Embedding Competencies within Disciplines

Deliberately, Explicitly, & Systematically

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Executive Summary

While CCR's Competencies outline a framework—beyond Knowledge—of what people must learn for success, teaching them explicitly can be difficult or overwhelming even for expert teachers. To explicitly teach the Competencies, a framework matching them to specific Disciplines is necessary. This system allows each Discipline to focus on specific Competencies that can be systematically designed to guarantee comprehensive coverage of Skills, Character, and Meta-learning, for any individual student moving through the system. These Competencies should be matched with the disciplines best suited for their learning. Such a system also limits the scope of what teachers must incorporate and master *to the most relevant and essential Competencies so as to prevent overload*.

CCR recommends the mapping between Disciplines and Competencies as described below; it is a strong suggestion about which Competencies should be taught in which discipline. These conclusions were reached based on both top-down (synthesis from research) and bottom-up (opinions from US State Teachers of the Year) approaches.

Figure 1. Top 4 Bottom 4 Framework. *Dark green areas indicate the top Competencies per Discipline. Asterisks within them denote the core (top 2) Competencies; rationales for top intersections are detailed in Appendix A and B. Light green indicates mid Competencies and grey indicates bottom Competencies. Traditional Disciplines are listed in bold, and the Modern Disciplines are beneath them. Note that to avoid forcing the data to fit the model, it was occasionally necessary to select slightly more or fewer than exactly four Competencies per Discipline.*

	COMPETENCIES											
DISCIPLINE	Skills				Character						Meta-Learning	
	Creativity	Critical Thinking	Communi-cation	Collabo-ration	Mindful-ness	Curiosity	Courage	Resilience	Ethics	Leadership	Meta-cognition	Growth Mindset
Mathematics		*										*
Science		*				*						
Language - Domestic			*								*	
Language - Foreign											*	*
Social Studies					*				*			
Arts - Visual	*		*									
Arts - Performing				*			*					
Technology & Engineering	*											*
Media			*			*						
Entrepre-neurship							*			*		
Personal Finance								*			*	
Wellness					*		*					
Social Sciences		*									*	

Overview and Motivation

In designing a 21st Century education where the dimensions of Skills, Character, and Meta-Learning are of equal importance to Knowledge, the bar set for how to teach these Competencies well is high. Just as specific learning objectives in the traditional curriculum have been scaffolded and allocated to different courses, it is necessary to teach the Competencies in a way that is:

- **Deliberate**—It is necessary to consciously and *intentionally* call out and integrate these Skills, Character, and Meta-learning Competencies as opportunities for learning, and scaffold their teaching with practice across different contexts for transfer.
- **Explicit**—Competencies deserve as much focus as Knowledge. While many lessons already incorporate creative components and groupwork, this is not the same as devoting time to properly *present and practice* subskills of Creativity and Collaboration.
- **Comprehensive**—Though not everyone will be an expert in each Competency, lacking any one completely can be disastrous (e.g. a Leader without Ethics). For a high *quality* education, a learner should encounter chances to improve at all Competencies through the course of their education.
- **Systematic**—To ensure the *quality* of a curriculum integrated with Competencies, each Competency must be paired with the Disciplines that best support them, and vice versa, in ways that align with both teacher expertise and insights from research.
- **Demonstrable**—Student learning of Competencies must be *measurable against research-backed assessment* items.

Meeting all the above requirements is an immense undertaking, and teaching one—let alone all twelve—of the Competencies well would be a challenge. Furthermore, teachers are already overwhelmed with requirements and often feel they are in a race against time to cover every content standard.[1, 2] Thus, though it is difficult to compartmentalize Competencies—which naturally blend into one another by design—and draw lines turning a spectrum of where they fit best into a discrete checkbox, it is necessary to make these difficult choices about which Competencies are best suited to which Disciplines. These decisions were made by blending the expertise of researchers on the constructs in a top-down literature review with the expertise of master teacher practitioners through direct input and teacher studies.

In distributing four Competencies to each subject, students have the opportunity to be exposed to Competencies from multiple dimensions within a single class as well as across different classes (thus aiding *Transfer*), while keeping the framework more manageable for the individual teacher. The Top 4 are chosen to be applicable to most or all units of study and are either essential to or easier to

[1] Schoen, Erbilgin, and Haciomeroglu, "Analyzing the Next Generation Sunshine State Standards for Mathematics: Is the State Curriculum Still a Mile Wide and an Inch Deep?" (2010)

[2] Marzano, Kendall, and Cicchinelli, What Americans Believe Students Should Know. (1998)

integrate into the existing curriculum or the nature of the discipline. The Mid 4, highlighted in a lighter green in Figure 1, are relevant to the subject and its practice but may be more central to a different discipline or overshadowed by the relative importance of other constructs.

This framework mapping Competencies to Disciplines is not intended to be constraining, to restrict teachers from playing to their own strengths, or to stifle the natural emergence of Competencies in any given teachable moment. For instance, even though Ethics does not play a large role in Mathematics, it still enriches the learning and learner development to address Ethics while discussing Algorithms and their biases—particularly if a recent event makes that situation all the more relevant. The remaining Bottom 4 in grey are meant to indicate Competencies that would show up on such an *ad hoc* basis, depending on the topic, context, or individual.

However, **avoiding** those Competencies that are present in the Top 4 of one's Discipline often detracts from the discipline's deeper nature. By prioritizing Knowledge alone, short term gains are made by sacrificing the longer-term benefits of developing skills that can support practicing the discipline beyond the classroom. For example, if one teaches science as a body of facts, without the critical thinking in its process, that knowledge can become outdated quickly. The student may leave with a passing state test score but also be more susceptible to future misinformation, and lack the skills necessary to contribute to the field as a scientist.

Furthermore, *Disciplines must rely on one another to ensure complete coverage* of the Competencies; defaulting on one's share of the Competencies by failing to address the Top 4 leaves gaps in learning that other subjects may not have the time or means to address. Not teaching the Top 4 Competencies does a disservice to everyone: the learners, colleagues, and the teacher. If all teachers in a system use this approach, they then can rely on their colleagues to cover the remaining competencies. A teacher then does not need to "do it all" and instead can focus on ensuring students make tangible gains in their specific competencies.

Implementing the proposed framework also guarantees comprehensiveness. The road to deliberate and systematic curricular reform, in which the Competencies and thus the non-Knowledge dimensions of learning get the "airtime" they need, requires the creation of these categories as a necessary step. There may be a future where there can be more flexibility across approaches as teachers develop the expertise, but as a first step, intentional, focused, and comprehensive infusion of Competencies is needed. This same need for a systematic framework is seen in subject matter knowledge: standards are ultimately assigned to subjects, even though some content is undoubtedly interdisciplinary.

Framework Development

Bottom-Up Research and Findings

Two rounds of research studies were conducted with dozens of U.S. State Teachers of the Year with incremental improvements to the research process based on the feedback from round one. Over multiple weeks, these teachers were asked to describe ways that they currently teach, or could imagine teaching, each of the twelve Competencies within their discipline. Teachers were given the option to skip a section when they felt they could not think of a realistic way to incorporate the Competency.[3]

After collecting over 6,000 responses, the responses were scored on a standardized scale by researchers trained on the rubric for interrater reliability. In each discipline-Competency pairing, both the quantity of responses provided by teachers and their average quality (i.e. rubric score) was compiled.

Though teachers rated the relative importance of competencies for future student success, and found them valuable, this measure differed from how often it was covered in the curriculum, from teachers' comfort with the Competency personally, and from teachers' comfort teaching it. Over 65% of all responses across disciplines were concentrated in the Skills Dimension when ranking the top four competencies for their disciplines, while under 8% of selections fell in this Dimension for the bottom 4.[4] The Skills Dimension already aligns with the "Four C's", "21st Century Skills" that teachers are generally aware of. Accordingly, if teachers were left to decide what to teach on their own, they would continue focusing on these constructs they already have a vocabulary for, and other areas would be relatively neglected. This is seen again in a quantity analysis, where fewer responses were provided along the Character dimension regardless of discipline. Both these results are consistent with findings of coverage of the competencies around the world.[5]

In reviewing the scores of teacher answers, it also appears that the quantity of answers for a Competency are not strongly correlated with the average quality answers. That is, even teaching concepts that were more familiar (such as the 21st Century Skills, which all scored relatively high on quantity measures) did not imply teaching them deliberately, explicitly, or systematically.

Qualitatively, teacher responses also showed that while Competencies could pair well with either specific *topics* in a discipline or the discipline as a whole, one did not necessarily imply the other. For

[3] Competencies in the Context of Disciplines: Supplemental Appendix 1 (2021). Center for Curriculum Redesign.
[4] Competencies in the Context of Disciplines: Supplemental Appendix 3b (2021). Center for Curriculum Redesign.
[5] Taylor, R. (2020). Competencies for the 21st century: Jurisdictional progress

example, while Critical Thinking is used to analyze source validity in history, it does not come into play when learning the chronology of Russian czars. On the other hand, Mindfulness can be great to insert into science when studying the human body's stress response but does not fit as naturally in most other areas.

Responses also revealed that Competencies often show up in non-traditional curriculum. Teachers reported a significant number of responses outside of disciplines, lessons, or units, such as in classroom management strategies, habits, advisory groups, clubs, etc. In total, a majority (54%) of responses were not specific to the discipline or content.

Some common failure modes also emerged in teacher responses:

1. *Teachers often miscategorized their ideas, labeling a potential lesson as one Competency when it in fact targeted another.*
   For example, many teachers described using graphic organizers to practice Creativity's Subcompetency of connecting and refining ideas. Though graphic organizers are helpful for seeing the underlying structure of information and could be used to better connect ideas together, teachers would often describe frameworks more suited towards Critical Thinking rather than Creativity applications (e.g., problem-solving frameworks for dissecting word problems instead of mind maps). Being sensitive to the context and end goals of individual student activities, rather than tunnel vision of the exact student action, was difficult.
2. *Formative or summative assessments of Competencies were explicitly prompted for alongside each lesson but were often left blank or vague (e.g., "this is measured by observing the class").*
   It is difficult to measure growth along Competencies due to the many factors involved in each. Providing research-backed assessment items is a necessary future step in teaching Competencies well.
3. *The lesson did not allow for scaffolded focus on the Competency.*
   The third of these failure modes requires carefully considering how much a teacher (and student) can process deliberately. A robust lesson, assignment, or project can address a multitude of Competencies. On an average day of class, a student may analyze a new topic (Critical Thinking), consider whether they understand (Metacognition), voice their thoughts (Communication) despite shyness (Courage), and give feedback to peers (Collaboration). However, the lesson does not—and in fact cannot—address them all deliberately; though students had the opportunity to practice, little is put into place to ensure they are actively practicing each skill (which there is not enough time for anyway). Thus it is necessary to scaffold competency infusion for teachers, potentially through a "primary" or "secondary" competency of focus which can be assisted by the Top 4 framework.
4. *Teachers felt a pressure to "do it all," addressing a wide variety of Competencies*
   Teachers may confuse possibility with desirability: because Competencies have the potential to be included in a lesson, many instances of passing reference to Competencies were called out,

though they were not a central component of the learning. Examples include tacking on a reflection to the end of the term to address Metacognition, or adding groupwork roles to any project to support Collaboration. This “checkbox” mindset is nowhere near sufficient for teaching competencies well. This is also a significant reason why the quantity of responses did not correlate strongly with quality. If teachers were given only a handful to focus on, they would be more able to practice each deeply and in a variety of contexts which would improve learning and transfer.

Though teachers stated the importance of integrating Competencies, they were also aware of the inherent difficulties in implementation. When asked what specifically made a Competency particularly difficult to teach, a large majority of teachers responded that it did not sufficiently align with their content area (see Appendix D.3 for details). A few exceptions included a lack of confidence in teaching Meta-learning and Ethics, both of which are often associated with its own set of content knowledge and pedagogy. Both these results further reinforce the need to specify targeted intersections of Competencies and Disciplines.

The Competency rankings were aggregated to produce the top three Competencies for each discipline and a dimensional analysis, as seen in Figure 2. This data was generated to provide a foundation for decision-making when seeking infusion of competencies into disciplinary curricula.

Figure 2. Top three Competencies by Discipline. *Some Disciplines have multiple top Competencies, and some Competencies have multiple first place disciplines. An "x" indicates the Discipline's top Competency in Dimension (or within 0.1 of top). The numbers indicate the first, second, and third place of a Competency within a Discipline (tied if within 0.1).*

	COMPETENCIES											
DISCIPLINE	Skills				Character						Meta-Learning	
	Creativity	Critical Thinking	Communi-cation	Collabo-ration	Mindful-ness	Curiosity	Courage	Resilience	Ethics	Leadership	Meta-cognition	Growth Mindset
Mathematics		x1		2	3			x2			x2	3
Science		x		3			1			x1		x1
ELA	3	3	x1						x3	3	x3	
Social Studies		x2	1	3		1			x1		x	
Arts - Visual	x2				1	2	3		x		x	2
Arts - Performing	x1		1		1	3	1	1	x1		x	
Physical Education				x1	3		3	2		x2	x1	

Thus, using only a bottom-up methodology sourced directly from teachers would lead to excessive overlap for the more popular Competencies while failing to ensure comprehensive coverage for the remaining twelve. It was found while scoring the teacher responses that teacher self-ratings were consistently higher than researcher ratings of their answers. This correlation can be interpreted in multiple ways: perhaps people are overconfident with their ability to teach something, or it is hard to pass down this knowledge to others just by sharing a lesson plan (or some combination of these and other ideas). Furthermore, a confluence of other factors impact these direct votes: they could be reflecting the importance of the Competency in general; the importance to the individual; the ease of teaching it; or even mere exposure to the idea of teaching it. It is therefore necessary to also consider the existing literature in synthesizing a final Top 4 framework. While neither approach is flawless, combining both opinions in the Top-down synthesis helps avoid extremes produced by either approach.

Across Disciplines and Competencies

A final Competency Embedding framework would not only balance Competencies among the Disciplines but also Disciplines among Competencies. Each Competency should show up in different contexts, and each Discipline should be able to teach to its strengths.

To give each Discipline its **relative** strengths while keeping the assignments of other courses in mind, it was necessary to weigh the scarcity of the Competency in other disciplines. This meant that instead of looking at the "absolute" quality score of responses, it is more relevant to look at the top Competencies within a Discipline, even if the spread of those scores was not even. Furthermore, it was necessary to consider Competencies that did not necessarily rise to the top but that performed better in one subject than the others. As an example, one sign of a good—but less intuitive—fit of a Competency to a Discipline was when Courage (a construct outside of well-known frameworks) still performed relatively well in Performing Arts compared to other disciplines. Even if four or more other Competencies received higher quality answers in that Discipline, Courage is still a better relative fit for Performing Arts and a context in which it makes sense to nurture compared to e.g. Science.

Additionally, the framework should give each Competency even representation across multiple disciplines. Competencies were assigned with the goal of core coverage in at least two disciplines, so that they would be encountered in a variety of contexts for better transfer.[6] In the same vein, researchers sought to give each discipline a variety of types of Competencies. For example, even if a discipline was very strong in multiple skills, it would still make sense to see which character dimensions were suited for it in order to avoid more bias towards the Skills. With this approach, a curriculum designer can ensure their students receive exposure to a relevant education that blends Knowledge, Skills, Character, and Meta-Learning.

Unique differentiators of a discipline that aligned it well with certain Competencies were also considered, from its foundational concepts to specific branches of knowledge. It was found that some disciplines are fundamentally integrated with understanding a certain Competency. For example, while Ethics exists in an orchestra room, it is less pressing for success in the 21st century than the Ethics studied through the lens of science classes centered on understanding the implications of newer technologies, from genetic engineering to forever chemicals. A preliminary discussion of the rationale associated with the top pairings is provided in the appendices.

Throughout this process, it was necessary to use educated human judgement to find the right balance between the bottom-up data and existing studies in the literature. Using completely algorithmic

[6] Perkins, D. N., & Salomon, G. (1992). Transfer of learning. International encyclopedia of education, 2, 6452-6457.

approaches could lead to some Competencies being "force-fed" to disciplines where it was completely unsuitable. For instance, bottom-up data and top-down literature alike suggest it is difficult to develop a competency like Leadership in traditional disciplines (where there is often a greater emphasis on Collaboration). Thus, assigning it to any Discipline in the study would not be productive. Accordingly, instead of applying a hard-and-fast rule of two disciplines per Competencies, it was employed as a helpful guiding heuristic.

Example: Focusing in on Mathematics

To give a more detailed picture of how Competencies were assigned to a Discipline, the process for Mathematics is shown below (Figure 3). It is evident that the literature has its own biases: while meta-analyses of useful pedagogical interventions include relatively little explicit emphasis on Critical Thinking, the importance of teaching Metacognition in mathematical thinking for meaningful gains in student learning is well-documented.[7] From a top-down perspective, it would appear that the latter is clearly more important than the former.

Teachers also bring important expertise, as they view Competency implementation in an integrated way by simultaneously considering content standards, content, and a realistic classroom context. On the other hand, teachers do not know enough about some Competencies such as Metacognition (a result not specific to Mathematics teachers), which then fall out of their reported top 4. While Critical Thinking is rated quite highly, other common classroom practices such as Communication also appear. Practitioners selecting a Competency often mean it should not be in the Bottom 4, as it appears often enough to warrant mentioning; however, other Disciplines may have a comparative advantage in its instruction. Lastly, organizations like P21.org have done a good job over 20 years to hammer the 4 C's of Skills, which the teachers enumerate easily, compared to Character or Meta-Learning qualities.

[7] This relationship is not immediately evident in a cursory search; for instance, the term "critical thinking" appears more often than "metacognition" in conjunction with mathematics education. However, upon closer examination of results, it becomes apparent that *critical thinking is a common phrase that studies ascribe to mathematical thinking, not defined in ways aligning with the CCR framework, and whose relationship to Mathematics is rarely the central object of study*. On the other hand, in large meta-analyses of evidence for effective interventions in mathematics pedagogy, **Metacognition is widely regarded as a clearer focus than Critical Thinking** (e.g. E.g. Hattie, J., Fisher, D., Frey, N., Gojak, L. M., Moore, S. D., & Mellman, W. (2016). Visible learning for mathematics, grades K-12: What works best to optimize student learning. Corwin Press.)

Figure 3. CCR Consensus Top 4 (Final Framework) vs. Researcher Top 4 vs. Expert Practitioner Top 4. *The final framework is given in Competency order (not order of importance), and repeated instances of a Competency are color-coded to track correspondences.*

CCR Consensus - Top 4	Top 4 from Researchers	Top 4+ from Practitioners
Critical Thinking	Metacognition	Critical Thinking
Resilience	Resilience	Communication
Metacognition	Mindfulness	Growth Mindset
Growth Mindset	Growth Mindset	Creativity
		Curiosity
		Resilience
CCR Consensus - Bottom 4	Bottom 4 from Researchers	Bottom 4 from Practitioners
Mindfulness	Courage	Mindfulness
Courage	Leadership	Ethics
Ethics	Curiosity	Leadership
Leadership	Critical Thinking	Courage

There is often some degree of overlap from both types of experts, which is always reflected in the consensus top 4 when present. The final top four (leftmost column) thus represent the deliberate, explicit, systematic, comprehensive, and demonstrable focus in Mathematics. While the next four (Creativity, Communication, Collaboration, Curiosity) in the table, they are still relevant to the Discipline, and there will be many moments they could come up. However, focusing on them *at the expense of the top 4* is not recommended. And lastly, the bottom 4 are likely to only appear on an ad-hoc, topic-by-topic basis.

Future Steps & Implications

Every discipline has a key role to play for development of Competency expertise and transfer. If all disciplines focus on teaching their top Competencies, benefits will exist at the curricular, course, and learner level. Curricula will be integrated with relevant Competencies which will in turn increase content relevance and depth of understanding of what it means to proactively practice and contribute to each field. At the same time, teachers will feel less pressure to cover all the Competencies beyond their content area, by either addressing one cursorily or otherwise cognitively overloading learners.

Instead, more time can be devoted to the scaffolded development of each, aiming for depth over wide but shallow knowledge. Learners are guaranteed to practice each Competency in a variety of disciplines in a way that facilitates better understanding of both the content and Competency. Adopting this framework ensures the deliberate, explicit, comprehensive, systematic and demonstrable integration of Competencies at all levels.

Even after synthesizing these various sources of expertise, some gaps still exist in the proposed mapping of Competencies to traditional disciplines. Leadership, for instance, was poorly covered from both a top-down and bottom-up angle. However, these gaps would largely be covered by the introduction of modern disciplines, indicated in Figure 1, which also better reflect the job sectors and demands of today.

As teaching Competencies has been shown to be difficult, future directions of research should be focused on developing specific materials to help teachers implementing these into their classrooms, by:

- Specifically examining at the intersection of the Competency and discipline, supplementing teachers with specific topics, techniques, or example lessons that work well, to better integrate the Competency's teaching with the Knowledge. This is especially important for Competencies that teachers self-report lower confidence in, such as Mindfulness or Ethics.
- Looking at context-free aspects of Competencies which generalize across disciplines, such as how to explicitly introduce and practice a Subcompetency, so that it receives the same level of attention and scaffolding given to Knowledge standards.
- Developing not only learning experiences but also potential assessments of and learning progressions for each Subcompetency, so that teachers can measure learners' progress

Appendix A: Traditional Disciplines x Competencies

Below are some of the rationales from the research, or top-down, perspective for the Top 4 Competencies in the traditional disciplines. More in-depth research could supplement these rationales, though doing so fully is beyond the scope of this document; sources are provided for "core" (top 2 of top 4) intersections, often where research and teacher intuition agree. The relevant section of Figure 1 is reproduced below for convenience.

© Center for Curriculum Redesign	COMPETENCIES											
DISCIPLINE	Skills				Character						Meta-Learning	
	Creativ-ity	Critical Thinking	Communi-cation	Collabo-ration	Mindful-ness	Curiosity	Courage	Resilience	Ethics	Leadership	Meta-cognition	Growth Mindset
Mathematics		*										*
Science		*				*						
Language - Domestic			*								*	
Language - Foreign											*	*
Social Studies					*				*			
Arts - Visual	*		*									
Arts - Performing				*			*					

In Mathematics:

- ***Critical Thinking** is needed for generalizing problem solving, instead of blindly applying algorithms. In mathematics classes, students should learn to identify mathematical questions; evaluate and select problem-solving strategies; justify their solutions with reasoning; and consider how and when these techniques and solutions can be applied to later different problems.[8]
- ***Growth Mindset** can help individuals overcome the prevalent mindset that they are "not a math person". When developed intentionally, it can counteract a gender gap in STEM.[9]

[8] Su, H.F., Ricci, F.A., & Mnatsakanian, M. (2016). Mathematical teaching strategies: Pathways to critical thinking and metacognition. Journal of Research in Education and Science (IJRES), 2 (1), 190-200.

[9] Dweck, C. (2006) Is Math a Gift? Beliefs that Put Females at Risk, in S.J. Ceci & W. Williams (Eds) Why Aren't More Women in Science? Top Researchers Debate the Evidence. Washington DC: American Psychological Association.

- Resilience is useful as people generally find math difficult, and must practice and persevere to develop fluency.
- Metacognition plays a role in monitoring one's own understanding and planning accordingly; the difficulty of mathematics can be offset by not only strength in the subject, but also the regulation of one's own understanding.

In Science:

- ***Critical Thinking** is fundamental to the scientific method and scientific thinking. The foundations of science are rooted in its method, which is all about organizing information clearly, designing controlled experiments to reason clearly about causality, and to quantify & deal rigorously with uncertainty and assumptions. These traits correspond with those seen in Critical Thinking: "precision, clarification, open-mindedness, seeking reasons, and dealing with all parts of a problem."[10]
- ***Curiosity** underlies the process of observations that drive scientific questions. In many senses, asking repeated "why" to link observations of phenomena in the natural world is precisely the driving force behind the scientific process.[11]
- Collaboration is an increasingly large part of science, as the number of researchers in a field and body of knowledge continues to grow.[12] Collaborating both within and across disciplines for peer review, and with non-scientists to get a fuller picture of relevant factors is part of science.
- Ethics is included specifically for its link to bioethics and emerging technologies from GMOs to CRISPR.
- Growth Mindset is included for similar reasons to those in Mathematics: to avoid the conception of not being a science person, and to increase representation in STEM.

In domestic language:

- ***Communication**—both its production and interpretation—are the centerpiece of a domestic language course, often through reading, writing, speaking, and listening.[13]

[10] Matthews, M. R. (2014). Science teaching: The contribution of history and philosophy of science. Routledge.

[11] NGSS Lead States. Understanding the Scientific Enterprise: The Nature of Science in the Next Generation Science Standards. Accessed March 2021.

[12] Larivière, V., Gingras, Y., Sugimoto, C. R., & Tsou, A. (2015). Team size matters: Collaboration and scientific impact since 1900. Journal of the Association for Information Science and Technology, 66(7), 1323-1332.

[13] e.g. Common Core State Standards. Accessed March 2021.

- ***Metacognition** helps comprehension of language, even one that is "native"—metacognitive reading strategies have been shown to play a significant role in reading comprehension[14]and oral communication processing.[15]
- Creativity allows people to not only passively consume, but use language to express their unique messages and interpretations. Moving from consumption to production of the language to create something original and generative from an internal vision, and editing down a creative work to better align with a theme, is also a creative endeavor.
- Critical thinking allows people to more critically examine sources and information. It also serves as the foundation for interpreting difficult texts, summarizing, justifying claims, and analysis.

In foreign language:

- ***Metacognition** enhances language learning.[16, 17] Awareness of the innate processes that allow us to process and acquire language, along with the best strategies for practice, allows for better regulation and learning. Furthermore, identity is deeply connected to language; people exhibit language-specific versions of personality.[18]
- ***Growth Mindset** allows people to productively address the multitude of beliefs they may have about themselves and language in acquiring a second one, from beliefs about intelligence in their native language transferring to beliefs about aptitude for acquiring a second language (e.g., "only children can learn it").[19] People must also embrace the mistakes they will inevitably make to improve their fluency.
- Courage & Resilience are necessary to overcome the initial barrier to sounding awkward or being wrong in a language, and trying something completely foreign. Resilience over time in the form of committed effort and practice is also necessary for successful language-learning.
- Mindfulness involves physicality, and a level of bodily awareness helps learning language in noticing how one's mouth moves differently. However, foreign language classes are not only important for acquiring language (especially with the rise of faster and more accurate translations), but to learn about customs and traditions in other cultures. Mindfulness helps

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[14] Ahmadi, M. R., Ismail, H. N., & Abdullah, M. K. K. (2013). The Importance of Metacognitive Reading Strategy Awareness in Reading Comprehension. English Language Teaching, 6(10), 235-244.

[15] Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. American psychologist, 34(10), 906.

[16] Anderson, N. J. (2002). The role of metacognition in second language teaching and learning (Vol. 4646). Washington, DC: ERIC Clearinghouse on Languages and Linguistics

[17] Chamot, A. U. (2005). Language learning strategy instruction: Current issues and research. Annual review of applied linguistics, 25, 112-130.

[18] Luna, David & Ringberg, Torsten & Peracchio, Laura. (2008). One Individual, Two Identities: Frame Switching among Biculturals. Journal of Consumer Research.

[19] Lou, N. M., & Noels, K. A. (2019). Promoting growth in foreign and second language education: A research agenda for mindsets in language learning and teaching. System, 86, 102126.

cultivate open-mindedness to other cultures. Understanding that the way one natively does something is not the only way it can be done is part of this (as well as Metacognition).

In Social Studies:

- ***Mindfulness** is relevant as historians and educators in the field alike emphasize the importance of "historical empathy";[20] part of the nature of history is cultivating understanding both at a cognitive level and empathetic level of others' lived experiences, and why they made the decisions they did
- ***Ethics** is a key part of civics education and the ethics of creating or writing history, and one often-cited reason to learn history is to learn lessons from the past to avoid repeating it. This necessitates learning about difficult histories and traumatic pasts.[21] Racism, religious intolerance, and prejudice must be addressed to help people relate history to the present and have a better understanding of their ethical responsibilities.[22]
- Critical thinking is highly involved due to the need to understand the perspectives and potential biases of the primary and secondary sources involved, and in analyzing not only what is given, but also viewpoints that are missing. It is also necessary to keep a wide variety of factors in mind to draw and support valid conclusions and comparisons about different time periods and peoples.
- Communication is key to understanding how to look at history through the lens of passing a record of the past to the present. Listening to other people and hearing their lived experiences is part of Communication, as well as synthesizing that information into a writing project or presentation project.

In Visual Arts:

- ***Creativity** readily maps to the visual arts, whose very purpose in education can be described as a process of creative and critical inquiry in a visual medium.[23]
- ***Communication** is often the motivation behind artistic pursuits**.** Children's communication and self-expression take many forms including drawing, painting and sculpture, using artwork as a means of exploring imaginary worlds.[24] Art is a different mode of expression from language, but just as valid, as seen in adages like "a picture is worth a thousand words."

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[21] Edling, S., Sharp, H., Löfström, J., & Ammert, N. (2020). Why is ethics important in history education? A dialogue between the various ways of understanding the relationship between ethics and historical consciousness. Ethics and Education, 15(3), 336-354.

[22] Facing History. Evaluation Studies and Research. Accessed March 2021.

[23] Freedman, K., & Stuhr, P. (2004). Curriculum change for the 21st century: Visual culture in art education. Handbook of research and policy in art education, 815-828.

[24] State of Victoria, Department of Education and Training (2016). Victorian Early Years Learning and Development Framework.

- Mindfulness is useful in art both as being in tune with one's inner feelings and vision and understanding what resonates and what does not, as well as using art as a productive outlet for strong emotions.
- Resilience and practice are necessary to improve one's artistic skills. Teachers often cited how Resilience in the form of community can be built through art and community art projects.

In Performing Arts (e.g., theater, dance, music):

- ***Collaboration** is key to any ensemble. Each individual must see that the group's success is not the same as the success of any or even every individual; rather, the group is an emergent phenomenon, and people must collaborate within its framework.[25]
- ***Courage** is often needed in a performing context; a very common fear is that of public speaking, and it requires a great deal of vulnerability to have the spotlight before an audience. Drama techniques have been shown to mitigate this fear[26], and these techniques have been successfully adapted into other disciplines to reduce anxiety.[27]
- Mindfulness is involved in knowing and verbalizing one's emotions, and performing arts translate those emotions into a visual medium for the audience. Mastery of these emotions and their communication is involved in each of the performing arts disciplines. Physicality is also inherent to most of these branches of performing arts, from moving one's body rhythmically to articulating notes properly on an instrument.
- Resilience allows students to better build community within their ensemble and continue practicing (e.g., an instrument) to improve both themselves and the whole.

Appendix B: Modern Disciplines x Competencies

Below are some of the rationales from the research, top-down, perspective of the Top 4 Competencies in the modern Disciplines, which are subjects less commonly taught in schools or addressed by knowledge standards. These disciplines have been identified as increasingly relevant to the workforce, key for supporting the development of Competencies, and necessary for the 21st century. As before, more in-depth research could supplement these rationales, and sources are provided for "core" (top 2 of top 4) intersections. The relevant section of Figure 1 is reproduced for convenience.

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[25] Sawyer, R. K. (2006). Group creativity: musical performance and collaboration. Psychology of music, 34(2), 148-165.
[26] Casteleyn, J. (2019). Playing with improv theatre to battle public speaking stress. Research in Drama Education: The Journal of Applied Theatre and Performance, 24(2), 147-154.
[27] Atas, M. (2015). The reduction of speaking anxiety in EFL learners through drama techniques. Procedia-Social and Behavioral Sciences, 176, 961-969.

© Center for Curriculum Redesign	COMPETENCIES											
DISCIPLINE	Skills				Character						Meta-Learning	
	Creativity	Critical Thinking	Communi-cation	Collabo-ration	Mindful-ness	Curiosity	Courage	Resilience	Ethics	Leadership	Meta-cognition	Growth Mindset
Technology & Engineering	*											*
Media			*			*						
Entrepre-neurship							*			*		
Personal Finance								*			*	
Wellness					*		*					
Social Sciences		*									*	

In Technology & Engineering:

- ***Creativity** is not only limited to artistic and aesthetic pursuits, but it also includes the processes needed to find and implement new solutions.[28] Many approaches to Technology and Engineering involve looking at problems from new angles and applying different ways of thinking to familiar issues to create and improve products and systems (such as biomimicry);[29] this sort of Creativity has been identified as an essential in-demand skill for engineers entering the workforce.[30] Furthermore, Technology and Engineering are also particularly attuned to the physical, fiduciary, and temporal limits of our world, and thus well-suited for teaching how to be creative under these constraints.
- ***Growth Mindset** is supported by the naturally iterative nature of Technology and Engineering that requires the ability to view failures and mistakes as learning opportunities. Working with technology and in technology classes, many people experience computer anxiety which further widens the gender gap present in the discipline.[31] Not only can a focus on

[28] Cropley, D. H. (2016). Creativity in Engineering. In G. E. Corazza & S. Agnoli (Eds.), *Multidisciplinary Contributions to the Science of Creative Thinking* (pp. 155–173). Springer.

[29] Liu, Z., & Schonwetter, D. J. (2004). Teaching creativity in engineering. International Journal of Engineering Education, 20(5), 801-808.

[30] Qadir, J., Yau, K. L. A., Imran, M. A., & Al-Fuqaha, A. (2020, October). Engineering Education, Moving into 2020s: Essential Competencies for Effective 21st Century Electrical & Computer Engineers. In 2020 IEEE Frontiers in Education Conference (FIE) (pp. 1-9). IEEE.

[31] Liao, Y. K. C. (2018, October). Gender Differences on Computer Anxiety: A Meta-analysis of Studies from 1980s to 2010s. In E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education (pp. 152-159). Association for the Advancement of Computing in Education (AACE).

Growth Mindset reduce these concerns, but curricula have also been shown to reduce fixed mindsets when they are designed with open-ended projects focused on creating products and generating solutions (both common in technology and engineering classes).[32]

- Critical Thinking encompasses abilities such as computational and systems thinking, which underlie many core ideas in this Discipline. Understanding how systems and technologies work at a deep level, as well as what assumptions they rely upon, is necessary for creating successful products.
- Collaboration is *essential* to the daily operations of people working in the technology and engineering sector.[33] Almost every product is developed and executed in teams of various sizes. To best prepare students for the workforce and realities of a career in this sector, it is valuable to practice working in teams both synchronously and asynchronously, accepting feedback, and sharing initiative.
- Ethics will only continue to be more important in this rapidly-developing sector; too often, technology and engineering barrels forward without stopping to consider the Ethics involved. It is increasingly clear that products of technology and engineering are not objective: bias exists in algorithms, AI must be made more legible for safety, bioethics looms large already, and engineered solutions depend on the perspectives of those they are trying to serve; these problems can only be addressed when Ethics is considered alongside the development of these advances, not as an afterthought.

In Media:

- ***Communication** is central to conveying an idea through any medium, from video to audio to writing to graphics.[34] Creating these messages, selecting the best medium for them, knowing one's audience, and interpreting such messages are all aspects of Communication.[35] As Media education and careers continue to ask difficult questions, it is crucial that students learn not only how to ask those questions, but how to listen to their responses and parse through them. Furthermore, as our world becomes increasingly globalized, learning how to communicate with those in different cultures and worlds and being attuned to differences in paralingual and nonverbal communication will only become more critical for those studying Media.
- ***Curiosity** is the drive that underlies the investigative nature of communicating one person or group's story and ideas—whether it is data-driven or in narrative form—to others. Both creating and interpreting media involve a kind of questioning that dive into deeply

[32] Reid, K. J., & Ferguson, D. M. (2014, March). Do design experiences in engineering build a "growth mindset" in students?. In 2014 IEEE Integrated STEM Education Conference (pp. 1-5). IEEE.

[33] Wu, L., Wang, D., & Evans, J. A. (2019). Large teams develop and small teams disrupt science and technology. Nature, 566(7744), 378-382.

[34] Fedorov, A. (2008). On media education.

[35] Christ, W. G. (Ed.). (2020). Media education assessment handbook. Routledge.

understanding why something is by asking difficult questions, empathizing with others, and paying attention to the perspectives that are both present and absent.[36]

- Creativity can shape and refine a story into a cohesive form by unifying disparate sources under a single theme. It is necessary in relaying information in an attention-grabbing, suitable, and novel way. In a world where authenticity and originality is at a premium, Creativity can help students search for new approaches to familiar, well-trodden issues and problems. Furthermore, the world of Media is currently a turbulent, unstable sphere. Students setting out into such a world need to be comfortable with risk and uncertainty in order to keep growing and moving.
- Critical Thinking is involved in identifying and organizing the relevant parts of reality for fact-checking, both while producing a work of media and consuming it. Like in social studies, thinking critically allows keeping factors from many sources in mind to draw and support valid conclusions about a situation and how it relates to the present, past, and future. Media studies also emphasize the importance of media literacy -- a tenet of Critical Thinking -- and the value of hearing a different perspective.
- Courage and Ethics are involved through the media's role in shaping public opinion. For citizens in a democracy to participate in an informed way, individuals must hold themselves to ethical standards and be courageous in their pursuit of truth by considering viewpoints that may not be popular or widely accepted. Ethics is also crucial in Media studies because it emphasizes the role of trust inherent in carrying and relaying someone else's story.

In Entrepreneurship:

- ***Courage** supports entrepreneurial success by allowing people to move forward with the venture through uncertainties and difficulties.[37] By the nature of entrepreneurship, pitching a new idea involves risk;[38] over time, practicing overcoming these obstacles becomes Resilience. Courage is inseparable from Entrepreneurship because of the role of vulnerability. It requires an individual to deliberately step off the beaten path and brazenly try.
- ***Leadership** is central to pioneering entrepreneurship; graduates from business schools outnumber available jobs, and new start ups can create opportunities not only for individuals but also for others.[39] Smaller-scale Leadership also helps smaller projects, as sharing vision and passions with others leads to growth for the larger group.[40] This also blends into the Collaborative nature of entrepreneurship: respectfully working with others at all levels of the

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[36] Lynch, D. (2015). Looking at the future of journalism education. Knight Foundation.

[37] Bockorny, K. M. (2015). Psychological capital, courage, and entrepreneurial success (Doctoral dissertation, Bellevue University).

[38] Isenberg, D. J. (2010). How to start an entrepreneurial revolution. Harvard business review, 88(6), 40-50.

[39] Hameed, I., & Irfan, Z. (2019). Entrepreneurship education: a review of challenges, characteristics and opportunities. Entrepreneurship Education, 2(3), 135-148.

[40] Envick, B. R. (2014). Achieving entrepreneurial success through passion, vision, & courage: a cognitive model. Academy of Entrepreneurship Journal, 20(1).

organization, but with greater emphasis on also contributing to the community at large, an increasingly important tenet of entrepreneurship in today's ultra-connected world.

- Communication with funders, stakeholders and coworkers is necessary to obtain capital, share one's message and understand the perspectives of a potential customer base while developing a product. It is easy for entrepreneurs to -- unintentionally or intentionally -- isolate themselves into an echo chamber where they are only hearing what they already believe. Communication can help entrepreneurs not only ask the right questions, but also truly listen to their responses and incorporate them into their work. Furthermore, marketing is a central part of entrepreneurship -- which is all about successfully interacting with various audiences and demographics, a cornerstone of Communication.

In Personal Finance:

- ***Resilience** is needed over one's lifetime to persevere through the obstacles that today's difficult financial circumstances present.[41] Financial fragility is strongly linked to financial literacy, and practicing the requisite skills and consistently seeking help as needed will help one manage the financial decisions needed to navigate through financial crises.[42]
- ***Metacognition** involves self-awareness of one's knowledge and skills which helps manage individual financial resources effectively for lifetime financial security.[43] It has been shown that learning facts and calculation skills alone is not successful in improving financial stability;[44] changes that transfer to an individual's life involve interventions around how people process information.[45] In such a context-sensitive process, individuals must set their own goals, select the corresponding investment and budgeting strategies, and both monitor and self-regulate their relationship with money.
- Critical Thinking not only is associated with numeracy which helps individuals reason about spending in saving[46] but also affects people's ability to set clear criteria for making decisions involving money. Around 40% of individuals report moderate to severe difficulties in thinking about retirement-related financial planning issues which can be addressed in part by assessing

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[41] Boshara, R., Gannon, J., Mandell, L., Phillips, J. W., & Sass, S. (2010). Consumer trends in the public, private, and nonprofit sector. National Endowment for Financial Education Quarter Century Project.

[42] Lusardi, A., Hasler, A., & Yakoboski, P. J. (2020). Building up financial literacy and financial resilience. Mind & Society, 1-7.

[43] Hastings, J. S., Madrian, B. C., & Skimmyhorn, W. L. (2013). Financial literacy, financial education, and economic outcomes. Annu. Rev. Econ., 5(1), 347-373.

[44] Fernandes, D., Lynch Jr, J. G., & Netemeyer, R. G. (2014). Financial literacy, financial education, and downstream financial behaviors. Management Science, 60(8), 1861-1883.

[45] Antonietti, A., Borsetto, A., & Iannello, P. (2016). A metacognitive approach to financial literacy. In International handbook of financial literacy (pp. 57-68). Springer, Singapore.

[46] Soll, J. B., Keeney, R. L., & Larrick, R. P. (2013). Consumer misunderstanding of credit card use, payments, and debt: Causes and solutions. Journal of Public Policy & Marketing, 32(1), 66-81.

a situation more critically.[47] All people fall prey to psychological traps, many of which are amplified in financial situations. Critical Thinking can help individuals work against those instincts and spot logical fallacies in the often emotionally-driven world of personal finance.

- Courage allows people to face and overcome risks of financial instability. Investment often involves a willingness to take the inherent risks involved. While gauging risk correctly affects one's ability to accumulate wealth in saving for retirement, successfully managing personal finances involves translating that risk assessment into action, which in turn affects later wealth accumulation; for instance, lower willingness to take risks by women compared to men predicts gender differences in wealth accumulation.[48]

In Wellness:

- ***Mindfulness** is associated with one's monitoring and regulation of strong negative emotions, as well as intentionally cultivating a positive outlook. Managing stress and avoiding burnout can improve outcomes for professionals and students.[49, 50] Adolescents are particularly susceptible to stress, and this form of socioemotional learning can help alleviate some of its negative effects and begin a lifelong habit of practicing self care.[51]
- ***Courage** in the form of emotional vulnerability affects one's ability to be emotionally in tune with both themselves and others.[52] Students often need to practice this vulnerability in seeking help and being compassionate -- neither of which may be the norm.[53] In the reverse direction, courageous behavior is often characterized by making contributions that benefit others and uphold personal integrity, leading to greater thriving.[54]
- Resilience in the long run allows people to adapt to changes and uncertainty. Resilience allows you to establish and uphold boundaries in your life -- between yourself and others, yourself and work, yourself and the media, etc. Resilience also helps one establish a sense of purpose, a feat that can contribute to one's overall wellness. Managing stress and expressing emotions appropriately is also a key element of Resilience that directly relates to an individual's sense of Wellness.

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47 Kiso, H., & Hershey, D. A. (2017). Working adults' metacognitions regarding financial planning for retirement. Work, Aging and Retirement, 3(1), 77-88.

48 Bernasek, A., & Shwiff, S. (2001). Gender, risk, and retirement. Journal of economic issues, 35(2), 345-356.

49 Meiklejohn, J., Phillips, C., Freedman, M. L., Griffin, M. L., Biegel, G., Roach, A., ... & Saltzman, A. (2012). Integrating mindfulness training into K-12 education: Fostering the resilience of teachers and students. Mindfulness, 3(4), 291-307.

50 Johnstone, J. M., Roake, C., Sheikh, I., Mole, A., Nigg, J. T., & Oken, B. (2016). School-based mindfulness intervention for stress reduction in adolescents: Design and methodology of an open-label, parallel group, randomized controlled trial. Contemporary clinical trials communications, 4, 99-104.

51 Schmoyer, K. (2020). Cultivating social and emotional wellness in teachers and students through SEL and mindfulness-based interventions.

52 Brown, B. (2015). Daring greatly: How the courage to be vulnerable transforms the way we live, love, parent, and lead.

53 Curtis, K. (2014). Learning the requirements for compassionate practice: student vulnerability and courage. Nursing Ethics, 21(2), 210-223

54 Finfgeld, D. L. (1999). Courage as a process of pushing beyond the struggle. Qualitative Health Research, 9(6), 803-814.

- Metacognition and Growth Mindset support wellness as all aspects of Meta-Learning feed directly into one's well-being and sense of self. By setting personal goals, believing in oneself, and living an examined life, one can better understand and articulate their sense of purpose and direction.

In the Social Sciences

- ***Critical Thinking** supports the social sciences just as in life and physical sciences. It is necessary to design rigorous experiments and codify not only quantitative but also empirical qualitative data.[55] In the face of increasing concerns about legitimacy, limitations, and replicability,[56] it is more important than ever to examine one's assumptions and subject oneself to criticism as a scientist.[57]
- ***Metacognition** is particularly important in social sciences (in contrast with traditional sciences) because of the emphasis on identifying relevant questions in the discipline and avoiding normative assumptions about what ought to be true.[58] Because this often involves studying areas where individuals have their own lived experiences, it is important to step back from one's own perspective and be aware of one's biases and blind spots by actively seeking other perspectives and possibilities.
- Curiosity, much as in traditional sciences, is involved in the necessary stance of openness towards the world and readiness for surprise at one's observations. In the social sciences, there is that same drive to seek knowledge and understanding behind what appear to be everyday phenomena.
- Ethics is relevant to the study of human participants, from the confidentiality of data to care in experimental design, such as diverse representation among participants. Furthermore, considering the implications of results is crucial when the results may influence policy that directly affects people's lives.

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