On Becoming: Why Disposition Distinguishes Education from Training

Jeffry S. Babb
jbabb@wtamu.edu
Computer Information and Decision Management Department
West Texas A&M University, Canyon, TX 79016, USA

David J. Yates
dyates@bentley.edu
Computer Information Systems Department
Bentley University
Waltham, MA 02452, USA

Leslie J. Waguespack
lwaguespack@bentley.edu

Abstract

In 2020, the IEEE/ACM Computing Curricula 2020 report, the ACM/AIS/ISCAP Undergraduate Model Curriculum, and the AASCB Standards for Business Accreditation were all released. Each refers more prominently to dispositive aspects of the knowledge, skills, and capabilities that a curriculum is used to shape, hone, and prepare graduates. Both the CC2020 and IS2020 reports specifically recommend a competency-based curriculum in which dispositions are both a relatively new addition as well as an addition that may be fraught as the consideration and/or adoption process proceeds. New curricular guidelines, model curricula, and accreditation standards provide an occasion for assessment and reflection such that foundational assumptions may be reviewed. The competency model challenges Information Systems curriculum design in two key aspects that are the subject of this paper. First, the dispositive dimension poses key challenges in the Information Systems discipline and provides a new area of focus in the literature on Information Systems curriculum development. Second, the inclusion of dispositions in the CC2020/IS2020 competency model provides an opportunity to explore interconnections that can be more informative than course containers, course descriptions, and lists of topics. Dispositions provide an opportunity to also consider students' learning and growth facilities by focusing on what facilities the growth of competency beyond the application of knowledge and skills. We promote the uptake of the CC2020/IS2020 competency model by focusing on and advocating for dispositions as a means of accounting for, and designing for, students' 'becoming' in their advancement in the application of skills and knowledge in the task environment. The dispositive component of the competency model promises extended expression, facility of comparison, and clarity in exchange to bring utility and understanding in the Information Systems curriculum development process.

Keywords: professionalism, competency, mindset, dispositions, accountability, computing education, curriculum design.

1. Introduction

Recent computing curricula reports (CC2020), and specific disciplinary model curriculum reports (CC2020, IS2020, and the impending CS2023 and DS2023) have been authored using a competency approach to modeling computing curricula. A key component of the models in these reports is the inclusion of dispositions in the model. As dispositions suggest the habitual

inclination and tendencies that best facilitate the development of the skills and knowledge that underly successful development of the competency, the inclusion of dispositions, which can be thought of as being somewhat subjective, could be construed as a shift towards the esoteric. This presented opportunities for friction and for growth. We next examine how others have examined dispositions in computing curriculum development.

Knowledge Areas, Knowledge Units, and Learning Outcomes (KA, KU, LO) were common ontological organizations in model curricula development 20 years ago. While they are still useful to articulate the knowledge elements and skills levels inherent in the CC2020 competency model, these elements (KA, KU, LO) can usually be directly observed: a developed algorithm, a security policy, a normalized schema, or UX design. However, the potentially fraught and beneficial aspect of the CC2020 and IS02020 competency model is the inclusion of dispositions. Dispositions, which at first seem immediately familiar, quickly become inscrutable as they must be explicated, articulated, and reconciled as mediators and moderators of the full competency expression; more so when a competency expression attempts to match a given task environment.

Dispositions are arguably a matter of the affective cognitive realm (Ben-Ze'ev, 1997) and arguably occupy a similar space as that of Covey's (2020) seven habits. Like Covey's habits, dispositions may be understood as conditions, or habits of mind, that assists in problem framing and solution design. When we enter the behavioral and affective realm of dispositions in the competency model, they may strike some as being apart from the more concrete elements of computing knowledge. Thus, while computing accreditors, such as ABET, do not shy away from specifying attention to sociologic and behavioral psychologic realms in their criteria for computing programs, the authoring and pedagogical implementation of dispositions remains relatively new ground in model curricula for Information Systems. That is, we are used to students' demonstration of computing knowledge and ability, via observable artifacts, and less so from the enabling habits and attitudes that facilitate.

In this paper we will explore the essential nature of the dispositive component of the competency model and suggest that the investments in the dispositive dimensions of competencies can be meaningful and long-lasting as student progress in their careers. In this sense, we advocate that dispositions serve as a "glue" used to adhere the vital component of a competency's contextual application in a task environment to the foundational knowledge needed to facilitate computing solutions.

Because dispositions may not be a common element in many skills-oriented technical courses and curricula, or because other collateral disciplines may assume the mantle of basic principles of habit and behavior, it is likely that dispositions and their importance can be missed in the development of competencies. Whereas recent guidance from model curricula (IS2020) or accrediting bodies (the ABET CAC Criteria) place a firm emphasis and embrace on the indelible and concrete technical knowledge and skills, the benefit of examining the seemingly esoteric essence of dispositions is the appeal made in this paper. Dispositions are vital as they reflect the knowing-in-action (Schön, 1995) that can be best shaped by discovering both explicit and implicit purposes and placement of disposition in competency expressions of curricula.

Lastly, this paper proposes that the lasting value of dispositions is their reflection of the evergreen habits of orientation, perspective, and framing that are the hallmarks of reflective practice of an IS professional (Brown, 1995; Rein and Schön, 1996). We hope that the reader will develop a greater appreciation for the potential, pitfalls, and nuances possible with care for what dispositions bring to the table in the CC2020/IS2020 competency model.

The paper proceeds as follows. First, we examine the purpose and placement of dispositions within the competency model. We next examine the literature on dispositions regarding competencies in computing curriculum development. We next explore how the CC2020 competency model was manifested in the IS2020 model curriculum with some text analytic techniques. With that, we next postulate on what typical challenges would be encountered in specifying dispositions during competency development. We conclude with potential benefits and purposes of dispositions with regard to overarching goals for academic computing programs and the student outcomes they facilitate.

2. The Significance of Disposition in Competency

CC2020 asserts that adopting its competency model enables educating, prescribing, and evaluating a practice of computing that delivers a broad range of practical benefits to society:

ISSN: 2473-4901
v9 n6011

students, benefactors, faculty, administrators, employers, accreditors, lawmakers, and society.

"Describing computing competence in a practical context shifts the focus of curricula away from describing a body of knowledge in relation to a disciplinary area and channels it toward pragmatic […] accomplishment and performance. It challenges […developing …] proficient computing professionals, and it allows society to recognize the purpose and benefits of […computing …] within a competency framework." (cc2020)

Indeed, at the CC2020 project's inception in early 2017 the capability and character of "proficient computing professionals" fused as the driving theme. The transformation from "knowing" to "practicing" was driven by both a commitment that students "learn better" and that graduates "perform better" in the real world. CC2020 set aside the tradition of a narrow preoccupation of dissecting computing as a body of knowledge to supplant it with a more comprehensive conception, that of competent professional action and conduct. CC2020's model of competency categorically represents professional action and conduct as "knowing what," "knowing how," and "knowing why."

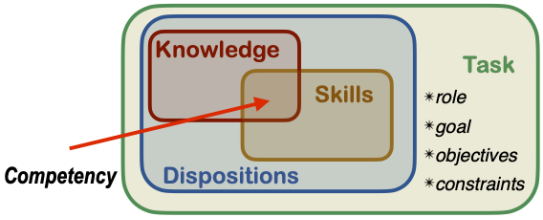


Figure 1. Competency = [Knowledge + Skills + Dispositions] in Task (Clear & Parrish et al., 2020)

The new, key element is **disposition** that explicitly fuses action and conduct to the effect of purposeful behavior.

disposition *… Natural tendency or bent of the mind, esp. in relation to moral or social qualities; mental constitution or temperament; turn of mind…*
[Oxford English Dictionary]

Disposition's role in competency (both formative and performative) enjoins delineating traits that characterize "professionalism." In concert these traits commonly interpret a "professional **mindset**." CC2020 elaborates their formative intention of disposition in competency as follows:

The meta-language of competency, "knowing what," "knowing how," and "knowing why," crisscrosses domains of scientific fact, practiced behavior, and cultural norms. Scientific (technically rational) fact and practiced behavior lend themselves to a categorical assessment: true or false, present or absent, consistent or inconsistent, it works, or it doesn't. Dispositions enfold intellectual, social, and moral predilections or tendencies that influence behaviors that do not lend themselves as easily to a categorical assessment. These predilections reflect value judgements that are not amenable to scientific proof. Values may differ or be held differently among individuals or cultures. And value judgements are also often mutable over time—affected by the experience of practice!
…
Dispositional expectations enrich the description/assessment of competency and/or the related pedagogy. Ascribing a disposition to a competency indicates a clear commitment to self-reflection and a sober examination of mission, goals, and objectives to reach the clarity that enables its effective integration in curriculum design, the agency of pedagogy, and the character of professionalism.
…
Disposition is an area that clearly distinguishes competency from a learning outcome and is an essential characteristic of a well-structured competency. As such it represents a significant extension in the expressiveness of learning goals and adds language common to professional expectations. However, when used in free form, such terms may easily become vague or difficult to interpret. This is where the specification of a competency—that is the combination of the free-form text with its constituent K+S+D in [Task] framing—becomes more valuable. The competency statement is prose that succinctly conveys the essential intention of curricular details, while the structured enumeration of the K-S pairs and D elements conveys intention in action. [CC2020 p134]

Discerning and incorporating disposition in a competency specification of computing actions and conduct described in practice, empowers agencies of licensure, managers, educators, and communities to formulate, recognize, and effectively assert a whole of values and commitments that they deem characteristic to the judgement and conduct of a practitioner who is worthy of trust and respect as a professional.

The CC2020 decision to enfold dispositions to stipulate the character of professional practice clearly articulates what distinguishes educating

computing professionals from training computing practitioners.

train *… To subject to discipline and instruction for development of character, behavior, or skill… To give sustained instruction and practice to…*
[Oxford English Dictionary]

educate *… To teach (a child) a program of various academic and non-academic subjects, typically at a school; to provide with a formal education.*
[Oxford English Dictionary]

3. Dispositions in the Literature

Since 2017 (Sabin, et al., 2017), the benefits of recognizing dispositions and task context in competency statements for computing curricula have become more obvious (Frezza, Daniels, Pears et al., 2018; Takada, Cuadros-Vargas, Impagliazzo, et al., 2020). Furthermore, developing and including dispositions in competency statements is critical to advancing the use of competencies for describing the goals of tertiary education. In part, dispositions serve as a lens through which student behavior can be observed (Frezza, Clear & Clear, 2020; Watson, Besmer, Banks et al., 2021). In a professional setting, dispositions are observed in relation to conceptual and procedural knowledge (Billing, 2007). This study intends to understand and advance the development and inclusion of dispositions in competency statements.

To understand to what extent and where the dispositions proposed in the CC 2020 report (Clear & Parrish et al., 2020) appear in the literature, we formulated queries in Google Scholar for four major publication outlets. The primary audience for these outlets is educators in three computing disciplines, i.e., computer science, electrical engineering, and information systems. Table 1 shows the number of publications for each disposition that appeared in the ACM Transactions on Computing Education (ToCE), IEEE Frontiers in Education (FIE), ISCAP Information Systems Education Journal (ISEDJ), and ISCAP Journal of Information Systems (JISE). Table 1 shows that all dispositions have been studied, albeit to different degrees. Being collaborative or professional has been studied the most frequently in these outlets whereas being meticulous or passionate has been studied least frequently. The Google Scholar search queries for these dispositions are described in Appendix B. Most of these articles were published in the last ten years; for example (Cabo, 2021; Frezza & Adams; 2020; Groeneveld, Vennekens & Aerts, 2021; Jacob, Montoya, Nguyen & Warschauer, 2022; Knestis, Cheng, Fontaine & Feng, 2022; Podeschi & DeBo, 2022; Waguespack, Yates & Babb, 2022; Wijeratne, Dennehy, Quinlivan et al., 2022) have appeared since 2019. However, many relevant articles appeared before 2010, e.g. (Bryant, Campbell & Kerr, 2003; Graham & Caso, 2002; Guthrie & Navarrete, 2004; Richards, 2009; Saulnier, 2005; Sterling & Brinthaupt, 2003; Urquiza-Fuentes & Velázquez-Iturbide, 2009; Williams & Upchurch, 2001).

From the more than 2,000 articles counted in Table 1, we wanted to discern the areas in which areas the authors had focused their research on dispositions. To do this we identified the six articles that Google Scholar considered most relevant for each of the dispositions and each of the publications in Table 1. The result of this bibliometric analysis yielded 138 articles. Thirty-four of these articles appeared in ACM ToCE, 41 in FIE, 33 in ISEDJ, and 30 in JISE. The 25 words that appeared most frequently in the titles of these articles appear in Table 2. Several of the words in Table 2 reflect the fact that the audience of our four publication outlets are educators, e.g., learning, education, students, teaching, course(s), curriculum, and knowledge. Most of the other words are commonplace when describing computing disciplines, e.g., computing, engineering, computer, information, systems, programming, science, technology, etc.

Words in Article Titles (see Appendix D)	**Word Frequency**
Learning	43
Education	25
Students	24
Computing	23
Engineering	20
Computer	18
Information	16
Systems, Teaching	15
Course, Programming, Skills	14
Curriculum, Development	13
Assessment, Courses, Student	12
Study	10
Online, Science, Technology	9
Knowledge, Professional, Project, Thinking	8

Table 1. Word frequency distribution for titles resulting from bibliometric analysis.

We also wanted to visualize the 138 article titles in word clouds to understand what themes (not just words) appeared most frequently. Figure 10 extends Table 2 from 25 words to 50 words. The

ISSN: 2473-4901
v9 n6011

words in yellow and orange in this figure add insights beyond those derived from the data in Table 2. For example, the word "design" reminds us that computing disciplines are disciplines of design (Brooks, 2010), including information systems (Babb, Waguespack & Abdullat, 2019). The word "attitudes" reminds us that most of the published work in computing education frames competencies in the language of knowledge + skills + attitudes (Volman, van Eck, Heemskerk & Kuiper, 2005) rather than knowledge + skills + dispositions (Clear & Parrish et al., 2020; Sabin, et al., 2017). Also, that "professional" and "collaborative" are the only two dispositions that appear by name in Figure 10 is consistent with the fact that these are the most studied dispositions listed in Table 1.

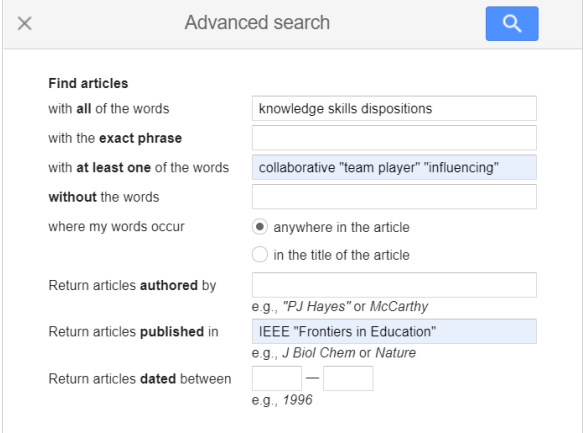
Table 2. Dispositions, synonyms, and adjacent concepts used in queries to identify relevant articles. Figure 2 provides details of the search terms used to develop the list.

A word cloud analysis provided an additional perspective by considering both phrases and words. The most common word in our article titles – learning – isn't just about student learning. "Learning" also appears in article titles that refer to problem- or project-based learning [seven articles, e.g., (O'Grady, 2012; Woodward, Sendall & Ceccucci, 2010)], self-directed learning [two articles (Johnson, Ulseth, Smith & Fox, 2015; McCartney, Boustedt, Eckerd, et al., 2016)], and learning enhanced by reflection (Barroso & Morgan, 2012) and technology (Motschnig-Pitrik, Kabicher, Figl & Santos, 2007). We saw in Table 2 that "information" (row seven) and "systems" (row eight) occur at about the same frequency. However, these words often appear as part of the phrase "information systems" (IS), referring to IS course(s), IS curriculum, and IS education, for example, as in (Saulnier, 2009; Nwokeji, Stachel, Holmes & Orji, 2019; Topi, 2019).

4. Dispositions in IS2020

The IS 2020 report (Leidig & Salmela et al., 2020) argues that dispositions are essential components of competency statements, because there "is often a character and quality of application inherent in the domain and context of application that suggests the qualifiers inherent to that domain. The *computing-of-x* and *x-computing* phenomena suggest that demand for the contextualized use of knowledge-skill pairing in IS will continue to rise as the pervasiveness and ubiquity of computing into nearly all aspects of society, organizations, government, and business continues in a process often referred to as digitalization. Dispositions are the adjectives that bring the socio-technical aspects of technology use to bear" (pp. 38-39). Leidig and Salmela et al. (2020) go on to enumerate 178 competencies in the report (pp. 95-182), including their knowledge-skill pairs and "key dispositions" (p. 97).

Disposition	**Synonyms and Adjacent Concepts**
Adaptable	flexible, agile
Collaborative	team player, influencing
Inventive	exploratory, curious
Meticulous	attentive to detail, attention to detail
Passionate	with passion, with conviction
Proactive	with initiative, self-starter
Professional	with professionalism, work ethic
Purpose-driven	purposeful, purposefully engaged
Responsible	with judgment, with discretion, rectitude
Responsive	Respectful
Self-directed	self-motivated

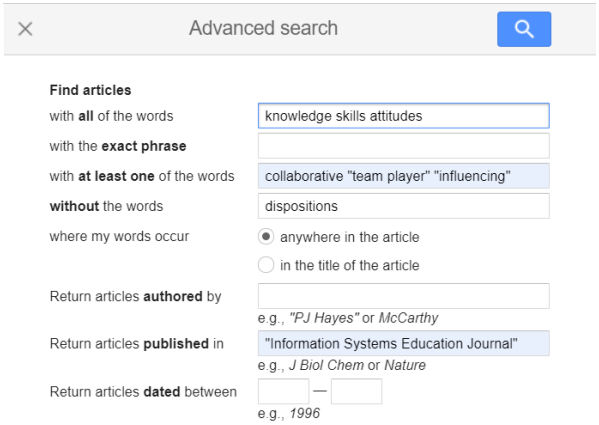



```
knowledge skills dispositions collaborative OR "team player" OR influencing source:IEEE source:"Frontiers in Education"
```

Figure 2. Example user interface and Google Scholar syntax for K-S-D query for *collaborative*.

ISSN: 2473-4901
v9 n6011

To help faculty, administrators, and professionals make sense of so many key dispositions, the IS 2020 report authors group them into the six competency realms shown in Figure 3. Since each competency names three key dispositions, Figure 3 shows 534 in total (the numbers in parentheses). For example, Systems Development (in yellow) specifies that a subset of the 11 dispositions in Table 2 are "key" for the 64 competencies within this competency realm. Hence, Systems Development explicitly requires 192 key dispositions, in aggregate, because each of these competencies includes three key dispositions. These dispositions, when tallied, appear in the proportions shown in Figure 4. A further elaboration in the Software Systems Development realm is shown in Figure 5.




```
knowledge skills attitudes collaborative OR "team player" OR influencing -dispositions source:"Information Systems Education Journal"
```

Figure 3. Example user interface and Google Scholar syntax for K-S-A query for *collaborative*.

Note that Figure 6 shows that the report suggests that being purpose-driven, meticulous, inventive, and self-directed are most important when learning and practicing the competencies within Systems Development.

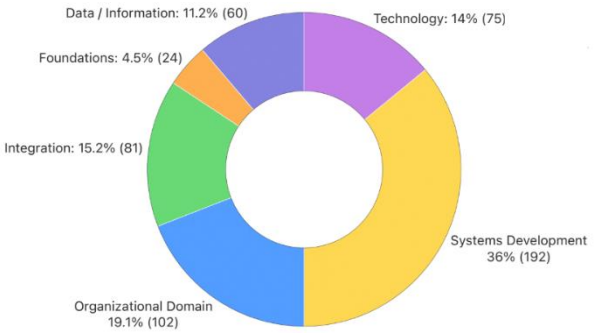


Figure 4. Distribution of key dispositions among six IS 2020 competency realms.

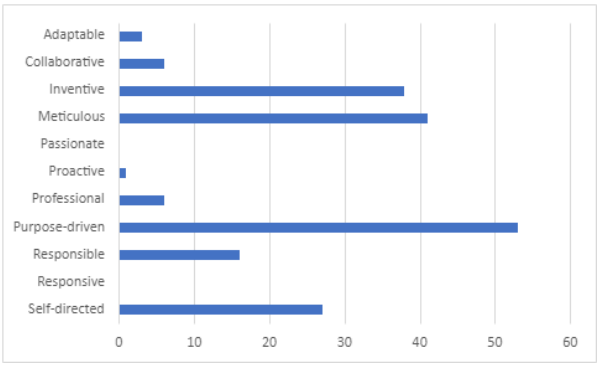


Figure 5. Distribution of key dispositions within the IS 2020 Systems Development competency realm.

Figure 6 shows the distribution of the 11 CC 2020 dispositions across all six competency realms in Figure 3. For IS as a whole, as envisioned by Leidig and Salmela et al. (2020), the most important key dispositions (in decreasing frequency of occurrence on pp. 95-182) are being purpose-driven, self-directed, meticulous, and inventive. The remaining seven dispositions occur between 51 times (professional) and one time (passionate).

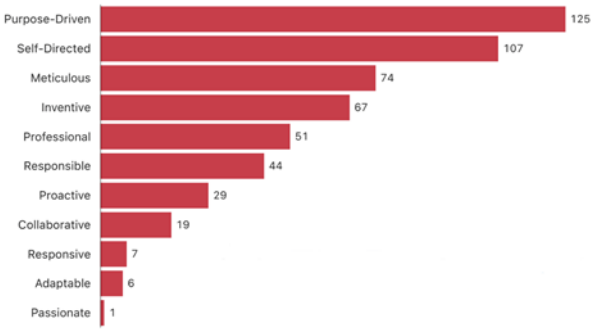


Figure 6. Aggregate distribution of key dispositions across all six IS 2020 competency realms.

ISSN: 2473-4901
v9 n6011

5. The Challenge of Disposition in Competency Specification

[CC2020] offers a list of eleven prospective dispositions derived from the literature to round out the knowledge, skills, dispositions as components of competency. Disposition as an intrinsic component of competency represents the opportunity [for the competency author] to clearly express institutional and programmatic values expected in a graduate's work. Dispositional expectations enrich the description/assessment of competency and/or the related pedagogy. Ascribing a disposition to a competency indicates a clear commitment to self-reflection and a sober examination of mission, goals, and objectives to reach the clarity that enables its effective integration in curriculum design, the agency of pedagogy, and the character of professionalism. [CC2020 p134]

Indeed, the CC2020 competency model offers an enhanced and enlightened framework to detail technical expertise but also, a purposeful intension of professionalism to serve society. The transliteration of the knowledge-centric aspects of past, traditional curricular descriptions is less fraught with challenge than the reflective process of discernment and specification of professional conduct and character in the medium of dispositions. It is the latter that we wish to explore in this discourse.

Mindset Dimension – In cognitive psychology a mindset represents the cognitive processes activated in response to a given task. (French & Chang, 2016) In decision theory and general systems theory, a mindset is a set of assumptions, methods, or notions held by one or more people or groups of people. (Cambridge English Dictionary)

In the adapted quotations that follow, the design theorist refers to *mindset* as "appreciative system" and *practitioner* as "stakeholder." (Waguespack, 2019, p. 27).

A [practitioner]'s [mindset] cues what facts to attend to in any particular experience while that same experience results in a learning effect that informs, reinforces and refines the [practitioner]'s apprehension of value and significance, thus altering that [mindset].

[A… mindset] is a complex and emergent agency of choice in [practitioner] behavior situated in a social context.

[Practitioners] possess [mindsets] individually as their experience and judgements are personal. In a community of [practitioners] there are recurrent threads of experience, shared knowledge, and commonly held norms that proceed from culture: social, professional, religious, or intellectual. A culture commonly promulgates a standard of appreciation that facilitates a shared cooperation and collaborative decision-making that reinforces community – intentionally or unintentionally. Formal education, professional training, and certification, as well as, religious communities, all purposefully foster aspects of shared culture to shape community identity, goals, and expectations of behavior. Shared culture is a basic defining aspect of any community – formal or informal. Any human conception of satisfaction is founded upon [a mindset] that is subject in part to the subjective interpretation of norms and aspirations – individual and cultural metaphors.

Figures 7, 8, and 9 use mindmaps to extend the juxtaposition of the mindset dimension of the disposition with both the competency and the competency's task environment and context.

Figure 7. Mindset Dimension of Professionalism

ISSN: 2473-4901
v9 n6011

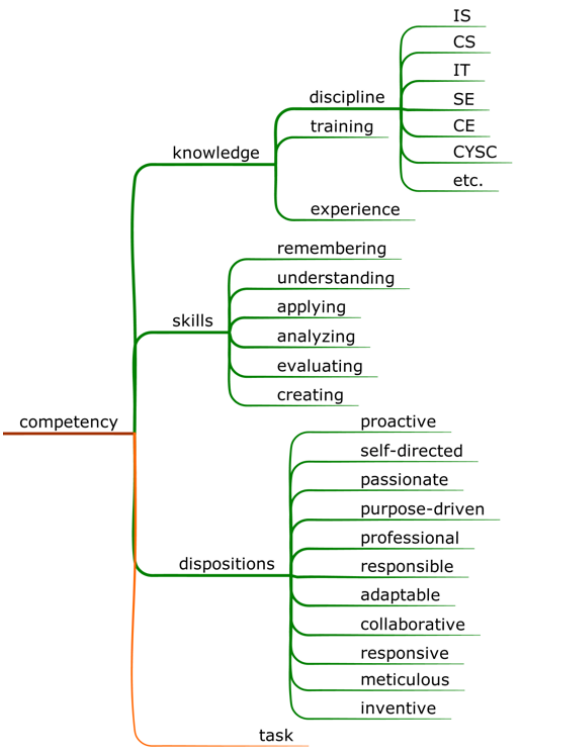


Figure 8. Competency Dimension

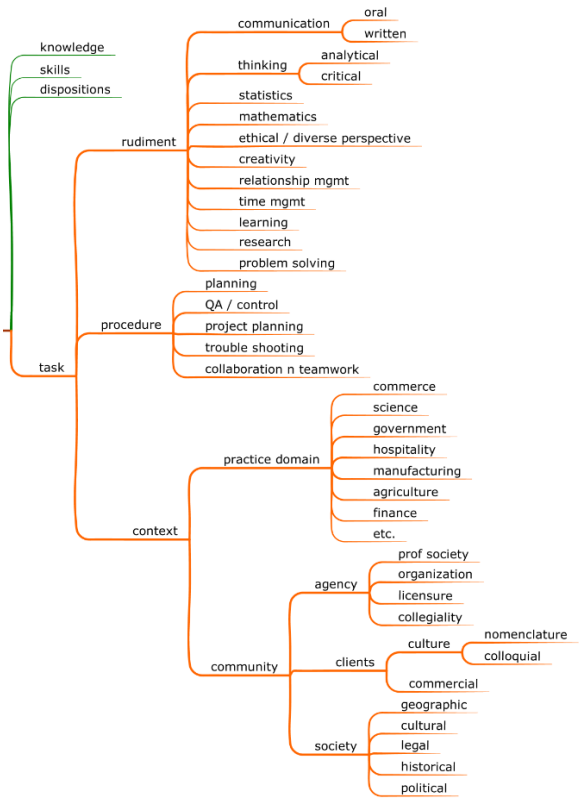


Figure 9. Competency: Task Aspect

6. The Reward in Disposition in Competency Specification

We argue that disposition specification provides a semiotic reflection that enables and activates the greatest promise of the consistency of a competency's availability and activation. As such, we present that the greatest opportunity in the competency model is the degree to which captured and imbued dispositions, forged in praxis, produces the behavior and outcomes. The connection between behavior and outcomes is framed by tasks and performance outcome expectations. The proof of a competency lies within resides within the expected outcomes, artifacts, and action inherent in the competency. Tie afforded to dispositions may well result in greater connection to the expected outcomes that the task environment desires.

To bolster this assertion, we take the position that Information Systems is inherently a design discipline where the appreciative system of the satisfaction of the "clients" of design requires an exquisite balance between feasibility and efficiency that demands dispositional maturity and acuity. As a designer, the IS professional, shaped by the performance expectations and responsibilities of competency, seeks a symmetric balance of quality and technical choice properties in a designed artifact. Dispositions, even the nascent list offered in the CC2020 report, provide the IS professional with an opportunity to balance motive and opportunity; to bridge the natural and artificial realms, and to explore and cultivate notions of satisfaction. This balance, perhaps the art of satisficing becomes necessary when available models of satisfaction are emergent and incomplete, thus full client satisfaction is fleeting.

To satisfice is to recognize tradeoffs and engage in the design of generative metaphor. This ability to "critically think" is to proffer design actions in the face of uncertainty. McGilcrist (2019) and Lakoff (1993) suggest that to design amidst uncertainty is to engage in pattern recognition that is only possible via reference metaphors. A word/concept will anchor the possible moves from one frame of reference for future possible design choices. Fred Brooks (1995) suggests that metaphor maps similar and dissimilar contexts and separates essences and accidents. These are the skills that bring robustness (does it endure in its construction and withstand change?) and vitality (does it continue to thrive?) to the IS professional's designs and the necessary grounding for these competencies lies within dispositions.

To do so is to embrace, as a regular practice, the esoteric. The discipline and habit to do so is a dispositive challenge for the design of a competency-based curriculum. Dispositions hold the key to long-term development and mastery, in praxis, of the metaphor, technical rationality, appreciative systems, and mastery medium of construction required for robustness and vitality as a professional.

7. Dispositions are Vital for Becoming

We have sought that the reader would consider disposition as a potential lynchpin, cornerstone, and pitfall of competency authoring. The greatest potential for dispositions would be in their ability to sustain and carry the knowledge and skills dimension of the competency model forward. We examine this premise with an extrapolation of the work of Scanlon (2011) on the subject of becoming as it relates to professionalizing. As professionalizing is a process that is fueld from a synthesis of the components of a competency – knowledge, skills, and disposition – over time and through experience, Scanlon's work on professionalizing may provide further insight. Scanlon (2011) articulates an archetypal model of a professional as having a body of knowledge based on abstract concepts and theories and requiring the exercise of considerable discretion, an occupationally controlled division of labor, credentialing procedures, training programs and an ethic encourages doing good rather than economic gain. To elaborate, Scanlon (2011) advocates that a professional's high social esteem is based on the provision of expert services from a position of power, trust, and discretion. Furthermore, it is proposed that professionals have fiduciary responsibilities to advance client well-being and to take responsibility for the governance and regulation of activities of their profession. Finally, Scanlon (2011) suggests that engagement in lifelong learning to better serve client needs is an essential aspect of maintain fidelity and trust. While professionalism of this sort is not yet fully, if not even nascently, realized in computing disciplines, the paths that lead to these vital aspects of professionalizing are dispositive in their essence. Thus, the maturity arc of "becoming" for computing must embrace the dispositive dimension that goes beyond technical rationality (Schön, 1983). The "becoming" that Scanlon (2011) describes appears to comport well with the possibilities and opportunities available when explicit focus is afforded to dispositions in a competency specification and a competency-based curriculum.

This paper has attempted to clarify that the dispositive dimension is the matter most important to the successful use of a competency based curricular approach to the IS curriculum design. One argument for this being the case is that dispositions are the newest and most untested element of the competency model. As such, the means for designing curricula for this, as well as measurement approaches to monitor continuous improvement, may be less developed. Here we have articulated a concern, given the fundamentally esoteric nature of the dispositive dimension, that the true promise of dispositions may be overlooked in the development of competency-based computing curricula. We have not taken a prescriptive approach here where best practices are articulated and tested strategies are sold. Rather, what we have attempted here is advocate for extra care, further study, and cautious focus on the novelty of dispositions given the history of computing curricula reports and models. It is possible that embracing further study and comprehension of dispositions can lead to much-needed institutionalization of professionalism and development (Berger and Luckmann, 1867; Schutz, 1962) of the Information Systems discipline itself. As such, we offer that our ability to successfully develop a competency-based approach to Information Systems curricula lies perhaps more with our ability to instill key orientations, behaviors, and instincts in our students about the nature of computing, than the technologies and tools that facilitate our designs and solutions. It is likely that the positive orientations of dispositions will outlast the ebb and flow of technologies; such is the promise we see in the use of dispositions to nurture the "becoming" for our students.

8. REFERENCES

ACM CoE. (2018), *ACM Code of Ethics and Professional Responsibility*. Retrieved from https://www.acm.org/binaries/content/assets/about/acm-code-of-ethics-booklet.pdf (current June 15, 2021).

Aeroflot Flight 593. (2017). Retrieved from https://en.wikipedia.org/wiki/Aeroflot_Flight_593.

Anderson, L. W., & Krathwohl D. R. (2001). *A taxonomy for learning, teaching and assessing: A revision of Bloom's taxonomy of educational objectives*. Pearson Longman.

Babb, J. S., Waguespack, L. J., & Abdullat, A. (2019). Subsumption of information systems education towards a discipline of design.

Journal of Information Systems Education, 30(4), 311-320.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51(6), 1173-1182.

Barroso, L. R., & Morgan, J. (2012). Utilizing reflection in projects for increased metacognition and enhanced learning. In *Proc. of the 42nd Frontiers in Education Conference* (FIE).

Ben-Ze'ev, A. (1997). The affective realm. New Ideas in Psychology, 15(3), 247-259.

Berger, P. and T. Luckmann 1967 The Social Construction of Reality. New York: Doubleday.

Billing, D. (2007). Teaching for transfer of core/key skills in higher education: Cognitive skills. *Higher Education*, 53(4), 483-516.

Birdwell-Mitchell, E. N. (2018). Too legit to quit: Institutional perspectives on the study of schools as organizations. *The SAGE Handbook of School Organization*, 139-155.

Borras, C., Pablo Bares, J., Rudder, D., Amer, A., Millan, F., & Abuchaibe, O. (2004). Clinical effects in a cohort of cancer patients overexposed during external beam pelvic radiotherapy. *International Journal of Radiation Oncology Biol. Phys.*, 59(2), 538-550.

Brookfield, S. P. (2017). *Becoming a critically reflective teacher* (2nd ed.). Jossey-Bass.

Brooks Jr, F. P. (1995). The mythical man-month: essays on software engineering. Pearson Education.

Brooks, F. P. (2010). *The design of design: Essays from a computer scientist*. Addison-Wesley Professional.

Brown, P. (1995). Naming and framing: The social construction of diagnosis and illness. *Journal of health and social behavior*, 34-52.

Bryant, K., Campbell, J., & Kerr, D. (2003). Impact of web based flexible learning on academic performance in information systems. *Journal of Information Systems Education*, 14(1), 41-50.

Cabo, C. (2021). Use of machine learning to identify predictors of student performance in writing viable computer programs with repetition loops and methods. In *Proc. of the 51st Frontiers in Education Conference*.

CC 2005. (2005). *Computing Curricula 2005: The Overview Report*, ACM, AIS, IEEE. Retrieved from https://www.acm.org/binaries/content/assets/education/curricula-recommendations/cc2005-march06final.pdf (current June 15, 2021).

Clear, A., Parrish, A., Ciancarini, P., Cuadros-Vargas, E., Frezza, S., Gal-Ezer, J., Impagliazzo, J., Pears, A., Takada, S., Topi, H., van der Veer, G., Vichare, A., Waguespack, L., Wang, P., Zhang, M. (2020). *Computing Curricula 2020 (CC2020), Paradigms for Future Computing Curricula*, ACM, IEEE.

Clear, T. (2017). Meeting employers expectations of DevOps roles: Can dispositions be taught? *Inroads*, 8(2), 19–21.

Covey, S. R. (2020). *The 7 habits of highly effective people*. Simon & Schuster.

Cramton, R. C. (1982). The current state of the law curriculum. *Journal of Legal Education*, 32(3), 321-335.

Elias, D. (1997). It's time to change our minds: An introduction to transformative learning. *ReVision*, 20(1), 2+.

French, R. P., II, & Chang, H. (2016). Conceptual re-imagining of global 'mindset': Knowledge as prime in the development of global leaders. *Journal of International Organizations Studies*, 7(1), 49–62.

Frezza, S., Clear, T., & Clear, A. (2020). Unpacking dispositions in the CC2020 computing curriculum overview report. In *Proc. of the 50th Frontiers in Education Conference* (pp. 1-8).

Frezza, S., Daniels, M., & Wilkin, A. (2019). Assessing students' IT professional values in a global project setting. *ACM Transactions on Computing Education* (TOCE), 19(2), 1-34.

Frezza, S., Daniels, M., Pears, A., Cajander, Å., Kann, V., Kapoor, A., ... & Wallace, C. (2018). Modelling competencies for computing education beyond 2020: A research based approach to defining competencies in the computing disciplines. In *Proc. of Annual ACM Conference on Innovation and Technology in Computer Science Education* (pp. 148-174).

Gotterbarn, D., & Miller, K. W. (2009). The public is the priority: Making decisions using the

software engineering code of ethics. *IEEE Annals of the History of Computing*, 42(6), 66-73.

Graham, J. M., & Caso, R. (2002). Measuring engineering freshman attitudes and perceptions of their first-year academic experience: The continuing development of two assessment instruments. In *Proc. of the 32nd Frontiers in Education Conference*.

Gray, J. M. (2015). *Virtue ethics: Examining influences on the ethical commitment of information system workers in trusted positions*. Ph.D. Thesis, Nova Southeastern University.

Groeneveld, W., Vennekens, J., & Aerts, K. (2021). Identifying non-technical skill gaps in software engineering education: What experts expect but students don't learn. *ACM Transactions on Computing Education (ToCE)*, 22(1), 1-21.

Guthrie, R. A., & Navarrete, C. J. (2004). Service-learning impact on IS students in a web development course. *Information Systems Education Journal*, 2(12), ISSN 1545-679X.

Hurlburt, G. F., Miller, K. W., & Voas, J. M. (2009). An ethical analysis of automation, risk, and the financial crises of 2008. *IT Professional*, 11(1), 14-19.

IEEE CoE. (2021), IEEE Code of Ethics. Retrieved from https://www.ieee.org/about/corporate/governance/p7-8.html (current June 15, 2021).

IT 2017. (2017). *Information Technology Curricula 2017*, ACM, IEEE. Retrieved from https://www.acm.org/binaries/content/assets/education/curricula-recommendations/it2017.pdf (current June 15, 2021).

Jacob, S. R., Montoya, J., Nguyen, H., Richardson, D., & Warschauer, M. (2022). Examining the what, why, and how of multilingual student identity development in computer science. *ACM Transactions on Computing Education (ToCE)*.

Johns, C. (1995). Framing learning through reflection within Carper's fundamental ways of knowing in nursing. *Journal of Advanced Nursing*, 22(2), 226-234.

Johnson, B., Ulseth, R., Smith, C., & Fox, D. (2015). The impacts of project based learning on self-directed learning and professional skill attainment: A comparison of project based learning to traditional engineering education. In *Proc. of the 45th Frontiers in Education Conference* (FIE).

Knestis, K., Cheng, J., Fontaine, C. M., & Feng, R. (2022). Engaging government-industry-university partnerships to further gender equity in STEM workforce education through technology and information system learning tools. *Journal of Information Systems Education*, 33(1), 23-31.

Kolb, D. A., & Wolfe, D. M. (1981). *Professional education and career development: A cross sectional study of adaptive competencies in experiential learning*. Final Report.

Lakoff, G. (1993). The contemporary theory of metaphor.

Leidig, P., Salmela, H, & The Joint ACM/AIS IS2020 Task Force. (2020). *IS2020: A Competency Model for Undergraduate Programs in Information Systems*, ACM, AIS.

Liu, K. (2000). *Semiotics in information systems engineering*. Cambridge University Press.

Lyytinen, K., & Yoo, Y. (2002). Ubiquitous computing. *Communications of the ACM*, 45(12), 63-96.

Maslow, A. H. (1981). Motivation and personality. Prabhat Prakashan.

McCartney, R., Boustedt, J., Eckerd, A., Sanders, K., Thomas, L., & Zander, C. (2016). Why computing students learn on their own: Motivation for self-directed learning of computing. *ACM Transactions on Computing Education (ToCE)*, 16(1), 1-18.

McGilchrist, I. (2019). *The master and his emissary: The divided brain and the making of the western world*. Yale University Press.

Meyer, J. H. F., Land, R., & Baillie, C. (2010). *Threshold concepts and transformational learning*. Sense Publishing.

Miller, M. A., & Malcolm, N. S. (1990). Critical thinking in the nursing curriculum. *Nursing & Health Care*, 11(2), 67-73.

Motschnig-Pitrik, R., Kabicher, S., Figl, K., & Santos, A. M. (2007). Person centered, technology enhanced learning in action: Action research in a course on organizational development. In *Proc. of the 37th Frontiers in Education Conference* (FIE).

Newman, J. H. (2008). *The idea of a university defined and illustrated*. Yale University Press.

Nwokeji, J. C., Stachel, R., Holmes, T., & Orji, R. O. (2019). Competencies required for developing computer and information systems curriculum. In *Proc. of the 49th Frontiers in Education Conference* (FIE).

Nwokeji, J. C., Stachel, R., Holmes, T., & Orji, R. O. (2019). Competencies required for developing computer and information systems curriculum. In *Proc. of the 49th Frontiers in Education Conference* (FIE).

O'Grady, M. J. (2012). Practical problem-based learning in computing education. *ACM Transactions on Computing Education (ToCE)*, 12(3), 1-16.

Parviainen, P., Tihinen, M., Kääriäinen, J., & Teppola, S. (2017). Tackling the digitalization challenge: How to benefit from digitalization in practice. *International Journal of Information Systems and Project Management*, 5(1), 63-77.

Podeschi, R. J., & DeBo, J. (2022). Integrating AWS cloud practitioner certification into a systems administration course. *Information Systems Education Journal*, 20(5), 17-26.

Rein, M., & Schön, D. (1996). Frame-critical policy analysis and frame-reflective policy practice. Knowledge and policy, 9(1), 85-104.

Richards, D. (2009). Designing project-based courses with a focus on group formation and assessment. *ACM Transactions on Computing Education (ToCE)*, 9(1), 1-40.

Sabin, M., & The Joint ACM/IEEE-CS IS2017 Task Group. (2017). *IT2017: Curriculum Guidelines for Baccalaureate Degree Programs in Information Technology*, ACM, IEEE-CS.

Saulnier, B. M. (2005). Service learning in computer information systems: "Significant" learning for tomorrow's computer professionals. *Information Systems Education Journal*, 3(10).

Saulnier, B. M. (2009). From "sage on the stage" to "guide on the side" revisited: (Un) covering the content in the learner-centered information systems course. *Information Systems Education Journal*, 7(60), 1-10.

Scanlon, L. (2011). *'Becoming' a professional* (pp. 13-32). Springer Netherlands.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. Basic books.

Schön, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. Jossey-Bass.

Schön, D. A. (1995). Knowing-in-action: The new scholarship requires a new epistemology. *Change: The Magazine of Higher Learning*, *27*(6), 27-34.

Schutz, A. (1962). Phenomenology and the social sciences. In *Collected papers I: The problem of social reality* (pp. 118-139). Dordrecht: Springer Netherlands.

Stamper, R. K. (1991). The semiotic framework for information systems research. *Information systems research: Contemporary approaches and emergent traditions*, 515-528.

Sterling, G. D., & Brinthaupt, T. M. (2003). Faculty and industry conceptions of successful computer programmers. *Journal of Information Systems Education*, 14(4), 417-424.

Takada, S., Cuadros-Vargas, E., Impagliazzo, J. et al. (2020). Toward the visual understanding of computing curricula. *Education and Information Technologies*, (25), 4231–4270.

Topi, H. (2017). Information systems in CC2020: Comparing key structural elements of curriculum recommendations in computing. In *Association for Information Systems SIGED IAIM Conference*.

Topi, H. (2019). Reflections on the current state and future of information systems education. *Journal of Information Systems Education*, 30(1), 1-9.

Urquiza-Fuentes, J., & Velázquez-Iturbide, J. Á. (2009). A survey of successful evaluations of program visualization and algorithm animation systems. *ACM Transactions on Computing Education (ToCE)*, 9(2), 1-21.

US DoE (2020). Competency-Based Learning or Personalized Learning. U.S. Department of Education, Retrieved from https://www.ed.gov/oii-news/competency-based-learning-or-personalized-learning (current June 15, 2021).

Volman, M., van Eck, E., Heemskerk, I., & Kuiper, E. (2005). New technologies, new differences. Gender and ethnic differences in pupils' use of ICT in primary and secondary education. *Computers & Education*, 45(1), 35-55.

Waguespack, L. J. (2019). *Designing thriving systems: Marrying technical rationality and appreciative systems*. Springer-Nature, Switzerland AG.

Waguespack, L., & Babb, J. (2019). Toward visualizing computing curricula: The challenge of competency. *Information Systems Education Journal*, 17(4), 51-69.

Waguespack, L., J., Yates, D. J., & Babb, J. S. (2022). Beyond competency: The imperative to foster professionalism in computing graduates. *Information Systems Education Journal*, 20(5), 67-81.

Watson, J., Besmer, A., Banks, M. S., Ray, D., & Derksen, G. (2021). Investigating student behavior in an interdisciplinary computing capstone course. *Information Systems Education Journal*, 19(6), 45-54.

Wear, D., & Castellani, B. (2000). The development of professionalism: Curriculum matters. *Academic Medicine*, 75(6), 602-611.

Weick, K. E. (1998). Introductory essay—Improvisation as a mindset for organizational analysis. *Organization Science*, 9(5), 543-555.

Wijeratne, D., Dennehy, D., Quinlivan, S., Buckley, L. A., Keighron, C., & Flynn, S. (2022). Learning without limits: Identifying the barriers and enablers to equality, diversity, and inclusion in IS education. *Journal of Information Systems Education*, 33(1), 61-74.

Williams, L., & Upchurch, R. (2001). Extreme programming for software engineering education? In *Proc. of the 31st Frontiers in Education Conference*.

Woodward, B. S., Sendall, P., & Ceccucci, W. (2010). Integrating soft skill competencies through project-based learning across the information systems curriculum. *Information Systems Education Journal*, 8(8), ISSN 1545-679X.

ISSN: 2473-4901
v9 n6011

Disposition	**Publications**				**Publications (Total)**
	ToCE (ACM)	FIE (IEEE)	ISEDJ (ISCAP)	JISE (ISCAP)	
Adaptable	52	243	34	56	385
Collaborative	155	867	91	149	1,282
Inventive	73	315	41	80	509
Meticulous	6	17	2	5	30
Passionate	8	34	2	1	45
Proactive	14	103	19	22	158
Professional	117	644	62	99	922
Purpose-driven	13	66	18	9	106
Responsible	40	301	27	52	420
Responsive	31	110	11	21	173
Self-directed	33	187	28	29	277

Table 3. Publications that mention disposition (or attitude), knowledge, and skills in four outlets.

ISSN: 2473-4901
v9 n6011

Appendix A — CC2020 Prospective Dispositions

Disposition	Elaboration
D-1 Proactive	With Initiative / Self-Starter Shows independence. Ability to assess and start activities independently without needing to be told what to do. Willing to take the lead, not waiting for others to start activities or wait for instructions.
D-2 Self-Directed	Self-motivated / Self-Directed Demonstrates determination to sustain efforts to continue tasks. Direction from others is not required to continue a task toward its desired ends.
D-3 Passionate	With Passion / Conviction Strongly committed to and enthusiastic about the realization of the task or goal. Makes the compelling case for the success and benefits of task, project, team or means of achieving goals.
D-4 Purpose-Driven	Purposefully engaged / Purposefulness Goal-directed, intentionally acting and committed to achieve organizational and project goals. Reflects an attitude towards the organizational goals served by decisions, work or work products. e.g., Business acumen.
D-5 Professional	With Professionalism / Work ethic. Reflecting qualities connected with trained and skilled people: Acting honestly, with integrity, commitment, determination and dedication to what is required to achieve a task.
D-6 Responsible	With Judgement / Discretion / Responsible / Rectitude Reflect on conditions and concerns, then acting according to what is appropriate to the situation. Making responsible assessments and taking actions using professional knowledge, experience, understanding and common sense. E.g., Responsibility, Professional astuteness.
D-7 Adaptable	Adaptable / Flexible / Agile Ability or willingness to adjust approach in response to changing conditions or needs.
D-8 Collaborative	Collaborative / Team Player / Influencing Willingness to work with others; engaging appropriate involvement of other persons and organizations helpful to the task. Striving to be respectful and productive in achieving a common goal.
D-9 Responsive	Responsive / Respectful Reacting quickly and positively. Respecting the timing needs for communication and actions needed to achieve the goals of the work.
D-10 Meticulous	Attentive to Detail Achieves thoroughness and accuracy when accomplishing a task through concern for relevant details.
D-11 Inventive	Exploratory / Inventive Looking beyond simple solutions; Examining alternative ideas and solutions; seeks, produces and integrates appropriate alternative

ISSN: 2473-4901
v9 n6011

Appendix B. Google Scholar Search Query Examples for Dispositions

For each of the dispositions in Table 3, we ran Google Scholar queries to count the papers in each of our four publication outlets. For each disposition, we included synonyms and adjacent concepts from Clear & Parrish et al. (2020) and Leidig & Salmela et al. (2020) in the queries. We also distinguished articles that included the term "attitudes" as an alternative to "dispositions." For example, Figure 5 shows the knowledge, skills, and dispositions (K-S-D) query for *collaborative* in IEEE Frontiers in Education. Similarly, Figure 6 shows the knowledge, skills, and attitudes (K-S-A) query for *collaborative* in the Information Systems Education Journal. Finally, Table 2 lists the dispositions, synonyms, and adjacent concepts used in these 88 queries.

ISSN: 2473-4901
v9 n6011

Appendix C. Word Cloud Visualizations for Unique Article Titles

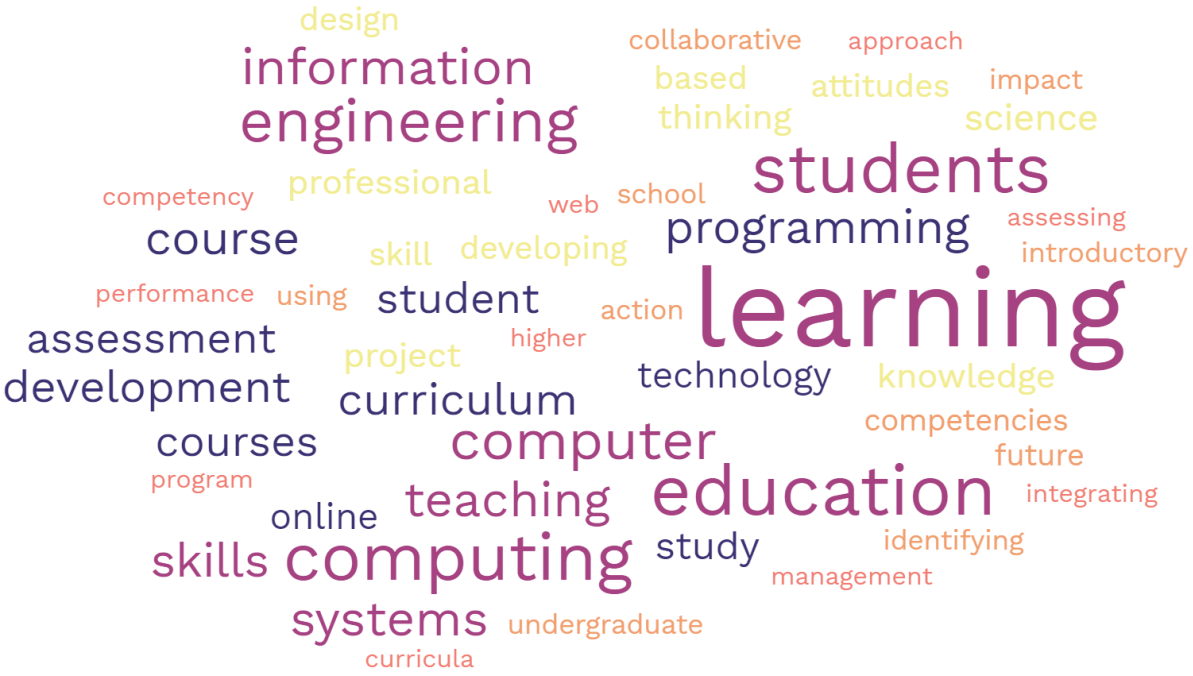


Figure 10. Word cloud from online tool that analyzes just words (freewordcloudgenerator.com).

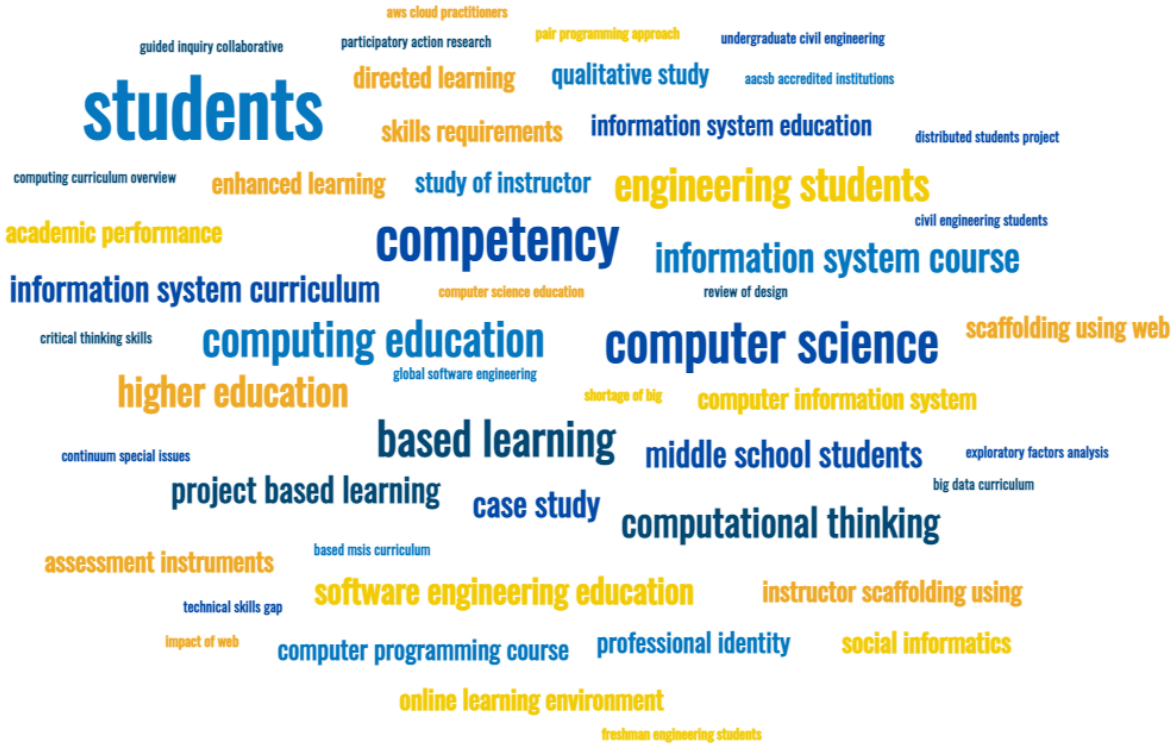


Figure 11. Word cloud from online tool that analyzes words and phrases (monkeylearn.com).

ISSN: 2473-4901
v9 n6011

Appendix D. URLs and Dispositions for Unique Articles

Unique Article URL	Dispositions from Unique Article	Title
http://jise.org/volume14/n1/JISEv14n1p41.html	Adaptable, Responsive	Impact of Web Based Flexible Learning on Academic Performance in Information Systems
http://jise.org/Volume14/n4/JISEv14n4p417.html	Meticulous	Faculty and Industry Conceptions of Successful Computer Programmers
http://jise.org/volume15/n2/JISEv15n2p181.html	Inventive	Project Management Courses in IS Graduate Programs: What is Being Taught?
http://jise.org/volume18/n3/JISEv18n3p357.html	Purpose-driven	Teaching Practices for Effective Cooperative Learning in an Online Learning Environment (OLE)
http://jise.org/volume18/n4/JISEv18n4p469.html	Professional	Requisite Skills and Knowledge for Entry-level IT Auditors
http://jise.org/Volume19/n1/JISEv19n1p111.html	Inventive, Self-directed	Assessing Individual-level Factors Supporting Student Intrinsic Motivation in Online Discussions: A Qualitative Study
http://jise.org/volume20/n2/JISEv20n2p199.html	Responsive	Selecting a Virtual World Platform for Learning
http://jise.org/volume20/n2/JISEv20n2p249.html	Purpose-driven	Action Learning with Second Life - A Pilot Study
http://jise.org/volume20/n3/JISEv20n3p289.html	Inventive	An Exploratory Review of Design Principles in Constructivist Gaming Learning Environments
http://jise.org/Volume20/n3/JISEv20n3p369.html	Adaptable, Responsible, Responsive	Practicing Learner-Centered Teaching: Pedagogical Design and Assessment of a Second Life Project
http://jise.org/Volume21/n2/JISEv21n2p203.html	Collaborative	Are Men More Technology-Oriented Than Women? The Role of Gender on the Development of General Computer Self-Efficacy of College Students
http://jise.org/Volume21/n3/JISEv21n3p323.html	Collaborative, Responsible, Self-directed	A Systematic Review of Developing Team Competencies in Information Systems Education
http://jise.org/Volume22/n1/JISEv22n1p31.html	Adaptable, Collaborative, Professional, Responsible	Curriculum Mapping as a Tool for Continuous Improvement of IS Curriculum
http://jise.org/volume24/n1/JISEv24n1p41.html	Responsive	The Need to Address Mobile Device Security in the Higher Education IT Curriculum
http://jise.org/Volume25/n2/JISEv25n2p125.html	Self-directed	A Case Study of Instructor Scaffolding Using Web 2.0 Tools to Teach Social Informatics
http://jise.org/Volume30/n1/JISEv30n1p1.html	Professional, Responsible	Reflections on the Current State and Future of Information Systems Education
https://aisel.aisnet.org/jise/vol16/iss3/8/	Proactive, Responsive	A Competency Based MSIS Curriculum
https://aisel.aisnet.org/jise/vol19/iss2/11/	Adaptable, Proactive, Professional	Integrating Soft Skills Assessment through University, College, and Programmatic Efforts at an AACSB Accredited Institution

ISSN: 2473-4901
v9 n6011

https://aisel.aisnet.org/jise/vol20/iss1/8/	Meticulous	Designing IS Curricula for Practical Relevance: Applying Baseball's "Moneyball" Theory
https://aisel.aisnet.org/jise/vol20/iss3/10/	Inventive	Knowledge and Skill Requirements for Entry-Level Information Technology Workers: A Comparison of Industry and Academia
https://aisel.aisnet.org/jise/vol21/iss2/5/	Collaborative	The Importance of Emphasizing Individual Learning in the "Collaborative Learning Era"
https://aisel.aisnet.org/jise/vol23/iss1/8/	Meticulous	An Alumni Assessment of MIS Related Job Skill Importance and Skill Gaps
https://aisel.aisnet.org/jise/vol23/iss2/8/	Collaborative, Inventive, Professional, Responsible	Knowledge and Skill Requirements for Entry-Level IT Workers: A Longitudinal Study
https://aisel.aisnet.org/jise/vol24/iss2/6/	Self-directed	Teaching Introductory Programming to IS Students: The Impact of Teaching Approaches on Learning Performance
https://aisel.aisnet.org/jise/vol25/iss2/4/	Professional, Responsive, Self-directed	A Case Study of Instructor Scaffolding Using Web 2.0 Tools to Teach Social Informatics
https://aisel.aisnet.org/jise/vol28/iss1/5/	Passionate, Proactive	An Integrated Learning Approach to Teaching an Undergraduate Information Systems Course
https://aisel.aisnet.org/jise/vol29/iss2/2/	Adaptable, Self-directed	Do Pair Programming Approaches Transcend Coding? Measuring Agile Attitudes in Diverse Information Systems Courses
https://aisel.aisnet.org/jise/vol30/iss4/5/	Adaptable, Collaborative, Inventive, Proactive, Responsible	Teaching Critical Thinking, Problem Solving, and Design Thinking: Preparing IS Students for the Future
https://aisel.aisnet.org/jise/vol33/iss1/4/	Purpose-driven	Engaging Government-Industry-University Partnerships to Further Gender Equity in STEM Workforce Education Through Technology and Information System Learning Tools
https://aisel.aisnet.org/jise/vol33/iss1/8/	Purpose-driven	Learning Without Limits: Identifying the Barriers and Enablers to Equality, Diversity, and Inclusion in IS Education
https://dl.acm.org/doi/abs/10.1145/1513593.1513595	Purpose-driven	Designing Project-Based Courses with a Focus on Group Formation and Assessment
https://dl.acm.org/doi/abs/10.1145/1538234.1538236	Inventive	A Survey of Successful Evaluations of Program Visualization and Algorithm Animation Systems
https://dl.acm.org/doi/abs/10.1145/1993069.1993073	Purpose-driven, Responsive	Computational Thinking and Expository Writing in the Middle School
https://dl.acm.org/doi/abs/10.1145/2037276.2037283	Proactive	Universal Design: Implications for Computing Education
https://dl.acm.org/doi/abs/10.1145/2160547.2160550	Purpose-driven	The Curriculum Planning Process for Undergraduate Game Degree Programs in the United Kingdom and United States
https://dl.acm.org/doi/abs/10.1145/2275597.2275599	Inventive	Practical Problem-Based Learning in Computing Education

ISSN: 2473-4901
v9 n6011

https://dl.acm.org/doi/abs/10.1145/2382564.2382567	Responsive	When Life and Learning Do Not Fit: Challenges of Workload and Communication in Introductory Computer Science Online
https://dl.acm.org/doi/abs/10.1145/2499947.2499951	Collaborative	Talking about code: Integrating pedagogical code reviews into early computing courses
https://dl.acm.org/doi/abs/10.1145/2534971	Collaborative, Inventive, Responsible	Introducing Discipline-Based Computing in Undergraduate Engineering Education
https://dl.acm.org/doi/abs/10.1145/2576872	Professional	Computational Thinking in Elementary and Secondary Teacher Education
https://dl.acm.org/doi/abs/10.1145/2662412	Proactive	Teaching Introductory Programming: A Quantitative Evaluation of Different Approaches
https://dl.acm.org/doi/abs/10.1145/2737596	Proactive	Translating Principles of Effective Feedback for Students into the CS1 Context
https://dl.acm.org/doi/abs/10.1145/2747008	Self-directed	Why Computing Students Learn on Their Own: Motivation for Self-Directed Learning of Computing
https://dl.acm.org/doi/abs/10.1145/2793507	Collaborative, Proactive	A Method to Analyze Computer Science Students' Teamwork in Online Collaborative Learning Environments
https://dl.acm.org/doi/abs/10.1145/2996201	Adaptable, Collaborative, Meticulous, Professional	A Meta-Analysis of Pair-Programming in Computer Programming Courses: Implications for Educational Practice
https://dl.acm.org/doi/abs/10.1145/3077617	Professional	Early Lessons from Evaluation of Computer Science Teacher Professional Development in Google's CS4HS Program
https://dl.acm.org/doi/abs/10.1145/3231710	Collaborative, Inventive, Professional, Responsible	Assessing Students' IT Professional Values in a Global Project Setting
https://dl.acm.org/doi/abs/10.1145/3277568	Self-directed	Searching for Global Employability: Can Students Capitalize on Enabling Learning Environments?
https://dl.acm.org/doi/abs/10.1145/3283070	Meticulous, Passionate	Identifying Pathways to Computer Science: The Long-Term Impact of Short-Term Game Programming Outreach Interventions
https://dl.acm.org/doi/abs/10.1145/3283071	Meticulous	Transformative and Troublesome? Students' and Professional Programmers' Perspectives on Difficult Concepts in Programming
https://dl.acm.org/doi/abs/10.1145/3294011	Adaptable, Collaborative, Inventive, Professional, Responsible, Responsive	Global Software Engineering Education Practice Continuum Special Issue of the ACM Transactions on Computing Education
https://dl.acm.org/doi/abs/10.1145/3322210	Responsive	Pedagogy that Supports Computer Science for *All*
https://dl.acm.org/doi/abs/10.1145/3381911	Passionate, Self-directed	Understanding the Motivations of Final-year Computing Undergraduates for Considering Accessibility

ISSN: 2473-4901
v9 n6011

https://dl.acm.org/doi/abs/10.1145/3421254	Adaptable, Inventive, Professional	Knowledge, Skills, and Abilities for Specialized Curricula in Cyber Defense: Results from Interviews with Cyber Professionals
https://dl.acm.org/doi/abs/10.1145/3487052	Passionate, Proactive	A Sociocultural Perspective on Computer Science Capital and its Pedagogical Implications in Computer Science Education
https://dl.acm.org/doi/abs/10.1145/3487054	Adaptable, Passionate, Responsive, Self-directed	Interest Development Theory in Computing Education: A Framework and Toolkit for Researchers and Designers
https://dl.acm.org/doi/abs/10.1145/3500918	Responsive	Examining the What, Why, and How of Multilingual Student Identity Development in Computer Science
https://dl.acm.org/doi/abs/10.1145/3517134	Responsible	A Qualitative Study of Experienced Course Coordinators' Perspectives on Assessment in Introductory Programming Courses for Non-CS Majors
https://dl.acm.org/doi/full/10.1145/3453653	Passionate, Responsible	"What Happens to the Raspado man in a Cash-free Society?": Teaching and Learning Socially Responsible Computing
https://dl.acm.org/doi/full/10.1145/3458037	Passionate	Intercultural Computing Education: Toward Justice Across Difference
https://dl.acm.org/doi/full/10.1145/3464431	Adaptable, Meticulous, Responsible, Self-directed	Identifying Non-Technical Skill Gaps in Software Engineering Education: What Experts Expect But Students Don't Learn
https://dl.acm.org/doi/full/10.1145/3471573	Purpose-driven	Coding with Minecraft: The Development of Middle School Students' Computational Thinking
https://dl.acm.org/doi/full/10.1145/3485062	Self-directed	Toward a Framework for Teaching Artificial Intelligence to a Higher Education Audience
https://dl.acm.org/doi/full/10.1145/3511886	Adaptable	Adaptive Assessment and Content Recommendation in Online Programming Courses: On the Use of Elo-rating
https://ieeexplore.ieee.org/abstract/document/1158168	Meticulous	Fostering and managing curriculum change and innovation
https://ieeexplore.ieee.org/abstract/document/1158180	Inventive	Measuring engineering freshman attitudes and perceptions of their first year academic experience: the continuing development of two assessment instruments
https://ieeexplore.ieee.org/abstract/document/4117031	Responsive	Participatory Action Research in a Blended Learning Course on Project Management Soft Skills
https://ieeexplore.ieee.org/abstract/document/4417890	Responsive	Person centered, technology enhanced learning in action: Action research in a course on organizational development
https://ieeexplore.ieee.org/abstract/document/4720400	Inventive	An exploratory factor analysis of the Pittsburgh Freshman Engineering Attitudes Survey
https://ieeexplore.ieee.org/abstract/document/5673411	Proactive	Development of an assessment instrument to examine outcomes of entrepreneurship education on engineering students

ISSN: 2473-4901
v9 n6011

https://ieeexplore.ieee.org/abstract/document/6462335	Purpose-driven	Utilizing reflection in projects for increased metacognition and enhanced learning
https://ieeexplore.ieee.org/abstract/document/6462410	Collaborative	Student reflections on Collaborative Technology in a globally distributed student project
https://ieeexplore.ieee.org/abstract/document/6462502	Passionate	Identifying the impact of the SPIRIT program in student knowledge, attitudes, and perceptions toward computing careers
https://ieeexplore.ieee.org/abstract/document/6684830	Self-directed	PBL in teaching computing: An overview of the last 15 years
https://ieeexplore.ieee.org/abstract/document/6684939	Purpose-driven	Should Makers be the engineers of the future?
https://ieeexplore.ieee.org/abstract/document/6685132	Adaptable	Peer assessment in experiential learning Assessing tacit and explicit skills in agile software engineering capstone projects
https://ieeexplore.ieee.org/abstract/document/7044169	Adaptable, Proactive	Transversal competencies of electrical and computing engineers considering market demand
https://ieeexplore.ieee.org/abstract/document/7044218	Purpose-driven	Might young makers be the engineers of the future?
https://ieeexplore.ieee.org/abstract/document/7344028	Professional, Self-directed	The impacts of project based learning on self-directed learning and professional skill attainment: A comparison of project based learning to traditional engineering education
https://ieeexplore.ieee.org/abstract/document/7344057	Professional	An exploration of Bloom's knowledge, skills, and affective-based goals in promoting development of freshmen engineering students' professional identities
https://ieeexplore.ieee.org/abstract/document/7344118	Professional	Teamwork attitude, interest, and self-efficacy: Their implications for teaching teamwork skills to engineering students
https://ieeexplore.ieee.org/abstract/document/7344401	Proactive	Mapping career success competencies to engineering leadership capabilities
https://ieeexplore.ieee.org/abstract/document/7344408	Adaptable	Rapid improvement of students' soft-skills based on an agile-process approach
https://ieeexplore.ieee.org/abstract/document/736846	Collaborative	Pupils' attitudes to technology: a review of studies which have a bearing on the attitudes which freshmen bring with them to engineering
https://ieeexplore.ieee.org/abstract/document/738551	Responsible	Stimulating creativity: teaching engineers to be innovators
https://ieeexplore.ieee.org/abstract/document/7757677	Inventive	Development of an assessment for measuring middle school student attitudes towards robotics activities
https://ieeexplore.ieee.org/abstract/document/7757714	Passionate	Actualizing students' prior knowledge in engineering education
https://ieeexplore.ieee.org/abstract/document/7757720	Meticulous	Engineering and Computational Thinking talent in middle school students: A framework for defining and recognizing student affinities
https://ieeexplore.ieee.org/abstract/document/839080	Proactive, Self-directed	Developing the attribute of lifelong learning
https://ieeexplore.ieee.org/abstract/document/839085	Collaborative	Interactive dynamics: effects of student-centered activities on learning

ISSN: 2473-4901
v9 n6011

https://ieeexplore.ieee.org/abstract/document/840438	Adaptable, Responsible	Engineering education curriculum: innovations to get a more flexible and dynamic course
https://ieeexplore.ieee.org/abstract/document/841732	Responsible	A cooperative model for orienting students to research groups
https://ieeexplore.ieee.org/abstract/document/8659152	Responsive	Authentic Knowledge, Learning Outcomes, and Professional Identity: A Mixed-Methods Study of a Successful Engineering Course
https://ieeexplore.ieee.org/abstract/document/9028350	Inventive	Addressing the Shortage of Big Data Skills with Inter-Disciplinary Big Data Curriculum
https://ieeexplore.ieee.org/abstract/document/9028355	Purpose-driven	Developing and Assessing Engineering Competencies at Experiential Learning Spaces
https://ieeexplore.ieee.org/abstract/document/9028408	Collaborative	Teaching Cybersecurity Using Guided Inquiry Collaborative Learning
https://ieeexplore.ieee.org/abstract/document/9028613	Collaborative, Meticulous, Passionate	Competencies Required for Developing Computer and Information Systems Curriculum
https://ieeexplore.ieee.org/abstract/document/9028621	Passionate	On the role of industry contact on the motivation and professional development of engineering students
https://ieeexplore.ieee.org/abstract/document/9273973	Adaptable, Collaborative, Inventive, Meticulous, Passionate, Proactive, Professional, Purpose-driven Responsible, Responsive, Self-directed	Unpacking Dispositions in the CC2020 Computing Curriculum Overview Report
https://ieeexplore.ieee.org/abstract/document/9274058	Meticulous, Professional, Purpose-driven, Responsible, Self-directed	Bridging Professionalism: Dispositions as Means for Relating Competency across Disciplines
https://ieeexplore.ieee.org/abstract/document/9274197	Responsive	Application of Adult Learning Theory to STEM Education in Online Learning Environment
https://ieeexplore.ieee.org/abstract/document/9274269	Passionate	Undergraduate Civil Engineering Students' Perspectives on Skills for Future Success
https://ieeexplore.ieee.org/abstract/document/9274288	Adaptable, Inventive, Proactive, Professional, Responsible, Self-directed	From Knowledge-based to Competency-based Computing Education: Future Directions
https://ieeexplore.ieee.org/abstract/document/9637302	Meticulous	Use of Machine Learning to Identify Predictors of Student Performance in Writing Viable Computer Programs with Repetition Loops and Methods
https://ieeexplore.ieee.org/abstract/document/963882	Responsive	Extreme programming for software engineering education?
https://eric.ed.gov/?id=EJ1137403	Purpose-driven	Where Do Student Outcomes Begin? Developing Professional and Personal

ISSN: 2473-4901
v9 n6011

		Management Skills as a Strategy for Student Success in the First Computing Course and Beyond
https://eric.ed.gov/?id=EJ1146918	Self-directed	Critical Thinking Measurement in ICT
https://eric.ed.gov/?id=EJ1146931	Proactive	A Value Chain Approach for Attracting, Educating, and Transitioning Students to the IT Profession
https://eric.ed.gov/?id=EJ1146969	Collaborative, Professional	Integrating Soft Skill Competencies through Project-Based Learning across the Information Systems Curriculum
https://eric.ed.gov/?id=EJ1147031	Inventive	Factors That Influence Transfer of Learning from the Online Environment
https://eric.ed.gov/?id=EJ1258150	Proactive, Self-directed	Encouraging Lifelong Learning through Tech Explorations
https://eric.ed.gov/?id=EJ1258227	Professional, Purpose-driven, Responsible	eXtensible Computing Curriculum Reporting Language (XCCRL)
https://eric.ed.gov/?id=EJ1297703	Proactive	Effects of Teaching and Practice of Time Management Skills on Academic Performance in Computer Information Systems Courses
https://eric.ed.gov/?id=EJ1301236	Inventive	Cognitive Learning Strategies in an Introductory Computer Programming Course
https://eric.ed.gov/?id=EJ1329490	Responsive	Investigating Student Behavior in an Interdisciplinary Computing Capstone Course
https://isedj.org/2/12/ISEDJ.2(12).Guthrie.pdf	Purpose-driven, Responsive	Service-Learning Impact on IS Students in a Web Development Course
https://isedj.org/2012-10/N4/ISEDJv10n4p41.html	Inventive	A Case Study: Applying Critical Thinking Skills to Computer Science and Technology
https://isedj.org/2013-11/N3/ISEDJv11n3p42.html	Collaborative	Collaborative learning in online courses: Exploring students' perceptions
https://isedj.org/2013-11/N3/ISEDJv11n3p79.html	Professional	Reassessing the Skills Required of Graduates of an Information Systems Program: An Updated Analysis
https://isedj.org/2014-12/n1/ISEDJv12n1p42.html	Responsible	Confronting the Issues of Programming In Information Systems Curricula: The Goal is Success
https://isedj.org/2014-12/n6/ISEDJv12n6p36.html	Collaborative	Evaluating Effectiveness of Pair Programming as a Teaching Tool in Programming Courses
https://isedj.org/2016-14/n1/ISEDJv14n1p71.html	Adaptable, Purpose-driven, Responsible	Developing Capable Undergraduate Students: A focus on Problem Based Learning and Assessment
https://isedj.org/2016-14/n3/ISEDJv14n3p55.html	Collaborative	Developing Project Based Learning, Integrated Courses from Two Different Colleges at an Institution of Higher Education: An Overview of the Processes, Challenges, and Lessons Learned
https://isedj.org/2016-14/n5/ISEDJv14n5p44.html	Adaptable	Use of Failure in IS Development Statistics: Lessons for IS Curriculum Design
https://isedj.org/2017-15/n6/ISEDJv15n6p72.html	Adaptable, Professional	Identifying The Real Technology Skills Gap: A Qualitative Look Across Disciplines

https://isedj.org/2018-16/n3/ISEDJv16n3p45.html	Meticulous, Self-directed	Reaching and Retaining the Next Generation: Adapting to the Expectations of Gen Z in the Classroom
https://isedj.org/2019-17/n3/ISEDJv17n3p20.html	Inventive	Using Codecademy Interactive Lessons as an Instructional Supplement in a Python Programming Course
https://isedj.org/2019-17/n3/ISEDJv17n3p29.html	Passionate	A Preliminary Study: The Use of VoiceThread in Online Business Courses
https://isedj.org/2019-17/n3/ISEDJv17n3p41.html	Adaptable	Applying an Agile Approach in an Information Systems Capstone Course
https://isedj.org/2019-17/n4/ISEDJv17n4p51.html	Collaborative, Professional, Purpose-driven, Responsible	Toward Visualizing Computing Curricula: The Challenge of Competency
https://isedj.org/2019-17/n4/ISEDJv17n4p91.html	Responsive	Hour of Code: A Study of Gender Differences in Computing
https://isedj.org/2022-20/n5/ISEDJv20n5.pdf#page=17	Adaptable	Integrating AWS Cloud Practitioner Certification into a Systems Administration Course
https://isedj.org/2022-20/n5/ISEDJv20n5.pdf#page=67	Adaptable, Collaborative, Inventive, Meticulous, Passionate, Proactive, Professional, Purpose-driven, Responsible, Responsive, Self-directed	Beyond Competency: The Imperative to Foster Professionalism in Computing Graduates
https://isedj.org/3/10/ISEDJ.3(10).Saulnier.pdf	Self-directed	Service Learning in Computer Information Systems: "Significant" Learning for Tomorrow's Computer Professionals
https://isedj.org/6/19/ISEDJ.6(19).Eagen.pdf	Responsible	The Design Charrette in the Classroom as a Method for Outcomes-based Action Learning in IS Design
https://isedj.org/6/39/ISEDJ.6(39).Wolk.pdf	Responsive	How Important is Student Computing Ability? The Role of Information Technology Competence in Business School Accreditation
https://isedj.org/7/43/ISEDJ.7(43).Wolk.pdf	Inventive	Using the Technology Acceptance Model for Outcomes Assessment in Higher Education
https://isedj.org/7/60/ISEDJ.7(60).Saulnier.pdf	Self-directed	From "Sage on the Stage" to "Guide on the Side" Revisited: (Un)Covering the Content in the Learner-Centered Information Systems Course

Table S. URLs for, and dispositions within, unique articles extracted from "Top 6" articles returned by Google Scholar for eleven dispositions in Table K.