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Using Vignettes to Elicit Students' Understanding of Dispositions in Computing Education

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Abstract—Vignettes are short stories along with a set of questions that engage the reader to comment on the story. Vignettes have been used in professional academic programs (e.g., teacher preparation and medical education), for professional development in various fields (e.g., teaching ethics in psychology and medicine), and in various research fields for data collection. In this work, vignettes are used to elicit students' understanding of dispositions in computing education. Professional dispositions enable behaviors that are valued in the workplace, such as adaptability or self-directedness. They are often explicitly stated in computing job postings. While the relevance of dispositions is widely recognized in the workplace, only recently have curricular guidelines for computing programs recognized professional dispositions as an integral part of competencies and as complementary to knowledge and skills. There is scarce literature on the use of vignettes in teaching undergraduate computing, or on how best to foster dispositions in students. In this project, four faculty from four diverse institutions in the U.S., along with three consulting experts, have collaborated to design and evaluate the use of vignettes in the classroom. This paper documents researchers' efforts to gain insights into students' perceptions of dispositions through the use of vignettes. Such insights may guide educators to identify pedagogical strategies for fostering dispositions among students. This paper presents an iterative process for vignette design with continuous review by researchers and focus group members. The vignettes in this study use stories of situations which demonstrate the application of a disposition, drawn from various fields and walks of life to represent diverse groups and experiences. Students are presented with the vignette story and asked to identify the disposition illustrated. To elicit students' understanding of dispositions in terms of their personal behaviors, students are asked to describe a situation in which they have experienced the disposition. Lessons learned in the design and use of vignettes are discussed.

Index Terms—Dispositions, vignettes, professional practice

I. INTRODUCTION

Professional dispositions enable behaviors that are valued in the workplace, such as *adaptability* and *self-directedness* [1]. Recent curricular guidelines for undergraduate computing pro-

grams have included dispositions¹ along with the knowledge and skills that employers expect of computing graduates [2], [3]. Job postings often list dispositions among the required attributes of new hires [4]. The importance of dispositions in the workplace is widely accepted. For example, SFIA, a global, employer-led competency framework for computing professionals, complements professional computing skills with explicitly stated behavioral factors, such as taking initiative, monitoring one's own work within deadlines, or finding new ways to complete tasks [5]. How to effectively cultivate (or raise awareness of) dispositions in the classroom setting, remains an open question for educators in computing programs [6]–[12]. This research is a starting point to answer that question.

This study is the work of researchers from four institutions along with three consulting experts who are exploring how professional dispositions can be fostered across undergraduate computing education. This paper documents efforts to gain insights into students' perceptions of dispositions through the design and use of vignettes to better understand how dispositions manifest in terms of behaviors.

Vignettes are short, plausible stories, in written, pictorial, or video forms, featuring real people (or hypothetical characters) and their behaviors in real-life (or fictionalized) situations that are relevant to the phenomenon of interest [13], [14], along with questions that engage the reader to think about the behaviors in the story. Vignettes are intended to encourage participants to express in their responses their honest interpretations of their own beliefs and behaviors [15]. Vignettes have been used as a research tool to enhance or complement other data collection methods. When compared to survey questions, for example, vignettes enable participants to produce more valid and reliable measures of their opinions [16].

¹Throughout this paper, we use the term *dispositions* to refer to *professional dispositions*.

Disciplines and educational programs that have used vignettes for research purposes include medical education [17], computing teacher education [18], [19], computing education [20], [21], engineering education [22], marketing (e.g., [23]), sociology [24], developmental psychology (e.g., [25]), school psychology [26] and medicine (e.g., [27], [28]). Vignettes have also been used for professional development purposes in fields such as mental health care [29], ethics in psychology [30] and medical ethics [31]. In an engineering education study [32], vignette scenarios were used to assess the students' application of the process-oriented knowledge and their critical thinking skills in devising a plan for a realistic, open-ended task. Vignettes have also been found to be effective in assessing teacher understanding of instructional strategies and for measuring the pedagogical content knowledge of teachers [33]–[35]. This work employs vignettes to explore pedagogy for cultivating dispositions in a way that resonates with students' experiences and how they think of dispositions in their work and life.

The next section describes the preliminary use of vignettes to gain insights into students' understanding of dispositions. Section III details the process of designing vignettes through continual review. The paper continues with a discussion and lessons learned in Section IV, before drawing conclusions and outlining next steps.

II. USING VIGNETTES

The use of vignettes in research typically involves two steps: presentation of a story (often called a *scenario*) and *engagement* of the participant. In this work we use real-life vignettes to gather responses that reflect honest thoughts and beliefs of the participants' lived experiences. This is to avoid the pitfall of fictionalized vignettes, which are more prone to eliciting idealized responses that reflect socially acceptable norms and values rather than one's own thoughts and feelings (see [15], cited in [36]).

TABLE I
DISPOSITIONS USED IN THE STUDY

Disposition	Descriptions based on expected student behaviors
Adaptable	Modify your strategies, techniques or tools to adjust to new events, circumstances, or demands
Collaborative	Work with other people as a team, exchange, share and discuss ideas, feedback, and actions to accomplish a task
Inventive	Find different ways of completing a task that may not be obvious at first glance
Meticulous	Paying 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
Proactive	Attempt a task before it is due even though such initiative may not be expected or rewarded
Responsive	Promptly attempt to resolve/address events, requests, feedback, or suggestions appropriately even when promptness may not be expected or rewarded
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

The vignettes in this study use written stories of situations or series of events which demonstrate the application of a disposition. An example is the story of Ada Lovelace translating notes on Charles Babbage's Analytical Engine from French to English to illustrate *meticulousness*. The dispositions considered in this study are listed in Table I, along with descriptions of behaviors that students can relate to while learning and doing work in the course. The dispositions are a subset of the dispositions described in the CC2020 curricular report [3]. The scenarios are drawn from various fields and walks of life to represent diverse groups and experiences.

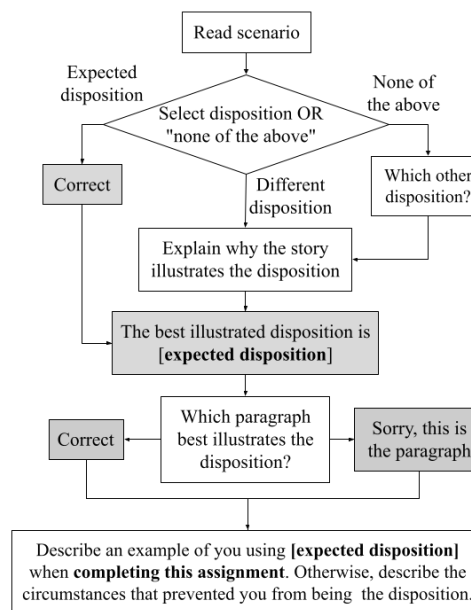


Fig. 1. Student engagement and related feedback with vignettes

To engage students and gather their thoughts on dispositions, vignettes are coupled with student assignments. The vignettes are implemented as part of an online form. Following completion of an assignment, students are presented with a vignette and a few references, should they choose to delve deeper into the vignette's scenario. Students are asked to select, from a list of five dispositions, the disposition that is best illustrated in the scenario. The dispositions are accompanied by behavioral descriptions (as shown in Table I). Student engagement and related feedback through a vignette exercise is shown in Figure 1. White boxes display questions or instructions. Shaded boxes indicate the feedback. If a student chooses an answer different from what is expected, they are asked to explain their choice. They are then asked to select the paragraph in the scenario that best illustrates the expected disposition. Finally, students are presented an *open-ended question* that asks them to describe, in terms of their own behaviors, how they exhibited the expected disposition when completing their recent assignment. If circumstances prevented them from exhibiting the disposition, students are asked to reflect on those circumstances.

Qualitative data collected from the vignettes are the be-

aviors that students associate with their own application of the disposition. These behaviors will help inform pedagogical strategies for fostering dispositions among students.

III. DESIGNING VIGNETTES

Initially, the plan was to design vignettes of about 500 words, but some faculty felt they involved too much reading or would take too much class time. Thus, the mini-vignette was born. As result, two versions of vignettes were developed to provide instructors flexibility on how much time they want students to spend on the exercises:

- Vignettes, where the scenario contains five paragraphs and up to 500 words.
- Mini-vignettes, where the scenario contains one or two paragraphs and up to 200 words. The only difference in engagement from what is shown in Figure 1 is that, with mini-vignettes, students are not asked to identify the paragraph that best illustrates the disposition.

The design of a vignette is an iterative process with several steps:

- 1) Choose a disposition.
- 2) Identify a story idea that illustrates the disposition. A story idea might be focused on a person, event, or activity.
- 3) Find multiple sources related to the story.
- 4) Draft a scenario of about 500 words in five paragraphs of similar sizes.
- 5) Ensure that the disposition is unambiguously illustrated in only one of the paragraphs.
- 6) Assess the scenario by having a focus group consisting of several computing educators read it and identify the disposition and the paragraph that best highlights the disposition.
 - a) If focus group results do not align with the targeted disposition or do not identify the correct paragraph, revise the scenario. Repeat Step 6.
 - b) Otherwise, continue with the next step.
- 7) Identify the disposition choices that the reader will be asked to choose from.
- 8) Create a form to present the scenario and drive the engagement flow (described in Figure 1.)

After classroom use, based on engagement feedback from students, it may be necessary to further revise a vignette by changing the scenario or the list of disposition choices.

The design of mini-vignettes varies slightly from the design of full-length vignettes. In Step 4, for mini-vignettes draft a scenario of about 200 words in one to two paragraphs, and skip Step 5, as there is no concern about which paragraph illustrates the disposition. Table II lists some of the scenarios developed by the research team, along with each scenario's targeted disposition.

The scenario concerning the development of Linux is shown in Figure III. The last paragraph is intended to illustrate the *collaborative* disposition. References included with the scenario are from Linux Foundation, Red Hat, and Wikipedia. The

TABLE II
SOME SCENARIOS AND TARGETED DISPOSITIONS

Scenario topic	Disposition
Edison's invention of the light bulb	Persistent
Development of the Linux operating system	Collaborative
reCaptcha and crowdsourcing	Inventive
Surgical practice to prevent infections	Meticulous
Water landing of jetliner with no deaths	Responsive

TABLE III
DEVELOPMENT OF LINUX: EXAMPLE OF VIGNETTE SCENARIO

In 1991, while a computer science student at the University of Helsinki, Linus Torvalds began a project as a hobby, not related to his coursework. In the project, he wrote programs in C to interact directly with the 80386 CPU of his personal computer while bypassing the operating system of the computer. These programs would go on to become the kernel of the Linux operating system, which is an alternative to Windows operating system.

Linus Torvalds wanted to call his software Freax, a combination of "free" and "x" to mean a flavor of Unix. But, when he uploaded the files of his program to a server for others to download, one of the volunteer administrators of the server named the project "Linux", and the name stuck. Apart from the kernel, the Linux operating system also contains a shell that allows the user to issue commands to the kernel and utilities such as compilers. The utilities and compilers are those produced by the GNU (Gnu is not Unix) project, a popular developer of open-source utilities.

At first, Linus made the Linux operating system kernel available for free personal but not commercial use. Later on, he released it under GNU General Public License (GPL) which allows four freedoms: the freedom to run, copy, study/improve and distribute the work. The use of GPL is cited as one of the reasons why Linux became one of the most popular operating systems of all time. Other reasons included that it was free and ran on affordable personal computers.

The Linux kernel is now ubiquitous. It is in Android phones, and it runs many of the servers used to place calls, send texts, stream music, watch videos, play games, etc. It runs TOP500 Supercomputers and powers public clouds. It runs rendering farms for movie studios and powers Chromebooks for kids doing virtual learning. It powers Raspberry Pi single board computers for hobbyists and powers everything from the Content Delivery Networks (CDNs) for streaming services to set top boxes and smart TVs.

Linux is now an enormous open source project that is being maintained and extended by over 600,000 programmers from around the world. Programmers submit programs or patches. Subsystem maintainers review the programs, sign off on patches and accept the code for inclusion. The entire effort is coordinated by Linux Foundation, a non-profit open source software foundation. While initially, most of the contributors were passionate volunteers, these days, most of them are paid by their employers such as Intel, Google, Facebook, Samsung, Oracle, Red Hat, SuSE and IBM to contribute.

list of five dispositions presented to students are: adaptable, collaborative, meticulous, persistent, and self-directed.

IV. DISCUSSION AND LESSONS LEARNED

Central to the work presented in this paper is the design of vignettes that engage students to think about a single disposition and how it may relate to their own learning experiences. Many lessons were learned as vignettes were designed and tested. Some of these are discussed below.

Multiple Perspectives. Real-life, impactful stories are often multi-faceted and can be viewed or interpreted from different perspectives. Scenarios of such stories would inevitably allow

the identification of multiple dispositions. For example, the story of Edison's light bulb could be used to illustrate *persistence* (he and his team tried out thousands of materials for the filament) or *inventiveness* (for the range of materials tried). This issue was resolved by rewriting the scenario to clearly highlight one interpretation and hence one disposition over the other. In further consideration of the role of perspective, one researcher was able to use stories that started as a full-length vignette scenario (5 paragraphs) and rewrote each of them as mini-vignette scenarios, such that each mini-vignette illustrates a different perspective and thus a different disposition.

Different Interpretations. Natural languages are ambiguous and open to misinterpretation, and attempting to develop unambiguous definitions is challenging. It seems that if one could write unambiguous definitions for each disposition, and have a clear understanding of what differentiates one disposition from another, then single-disposition scenarios should be easy to design. Consider the *adaptable* and *inventive* dispositions and their definitions in Table I. If one uses existing elements or techniques in a new way, are they "adapting" old elements for new purposes, or are they "inventing" something new (perhaps a new process for solving a problem)? It was found that such examples do not always lead to unanimous agreements. And if an adaptation or invention is due to some immediate crisis, is the disposition being exhibited really more a case of being *responsive*, rather than *inventive* or *adaptable*, or could it be all three? It was also found that most readers are familiar with these terms, and may often apply their prior knowledge and experience instead of the supplied definitions when choosing dispositions. To reduce ambiguity, it is considered helpful to provide descriptions of dispositions in terms of student behaviors (see Table I).

Overlapping Dispositions. Sometimes the designers simply could not agree on what the expected disposition was. Perhaps, being *inventive* is sometimes a special case of being *adaptable*. These types of relationships, among dispositions, that depend on the concrete situation described in the scenario were discovered. Moreover, two of the dispositions listed in CC2020 curricular report [3], *professional* and *responsible*, were found to be too abstract and subsuming of other dispositions. Specifically, our attempts to describe *professional* and *responsible* in terms of behaviors, overlapped with behaviors associated with other dispositions. Thus, these two dispositions were eliminated from this project.

Focusing the Reader. The list of disposition choices presented to students following the reading of a scenario was limited, in an attempt to eliminate any secondary dispositions that might be detected in a given scenario. As a result, students are seldom offered the choice of *adaptable*, because it was found that many dispositions could be viewed as a special type of adaptability. The identification of dispositions to exclude is part of the thought process in Step 7 in Section III.

Human Actors. Stories centered around people actively displaying behaviors were found to make it easier to identify a disposition. This is because dispositions are human qualities that enable behaviors, and a goal is to have students relate

these dispositions to their own behaviors. For example, the story of preventing infections during surgery illustrates the *meticulousness* disposition when the focus is on what the surgical staff does. If, on the other hand, the scenario focuses on the discovery of germ theory and sterilization and antiseptics, then *inventiveness* might come through.

Scenario Titles. It is also important to select a title for a scenario that does not give away the intended disposition or confuse students. For example, the title of the Edison scenario first included the term "invention," which would have been confusing since the scenario illustrates *persistence*.

Flexibility. As mentioned in the previous section, it was discovered that some educators found 500-word vignettes to be too long for their pedagogical purposes, so mini-vignettes were also designed. Now educators can choose what is best for their teaching environment.

V. SUMMARY AND NEXT STEPS

This research is work-in-progress. This paper described the initial use of vignettes to gain insights into computing students' perceptions of dispositions, detailed an iterative process of designing vignettes, and shared lessons learned.

After classroom use, based on students' choice of disposition or paragraph identification, it may be necessary to further revise a vignette by changing the scenario or the list of disposition choices. Other revisions might include updating disposition definitions or considering different dispositions from the ones currently targeted.

Students' responses to the open-ended question (discussed in Section III) will be qualitatively analyzed through content analysis [37]. This will generate categories that summarize students' concepts of dispositions and how students see themselves applying dispositions, similar to what was done in [12]. Qualitative results will help in revising definitions of dispositions in terms of observable behaviors. An improved understanding of how students apply dispositions may guide educators to identify pedagogical strategies for fostering dispositions among students.

Currently, the vignette form tells the student what the intended disposition is and which paragraph best illustrates it. However, there is no follow-up between students and instructor. The next step is to consider how instructors can communicate the results back to students and possibly facilitate discussion on multiple perspectives, overlapping dispositions, or different interpretations. Other pedagogical strategies for teaching and learning about dispositions will be explored.

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