

# Using Vignettes to Categorize Behaviors that Students Associate with Dispositions

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**Abstract**—This full research paper contributes to current work on fostering professional dispositions in computing and engineering education by identifying the categories of behaviors that students associate with dispositions while doing course work. Professional dispositions, demonstrated through desirable behaviors in the workplace, such as being persistent or self-directed, are explicitly sought by employers. Fostering dispositions among students has been identified in various curricular recommendations as an important goal.

In prior work, the authors used reflection exercises, in which students were presented with the definition of a disposition and asked to answer an open-ended reflection prompt on how they applied the disposition in their own work. Thematic analysis of student responses to reflection exercises resulted in categories of behaviors that students associated with dispositions. In the work discussed in this paper, the authors used vignette exercises to collect and analyze similar data and gain further insight into behavioral categories and students' perceptions of dispositions. Vignettes include short scenarios that demonstrate the application of dispositions in real life. A vignette exercise involves students reading a vignette scenario, identifying the disposition demonstrated by the scenario, and answering the same open-ended reflection prompt as in the reflection exercises from the earlier studies.

The research question for this study is: Which behavioral categories obtained from analyzing student responses to reflection exercises were confirmed using vignette exercises (and which were not confirmed), and which behavioral categories were refined? To answer this question, researchers from four different institutions of higher education collected data in multiple courses over two semesters. The student open-ended responses to vignettes were thematically analyzed to identify behavioral categories for four dispositions: *collaborative*, *meticulous*, *persistent* and *self-directed*.

The ultimate goal of this work is to create classroom interventions and learning activities that foster dispositions among students based on behavioral categories. This study supports this goal in two ways. It provides another iteration of behavioral category analysis and introduces vignettes to encourage students to reflect candidly and communicate clearly how they apply dispositions in terms of behaviors. The study results and their implications for fostering dispositions in a classroom setting are presented and discussed.

**Index Terms**—Dispositions, vignettes, professional practice

## I. INTRODUCTION

Professional dispositions facilitate consistent exercise of behaviors that are valued in the workplace, such as being *persistent* or *self-directed* [1], [2]. Professional dispositions are explicitly sought by employers (e.g. [3], [4]), and listed in job

postings [5]. In addition, their importance for computing education has been increasingly recognized in curricular guidelines for undergraduate education in information technology (IT2017 report [6]), information systems (IS2020 [7]), computer science (CS2023 [8]) and data science (CCDS2021 [9], and in the computing curricula overview report, CC2020 [10]. How to raise awareness of dispositions among students in computing and engineering programs is being studied [11], [12] and motivates the research addressed in this paper. This research uses vignettes to identify specific behaviors through which students understand dispositions. Identifying these behaviors can help design learning experiences that better promote and assess the behaviors tied to dispositions.

This work began with a multi-institutional study in the spring (U.S.) term of 2021, in which the research team (including this paper's authors) investigated students' understanding of dispositions in terms of students' behaviors while completing coursework [13]. The researchers developed a short post-assignment *reflection exercise* with questions that focused on five dispositions of interest: *adaptable*, *collaborative*, *persistent*, *responsible*, and *self-directed*. These dispositions were taken from the dispositions listed in the CC2020 report [10, p. 51]; the specific dispositions were chosen based on learning outcomes of the courses being taught that semester.

Reflection exercise responses were evaluated using Mayring's content analysis approach [14], resulting in the development of deductive-inductive categories of observable behaviors descriptive of the student's perspective. This study continued into the next term (fall (U.S.) 2021) [15], where these same researchers re-used the reflection exercises to study a different but overlapping set of five dispositions: *adaptable*, *meticulous*, *persistent*, *self-directed*, and *professional*. Again, the dispositions were from the CC2020 report [10] and were selected based on the courses being taught that semester, so *meticulous* and *professional* were substituted for *collaborative* and *responsible*. As before, students' perceptions were gathered by asking for examples of situations in which they applied each of the five dispositions in the context of assignments within their computing courses. For *meticulous* and *professional*, new behavioral categories were identified.

In the second phase of the study, researchers developed and employed *vignette exercises* to collect data on dispositions. Vignettes are short stories (or scenarios) along with a set of

questions that engage the reader to comment on the story. The vignettes used in this study involved scenarios which demonstrate the application of a disposition, drawn from various fields and walks of life to represent diverse groups and experiences. The design of these vignettes is described in [16]. To elicit students' understanding of dispositions in terms of their personal behaviors, students were presented with a vignette scenario after they completed a course assignment, and asked to identify the disposition demonstrated in the vignette. After directing their attention to a specific disposition, students were asked to describe a situation in which they applied this disposition while completing the assignment. The analysis of the data collected from students' responses to vignettes is the focus of this paper.

The use of vignettes differs from that of reflection exercises in prior studies in that in addition to asking students to reflect on their application of dispositions, vignettes also provide an exemplary case of a historical figure exercising the disposition in a real-life setting. Vignettes have been found to be a better vehicle for obtaining responses on beliefs, values, and attitudes than abstract questions [17], [18], and may avoid overly general responses [19].

The **research question (RQ)** of this study is: Which behavioral categories obtained from analyzing student responses to reflection exercises were confirmed using vignette exercises (and which were not confirmed)? Which behavioral categories were refined?

## II. RELEVANT BACKGROUND

The theoretical and empirical research literature that has guided this study focuses on dispositions and the application of vignettes in educational contexts. This study defines "professional disposition" as the awareness and intention to apply knowledge and skills by engaging in behaviors that are valued in the workplace. Three key aspects in this operational definition of dispositions are: *observable behaviors* indicative of the disposition [20], [21]; *awareness* of when an opportunity exists to engage in a behavior along with the *intention* to carry it out [22], [23]; and the context of *professional workplace* expectations that relate to desirable dispositions [2], [5]. In this section, the salient aspects of this paper's operational definition of dispositions are highlighted through relevant literature and studies about dispositions in education and computing profession. The section concludes with the use of vignettes in education and research.

### A. Dispositions in Education

Dispositions translate one's skills into action [22], [23]. Behaviors are indicators of applying a disposition. Teacher education accreditation standards in the U.S. use the term "disposition" to describe "attitudes, values, and beliefs demonstrated through behaviors" [24] and "habits of professional action [...] that underline an educator's performance" [25].

An individual may have the knowledge and skills to perform a task, but may not follow through if not aware of when to act or not inclined to do so [26], [27]. Recent studies

on critical thinking [28] and debugging [29], for example, investigate the interdependence between skill and disposition. The development of critical thinking is twofold. While critical thinking skills pertain to problem solving and inference, critical thinking dispositions, such as being open-minded and responsible, influence intellectual engagement and motivation of engineering students [28]. A similar argument is presented for debugging. Debugging as a skill is demonstrated through the application of effective debugging strategies to find and fix errors. Debugging as a disposition guides the application of the debugging skill towards "observable behaviors that reflect effective debugging practice" [29].

### B. Dispositions in Computing Profession

Professionals in any area of work demonstrate and continue to develop competencies demanded of their professional role on the job. Dispositional competencies are invariably stated in job postings and expected of college graduates [4], [5]. In an effort to bridge the competency gap between employers' expectations and computing graduates' college preparation, the NSF-funded project *DEAPening Employer Academic Partnerships (DEAP)* [30] has produced resources to help educators integrate competencies, including dispositions, into their academic programs. Among these resources is the research-based competency report on dispositions, *DEAP Competencies: Dispositions* [31]. Data collected from 52 research articles on computing competencies and 32 interviews with computing professionals were analyzed to identify dispositions required on the job across the field of computing [2].

The conceptual framework of the underlying research study of the DEAP report uses the competency taxonomy from the National Research Council's *Education for Life and Work* report [32]. The DEAP work adapts the NRC's taxonomy of intrapersonal and interpersonal competencies to their data analysis findings. DEAP research resulted in six disposition themes: *being collaborative*, *being conscientious*, *being leaderly*, *intellectual openness*, *life-long learning orientation*, and *self-regulation*. These themes encompass 42 individual dispositions [31].

### C. Vignettes in Education and Research

Vignettes describe situations and raise questions relevant to a phenomenon of interest through plausible short stories that feature real or fictionalized people and their behaviors [33], [34]. The use of vignettes in education and research encourages learners to share their own beliefs and reflect candidly on their behaviors [35]. For example, vignettes that feature critical incident stories were used to define and assess performative tasks in mission-critical roles in cybersecurity [36]. Vignette-style questions describing various programming moments prompted negative self-assessments of students' learning experiences in introductory computing courses [37]. Vignettes differ from surveys and interviews because a subject answers questions in the context of the scenario, which serves as an additional stimulus. Sampson and Johanessen [38] found that vignettes used as a stimulus can extend the discussion,

encourage engagement, and may reduce socially desirable responses. This effect was also noted by others [17], [19], who attributed it to the distancing effect of vignettes. Vignettes have been found to be a better vehicle for obtaining responses on beliefs, values, and attitudes than abstract questions [17], [18], and may avoid overly general responses [19].

### III. METHODS

The dispositions considered in this study are: *collaborative*, *meticulous*, *persistent*, and *self-directed*. The factors that motivated the selection of these dispositions are the following:

- The dispositions were relevant to the learning objectives of the courses where data was collected;
- The researchers had developed vignette scenarios for these dispositions;
- The study could contribute to the confirmation and refinement of the behavioral categories obtained from analyzing student responses to reflection exercises in prior work [13], [15].

TABLE I  
DISPOSITIONS USED IN THE STUDY

Disposition	Descriptions based on expected student behaviors
Collaborative	Work with other people as a team, exchange, share and discuss ideas, feedback, and actions to accomplish a task
Meticulous	Pay attention to detail even when the detail is incidental to the success of a solution and addressing it may or may not be expected or rewarded
Persistent	Stick with a task until it is completed even when the task seems difficult and even when you have doubts about your ability to complete the task
Self-directed	Learn new tools, techniques, etc. on your own to complete a task, even when the tool/technique is only minimally used/discussed in class and you may not receive extra credit for learning it

Note that two dispositions were examined only once in two different earlier studies: *collaborative* in [13] (using reflection response data collected in fall (U.S.) 2021 semester), and *meticulous* in [15] (using reflection data from spring (U.S.) 2022 semester), whereas *persistent* and *self-directed* were part of both studies. Some dispositions from these studies were found to be more abstract in that they overlap many of the other dispositions. For example, all but one of the behaviors associated with *professional* were also associated with other dispositions. Therefore, *professional*, *responsible*, and *adaptable* dispositions were dropped from the current study.

The vignettes used in this study were designed according to the template described in the authors' prior work [16]. The template guides students through the following steps:

- 1) **Scenario:** Read a scenario which is up to 500 words long, depicting a real life story of the application of a disposition.
- 2) **Disposition Definition:** Read brief definitions of the dispositions (as shown in Table I).
- 3) **Scenario Prompt:** Identify the disposition illustrated by the scenario and justify your selection.

- 4) **Reflection Prompt:** Provide an open-ended response to the reflection prompt: "Describe an example of you being [*disposition name*] when completing this assignment. Otherwise, describe the circumstances that prevented you from being [*disposition name*]".

This study analyzed students' open-ended responses to the reflection prompt of vignettes. The same reflection prompt was asked in reflection exercises in prior studies. Two versions of vignettes were developed: full-length vignettes of 500-word scenarios and mini-vignettes with scenarios of one or two paragraphs and up to 200 words. Table II lists the vignette scenarios used in the study and the dispositions they target.

TABLE II  
VIGNETTE SCENARIOS AND TARGETED DISPOSITIONS

Disposition	Vignette scenario
Collaborative	Development of the Linux operating system
Meticulous	Moog's synthesizer and music composition
	Jobs' attention to detail in pursuit of high quality
Persistent	Edison's invention of the light bulb
Self-directed	Marie Curie's development & deployment of mobile X-ray units

#### A. Data Collection

Vignette response data was collected in spring and fall (U.S.) in 2023 from 77 undergraduate computing students across four higher education institutions (labelled here as I1, I2, I3, and I4). Institutional differences are reflected by the institutional type: public (I1, I2, and I4) and private (I3); educational focus: liberal arts education (I1, I2), comprehensive (I3), and professional studies (I4); and student population: residential students (I1, I2) and commuter students (I3, I4). The computing courses from which data was collected included introductory computer science CS1 (I2), Data Structures Fundamentals (I4), Concepts of Programming Languages (I1), and Database Management Systems (I3).

The CS1 course (27 participants) contains weekly programming assignments. Students filled out vignettes after submitting four assignments, beginning in the second half of the semester. Students were expected to be *persistent* and *meticulous*, and received completion credit for filling out vignettes. The Data Structures Fundamentals course (4 participants) combines collaborative labs with individual assignments, and allocates the last third of the semester to a team project. Three vignettes that featured *persistent*, *collaborative*, and *self-directed* dispositions were incorporated in homework assignments and accounted for 10% of the assignment grade. The Database Management Systems course (31 participants) requires students to work in pairs on a semester long project in which they design and implement a database based on requirements. Students filled out mini-vignettes featuring *collaborative*, *meticulous*, and *persistent*, after three project stages, with each mini-vignette accounting for 5% of the project stage grade. Concepts of Programming Languages (15 participants) is a junior/senior level course required of all computer science majors. After one programming-intensive

assignment, students were asked to complete a mini-vignette that featured *persistent* disposition. Mini-vignette completion contributed to class participation grade.

### B. Data Analysis

To answer the research question the authors conducted a thematic analysis to identify, analyze, and report themes in the students' understanding of dispositions in terms of self-reported behaviors. The top-level themes in the content analysis were the four dispositions in this study (see Table I). The coding unit in the analysis process was the smallest meaningful component of a student response needed to identify a behavior indicative of the student's application of the disposition. Overall, student responses to the vignette's reflection prompt were short and had one meaning. In a few cases, responses had two meanings, so they were separated into two coding units. In all, vignette response data contained 139 coding units.

TABLE III  
DEDUCTIVE BEHAVIORAL CATEGORIES FOR THE STUDY'S DISPOSITIONS

Collaborative	Meticulous	Persistent	Self-directed
Problem-related communication	Paying close attention	Investing constant effort despite frustration	Successful problem solving
General communication and exchange	Producing correct solution	Participating regularly over project or course	Utilizing external resources
Sharing the workload to solve problems together	Testing code thoroughly	Increasing working hours	Critical self-assessment
Asking for help	Improving solution	Aiming at high quality	Planning ahead
Assisting others	Accepting feedback	Achieving success or long-term goal	Self-review
Cooperating with other students	Applying time management	Seeking help	
Sharing resources			

Mayring's content analysis approach [14] was applied for each disposition through a combination of deductive and inductive coding procedures. The authors adopted the thematic structure obtained from analyzing student responses to reflection exercises reported earlier [13], [15]. The deductive categories from these studies are summarized in Table III. The categories are listed in decreasing order of the number of coding units assigned to them.

For each disposition, analysis conducted by four researchers (this paper's authors) proceeded in a two-step process. In the first step, vignette responses for each disposition were independently coded by two researchers, using existing behavioral categories (Table III). Each researcher performed this analytical step for two different dispositions. Researchers recorded their questions and observations related to possible refinements of existing category names and definitions. Coding decisions and annotations of the category definitions were maintained in a shared structured document. The second step involved all four researchers collaborating to reconcile disagreements regarding the coding decisions made in the first step. The team continued to compare, discuss, and review the coding schemes of the four dispositions. The identification and categorization of student behaviors progressed in an iterative

manner until consensus was reached regarding category names, definitions, and excerpts of student responses designated as anchor examples [14].

To establish trustworthiness and build credibility in the qualitative analysis process, the study used three forms of triangulation [39], [40]. Data triangulation occurred through the use of data sources from four different courses at four institutions, over two consecutive academic terms. Method triangulation involved the use of two different instruments for data collection: vignettes with reflection prompt (in this study) and reflection exercises (with reflection prompt only in prior studies [13], [15]). Investigator triangulation consisted of the involvement of all four researchers in a two-step analysis process of multiple iterations to reach agreement on the study's behavioral categories.

## IV. RESULTS

The deductive-inductive qualitative analysis of the students' responses to reflection prompts of vignette exercises resulted in a coding scheme of behavioral categories associated with each of the four dispositions investigated in this study. The coding schemes are shown in Table IV for *collaborative*, Table V for *meticulous*, Table VI for *persistent*, and Table VII for *self-directed*. In these tables, the first column names the behavioral category. The second column contains generalized definitions of the category, which explain how the category was used to code student responses. The last column provides excerpts of student responses as anchor examples of the behavioral category [14]. The categories in each table are listed in decreasing order of the number of coding units to which they applied.

Two additional categories that are not included in the tables are *Not applied* and *Not pertinent* categories. The *not applied* category captures responses descriptive of circumstances that prevented students from applying the disposition (e.g., "I was not able to be persistent because ..."). The *not pertinent* category was used whenever responses did not indicate a behavior, or just repeated the name of the disposition (e.g., "I was persistent."), or did not provide an open-ended response.

Although all 24 behavioral categories from Table III were considered for analysis, six of them were not applicable to the analysis of student responses, as shown below:

- *Collaborative*: "General communication and exchange", "Assisting others with their solutions", and "Sharing resources"
- *Meticulous*: "Testing code thoroughly", "Applying time management"
- *Persistent*: "Seeking help"

A new category was developed for *meticulous* disposition: "Applying a detailed step-by-step process" (see Table V). Six behavioral categories were renamed:

- For *collaborative* disposition, "Cooperating with other students" was renamed "Independent problem solving during group collaboration". "Sharing the workload to

TABLE IV  
Collaborative DISPOSITION CODING SCHEME

Category	Category Definition	Excerpt(s) of student responses
Problem-related communication	Discussing hypothetical solutions or sharing ideas before implementing them; Sharing thoughts about the benefits and challenges of this hypothetical solution, listening to others' ideas	"During this project, my group mate and I spent a lot of time discussing ideas and going back and forth with one another regarding issues in our ER model for example. The conversation and work were a means of a collaborative effort."
Interactive problem-solving during group collaboration	Working together, usually in real time, to solve a problem, whereas all team members participate interactively and contribute equally to the progression toward the final integrative solution	"An example of me being collaborative during this assignment would be me coming together with my partner and brainstorming our ideas. At time there may have been a difference in ideas, but we came together to form one product. We both used our knowledge to the best of our abilities to aid in the completion of our project."
Independent problem-solving during group collaboration	Dividing the assigned work into parts and after everyone completes their tasks independently,, the parts are put back together and discussed	"We worked together to communicate on which parts needed to be fixed. We also equally distributed the work amongst each other while asking for help in between"
Asking for help	Occasion-related seeking of help; Discussing specific questions in the face of a specific challenge	"I got help from a tutor in order to complete homework3, my difficulties with linked list and node, prevents me from being of any help"

TABLE V  
Meticulous DISPOSITION CODING SCHEME

Category	Category Definition	Excerpt(s) of student responses
Producing correct solution	Focusing on actions required to achieve a correct solution	"I had to pay very close attention to each number and the set up of the expressions in order to make sure my program was calculating the correct amounts." "...even though there are no presented error within the IDE, there may be logical error which an IDE will not be able to detect so I have to carefully examine each line of code"
Paying close attention to detail	Directing attention to details, including possible discrepancies, missing or misplacement of data, not meeting expected conventions	"...when writing the different operations and functions i had to make sure that every little thing was in the right spot." "Identifying discrepancies in the table report would usually relate to minute details." "I was meticulous in formatting the sample data [...] and ensuring that each value was in the proper form ..."
Improving solution even if not required	Doing intrinsically motivated work, not necessarily required or expected, to improve quality of submitted work	"...I changed most of the numbers into symbolic constants despite some of them being unnecessary" "Formatting my program's output in a certain way even though it isn't required but it makes it look nicer"
Accepting feedback	Examining attentively feedback from educator or peers	"tried to edit [our scripts] in ways that was not asked of in the feedback. At the same time we still looked at the criticism, but we tried to see if there was anything extra, we could add."
Applying a detailed step-by-step process	Proceeding carefully and methodically by following a detailed process	"I then broke the process down into its smallest parts, followed by creating a list on paper of all the relationships I needed to create. Then, using a system of steps for each relationship, I was able to finally get a better understanding of the material after hours of work and research."

solve a problem or task together" was renamed "Interactive problem-solving during group collaboration" (Table IV). The renaming helped to distinguish between the role of the individual contributor who conducts work independently and makes their contributions, and the actual dynamics of working together through highly interactive activities.

- For *persistent* disposition, "Investing effort despite frustration" was renamed "Overcoming setbacks" (Table VI) because a careful analysis of student responses that fell into this category showed no explicit indication of feelings of frustration, but responses spoke of recurring setbacks that students had to persist to overcome. The other three cases of renamed categories pertaining to *persistent* required minor language clarifications.

All renamed categories had their definitions refined. Additional refinements involved improvements of many other category definitions.

In summary, through qualitative analysis of vignette data,

the authors were able to:

- Confirm the applicability of 17 of the 24 behavioral categories developed previously through reflection exercises;
- Find a new behavioral category for *meticulous* disposition;
- Rename six behavioral categories to better capture behaviors indicative of students' application of *collaborative* and *persistent* dispositions.
- Refine most of the definitions of behavioral categories across all four dispositions to emphasize their salient aspects.

Together, these findings answer the research question.

## V. DISCUSSION

### A. Implications for Using Vignettes

A major difference between this study and the previous study [13] is that vignettes are presented before students respond to the reflection prompt whereas, previously students only saw the reflection prompt. While the reflection prompt

TABLE VI  
Persistent DISPOSITION CODING SCHEME

Category	Category Definition	Excerpt(s) of student responses
Overcoming setbacks	Going through a lot of trial and error to solve problem; Trying (many) alternative ways of doing things to complete work no matter what; Working out the solution step-by-step despite difficulties	"I often found myself stuck but kept trying" "I manually put in break points so that I could follow the path and find out exactly where it went wrong, trying out different examples until I finally found the issue."
Achieving set goal or success	Working determinedly to achieve solution; Trying continuously to figure out and fix mistakes	"I had to try many different things and edited several different files before arriving at the right solution." "I was persistent by going back ...after realizing my solution didn't meet the requirements." "...checking the dozens of attributes multiple times to see if anything has been missed or is unnecessary"
Participating regularly over the course of the project	Spending constant effort without given up	"kept reading through the book at some examples and looking at how I could better understand everything" "I had to keep experimenting with the do while loops in order to get them to work"
Investing considerable time	Committing a lot of time (or extra time) to complete the work by the deadline; Scheduling necessary time on a regular basis	"I spent a great deal of time on this project and kept at it till it was complete"
Aiming at high quality	Applying effort with the goal of a high quality outcome	"I made sure to make a commit whenever I had completed an aspect of the project ... [It] pays off because in the future, when I work on large projects with multiple people, being comfortable making frequent commits will dramatically help when" "Even though my program behaved correctly it wasn't coded correctly, this was something I had to fix"

TABLE VII  
Self-Directed DISPOSITION CODING SCHEME

Category	Category Description	Excerpt(s) of student responses
Utilizing external resources	Self-selecting additional material/contents/persons to support learning and successful problem solving (taking action)	"I found myself searching the web and teaching myself different ways to set up my program when I found myself with an issue." "I was being self directed when completing this assignment because i had to learn new material and find out how to apply it within my code."
Successful problem-solving (learning)	Solving problems or tasks successfully without assistance from other persons	"An example of being self-directed while completing this project was figuring out where to properly declare all of the necessary functions and types of each function, as well as make adjustments whenever I would encounter problems in my code. I found that utilizing a boolean variable based on the user's input for the menu and passing it as a parameter in my printHoldings() function was optimal when it came to whether or not my function would print the worth of the user's portfolio out to the screen."
Critical self-assessment	Recognizing one's own capabilities and deficits or lack of expertise	"I often got very confused with how functions work exactly and spent an afternoon researching them to get my program to work."
Self-review	Considering / reviewing one's own actions and results	"I'm not sure if this really counts but, I was trying to do a lot of things in main that could have been their own functions so I decided to make small functions that could be used as many times as I wanted instead of having to write code twice. I also had to look up what parameter passing was so I could make sure not to use it in my project."

asks the student to describe their behavior in the context of a just-completed assignment, the vignette scenario presented before the prompt may serve as an additional stimulus. Empirical studies of attitudes, beliefs, and values have used vignettes to collect participants' perspectives and interpretation of the vignette scenario itself, and make judgments directly related to the contextual features of the vignette scenario [17]–[19]. The vignette design used in this study is different in that it includes both a scenario prompt (requiring direct response to the content of the vignette scenario), as well as a reflection prompt to elicit students' introspective analysis of their own behaviors while completing assigned coursework. The purpose of the scenario is to give students an impactful example of how the application of a disposition makes a difference in real life. With such an example in mind, students are asked to think of themselves applying the disposition in their lived experience of completing required coursework.

The fact that the reflection prompt is the same for both vignette exercises and reflection exercises studied earlier [13], [15] means that the two interventions can be compared. The authors have informally observed that the responses to the reflection prompt seem to be lengthier and more specific in vignette exercises. This is a possible reason that one of the categories within the *Collaborative* disposition, "general communication and exchange" that was found to be applicable to 7% of student responses to reflection exercises in our earlier studies, was not found to be applicable to any responses to vignette exercises. The increased level of detail in the vignette exercises may have allowed all responses to be coded with more specific categories. This merits confirmation through a mixed-method approach. In addition, a previous finding that the use of vignettes reduces socially desirable responses [18], [38] could be confirmed by comparing responses coded as "Not applied" on reflection exercises and vignette exercises.

Future research will also involve a deeper qualitative analysis of *Not applied* responses which could yield important insights as to why students see themselves as not being able to apply a disposition.

### B. Mapping Behavioral Categories to Dispositions Valued in the Workplace

One measure for evaluating the workplace relevance of the behavioral categories is to compare them with behaviors that computing professionals associate with dispositions. The DEAP project [30] discussed in Section II identified 42 dispositions by using two data sources: interviews of 32 computing professionals and the results of a systematic literature review of 52 empirical research articles. The 42 dispositions, listed and described in the *DEAP Competency: Dispositions* report [31], span six top-level themes: *being collaborative*, *being conscientious*, *being leaderly*, *intellectual openness*, *life-long learning orientation*, and *self-regulation*. Each disposition has a name, (e.g., *team player*), a description (e.g., “contribute to the team’s efforts, help team members when needed”), and illustrative quotes from the data.

TABLE VIII  
BEHAVIORAL CATEGORIES MAPPED TO RELEVANT DEAP DISPOSITIONS

Student Disposition	Student Behavioral Category	DEAP Disposition
		<i>Being Collaborative</i>
Collaborative	Assisting others	Being helpful
Collaborative	Interactive/independent problem solving in group collaboration	Being a team player
Collaborative	Problem-related communication	Valuing communication and collaboration
Self-directed	General communication	Being independent
Self-directed	Being able to solve problems successfully without assistance	
		<i>Being Conscientious</i>
Meticulous	Paying close attention to details	Attention to details
Self-directed	Critical self-assessment	Being self-driven
	Self-review	& intrinsically motivated
Persistent	Overcoming setbacks	Perseverance or tenacity
Self-directed	Planning ahead	Self-management
Meticulous	Applied time management	(time management)
Persistent	Investing considerable time	Work ethic (work hard)
	Participating regularly over the course of the project	
		<i>Intellectual Openness</i>
Persistent	Trying (many) alternative ways of doing things to complete work no matter what	Creativity (put things together in new ways)
Meticulous	Testing code thoroughly	Development and testing mindset
Collaborative	Asking for help	Willingness to ask for help
		<i>Self-Regulation</i>
Persistent	Overcoming setbacks	Resilience (work under pressure, continue through adversity)
Self-directed	Critical self-assessment	Self-aware, self-reflective (assess own capabilities)

The findings of an initial comparison between student behavioral categories and DEAP’s dispositions are summarized in Table VIII. Some key observations follow. Twenty one of the 24 student behavioral categories (Table III) are aligned with 14 DEAP dispositions (Table VIII). Two DEAP dispositional themes, *being collaborative* and *being conscientious*, relate to nine of the behavioral categories. These themes also

encompass all four dispositions in this study. For example, two behavioral categories indicative of *persistent*, “interactive problem solving” and “independent problem solving” in “a group collaboration” match the description of the DEAP disposition *being a team player*. Other *collaborative* behaviors aligned with the DEAP dispositions of *being helpful* and *valuing communication and collaboration* are: “assisting others”, “problem-related communication”, and “general communication and exchange”. Another close match is the student behavioral category of “asking for help”, which corresponds to the DEAP disposition of *willingness to ask for help*, listed under *intellectual openness* theme.

Five DEAP dispositions under the DEAP *being conscientious* theme have student behaviors associated with *meticulous*, *persistent*, and *self-directed*. Of these dispositions, student behaviors related to *meticulous* match DEAP dispositions directly: the behavioral categories “paying close attention to details”, “applying time management”, and “testing code thoroughly” correspond to DEAP dispositions that have almost the same names (*attention to details*, *self-management (time-management)*, and *development and testing mindset*).

In some cases the name of the DEAP disposition lacks necessary specificity for determining alignment with behavioral categories. For example, the name of the DEAP disposition *perseverance or tenacity* is as general as the disposition name of *persistent*. The matching between the two is established by considering specific behaviors listed in the DEAP disposition description. Thus, DEAP behavior descriptions of “continuing to work on a difficult problem” and “getting things done even if you find them dense or boring” align with the *persistent* behavioral category of “overcoming setbacks”.

Overall, DEAP disposition descriptions are stated in terms of behaviors that computing professionals are required to demonstrate in the workplace. There are, however, descriptions that read like disposition names. For example, the description of the DEAP disposition *being self-driven and intrinsically motivated* includes “being self-directed”, “being proactive”, and “being self-motivated” [31, p. 7]. Although the DEAP disposition matches *self-directed* disposition in this study, the corresponding DEAP description lacks behavior-based comparison terms. This draws attention to the inherent ambiguity of a disposition name and the challenge of translating an abstract, general meaning to concrete patterns of behaviors. Another challenge is the different ways in which dispositions relate to each other. For example, *persistent* behavior of “overcoming setbacks” aligns not only with *perseverance or tenacity* and *resilience* (as shown above), but also to the DEAP disposition of *resilience*, described as “work under pressure” and “continue through adversity”. Knowing that some behaviors are associated with more than one disposition suggests that educators can prioritize development of classroom practices that support those behaviors.

### C. Implications for Fostering Dispositions

Educators should consider how course policies and activities of the instructor can impact student expectations and attitudes

and possibly their practice of professional dispositions. For example:

- Collaboration practices, formal and informal, can lead students to develop important characteristics. Teamwork, for example, is widely recognized as important in preparing students for the profession, as successful teamwork involves practicing social and communication skills, managing schedules, and more. Students might benefit from specific training in these behaviors as opposed to being expected to develop them simply through teamwork.
- Expecting students to seek out sources of help beyond the textbook, class notes or instructor encourages self-directedness.
- Grading practices that pay attention to details can influence students' perceptions of whether or not they need to be meticulous.
- Assignments that require students to trace software step by step or debugging guided by instructors could contribute to students' development of meticulousness.

Instructors model many professional dispositions through their course organization, class- and assignment-preparedness, their punctuality, their consistency, their willingness to admit and fix their errors, and so much more. In contrast to course work, the following are some avenues for fostering dispositions with the involvement of industry:

- Internship and co-op experiences are very natural ways to expose students to professional practice. But as mentioned [12], there are complications and expenses associated with making these sorts of experiences a graduation requirement. One alternative to a required internship is to include an industry-supervised course project, such as in a capstone course. This, too, is not without setup cost, but can yield big payoffs.
- Another way to expose students to professional practice is through inclusion of speakers from industry into classes or other forums. If those industry representatives are alums of the program, they might even have a greater impact, as they provide successful role models for current students.

Dispositions take time to develop and may need to be learned. Having students consider and experience dispositions repeatedly, in different courses, at different times, in the classroom or through an internship will raise awareness. This reinforcement will increase the likelihood that students will begin to appreciate dispositions and learn the necessary behaviors. Students may need to practice the behaviors to develop dispositions. Therefore, research into figuring out which behaviors correspond to dispositions is critical to creating appropriate instructional materials. Further research into developing these instructional materials is warranted.

#### D. Limitations

This study collected data from student vignette responses for four dispositions, using five vignette scenarios. One limitation is that the vignette dataset was considerably smaller than

the reflection dataset: there were 139 coding units in the vignette dataset compared to 1207 coding units reported in the reflection study [13], [15] for the four dispositions considered herein. Another limitation is that the study involved the same institutions of higher education and similar courses taught by the same instructors. Future work is planned to replicate this study with other institutions, instructors, and courses to strengthen the study's dependability. Furthermore, additional studies in different educational contexts with ample information about participants and research context are necessary to ensure transferability of the study's findings.

Student completion of vignette exercises was evaluated differently in the courses from which data was collected in this study. In some courses, students received credit towards the grade of the assignment. In other courses, vignette exercises counted towards class participation. Different evaluation methods might influence how students reflect on their application of dispositions. Finally, the validity of the content of the vignette scenarios has not been formally established.

## VI. CONCLUSION

This study used vignettes to categorize behaviors that students associate with four dispositions: *collaborative*, *meticulous*, *persistent* and *self-directed*. In answering the research question (*Which behavioral categories obtained from analyzing student responses to reflection exercises were confirmed using vignette exercises (and which were not confirmed), and which behavioral categories were refined?*), the study found that 17 of the 24 behavioral categories obtained using reflection exercises were confirmed by thematic analysis of the vignette dataset; and one new category was developed for *meticulous* disposition. Analysis of the vignette dataset resulted in renaming of six behavioral categories and refinement of the definitions of many categories.

These results suggest that vignettes are a viable alternative to reflection-only exercises to raise awareness and appreciation of dispositions among students. A noteworthy observation is that not all the behavioral categories from reflection exercises were applicable to vignette data. This suggests the need for additional studies and possibly for creating vignette scenarios that specifically encompass these missing behavioral categories. Additional study may also lead to further refinement of behavioral categories. The behavioral categories can be used to design classroom activities and interventions to promote and assess students' application of dispositions. The continued use of vignettes shows promise for fostering dispositions among students.

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