Work in Progress: Importance of Dispositions on the Job: Survey of Computing Professionals

Marisa Exter
Curriculum & Instruction
Purdue Univeristy
West Lafayette, IN, USA
https://orcid.org/0000-0001-5317-8396

Nursah Yakut
Curriculum & Instruction
Purdue Univeristy
West Lafayette, IN, USA
https://orcid.org/0000-0002-2983-0329

Mihaela Sabin
Applied Engineering & Sciences
University of New Hampshire
Manchester, NH, USA
https://orcid.org/0000-0003-1315-5151

Deepti Tagare
College of Education and Human Development
University of Texas at San Antonio
San Antonio, USA
orcid.org/0000-0003-2369-3148

Iryna Ashby
Curriculum & Instruction
Purdue Univeristy
West Lafayette, IN, USA
https://orcid.org/0000-0001-6594-0026

***Abstract*— This work-in-progress research paper shares the findings of a survey of computing professionals regarding the importance of various dispositions on the job. Survey findings from recent graduates also include their perception of how well each disposition was covered in their undergraduate courses.**

Dispositions are beliefs, attitudes, or values, such as *being ethical, being persistent*, and *valuing collaboration.* Dispositions impact whether individuals will apply their knowledge and skills appropriately in any given situation. There is increasing recognition of the importance of dispositions in the realm of computing education, as evidenced by recent computing curricular guidelines (e.g., IT2017 and CC2020). However, few existing studies of professionals explicitly discriminate between dispositions and other types of competencies (e.g., cross-disciplinary or "soft" skills). Furthermore, little research has been focused on the degree to which professionals believe that dispositions have been adequately covered by computing education in the United States.

This study will present the findings of a survey of computing professionals, utilizing items based on on a list of 30 dispositions derived from earlier studies. It will present practitioners' perceptions of the importance of each of the 30 dispositions and will also present the satisfaction recent graduates (who have graduated with an undergraduate degree within the last 5 years) have with the coverage of these dispositions during their undergraduate experience. Findings of this paper may reveal not only of the importance of dispositions in general, but which dispositions are most important, and which are most or least covered in current educational programs.

The research team recommends that higher education administrators, curriculum designers and individual faculty members use the data-informed disposition list, in conjunction with college/university and departmental vision and values, to select a small number of dispositions to purposefully incorporate across their program. Findings may also be of interest to curricular guideline committees and scholars interested in dispositions, competency-based education, character education, or virtue ethics.

Keywords—dispositions, competencies, soft skills, industry, career readiness

Funded by the National Science Foundation.

I. Introduction

A. Competencies: Knowledge, Skills, and Dispositions

Competencies are the knowledge, skills, and dispositions that are essential to perform a task successfully in a professional context [6, 15, 19]. Successful progression across a career pathway often requires a combination of domain-specific competencies (knowledge and skills related to a specific field, such as computer science), as well as cross-disciplinary skills (such as written communication and problem-solving-related skills) [5, 6, 16]. However, such knowledge and skills may not be activated without related *dispositions*, like *being persistent* and *being flexible,* which influence a student's behavior and motivation. John Dewey noted that "knowledge of methods alone will not suffice; there must be the desire, the will to employ them. This desire is an affair of personal disposition" [8] (p.30). As defined by the [authors] dispositions are "personal qualities including values, beliefs, and attitudes that impact an individual's actions and behaviors. Dispositions help a person identify why things need to be done and motivate them to follow through in action using their knowledge and skills" (p.271).

It is valuable to clearly distinguish between skills and dispositions and recognize the relationship between them. Skills are *observable* behaviors, while dispositions are not directly observable. Unfortunately, the distinction between dispositions and skills (particularly cross-disciplinary skills) is often not made. Scholarly articles, reports commissioned by foundations and governmental agencies, and popular press articles discuss the importance of "professional skills", "21st-century skills", "foundational skills" or "soft skills," which typically combine a variety of cross-disciplinary skills and dispositions. This lack of distinction makes it difficult to target teaching approaches, as there are differences between how skills and dispositions are fostered and assessed.

However, cross-disciplinary skills and dispositions are often applied together to achieve a desired outcome [1, 13, 17]. For instance, the application of critical thinking in a relevant context requires the possession of cross-disciplinary skills such as analysis, interpretation, assessment, and inference from available information. Additionally, it necessitates dispositions like curiosity, which aids in identifying the appropriate moments to employ these skills, and a readiness to utilize them effectively when needed [1, 13].

B. Importance in Industry

Cross-disciplinary skills and dispositions are highly valued across different industries. For instance, a global survey of workforce professionals by McKinsey & Company in 2021 highlighted the importance of foundational skills, which include cross-disciplinary skills like communication, teamwork, time management, and critical thinking, along with dispositions such as self-awareness and adaptability. This view is echoed by employer surveys indicating a strong preference for these skills and dispositions in new hires, often placing greater emphasis on them than on academic achievements [2, 6–9].

C. Importance in Education

The trend toward a competency-based approach in professional certification, such as recent versions of the Software Engineering Competency Model (SWECOM) and the Software Assurance Competency Model (SWACOM), underscores the integration of these skills and dispositions in professional standards and practices [3, 6, 11]. Over the past decade, there has been an increased effort to incorporate cross-disciplinary skills and dispositions into computing curricula (e.g., initiatives by the ACM (Association for Computing Machinery) and IEEE Computer Society (IEEE-CS)). For instance, the Computer Science Curricula 2013 emphasized designing programs that prepare graduates for a rapidly evolving field, with an explicit focus on professional practice skills such as communication and ethics and included a knowledge area dedicated to *Social Issues and Professional Practic*e.

Further advancements were made with the adoption of the Information Technology Curricula 2017, which defined competency as a blend of knowledge, skills, and dispositions applied in context. This approach was expanded upon in the Computing Curricula 2020, which differentiated computing knowledge as 'know what', skills as 'know how', and dispositions as 'know why', placing a renewed emphasis on the integration of dispositions into educational frameworks.

Despite these frameworks, most programs often address cross-disciplinary skills and dispositions through general education courses in disciplines like humanities, business, or communication. However, as research suggests, transferring these competencies across disciplines without specific instructional support is challenging [2]. Moreover, there is a skepticism among some students about the value of such skills and dispositions in preparing them for their immediate job prospects and future careers in computing. This perception aligns with findings from the Pew Research Center, indicating a need for higher education to adopt new credentialing systems that more effectively showcase proficiency in 21st-century skills. While computing educators acknowledge the significance of and are driven to incorporate cross-disciplinary skills and dispositions into computing courses [4], they have reservations about their capacity to effectively integrate and teach these elements. They are also uncertain about the extent to which students will accept and be receptive to these new instructional methods [17]. This concern is echoed by the CC2020 Task Force, which noted that although computing educators excel in building knowledge and skills, they frequently struggle to develop dispositional qualities in their students (CC2020 Task Force, 2020).

Dispositions also take a significant amount of time to develop [7], and therefore should be given space across the duration of a degree program. Approaches that foster dispositions include engaging with hands-on, real-world computing problems in an application domain, including service-learning opportunities; requiring that students design ethical and responsible solutions; incorporation of reflective learning practices; and use of ongoing formative assessment and self-assessment, reflective portfolios, and other mechanisms to engage students and help them to make explicit their own understanding and development related to a given disposition [9, 10, 12, 14].

Because of these challenges, individual faculty, programs, and institutions must plan purposefully for integrating dispositions into their curriculum, which requires careful selection of a reasonable number of dispositions to be fostered within an individual course or across a program. An empirically derived list of dispositions can be a first step to guiding those choices.

One of the more well-known, research-based models for competencies for computing professionals is the Skills Framework for the Information Age [20], which provides a list of competencies required by professionals by their level of responsibility. While this is well grounded in data, this framework is primarily designed for employers and professionals, and therefore may not be as directly useful to educators and students. This report summarizes the findings of a survey of computing professionals regarding the importance of various dispositions on the job. Recent graduates also rate their perception of how well each disposition was covered in their undergraduate courses.

D. Purpose and Research Questions

Existing literature and reports tend to conflate cross-disciplinary skills and dispositions, are aimed at employers rather than educators and students, and/or focus on lists of dispositions developed by committee, rather than methodical empirical study. Prior research conducted by this team used qualitative approaches (a systematic literature review and interviews of professionals) to identify a set of dispositions professionals and employers indicate are commonly needed on the job [authors]. However, these approaches are not ideal for identifying which dispositions are most common or important on the job, nor do they provide solid evidence of how satisfied professionals are with their coverage in degree programs. Therefore, the purpose of this study is to build on the prior research to access the perceptions of a wider range of participants, by addressing the following research questions:

1. How important do computing professionals rate each disposition?

NOTE: In the original submission, there were two research questions. However, because we were not sufficient data from recent graduates, we were not able to address:

2. *To what degree do recent graduates (computing professionals who received an undergraduate degree within the past 5 years) believe these dispositions were stressed in their undergraduate experience?*

II. METHOD

A. Participants and Context

Participants were recruited through Qualtrics Panel's recruitment service, which aggregates data from "actively managed, double-opt-in market research panels" (personal communication). We have utilized their B2B service, which targets professionals recruited through sources such as business contact databases and frequent flier and loyalty programs (personal communication). The panel services are responsible for validating the participation lists through various– however, personally identifiable data is not shared with researchers. Participants (computing professionals) are directed to our survey (hosted on the Qualtrics platform). Only complete and "quality" responses were included in the dataset (i.e., responses in which a participant responded too quickly, gave the same answer to the entire response set, or responded "Not familiar" to the majority, or wrote nonsensical text were excluded from the dataset). By the time of the final paper, we had received "quality" responses from 113 individuals.

The survey instrument further filtered for eligible participants, who live within living within the United States and its territories, have worked in the last three years in a computing profession, and play one or more of the following roles passed the filtering criteria in the survey: Computing professionals play roles similar to the following: AI / ML Engineer; Business Intelligence / System Analyst; Cybersecurity Analyst / Engineer; Cloud / Network / Systems Architect / Engineer; Data Analyst / Engineer / Scientist; Database Administrator / Architect; Developer; DevOps Engineer / Specialist; Director / Manager; Embedded Application / Systems Developer; IT Support Engineer / Specialist; Network / Systems Administrator / Support Specialist; Quality Assurance / Reliability / Test Engineer; Systems / Software Architect; UX / UI / Web Designer.

As of August, 2024, 113 "quality" responses have been created (out of a set of over 1,900 participants). *We suspect that many of the "participants*

Table 1. Primary roles played by participants

Primary Role	Count
Director / Manager	42
IT Support Engineer / Specialist	18
Developer	11
Data Analyst / Engineer / Scientist	8
Cloud / Network / Systems Architect / Engineer	7
Network / Systems Administrator / Support Specialist	5
Cybersecurity Analyst / Engineer	4
Systems / Software Architect	4
Quality Assurance / Reliability / Test Engineer	4
AI / ML Engineer	3
Database Administrator / Architect	3
Business Intelligence / System Analyst	2
Embedded Application / Systems Developer	1
UX / UI / Web Designer	1

Among those 113 participants, the majority (47.7%) held a bachelor's as their highest degree and 38% have completed more than one degree. Among participants who held at least one undergraduate degree, 78.7% held a degree in a computing-related field (that is, computer engineering, computer science, cybersecurity, data science, information systems, information technology, or software engineering, or similar degrees). Table 1 shows the primary roles played by participants. Participants were also asked to indicate all roles they played, and all but one individual played multiple roles on their current job.

They were 59% white, 15% multi-racial, and 14% Asian. Seventy-seven percent were male, and 7% had a disability. The sample included experienced professionals, with 23% in the "More than 20 years" of experience group, 14% with 16-20 years, 23% 11-15 years, 23% 6-10 years, and 11% 3-5 years of experience.

It is noted that the original sample of 50 individuals was more diverse; we hope that as the technical corrections are made, the diversity of the "quality response" set will be more reflective of the population of computing professionals currently working in the United States.

B. Data Collection and Data Source

A survey instrument was created, based on a list of dispositions generated as part of earlier studies [18]. A scale was used to indicate "How important are each of the following in your current job" (Not important, Somewhat important, Important, Critical"). For recent graduates, an additional scale was used with the directive "Rate your satisfaction with how well your undergraduate degree prepared you for each of the following" (Not at all satisfied, Slightly satisfied, Moderately satisfied, Very satisfied). The survey takes approximately 20 minutes to complete.

Demographic data was collected through questions related to current and previous roles played, educational experience, industry and organization size, race/ethnicity, gender, and disability status.

C. Data analysis

Importance and satisfaction scales were converted to numerical values (1-4). Descriptive statistics (counts and percentages) are reported in this paper.

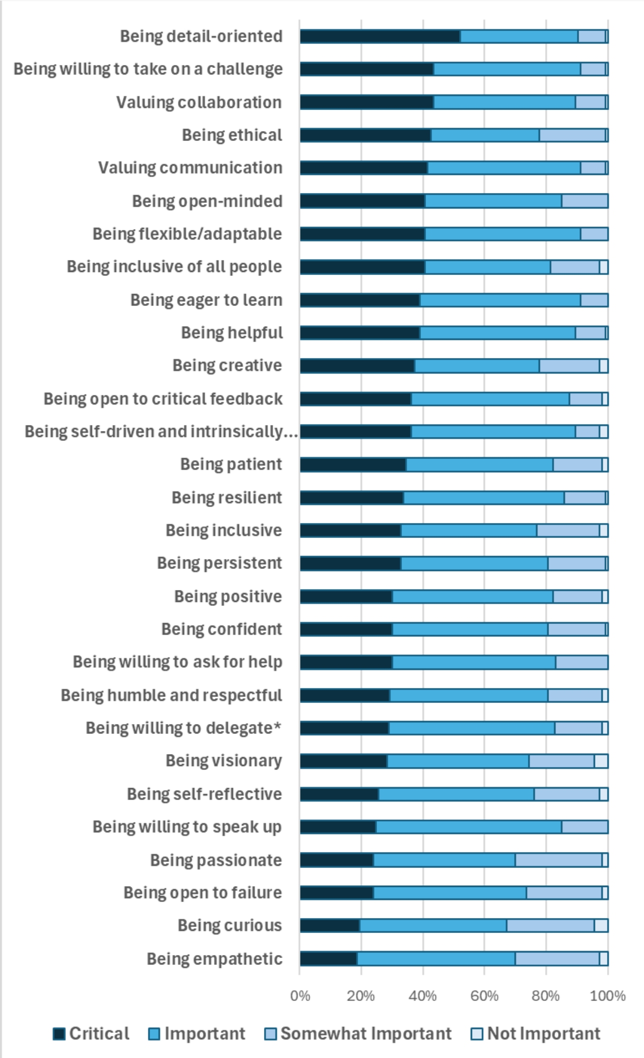
D. Quality Considerations

As part of an earlier study, the disposition list was created through an extensive qualitative analysis process that involved methodological and data triangulation (data derived from interviews and systematic literature), investigator triangulation (multiple researchers involved in each stage of analysis), peer debriefing, and member-checking with computing educators. *When preparing the survey for this study*, we conducted multiple rounds of expert review as well as a pilot test, using a think-aloud procedure to increase the clarity of items, consistency of responses (through adjustments of scales used), and content validity (including face validity). Comparison with existing literature on dispositions (as described in the review of literature above) provides some level of construct validity. Because of the nature of the survey (that is, we are measuring responses to individual dispositions, rather than using (sub)scales of items), some traditional measures for validity and reliability are not appropriate. Future studies may include use of exploratory factor analysis to examine whether there are some underlying factors that group the dispositions, potentially allowing for validation of a set of scales – however, that does not address the purpose of this study, which is to look at each disposition individually and compare importance across them.

III. RESULTS

Initial results are shown below. Because we did not receive sufficient "quality responses" from recent graduates, we can only report on the levels of importance provided by participants.

Fig. 1 Participants' Rankings of Importance on the Job for each Disposition (percentages; ordered by number of "critical" ratings. N=113)



*Two individuals did not complete this item

The majority of participants indicated that all dispositions are either "critical" or "important." As shown in Figure 1, *being open-minded, being flexible/adaptable, being eager to learn, being willing to ask for help,* and *being willing to speak up* are not only the most likely to be critical/important but are not rated below important by any participants. For 90% of participants, *being willing to take on a challenge, valuing communication, being flexible/adaptable,* and *being eager to learn* are "critical" or "important".

IV. DISCUSSION

The tentative results presented in this Work-in-Progress paper demonstrate that dispositions are important drivers in computing professionals' lives. As explained in the literature, they are crucial for guiding individuals to activate knowledge and skills when appropriate.

While many computing educators may be weary of taking on the job of teaching dispositions in their courses (as described in [authors], the findings of this paper support the importance of covering dispositions within higher education. However, because dispositions take time to develop and internalize and are difficult to transfer from one context to another (Costa), it is important to foster and assess them across the curriculum – within and across computing courses. Conversely, because they are time-consuming to develop, it is not feasible to focus on all 30 dispositions on this list. We recommend that programs combine data from our final study with a detailed consideration of their institutional and program-level vision, mission, and values to determine which dispositions to foster across the curriculum. Individual faculty members may choose to add additional dispositions that align well with the content of a particular course, while some program-level dispositions may not be appropriate for some courses.

V. LIMITATIONS AND AREAS FOR FUTURE RESEARCH

At the current time, the sample included in this study is not very diverse, and therefore not representative of computing professionals across the United States. It also does not include recent graduates, which is required to address the second research question. The research team is working closely with Qualtrics Panel to develop a set of quotas intended to increase the diversity of the sample.

Once this study has been completed, we will review the results and determine whether the instrument can be further refined. An exploratory factor analysis may reveal interesting connections between the disposition in the list. Additional research on how dispositions can best be fostered within computing degree programs is highly warranted.

VI. CONCLUSION

This paper presents early findings of a survey of professionals related to the importance they give dispositions related to what is required on the job. Future papers will also include data from recent graduates on the degree to which they believe these dispositions have been covered in their undergraduate education. Data from this study can be used to make curricular decisions and promote a movement towards the development of dispositions in computing graduates, making them more prepared to leverage their skills and knowledge in the workplace.

REFERENCES

[1] Carracedo A.N. and C. Saiz. 2011. Skills and dispositions of critical thinking: Are they sufficient? *An. Psicol.* 27, 1 (2011), 202–209.

[2] I. Ashby, M.E. Exter, and D. Varner. 2020. Developing crosscutting competencies for a transdisciplinary world: An extension of Bloom's taxonomy. In *Educational Technology Beyond Content: A New Focus for Learning*. 107–118.

[3] A. Burgess, A.M. Kelly, E. Butterfield, J. Keppler, D. McClenahan, K. Guillemette, and M. Phon. 2014. *Software Engineering Competency Model*. IEEE Computer Society. Retrieved from https://dahlan.unimal.ac.id/files/ebooks/SWECOM.pdf

[4] L. Carter. 2011. Ideas for adding soft skills education to service learning and capstone courses for computer science students. In *Proceedings of the 42nd ACM Technical Symposium on Computer Science Education*, 2011. 517–522. https://doi.org/10.1145/1953163.1953312

[5] S. Caskurlu, I. Ashby, and M. Exter. 2017. The Alignment Between Formal Education and Software Design Professionals. In *Needs in Industry: Faculty Perception. 2017 ASEE Annual Conference & Exposition*, 2017. . https://doi.org/10.18260/1-2–28941

[6] A. Clear, T. Clear, J. Impagliazzo, and P. Wang. 2020. From Knowledge-based to Competency-based Computing Education: Future Directions. In *2020 IEEE Frontiers in Education Conference (FIE*, 2020. 1–7. https://doi.org/10.1109/FIE44824.2020.9274288

[7] Arthur L. Costa and Bena Kallick. 2014. *Chapter 7, Observing and Assessing Dispositional Growth*. Reframing Teaching and Learning, Corwin, Dispositions. Retrieved from https://us.corwin.com/en-us/nam/dispositions/book242304

[8] John Dewey. 1933. How we think, a restatement of the relation of reflective thinking to the educative process. *D* (1933).

[9] M. Exter, S. Caskurlu, and T. Fernandez. 2018. Comparing Computing Professionals' Perceptions of Importance of Skills and Knowledge on the Job and Coverage in Undergraduate Experiences. *ACM Trans. Comput. Educ.* 18, 4 (2018), 1–29. https://doi.org/10.1145/3218430

[10] V. Garousi, G. Giray, E. Tuzun, C. Catal, and M. Felderer. 2020. Closing the Gap between Software Engineering Education and Industrial Needs. *IEEE Softw.* 37, 2 (2020), 68–77. https://doi.org/10.1109/MS.2018.2880823

[11] T. Hilburn, M. Ardis, G. Johnson, A. Kornecki, and N. Mead. 2013. *Software Assurance Competency Model*. Carnegie Mellon University. Retrieved from https://resources.sei.cmu.edu/asset_files/technicalnote/2013_004_001_47965.pdf

[12] J.M. Hollister, L.I. Spears, M.A. Mardis, J. Lee, C.R. McClure, and E. Liebman. 2017. Employers' perspectives on new information technology technicians' employability in North Florida. *Educ. Train.* 59, 9 (2017), 929–945. https://doi.org/10.1108/ET-02-2017-0019

[13] X. Liu and L. Li. 2014. Assessment training effects on student assessment skills and task performance in a technology-facilitated peer assessment. *Assess. Eval. High. Educ.* 39, 3 (2014), 275–292. https://doi.org/10.1080/02602938.2013.823540

[14] R. Raj, M. Sabin, J. Impagliazzo, D. Bowers, M. Daniels, F. Hermans, N. Kiesler, A.N. Kumar, B. MacKellar, R. McCauley, S.W. Nabi, and M. Oudshoorn. 2021. In *Professional Competencies in Computing Education: Pedagogies and Assessment. Proceedings of the 2021 Working Group Reports on Innovation and Technology in Computer Science Education*, 2021. 133–161. https://doi.org/10.1145/3502870.3506570

[15] M. Sabin, H. Alrumaih, J. Impagliazzo, B. Lunt, M. Zhang, B. Byers, W. Newhouse, B. Paterson, S. Peltsverger, C. Tang, G. Veer, and B. Viola. 2017. In *Information Technology Curricula 2017: Curriculum Guidelines for Baccalaureate Degree Programs in Information Technology. Association for Computing Machinery & IEEE Computer Society (IEEE-CS*. https://doi.org/10.1145/3173161

[16] M. Sabin, H. Alrumaih, J. Impagliazzo, B. Lunt, M. Zhang, B. Byers, W. Newhouse, B. Paterson, S. Peltsverger, C. Tang, G. Veer, and B. Viola. 2017. In *Information Technology Curricula 2017: Curriculum Guidelines for Baccalaureate Degree Programs in Information Technology. Association for Computing Machinery & IEEE Computer Society (IEEE-CS*. https://doi.org/10.1145/3173161

[17] D. Tagare, S. Janakiraman, M. Exter, S. Duan, M. Sabin, and J. Tavakoli. 2023. Dispositions that Computing Professionals Value in the Workplace: Systematic Literature Review and Interviews with Professionals. In *Proceedings of the 2023 ACM Conference on International Computing Education Research*, 2023. . https://doi.org/10.1145/3568813.3600118

[18] Deepti Tagare, Shamila Janakiraman, Marisa Exter, Suzhen Duan, Mihaela Sabin, and Jafar Tavakoli. 2023. Dispositions that Computing Professionals Value in the Workplace: Systematic Literature Review and Interviews with Professionals. In *Proceedings of the 2023 ACM Conference on International Computing Education Research*, 2023. ACM Digital Library, Chicago, 14. https://doi.org/10.1145/3568813.3600118

[19] C. Woodruffe. 1993. What Is Meant by a Competency? *Leadersh. Organ. Dev. J.* 14, 1 (1993), 29–36. https://doi.org/10.1108/eb053651

[20] SFIA - The global skills and competency framework for a digital world. Retrieved August 25, 2021 from https://sfia-online.org/en