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A PRELIMINARY EXAMINATION OF ADAPTIVE CASE STUDIES IN NURSING PATHOPHYSIOLOGY

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INTRODUCTION

Case studies are a valuable nursing educational tool that allow students to analyze clinical problems based on real-life scenarios. Because of perceived increased engagement, case-based learning has been used extensively in nursing education (Thistlethwaite et al., 2012). A growing body of evidence provides support for the educational benefits of case-based pedagogy including improved learner outcomes such as critical thinking (Kaddoura, 2011; Uluyol & Tolga, 2014), understanding of difficult concepts (Kulak & Newton, 2015), and clinical skills (Raurell-Torredà et al., 2015).

The fidelity, or how closely cases mimic real life, ranges from relatively low (static text or narrated scenarios) to very high (using mannequin based or virtual reality (VR) based simulation). High fidelity simulation usage has increased dramatically because it provides opportunities for students to increase knowledge and critical thinking skills. However, there can be significant financial, time, personnel, and space resources devoted to operating a simulation center. These costs can negatively impact the feasibility of using high fidelity simulation case studies in all courses (Frick, Swoboda, Mansukhani, & Jeffries, 2014; Harlow & Sportsman, 2007).

A disadvantage of many case studies, whether delivered in low or high fidelity, is that they are presented in one static instance, with questions and/or discussion following. Even when a case may be presented in segments, each component is generally presented once, with no ability for the student to revisit and practice the topic. Students who do not learn concepts the first time may miss out on the benefits of the case study. In situations where the case study has no clear answers and the discussion itself is the learning experience, students who do not engage in the discussion, may not have significant benefits from the approach. Even when fully engaged in the discussion students may falsely believe they understood the material when, in fact, they have not.

THE ADAPTIVE LEARNING PLATFORM

The University of Central Florida (UCF) began a pilot investigation of the use of adaptive learning in 2014. After exploring vendors and with faculty input, Realizeit was selected as the university's enterprise adaptive learning platform (Bastedo & Cavanagh, 2016). Realizeit is an adaptive learning platform that uses Bayesian estimation techniques within a faculty-created course to give each student a personalized pathway through the instructional content (Howlin & Lynch, 2014). Realizeit is a content agnostic adaptive learning platform which allows faculty to create the learning content and assessment or ingest content from sources such as open educational resources (Howlin, n.d.). As the student progresses through course content, a comprehensive stream of data is generated that guides the algorithmic adaptivity and personalization. Realizeit's Curriculum Prerequisite Network involves a series of nodes, depicting granular course content, that are connected by edges depicting the pathways of prerequisites that students must traverse to achieve mastery (Howlin & Lynch, 2014a). The Realizeit Determine Knowledge function acts as a pretest to initially assess student knowledge and place students within the content (Lynch & Howlin, 2014).

Adaptive learning acts as a GPS, while Realizeit continually assesses students as they progress through the content map, directing them in the pathways that help them most efficiently learn course material (Howlin, n.d.). Faculty create the content, assessments, and the connections between nodes that depict the learning pathways. While this gives faculty a significant amount of control over the course content and assessment, it also requires a significant amount of time and effort to create. To ameliorate this workload for faculty, UCF has created a Personalized and Adaptive Learning (PAL) team of instructional designers that are experienced with Realizeit and who facilitate faculty development of adaptive learning courses (Chen, Bastedo, Kirkley, Stull & Tojo, 2017). Figure 1 (taken from Howlin & Lynch, 2014b) depicts a representative learning path for students indicating what concepts have been mastered (green nodes) and those yet to be completed (red). This roadmap guides students through the course objectives that are necessary to master in order to successfully complete the course.

Once the details of the modules, nodes and case studies are created by the instructor, they are then ingested into the adaptive platform by the instructional designer, with links to related content (Chen, Bastedo, Kirkley, Stull & Tojo, 2017). This becomes the content in which the adaptive learning algorithm moves students through the case, depending on their knowledge growth and pathways taken.
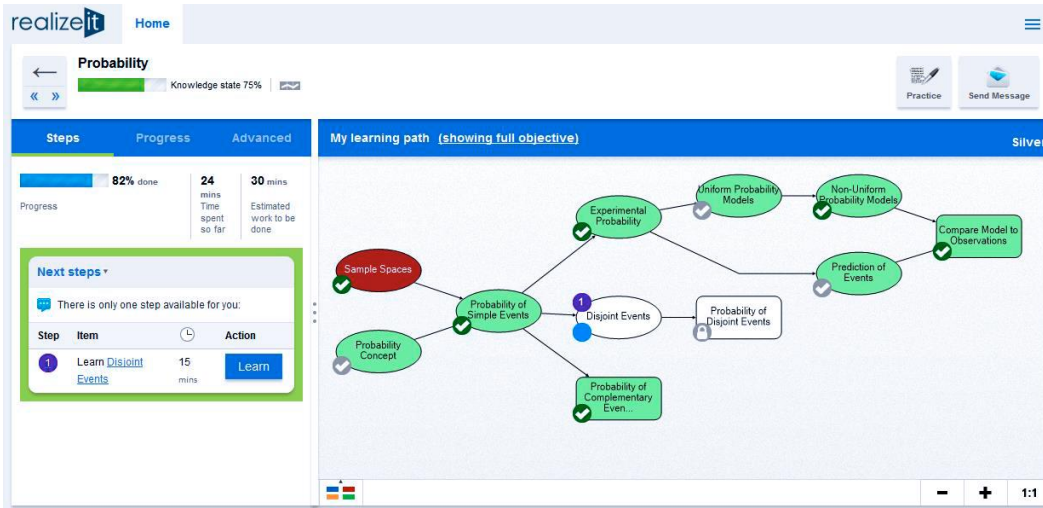
Figure 1. The student view of a Realizeit learning path

The nature of Realizeit adaptivity allows for questions with embedded variables. A question "format" can incorporate variables that then pull from a given range with each iteration, thereby allowing students to receive unique problems that are similar in content. This feature was utilized to develop pathophysiology case studies—applied examples that present patient data to allow students to utilize concepts learned within the course to make a diagnosis, as would be required in the real world. As the students progressed through the modules, Realizeit captured metrics related to both student interaction with the program and knowledge of content. Cases were designed to use students' knowledge of content to simulate the type of evaluation they might have to make when looking at various labs and diagnostic results routinely encountered during patient care. Students can repeat the case as many times as they choose and must use knowledge versus recognition to answer questions. Using case studies which can be repeated in a new way, students have an opportunity to increase their understanding of core clinical concepts.

For the purpose of the pilot project, case studies were not part of the graded assignments to allow for research examining how effectively students engaged in the system. In addition, faculty were, in essence, learning the capabilities of adaptive learning and this project allowed for confidence in the adaptive learning course itself.

METHOD

This pilot study investigated the feasibility and use of adaptive case studies in a nursing pathophysiology course developed within the Realizeit adaptive learning environment. This course was delivered during the spring, summer, and fall 2015

semesters over 5 distinct sections: two online, two in a blended format, and one face-to-face. These courses were part of a larger institution-wide pilot evaluation of adaptive learning at UCF.

Analytics data generated and captured by Realizeit provided measures of student engagement with the content in terms of the number of times that students attempted each case study as well as the time spent on each. The system also documented the number of unique instances of case study variables presented to each student. In other words, the analytics indicated if a given student who repeated a case study got a unique "case" each time or if he or she was presented the same case study variables in each instance. This is important because a benefit of using an adaptive learning system is the ability to provide unique practice opportunities each time a student attempts the case study.

Realizeit captured data also provided information as to how the students' interaction with the case studies impacted their performance in the modules, the change in scores for those repeating case studies, and the average performance by time spent in case studies. These internally captured metrics documented whether students engaged with the case studies and how much time they spent working on each case study.

SAMPLE

The study included students enrolled in undergraduate nursing pathophysiology in spring (n=95), summer (n=22) and fall (n=124) semesters during 2015. Pathophysiology was chosen because the content covered in this course has been taught using case studies in the past and this pilot was, in part, to examine how to increase the fidelity and variability of cases in this course.

As one of the class requirements, students engaged with content through the Realizeit adaptive learning platform, delivered seamlessly via the campus-wide Instructure Canvas learning management system (LMS), branded as Webcourses. Content, defined by the instructor, was organized in topic "nodes" with a number of nodes comprising an overall topic objective. Realizeit internal algorithms suggested pathways through the content based on the parameters established by the instructor and an assessment of student knowledge on topics. Three content areas were chosen for this pilot based on content that have been historically difficult for students to master in prior semesters. The case studies examined here were part of the content developed for the topics: Fluid, Electrolyte, and Acid-Base Balance Disturbances (Module 2), Pathophysiology of Cardiovascular Disorders (Module 6), and Pathophysiology of Endocrine Disorders (Module 8). The case studies were a separate ungraded node at the end of each of these modules that students could choose to complete or not. As students progressed through each node within objectives, Realizeit analytics were

captured and analyzed for this study, specifically examining the data in an effort to measure student engagement and performance within each case study.

RESULTS
UNIQUE CASE STUDIES

Data analytics collected through each semester verified that the system did, in fact, provide the majority of students with a unique instance each time they attempted a case study. Across the three case studies, all but one of the 1,544 simulations presented to students were unique, providing a benefit over what would typically be a limited number of distinct options when using instructional case studies without the adaptive learning system. Additionally, this provides reassurance that the case studies are ideally set up so that it is highly unlikely that two students see the same values. While this pilot did not specifically design cases to be worked through by students collaboratively, students could, in theory, collaborate on these case studies, discussing changes in values and how those would impact patient diagnoses.

STUDENT INTERACTION WITH CASE STUDIES

Students have the ability to repeat each case study for practice, which should ideally improve their ability to learn the concepts being taught. Table 1 illustrates the breakdown of how many students completed each case study. For the pilot study, the case studies were embedded within the content, but were not specifically part of the grading rubric. System analytics indicated that the majority of students completed each case study only once, although they could complete as often as they like for review. Table 1 illustrates the breakdown of students who completed the case studies over the course of the semesters. Very few students completed the case studies more than 5 instances and the number of students who complete the case studies drops off as the number of attempts increases.

Table 1. Percent of students attempting case studies multiple times (N=359).

Case Study	Number of attempts						
	0	1	2	3	4	5	6+
Module 2	14.8	34.5	21.2	11.4	6.1	4.2	7.8
Module 6	24.2	54.3	12.8	3.9	1.4	1.7	1.7
Module 8	21.7	59.9	11.1	3.6	1.7	0.6	1.4

Table 2 illustrates the mean and standard deviation that depicts students' interaction with the three case studies, including their scores on assessment questions within the case, average time spent (total time/attempts), and the total time they spent in each case study. There is wide variability in the way students interact with each case study.

Table 2. Means and standard deviations for score, average time, and total time for students on each case study

Case Study	Score (%)		Avg. Time (minutes)		Total Time (minutes)	
	Mean	SD	Mean	SD	Mean	SD
Module 2 (N=306)	40	22	6.29	5.96	12.95	12.39
Module 6 (N=272)	31	22	7.19	7.90	9.57	9.89
Module 8 (N=281)	35	22	5.66	5.44	7.17	6.98

The attempt variable, a measure of the number of attempts a student tries to do a case study, is triggered when a case study node is accessed. Although students may open this window to merely "view" the content and not interact with it in any meaningful way, this will still count as one attempt. This is evident based on the range of scores for one attempt showing that students answered fewer than 50% of the assessment questions correctly in these modules. Students that opened the case but did not answer any questions had all questions marked as incorrect, pulling the average scores for each case down.

Time spent in the case studies is another measure of how much students engaged with the content of each. This measure is also important in depicting how much effort students will need to expend to be able to complete the case study as part of a larger module of content. As illustrated in Table 2, the average time (in minutes) that students spent in each case study varied widely. All three modules had some students who spent only a fraction of time in the module – nearly zero—with minimums of .03-.08 minutes. These are expected to be students who may have opened the case study but did not engage with it. On the other extreme, maximum average times spent in each case study also varied from an average time spent of 37, 67, and 34 minutes for the module 2, 6, and 8 case studies, respectively.

The total time spent in each module showed similar variability (Table 2). Average total times ranged from 7.17 minutes for Module 8 to 12.95 minutes for Module 2 for students who opened a case at least once. However, the large standard deviations are indicative of the wide ranges of total time spent. Again,

the minimum values approached zero for the total time spent in each of the three case studies, indicating that some students did not engage with them at all, just merely opened the case itself. However, maximum total time values ranged from 59 minutes for Module 8 to 102 minutes for Module 2. It should be noted that time is a crude measure of engagement as the measure of how long a student visits a page is not necessarily an indication that they are either engaging with the content or learning during that time. But, the converse is also true, very low time spent on a page does reflect that students did not have the time to engage fully with the content. Certainly, finding the balance between creating a meaningful simulation that at the same time is not too taxing so as to inhibit learning is important.

DISCUSSION AND CONCLUSIONS

This pilot study provides preliminary evidence to support the use of adaptive case studies in nursing education. Students were delivered unique case studies with each attempt, encouraging deeper understanding of concepts by providing realistic simulations of what practicing nurses might encounter in the field.

The majority of students completed the case study at least once, although they were not part of the grade for this pilot study. Those students who did complete the case studies spent a reasonable amount of time on each. The analytics data gathered as a function of this pilot test--time on task, number of times cases accessed, and scores on each case--provided valuable information on student behavior and engagement with the three case studies. Data indicated that a large number of students did not attempt the case studies, perhaps because they knew they were not required as part of the course grade. Time spent on each case study similarly indicated that there were students who did not engage with these exercises. Based on the results of this pilot study, these case studies are now being included as part of the grade for each module. Realizeit analytics were able to definitively prove, however, that each student received a unique case study— pointing to the value of this method as opposed to the more common paper handouts long used in face-to-face sections.

Learning analytics data captured as students' progress through adaptive learning content can allow for a critical future examination of how these metrics correlate with student performance in each case study and in the overall objectives for the course. Future studies are warranted to examine the impact of students' engagement with these simulations on knowledge acquisition and other educational outcomes and to examine their use in other content areas.

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