20Transferable%20Skills.pdf

Webb, N. M., Troper, J. D., & Fall, R. (1995). Constructive activity and learning in collaborative small groups. *Journal of Educational Psychology*, *87*(3), 406–423.

Winne, P. H., & Hadwin, A. F. (1998). Studying as self-regulated learning. In D. J. Hacker, J. Dunlosky, & A. C. Graesser (Eds.), *Metacognition in educational theory and practice* (pp. 277–304). Routledge.

World Economic Forum. (2015). *New vision for education: Unlocking the potential of technology*. http://www3.weforum.org/docs/WEFUSA_NewVisionforEducation_Report2015.pdf

World Economic Forum (2016). *The future of jobs: Employment, skills and workforce strategy for the fourth industrial revolution*. www3.weforum.org/docs/WEF_Future_of_Jobs.pdf

World Economic Forum. (2019). *The future of jobs report 2018*. https://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf

World Economic Forum. (2020). *Schools of the future: Defining new models of education for the fourth industrial revolution*. https://www3.weforum.org/docs/WEF_Schools_of_the_Future_Report_2019.pdf

Yang, J., & Zhao, X. (2021). The effect of creative thinking on academic performance: Mechanisms, heterogeneity, and implication. *Thinking Skills and Creativity, 40,* Article 100831. https://doi.org/10.1016/j.tsc.2021.100831

Yusuff, K. B. (2018). Does personalized goal setting and study planning improve academic performance and perception of learning experience in a developing setting? *Journal of Taibah University Medical Sciences*, *13*(3), 232–237. https://doi.org/10.1016/j.jtumed.2018.02.001

Zepeda, C. D., & Nokes-Malach, T. J. (2021). Metacognitive study strategies in a college course and their relation to exam performance. *Memory & Cognition*, *49*(3), 480–497. https://doi.org/10.3758/s13421-020-01106-5

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 13–39). Academic Press.

Zimmerman, B. J., & Kitsantas, A. (1996). Self-regulated learning of a motoric skill: The role of goal setting and self-monitoring. *Journal of Applied Sport Psychology*, *8*, 69–84.

Zimmerman, B. J., & Martinez-Pons, M. (1992). Perceptions of efficacy and strategy use in the self-regulation of learning. In D. H. Schunk & J. Meece (Eds.), *Student perceptions in the classroom: Causes and consequences* (pp. 185–207). Erlbaum.

ABOUT ACT

ACT is a mission-driven, nonprofit organization dedicated to helping people achieve education and workplace success. Headquartered in Iowa City, Iowa, ACT is trusted as a national leader in college and career readiness, providing high-quality assessments grounded in over 60 years of research. ACT offers a uniquely integrated set of solutions designed to provide personalized insights that help individuals succeed from elementary school through career. Visit us online at www.act.org.