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Interdisciplinary and Innovative: A Nursing and Computer Science Collaboration to Create a Barcode Medication Administration System

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Interdisciplinary and Innovative: A Nursing and Computer Science Collaboration to Create a Barcode Medication Administration System

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Abstract:

Preventing medication errors remains a priority in nursing education. The implementation of Barcode Medication Administration (BCMA) systems is one strategy that has been used to reduce medication errors. Nursing students benefit from practice using BCMA in simulated settings which may enhance the transfer of these skills to the clinical practice setting. While there are BCMA educational products available for nursing students, the purchase of these products is cost prohibitive for many nursing programs. In order to overcome the barrier of cost, an interdisciplinary and innovative collaborative approach was used to create a fully functional low-cost BCMA system.

Main Article:

According to the Institute of Medicine's (2000) report, *To Err is Human*, medication errors contribute to 7,000 deaths annually. One strategy that has been employed to reduce medication errors is the use of Barcode Medication Administration (BCMA) systems in the healthcare setting. Multiple studies have shown up to an 80% reduction in the number of medication errors when BCMA systems are used in clinical practice (Chan et al., 2019, Craig et al., 2021, Lin et al., 2018; Truitt et al., 2016; Leung et al., 2015). Teaching nursing students how to effectively use a BCMA system has become an essential component of clinical nursing education as nurses are expected to have the knowledge, skills and abilities related to medication administration as they enter clinical nursing practice. Many nursing programs and clinical agencies allow nursing students to use the BCMA systems in the clinical agencies as students learn how to administer medications during their clinical experiences. Clinical faculty often guide their students in the step by step use of the BCMA system which can be time consuming and may limit time that could be spent on developing clinical judgement related to medication

administration. Having a BCMA system in a simulation lab that is available to nursing students can provide opportunities for students to practice medication administration and improve medication administration efficiency.

There are currently several BCMA educational products available for purchase (Assessment Technologies Institute, 2021; Elsevier, 2021; & Lippincott, 2021). Many of them cost thousands of dollars annually and are cost prohibitive for many nursing programs. Additionally, the step by step process used in these BCMA educational products may not mimic the process that is used at the clinical settings where students practice. There are often limited options to tailor the BCMA educational products to the medication formularies and simulation scenarios that have been previously created by faculty. In order to overcome the barriers of cost and suitability of the current BCMA educational products, an interdisciplinary and innovative collaboration between the nursing and computer science departments at a private liberal arts college/university in the Midwest led to the development of a fully functional low-cost BCMA system.

The project was guided by one nursing department faculty and two computer science faculty who worked with two senior computer science students to develop a BCMA system that would be used in the nursing department simulation laboratory. The interdisciplinary nature of the collaboration provided opportunities for students and faculty from two departments, each with unique expertise, to work together to solve a complex problem. Each project team member brought their discipline specific domain knowledge to the project and collectively designed and built the system through frequent communication and an iterative process of review and revision until the software was fully functioning. According to Gibson, C., Stutchbury, T., Ikutegbe, V. and Michielin, N., (2019), having these collaborative experiences can help build leadership

capacity and develop interpersonal teamwork skills. These skills can translate well into professional settings and lead to successful future collaborations.

The software planning and development occurred remotely, due to the COVID-19 pandemic, over a time period of 10 weeks. Because the computer science students did not have any previous knowledge of BCMA systems that are used in healthcare, the nursing faculty met with the students weekly to describe the BCMA process and discuss various medication administration scenarios that would be required in the BCMA system. The students also met weekly with the computer science faculty to discuss the technical details, including the choice of programming language, development platforms, and database design.

The students developed the application using the Ruby on Rails web framework (Hansson, 2004). As is common in Rails-based applications, the BCMA software is structured using a traditional Model-View-Controller architecture, which divides the application into three interconnected systems: the model handles data storage and validation in the database (which stores user, medication administration record, and patient record data), the controller handles interactions via the user interface, and the views encompass the graphical interface. The system supports plug-in and/or Bluetooth barcode scanners that register as “keyboard” devices. Barcode value operate similar to standard web “login” procedures, granting access to a particular patient record.

The BCMA system was designed to have several features that mimic the process that is used with the BCMA system in the clinical setting where students complete their clinical experiences. The newly developed BCMA system allows students to enter medication orders that immediately populate the medication administration record, document medications, and edit documentation. Faculty can create patient records, document previous doses of medications, set

the time to match clinical scenario time, print patient armbands barcodes and print medication barcodes.

The system can be used with previously developed simulation scenarios as well as allow faculty to add newly developed simulation scenarios and new medications to the formulary database. In addition to the functional medication administration features, the system also has audible and visual error messages that appear when a patient armband is not scanned or if an incorrect medication is scanned.

Several medication administration scenarios were created to mimic common scenarios that would be encountered in the clinical setting. Scenarios included medications that require a dual sign-off, injections that require a location documentation, insulin sliding scale, insulin carbohydrate coverage, continuous infusions, titrated infusions, partial package doses, patient-controlled analgesia, as needed medications, transdermal patch removal, and medications that require lab value input prior to administration of the medication.

Costs that were incurred during the development and implementation of the BCMA were the purchase of 11 barcode scanners for $960, modest stipends for the summer work of the faculty moderators, and student employment salaries for the two computer science students. These costs were funded by a faculty development grant from the college/university.

This collaborative produced several benefits to the nursing students and benefits to the computer science students. Clinical faculty anecdotally report nursing students demonstrate an improved transition to the clinical setting and increased confidence with the barcode medication administration workflow. During clinical experiences, students now spend time developing the clinical judgment elements of medication administration and faculty can help stimulate critical thinking during medication administration without using time to teach the process of the barcode

medication administration workflow. Further research is needed to examine the effectiveness of using a BCMA system and impact on student learning in an undergraduate program and how this affects the medication administration process in the clinical setting.

The Computer Science students had an amazing opportunity to utilize their education beyond academia to work with a real customer on a real-world project with real impact. Computer Science students led the development from all angles using the Scrum framework (an agile software development technique that the students newly learned for this project) to deal with resource limitations, such as time, and handle ambiguities and changes in project requirements which inevitably arise when working on a real-world project (Schwaber, 1997). This provided them a rare opportunity to experience what it feels like to have a career as a software engineer in industry, and an opportunity to learn many of the techniques, frameworks, and tools used by today's software developers.

By developing a BCMA system through this interdisciplinary collaboration, undergraduate nursing students now have the required hands on experience using this technology to safely and effectively administer medications to simulated patients in the nursing simulation lab. These simulated experiences may translate into the knowledge, skills and abilities that students need when giving medications to patients in the live clinical setting and help continue to reduce medication errors in the future.

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