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FACULTY RESEARCH AND DEVELOPMENT CONFERENCE

VOLUME VIII

Eighth Annual Faculty Research Conference

Enhancing Institutional Excellence: A Role for Student and Faculty Research

November 19, 2021 :: Baltimore, MD

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Keynote Speaker

Dr. Margaret Stevens, Associate Professor of History, Essex County College

Margaret Stevens earned her PhD in American Studies from Brown University. She is an Associate Professor of History at Essex County College in Newark, NJ, where she proudly serves her hometown community of local and international students. Essex County College is categorized as a PBI (Predominantly Black Institution) and HSI (Hispanic Serving Institution). Since history is a praxis for Dr. Stevens, she and her students and fellow colleagues have not only researched the past but have helped to shape the present; for example, such initiatives as a 2018 trip to Puerto Rico in response to Hurricane Maria, in what was referred to as the "Puerto Rico Brigade," where Dr. Rivera also volunteered and participated, turns real life experiences into community activism and research. Her first book, *Red International Black Caribbean* (Pluto Press), centered on

newspaper-based archives of twentieth-century revolutionary history. Her second book, an authorized biography of former Newark Mayor Kenneth Gibson (now deceased), which includes extensive oral interviews with both Gibson and those who participated in his administration, as well as Newark residents of that era is about to be submitted as a full manuscript. Moreover, she is currently creating a documentary about the impact of Covid-19 on tourism-based economies, namely Aruba. The primary goal in all this research is to shed light on the struggles and triumphs of everyday working people as we strive to overcome the national and racial divisions that keep us all held back by capitalist oppression. Revolutionary optimism is what keeps her motivated--and not to mention, of course, her two-year-old son Jahsiri!

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Mentoring as a Way of Advancing Tenure and Promotion in Higher Institutions in the United States: A Systematic Review

Patience Ebuwei, DBA, MPH, RHIA

Pebuwei@Coppin.edu

Abstract

Tenure positions in the United States have been under increasing attack in higher education. The theoretical lens, Social Cognitive Theory by Albert Bandura, provided evidence that individual knowledge and skill can develop by observing others. The present study uses a realist synthesis and a thematic analysis to weigh how faculty mentoring does provide a practical feedback loop during the probational period. This study contributes to faculty mentoring in higher education in the United States. The study findings showed that junior faculty mentoring in academia creates institutional knowledge about the tenure process.

***Keywords*:** Tenure, faculty mentoring, career advancement, higher education

Introduction

The American Association of University Professors' report points out that tenure is a means to certain ends. Because (1) it leads to freedom of teaching and research and (2) offers economic security that makes the profession attractive to both men and women, and (3) a tenured position is vital to the success of a higher institution in fulfilling its responsibilities to its students and society (AAUP, n.d.-b).

Hill (2010) asserts that tenure positions have been under attack in higher education in the United States. Many may refute the presence of an all-out attack and may disagree with the trend of weakening of tenure positions (p. 111). However, this claim is not hyperbole. The American Association of University Professors states that the "tenure system in higher education has eroded, shrunk and that the majority of faculty are either adjunct, contingent faculty who are educators without the security of a tenure position" (AAUP, n.d.-b).

Mentroing Overview

Mentoring is the missing link for tenure-track faculty in attaining tenure positions. First, without a mentor to guide faulty seeking a tenure position in higher education in the United States, the tenure track faculty stay isolated in the tenure process. Second, it increases the body of knowledge in the tenure process. Third, faculty seeking tenure positions need wise counsel to guide them through the tenure process in the United States. Finally, mentoring helps a tenure track faculty prioritize activities required for the tenure evaluation.

Significance of the study

This study's findings will benefit the higher education tenure process and practices in the United States, as mentoring of faculty thus plays a pivotal role in faculty career advancement. However, the knowledge gap may be that mentoring as a mechanism, and feedback loop in higher institutions is not part of the culture seen as crucial in the academic structure and system component. Therefore, the research question for the current study is: How can faculty mentoring be used to create a practical feedback loop during the pre-tenure evaluation process in attaining tenure and promotion in higher education institutions in the United States? The researcher develops four propositions to guide the research question.

Table 1 below is the study proposition.

Study Propositions

Propositions	
Proposition: 1	Mentoring a tenure-track faculty helps the faculty develop knowledge and skill on the tenure process.
Proposition: 2	Faculty mentors assist tenure-track faculty in understanding the tenure requirements for publications services to the university, department, and community.
Proposition: 3	Mentoring allows a tenure-track faculty to develop self-efficacy and confidence in the tenure and process.

Proposition: 4	Mentors provide feedback that helps faculty to understand the tenure requirements and resources needed to become tenured.

Note. This table demonstrates the study propositions in answering the research question.

Theoretical Framework

Bandura (2005) reported that "social reality comes from what we learn, and it is the power of social modeling" (p. 10)—using this theory as a lens assists in understanding the tenure problem in higher institutions in the United States (Grant & Osanloo, 2014, p. 17). The social cognitive theory assumes an agentic viewpoint to self-regulation, self-development, self-efficacy, adaptation, and change (Bandura, 2005, p. 10).

Method

The methodology of the study is a systematic review. The study articles originated from (1) ERIC, (2), Educational research complete, (3) ProQuest, (4) Academic Search Ultimate, and (4) professional development collections. The search strategy was abstracted from the research question as stated above. The Boolean/phrase "AND" was used to search for tenure, College, and mentor. While Boolean/phrase "OR" was used to search for universities, including faculty. These phrases allow the reviewer to cast their net very wide and identify relevant studies (Gough, Oliver, & Thomas, 2107, p. 109).

The current research deployed both aggregate synthesis and thematic analysis. Dixon et al. (2005) argue that thematic analysis allows clear documentation of essential themes because the thematic analysis is flexible and allows the researcher freedom to integrate a qualitative, quantitative study popularly known as triangulations (p. 45). TAPUPAS aids to ensure openness and transparency in making a judgment in the appraisal process. Table 2 is the TAPUPAS score.

TAPUPAS Acronomy and Meaning

TAPUPAS		Score
Transparency	Open to outside scrutiny on how knowledge was generated	3

Accuracy	All knowledge must be supported by claim and meet the standard	3
Purposivity	The method fits the purpose of the research	3
Utility	Appropriate for the intended settings and fit for the use of the research	3
Propriety	All relevant stakeholders must create and manage knowledge legally, properly, and promptly.	3
Accessibility	Knowledge was presented that met the need of the researcher	3
Specificity	Meet the research standard	3

Note. Scoring represents 3 = highest quality, 2 = very good, 1 = missing in more than one criterion

Code Weave

Johnny Saldana~ asserts that qualitative data analysis must critically interpret how each study weaves together by integrating words from the coding into an analytic memo narrative. (2016, p. 48). Based on Saldana~ proposition, the study code and themes from **figure 1** were woven together and formed the analysis and findings.

Figure 1. Depicts codes, categories, and themes used in the synthesis

Synthesis and findings

The synthesis of findings followed an iterative process in analyzing the systematic review discussing how mentoring at a four-year university in the US can advance a tenure track faculty in attaining tenure. After the coding process, five themes did emerge, and this includes (1) career advancement, (2) tenure denial, (3) feedback loop, and (4), Building university capabilities.

Career advancement

Dhed and Mollica's (2007) study on mentoring new faculty affirmed the unwritten closed-door policy in higher Ed. So, therefore, mentoring can assist with questions, concerns, and support in the tenure process as tenure track faculty needs someone to show the exact process required for career advancement (p. 1824). Similarly, Filetti's (2009) research revealed that mentors thus serve as resources, coaches, and sponsors in academia. The study also explains that having a mentor increases scholarly productivity, promotes information sharing, and increases tenure attainment (p. 347). Furthermore, Mazerolle et al. (2018) found that mentoring is grounded in knowledge transfer (p. 260). Finally, This is relevant to the academic world as tenure-track faculty had to play a chess game wandering the precise requirement in the tenure process; through mentorship, tenure-track faculty can touch the future.

Tenure Denial

The study revealed that many institutions in the US use different criteria to evaluate faculty for tenure (p.7); this difference in faculty evaluation leads to faculty confusion. The absence of a mentor often makes matters worse for the faculty preparing for tenure. The lack of clarity in tenure criteria may have impacted faculty's tenure appraisal, including the lack of mentoring and the use of unstructured programs that may have negatively influenced faculty success, leading to tenure denial. (Waller and Shofoluwe 2013, Pfeiffenberger et al. 2014; McRae and Zimmerman 2019).

Feedback loop

Knowing the rules is knowing the tenure process, and through a feedback mechanism, tenure track faculty can understand the complex tenure requirements. Waller and Shofoluwe (2013) research confirmed that academic inadequacy habitually complicates the ability of a junior faculty in the effort of attaining tenure. Therefore, junior faculty needs a mentor who can help them balance their time with research, community services, teaching effectiveness, and manage their teaching responsibilities. (Mullen and Forbes 2003, Zilberstein-Levey 2006,Waller and Shofoluwe 2003). A feedback loop in higher education in the tenure process will empower tenure-track faculty to develop self-efficacy in the tenure and process.

Building Universities Capabilities

Capacity-building is essential in the process of developing and strengthening skills, abilities, techniques, and resources that organizations and communities need to adapt to in a fast-

changing world. (ramsthaler@un.org, 2014). With this type of structure, a tenure-track faculty can survive and familiarize themselves with the tenure practices in Higher Ed by developing self-confidence in the tenure process (Broughton et al. 2019, Fuller et al. 2008). In addition, tenure track faculty need a mentor to survive the convoluted parameters set by higher ed institutions in the United States.

Conclusion

In conclusion, there is an evident gap in knowledge concerning how higher ed's environmental factors, faculty knowledge, and organizational behavior affect tenure decisions. According to the USM bylaws, policies, and procedures of the Board of Regents, the relative weight of the tenure criteria is at the discretion of the institution" (*II-1.00 -Policy on appointment, rank, and tenure of faculty (Approved by the Board of Regents*, n.d.).

In addition, Arreola (2007) emphasized that the lack of psychometric expertise or rigor used in developing the tenure and promotion evaluation is dubious and lacks the assessment's validity or reliability. Yet, higher ed in the United States uses these metrics to make a lifetime decision in the tenure process. From these findings, it is clear that faculty on tenure-track needs a life guide to rescue them from drowning. These faculty are floating on a boat, waiting to plunge, drown or swim.

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Quantum simulation of ϕ^4 theories in qudit systems

Doga Murat Kurkcuoglu,[1] M. Sohaib Alam,[2,3,4] Joshua Adam Job,[5] Andy C. Y. Li,[1] Alexandru Macridin,[1] Gabriel N. Perdue,[1] and Stephen Providence[6]

[1] *Fermi National Accelerator Laboratory, Batavia, IL, 60510, USA*

[2] *Rigetti Computing, Berkeley, CA, 94701, USA*

[3] *Quantum Artificial Intelligence Laboratory (QuAIL), NASA Ames Research Center, Moffett Field, CA, 94035, USA*

[4] *USRA Research Institute for Advanced Computer Science (RIACS), Mountain View, CA, 94043, USA*

[5] *Lockheed Martin Advanced Technology Center, Sunnyvale, CA, 94089*

[6] *Coppin State University, Baltimore, MD, 21216, USA*

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We discuss the implementation of quantum algorithms for lattice Φ^4 theory on a circuit quantum electrodynamics (cQED) system. The field is represented on qudits using a discretized field amplitude basis. The main advantage of a qudit system is that its multi-level characteristics allows the field interaction to be implemented with only diagonal single-qudit gates. Considering the set of universal gates formed by the single-qudit phase gate and the displacement gate, we address initial state preparation and single-qudit gate synthesis with variational methods.

Introduction

Bosonic fields are ubiquitous in physics, from particle physics models such as the Higgs-Englert boson model[1] and Skyrme model [2] to effective field models that describe collective excitations in condensed matter physics such as phonons, magnons, plasmons, etc. The simulation of real time evolution of quantum fields is difficult to address analytically or with classical simulations. The perturbative expansion of the Φ^4 term in propagators yields coupled two-point propagators which are difficult to keep track of for higher order terms in the series. Classical simulations of scalar fields are limited to small systems since the memory requirement increases exponentially with system size. This computational difficulty has inspired proposals to study field theory simulations on qubit-based quantum computers [3–8]. Another path forward for studying the dynamics of field theories is to utilize cold atoms in optical lattices and simulate the field in an actual quantum environment [9]. Relatively little work has been done on qudit (N-level) systems, although recently qudit simulations of a 1+1 QED model was discussed in [10]. Here we propose to use high-dimensional qudits ($d \geq 10$) for the simulation of scalar field dynamics.

The purpose of this work is to set out the necessary ingredients for real time simulation of scalar fields on qudit based platforms, including initial state preparation and gate synthesis for the Trotter steps. Recent advances in cQED systems make the platform an attractive candidate for field theory simulations [11]. In cQED systems, photon levels can be encoded and manipulated for qudit based quantum computation. The number of levels in a qudit are not restricted to two as is the case with qubit based platforms; thus the algorithms, gates, and state preparation for qudits require a separate discussion from their qubit counterparts. An advantage of high-dimensional qudit quantum simulations is that the field at every lattice site can be encoded in only a single qudit, unlike the qubit simulations where the local field is represented on many qubits. Single-qudit encoding of local fields also implies single-qudit gates for the implementation of local interactions. The interaction implementation in our model takes advantage of one of the most attractive experimental capability of cQED systems, namely the ability to easy manipulate the phase of each photon number state [12]. This experimental technique makes the field theory simulation rather straightforward in qudit based quantum computation. We discuss a field theory simulation algorithm with Φ^4 type interaction term in qudit based platforms and we demonstrate a short-time evolution example, simulated on a classical computer.

The paper is organized as follows: First we define the theory and Hamiltonian. We discuss the discretization of the field and expansion in harmonic oscillator basis. We then present two sections — one focused on a single-qudit computer, and one on a mult-qudit system. In the single qudit section, we discuss state preparation and gate preparation with variational algorithms, and how to find the ground state of a field with nonlinearities present. In multiple the qudit section, we discuss how a field might be modeled in entangled cavities. In a final section we show the simulation algorithm for the full Hamiltonian.

Definition of the theory

We consider the Φ^4 scalar field theory, defined by the Lagrangian [13]:

$$\mathcal{L} = \frac{1}{2}\left(\partial_0\hat{\Phi}\right)^2 - \frac{1}{2}\left(\nabla\hat{\Phi}\right)^2 - \frac{1}{2}m_0^2\hat{\Phi}^2 - \frac{\lambda}{4!}\hat{\Phi}^4, \tag{1}$$

where $\hat{\Phi} \equiv \hat{\Phi}(\mathbf{r}, t)$ is shorthand notation for a scalar field with eigenvalue Φ, $\hat{\Phi}(\mathbf{r}, t)|\Phi\rangle = \Phi(\mathbf{r}, t)|\Phi\rangle$ that is dependent on the position vector $\mathbf{r} = (r_1, r_2, r_3)$ and time t, $\partial_0 \equiv \partial/\partial t$ is the time derivative, $\hbar = 1$, and we use the $(+,-,-,-)$ sign convention for the Minkowski metric. In this work, we show time simulation for a 1+1 dimensional field theory, i.e. one spatial and one time degree of freedom. However, extension into higher dimensions is straightforward. The time simulation of a field will be realized with consecutive application of selected qudit gates such that the amplitudes of the Fock states in a qudit are manipulated.

The corresponding Hamiltonian density is obtained via a Legendre transformation of the Lagrangian,

$$\mathcal{H} = \left(\partial_0\hat{\Phi}\right)\hat{\pi} - \mathcal{L}, \tag{2}$$

where $\hat{\pi} = \partial_0\hat{\Phi}$ is the canonical momentum that satisfies the commutation relation $\left[\hat{\Phi}(\mathbf{r}, t), \hat{\pi}(\mathbf{r}', t')\right] = i\delta(\mathbf{r}-\mathbf{r}')\delta(t-t')$. The Hamiltonian density for the Φ^4 theory is

$$\mathcal{H} = \frac{1}{2}\hat{\pi}^2 + \frac{1}{2}\left(\nabla\hat{\Phi}\right)^2 + \frac{1}{2}m_0^2\hat{\Phi}^2 + \frac{\lambda}{4!}\hat{\Phi}^4. \tag{3}$$

In order to do numerical simulations the continuous field is discretized on a lattice, $\Phi \to \Phi_j(t)$ where j is a lattice site index. The lattice Hamiltonian reads

$$\mathcal{H}_d = a^d \sum_j \left[\frac{1}{2}\hat{\pi}_j^2 + \frac{1}{2}m_0^2\hat{\Phi}_j^2 + \frac{\lambda}{4!}\hat{\Phi}_j^4 + \frac{1}{2a^2}\sum_{e\neq j}^{d}\left(\hat{\Phi}_{j+e} - \hat{\Phi}_j\right)^2\right], \tag{4}$$

where d is the spatial dimension (here $d = 1$), a is the lattice constant and e is the index for the nearest-neighbor site. The commutation relation for the discretized field is $[\hat{\Phi}_j, \hat{\pi}_k] = ia^{-d}\delta_{j,k}$, where $\delta_{i,j}$ is the Kronecker delta. For clarity we scale the fields such that $\hat{\phi}_j = a^{\frac{d-1}{2}}\hat{\Phi}_j$, $\hat{\Pi}_j = a^{\frac{d+1}{2}}\hat{\pi}_j$, the bare mass $\mu^2 = m_0^2a^2$, and the dimensionless bare coupling constant $g = \lambda a^{3-d}$. The renormalized Hamiltonian is then:

$$\bar{\mathcal{H}} = \sum_j \left[\frac{\hat{\Pi}_j^2}{2} + \frac{1}{2}\left(\mu^2 + 2d\right)\hat{\phi}_j^2 - \sum_{e=1}^{d}\hat{\phi}_j\hat{\phi}_{j+e} + \frac{g}{4!}\hat{\phi}_j^4\right], \tag{5}$$

where $\bar{\mathcal{H}} = a\mathcal{H}_d$.

cQED systems are QED systems with an artificial atom (transmon) which is coupled to one [11] or multiple cavity modes [**?**]. In cQED systems, the EM fields inside a cavity can be manipulated via the transmon or by directly applying a control signal to the EM field. The resonator in which the TEM fields oscillate may be two-dimensional or three-dimensional. 3D cQED systems are well-suited to time-simulate a field ϕ due to their versatility, the ability to manipulate cavity modes, and long coherence times [14].

A qudit may support more than two levels, unlike a (logical) qubit. The Fock states in a cavity may be used to represent the fields. Thus, we will refer to the Fock states in a cavity as a qudit. These states allow us to represent one discretized ϕ field using a single qudit.

The manipulation of the amplitudes of the Fock states in a cavity can be made via selective phase gates. This requires the phase gates to be proportional to the photon number of the cavity (n). The phase that each state gains can be engineered to be linearly proportional to the photon number n, or the photon number to any arbitrary power k of the photon number n^k. This may be engineered by driving the transmon with a signal frequency that is dependent

on the photon number [12]. The qudit phase gate is known as the selective number of arbitrary photon (SNAP) gate. This offers a new and convenient platform for the simulation of field theories in cavity systems.

The Hamiltonian (5) describes a set of coupled self-interacting harmonic oscillators. The Hilbert space of the system

$$\mathcal{H} = \prod_{j=0}^{L-1} \otimes \mathcal{H}_j \tag{6}$$

is a product of local Hilbert spaces $\mathcal{H}_j$ where j is the lattice site label. A possible basis choice for the local Hilbert space is the field boson occupation number (to be distinguished from the cavity Fock states!),

$$|b_n\rangle_j = \frac{1}{\sqrt{n!}} \left(b_j^\dagger\right)^n |0\rangle_j \tag{7}$$

where the field boson creation operator is $b_j^\dagger = \left(\sqrt{m}\hat{\phi}_j - i\hat{\Pi}_j/\sqrt{m}\right)/\sqrt{2}$. For numerical simulations the local Hilbert space is truncated by introducing a boson occupation cutoff N_b. The cutoff N_b should be taken large enough such that the weight of the configurations with more then N_b field bosons per site is negligible. The boson mass m is a parameter which, in order to optimize the simulation computational resources, should be chosen to minimize the cutoff N_b. In our simulations we take it ?? The truncated local Hilbert space spanned by $\{|b_n\rangle_j\}_{n=\overline{0,N_b-1}}$ can be represented in a field amplitude discretized basis $\{|\varphi_\alpha\rangle_j\}_{\alpha=\overline{0,N-1}}$. The dimension N of the field amplitude basis is larger than N_b. The representation accuracy increases exponentially with increasing N. For example, a choice $N = 2N_b$ ensures a 10^{-4} accuracy. We map the discretized field amplitude vectors on qudit states. The local field operator act on these states as

$$\hat{\phi}_j|\varphi_\alpha\rangle_j = \left(\alpha - \frac{N-1}{2}\right)\Delta_\varphi|\varphi_\alpha\rangle_j \quad \text{with} \quad \alpha = \overline{0, N-1} \tag{8}$$

where the discretization field amplitude interval is $\Delta_\varphi = \sqrt{\frac{2\pi}{Nm}}$. The local conjugate field operator can be written as

$$\hat{\Pi}_j = m\mathcal{F}_N\hat{\phi}_j\mathcal{F}_N^{-1}, \tag{9}$$

where $\mathcal{F}_N$ is the single-qudit $N \times N$ discretized Fourier transform.

To study the time-propagation of the field, we Trotterize the Hamiltonian into infinitesimal time-steps δt,

$$e^{-i\bar{\mathcal{H}}T} = \left(e^{-i\bar{\mathcal{H}}\delta t}\right)^K. \tag{10}$$

The gates required for implementing the Trotter steps are,

$$e^{-i\xi n^4}, e^{-i\xi n^2}, e^{-i\xi nm}, \mathcal{F}_N, \tag{11}$$

where ξ is an arbitrary angle, n is the photon number in one Fock state and $\mathcal{F}_N$ is the $N \times N$ Fourier transform operator. The third gate is the coupling term where the photon numbers n and m of two cavities are coupled. We discuss the multiple qudit case below.

Any arbitrary $N \times N$ unitary gate U may be decomposed into SNAP and displacement gates with an appropriate choice of parameters [15]. These parameters may be found using variational methods. Mathematically, the matrix decomposition argument may be straightforwardly applied to multiple cavities which are coupled to each other. However, a variational search for the parameters for SNAP and displacement gates for large N values is computationally non-trivial. Further, creating conditional SNAP gates for multiple cavity platforms will require a more sophisticated computational and experimental approach. Thus in this work, the variational approach to engineer qudit gates will be restricted to the single qudit case. The parameters that are used to construct single qudit gates are assumed to be useful in the multiqudit gates which are tensor product of these single qudit ones. In the next section, we will discuss the state preparation and gate engineering for single qudit problems.

Single qudit

In this section, we discuss state preparation and gate creation for a simulation based on a single qudit. The simulation of field theories in qubit systems has been extensively studied over the last two decades [3, 4, 9, 16, 17]. In

these simulations, the fields are first encoded in binary form in entangled qubits. In order to time-simulate a single field in qubit systems, many one-qubit and two-qubit gates must be consecutively applied to the entangled state. With qudit SNAP gates, simulating a field can be realized with a single gate.

The Fock state in a single cavity represents a qudit. In order to simulate the time-evolution of the field via Trotterization, a single field ϕ_j is discretized in the qudit basis. The application of each term in the Hamiltonian in Eq. (5) to the single qudit means first applying a quartic term ϕ_j^4, then a quadratic term ϕ_j^2, a discrete Fourier transform $\mathcal{F}_N$, another quadratic evolution, and finally a discrete Fourier transform.

Let us begin by considering the simplest case, where we want to Trotter-simulate only a single ϕ_j field. The operator that we need to apply to the qudit state is $e^{-i\beta\phi_j\Delta t}$, with β is an unimportant constant to keep the units consistent. Operation on a qudit state requires a gate like $e^{-i\beta(n-N/2)\Delta\delta t}$. This is equivalent to a SNAP gate with $e^{-i(\beta\Delta\delta t)n} \equiv e^{-i\xi n}$ and a global phase of $e^{i\beta N/2\Delta\delta t}$ on a single qudit. Since we work with N Fock states, the SNAP and displacement gates must be truncated to N states. This could create a problem for the displacement gate, where the Fock states beyond N levels are coupled to the first N levels. It was shown that if the mean occupation number in a Fock state . We define the truncated displacement and SNAP gates for a single qudit as follows

$$D(\alpha) = e^{a\alpha - a^\dagger\alpha^*} \tag{12}$$

$$S_N^{(k)}(\vec{\theta}) = \sum_{n=0}^{N-1} |n\rangle\langle n| e^{i\theta_n n^k}, \tag{13}$$

where θ_n is an element of the vector $\vec{\theta}$. The truncated annihilation operator a does not satisfy the usual commutation relation but rather $\left[a, a^\dagger\right] = 1 - N|N-1\rangle\langle N-1|$. The simulation of time evolution for higher order fields such as ϕ_j^2, ϕ_j^4 etc. is going to be similar to that of a linear field. Consider the evolution of the quadratic term, $(1/2)(\mu^2 + 2d)\phi_j^2$ — this requires a Trotter operator:

$$\begin{aligned} V_{\phi^2} \equiv e^{-i\frac{1}{2}\left(\mu^2+2d\right)\phi_j^2\delta t} &= \prod_{n=0}^{N-1} |n\rangle\langle n| e^{-i\Omega_n(n-N/2)^2} \\ &= S_N^{(2)}(-\vec{\Omega}) S_N^{(1)}(N\vec{\Omega}) S_N^{(0)}(-(N^2/4)\vec{\Omega}), \end{aligned} \tag{14}$$

where $\vec{\Omega} \equiv \{\Omega_n\}$ is a N-vector whose elements are equal to $\Omega_n = (1/2)(\mu^2 + 2d)\Delta^2\delta t$ and μ^2 is the mass term. When μ is taken to be an imaginary number, the symmetry breaking phase $\phi \to -\phi$ can be studied by simply changing the overall sign of the phases of the SNAP gates.

Single-qudit gates may be engineered by means of variational parameters or finding an optimal signal. We construct the required gates and perform state preparation using $S_N^{(k)}(\vec{\theta})$ and $D(\alpha)$ gates by variationally finding the θ_n and α parameters by minimizing a cost function. The variational construction of gates involves blocks of single-qudit SNAP and displacement gates [15] $B(\vec{\theta}, \alpha) = D(\alpha)^\dagger S_N^{(k)}(\vec{\theta}) D(\alpha)$ that are combined to construct a unitary gate, $U(\vec{\alpha}, \vec{\Theta}) = \Pi_{i=1}^k B(\vec{\theta}_k, \alpha_k)$. Variational optimizaiton is not required for the phase gates, but is employed for gates such as the Fourier transform. One difficulty in this construction is that for a fixed single qudit state number N, the displacement gate excites states beyond N. To manage excitations in the higher and the lower Fock states, we add small number of additional m levels of qudit states at higher Fock states. The first m Fock states and the last m Fock states are going to be called the bumper states. The N Fock states in between these bumper states will represent the ϕ_j field and they will be called 'logical states'. This means taking the direct sum of logical states $|\psi_l\rangle$ and bumper states $|\psi_b\rangle$, $|\psi\rangle = |\psi_b\rangle \oplus |\psi_l\rangle \oplus |\psi_b\rangle$. In our algorithm, we first prepare the single-qudit state in the cavity ground state, $|\psi\rangle_{t=0} = |0\rangle$, where $|\psi\rangle_{t=0}$ is the initial state. Then, we variationally find the parameters of SNAP and displacement gates to have the $c_n(t)$ amplitudes represent a target state in a qudit

$$|\psi\rangle = \sum_{n=0}^{N+2m-1} c_n(t)|n\rangle. \tag{15}$$

The cost function that we use for state preparation is

$$\begin{aligned} \mathcal{L}_{\text{state}} = \left|\langle\psi|U(\vec{\alpha},\vec{\Theta})|0\rangle - 1\right|^2 + \\ \left|\mathcal{P}_m^t U(\vec{\alpha},\vec{\Theta})|0\rangle\right|^2 + \left|\mathcal{P}_m^b U(\vec{\alpha},\vec{\Theta})|0\rangle\right|^2, \end{aligned} \tag{16}$$

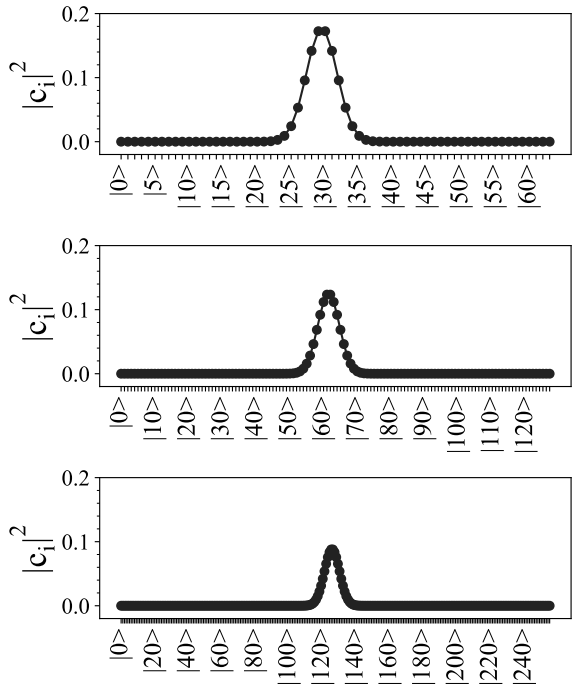

FIG. 1. (Color online) An example of discretized Gaussian states in a single qudit. In this example, $N = 12$ (green), $N = 24$ (orange), $N = 32$ (blue) and the bumper states are $m = 4$. Horizontal axis is the Fock states. Vertical axis is the absolute value squared of the amplitude of the field.

where $|0\rangle$ is the ground state of the cavity and $|\phi\rangle$ is the target state and the parameters that minimizes the cost function are $\vec{\alpha} = (\alpha_1, \alpha_2, ..., \alpha_k)$ and $\Theta = (\vec{\theta}_1, \vec{\theta}_2, ..., \vec{\theta}_k)$. The two terms are to make sure that the contribution of the bumper states are minimal. The projection matrices $\mathcal{P}_m$ for bumper states are

$$\mathcal{P}_m^t = \left(\begin{array}{c|c|c} \mathbf{1}_m & 0 & 0 \\ \hline 0 & \mathbf{0}_N & 0 \\ \hline 0 & 0 & \mathbf{0}_m \end{array}\right), \mathcal{P}_m^b = \left(\begin{array}{c|c|c} \mathbf{0}_m & 0 & 0 \\ \hline 0 & \mathbf{0}_N & 0 \\ \hline 0 & 0 & \mathbf{1}_m \end{array}\right), \tag{17}$$

where $\mathbf{1}_m$ is $m \times m$ identity matrix and $\mathbf{0}_N$ is the $N \times N$ zero matrix.

With the introduction of bumper states, the target unitary matrix U_{target} becomes a block matrix that contains the target $N \times N$ unitary matrix operation V_{target} and the block identity matrix

$$U_{\text{target}} = \left(\begin{array}{c|c|c} \mathbf{1}_m & 0 & 0 \\ \hline 0 & V_{\text{target}} & 0 \\ \hline 0 & 0 & \mathbf{1}_m \end{array}\right). \tag{18}$$

Thus unitary operation on a state $|\psi\rangle$ in $N + 2m$ Fock states is defined as $|\phi\rangle = U_{\text{target}}|\psi\rangle$, where $|\psi\rangle$ is the initial state, $|\phi\rangle$ is the target state. We used a gradient based algorithm to find the variational parameters where the details are presented elsewhere. Example states that represent a harmonic oscillator ground state wavefunction with $N = 12, 24, 32$ logical state and $m = 4$ bumper states are shown in Fig. 1.

The cost function we will use to prepare a single-qudit target gate is

$$\mathcal{L}_g = \left| \left(\frac{1}{N + 2m} \right) \text{Tr} \left(U_{\text{target}}^\dagger U(\vec{\alpha}, \vec{\Theta}) \right) - 1 \right|^2. \tag{19}$$

After we prepare the harmonic oscillator ground state, we Trotter-simulate the field to find the ground state when the nonlinearity g is present. If the total simulation time to find the ground state is $T = K\delta t$, the coupling constant g is increased adiabatically from 0 over the time period T. To find the ground state of a single qudit, we first apply the ϕ^4 term with SNAP gates. The unitary operator V for the Trotter step is

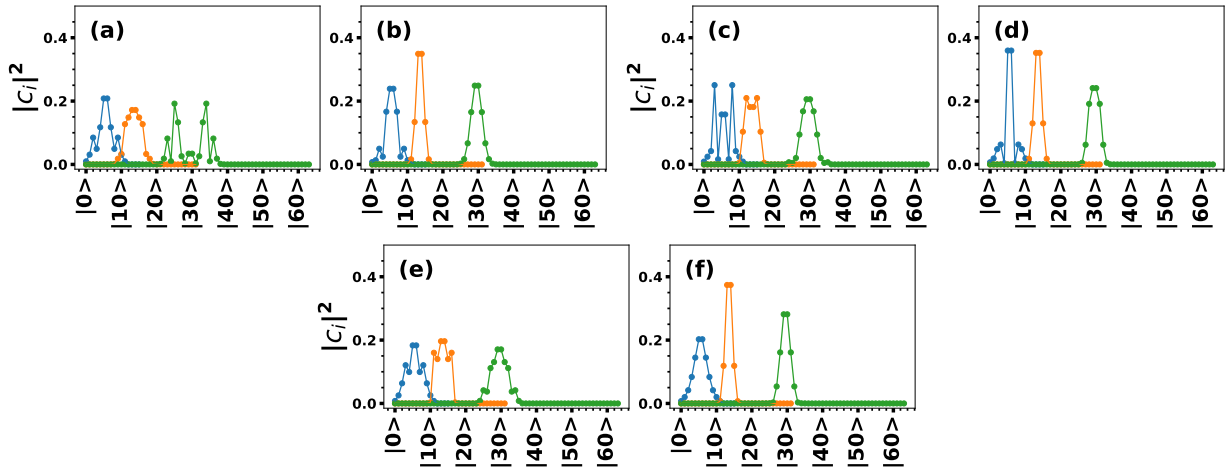

FIG. 2. The ground state of a field for a single qudit with different discretizations ($N = 12$ (top), $N = 16$ (middle), $N = 28$ (bottom)) with $m = 4$ bumper states are used. The dimensionless coupling constants are $g = 0.5$ (blue), $g = 1.5$ (orange), $g = 2.5$ (green), $g = 3.5$ (red). Left hand panel (a, c, e) are for imaginary mass, right hand panel (b, d, f) are for real mass.

$$V_{\phi^4}^{(s)} = e^{-i\frac{g_s}{4!}\phi_j^4\delta t} = \prod_{n=0}^{N-1} |n\rangle\langle n| e^{-i\lambda_{n,s}(n-N/2)^4}$$
$$= S_N^{(4)}(-\vec{\Lambda}_s) S_N^{(3)}\left(\frac{N}{2}\binom{4}{3}\vec{\Lambda}_s\right) S_N^{(2)}\left(\frac{N^2}{4}\binom{4}{2}\vec{\Lambda}_s\right) S_N^{(1)}\left(\frac{N^3}{8}\binom{4}{1}\vec{\Lambda}_s\right) S_N^{(0)}\left(\frac{N^4}{16}\vec{\Lambda}_s\right), \tag{20}$$

where $\Lambda_s = \{\lambda_{n,s}\}$, $\lambda_{n,s} = (g_s\Delta^4\delta t)/(4!)$, and $g_s = g(s/K)$, is the adiabatic coupling constant at time $s\delta t$ with an $s \in [0, K]$ integer. We then apply the quadratic field evolution in the Eq.14. The next gate is the Fourier transform gate. This is an $N \times N$ Hadamard gate with the elements of the $\mathcal{F}_N$ matrix defined as:

$$V_{\mathcal{F}} = (\mathcal{F}_N)_{l,m} = \frac{1}{\sqrt{N}} e^{i[(l-N/2)(m-N/2)]2\pi/N}. \tag{21}$$

In cQED systems, Fourier gate can be naturally realized by using two cavities which are coupled to one transmon on one side and taking advantage of the cross-Kerr term between two cavities by letting the transmon and cavity systems evolve over time [18]. For multicell cavities which are coupled to each other, the feasibility of this scenario is not clear. Thus, we employ the SNAP and truncated displacement gates and construct variational block matrices to engineer Fourier gate. We minimize the cost function defined in Eq.19 and variationally find the $\vec{\alpha}$ and $\vec{\Theta}$ parameters. We then evolve δt for the momentum Trotter step.

$$S_N^2(\vec{\theta}) = \prod_{n=0}^{N-1} |n\rangle\langle n| e^{i\frac{1}{2}\delta t\Pi_n^2}. \tag{22}$$

The $\Pi_n = (n - N/2)\Delta$ momentum operator is found by discrete fourier transform of the position $x_i = (i - N/2)\Delta$. Finally, the $V_{\mathcal{F}}$ Fourier gate is applied. The algorithm presented here is repeated K times until the total simulation time T is reached. The ground states of a field for $N + 2m = 12 + 2 \times 4, 16 + 2 \times 4, 28 + 2 \times 4$ are presented in Fig.2. The dimensionless coupling constant $g = 0.5, 1.5, 2.5, 3.5$ are plugged into the code with positive μ^2 (left panel) and negative μ^2 values (right panel).

Multiple qudits

In the previous chapter, we discussed how to prepare a state and a gate for a single qudit. A single discretized field ϕ_j is placed in a single qudit and ground state is found by applying phase gates over a fixed amount of time T. In order to simulate more than one field, we use multiple cavities coupled to each other [**?**]. Thus, the field

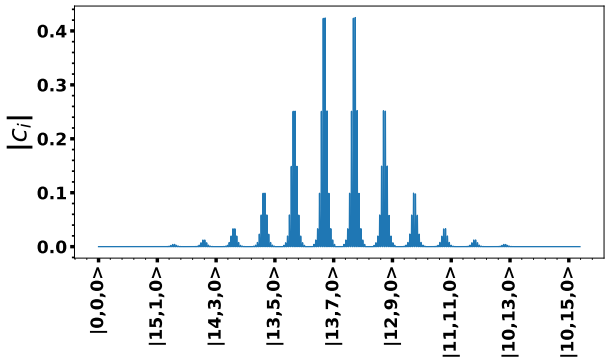

FIG. 3. The simulation results for three qudits and $N = 16$ with $m = 4$ bumper states. Coupling constants are $g = 0.5$, $f = 3.0$ and $\mu^2 < 0$. The total simulation time in arbitrary units is $T = 2$. The g and f coupling constants are adiabatically increased through simulation time. The indices in the vertical axis represent the photon number in that qudit.

discretization j corresponds to the qudit index, and the position space discretization n corresponds to the Fock state index in qudit j. The time simulation of a field can be realized with multicavity SNAP gate. The engineering of multicavity SNAP gate involves a conditional phase gate where the phase of a Fock state in a cavity is manipulated if a photon number on another cavity is satisfied. The experimental methods to realize SNAP and displacement gates for multiple cavities are beyond the scope of this paper. We assume that the parameters for single SNAP gate can be used for the conditional SNAP multiple cavities by appropriate experimental techniques. The multiqudit SNAP gate with m bumper states and truncated displacement gate can be constructed as

$$\mathbf{U}_{S_N}^{(k)}(\vec{\theta})_j = \mathbf{1}_{N+m} \otimes (...) \otimes \underbrace{U_{S_N}^{(k)}(\vec{\theta})}_{jth} \otimes (...) \otimes \mathbf{1}_{N+m}, \tag{23}$$

and

$$\mathbf{U}_D(\alpha)_j = \mathbf{1}_{N+m} \otimes (...) \otimes \underbrace{U_D(\alpha)}_{jth} \otimes (...) \otimes \mathbf{1}_{N+m}, \tag{24}$$

where

$$U_{S_N}^{(k)}(\vec{\theta}) = \left(\begin{array}{c|c|c} \mathbf{1}_m & 0 & 0 \\ \hline 0 & S_N^{(k)}(\vec{\theta}) & 0 \\ \hline 0 & 0 & \mathbf{1}_m \end{array}\right), U_D(\alpha) = \left(\begin{array}{c|c|c} \mathbf{1}_m & 0 & 0 \\ \hline 0 & D(\alpha) & 0 \\ \hline 0 & 0 & \mathbf{1}_m \end{array}\right). \tag{25}$$

We first prepare the initial multiqudit state by using the SNAP gates. The multi-cavity state is the tensor product of single-cavity states

$$|\Psi\rangle = |\psi_1\rangle \otimes |\psi_2\rangle \otimes (...). \tag{26}$$

Once the single qudit initial state is variationally prepared with SNAP and displacement gates, the same variational parameters can be used at each qudit for conditional SNAP gates to prepare the multiqudit state. After this state preparation, each qudit is in the ground state of the harmonic oscillator at $t = 0$. Next, the ground state of the field at each qudit is prepared when the interaction is present. The ground state preparation is made using the same algorithm we presented in the single qudit section, where we apply $V_{\phi^4}^{(s)}$, V_{ϕ^2}, $\mathcal{F}_N$, V_{ϕ^2}, $\mathcal{F}_N$ consecutively at each time δt to each qudit.

Simulation Results

In this section, we discuss the time-simulation algorithm for ϕ^4 type Hamiltonian in a multi-qudit system. In our simulations on a PC, three qudits are considered. We discussed engineering of the unitary gates with SNAP and displacement gate decomposition and the ground state preparation only with SNAP gates in multi-qudit systems. The simulation algorithm begins with the ground state $|0\rangle$ at each qudit. We then apply SNAP and displacement

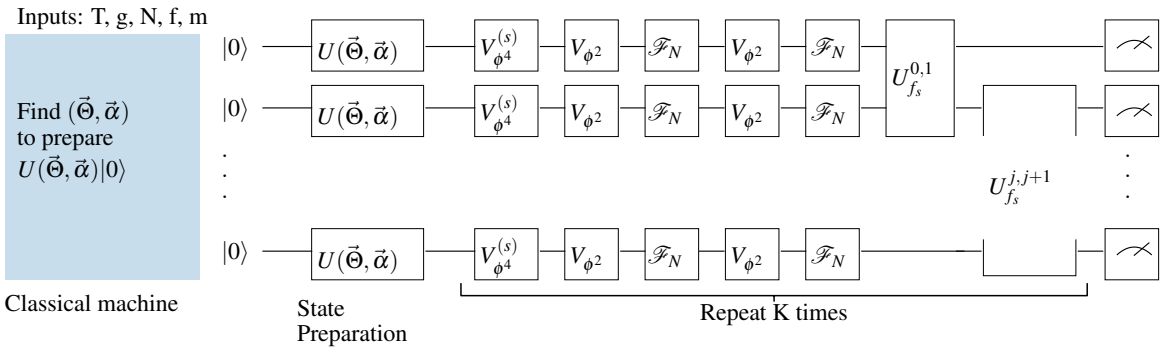

FIG. 4. The circuit diagram for Trotter simulation. First, the $\left(\vec{\Theta},\vec{\alpha}\right)$ parameters are variationally found on a classical computer. These parameters are used on the qudit device to prepare the state. Then, the Trotter steps are applied to each state K times and the states are measured.

gates in order to prepare the harmonic oscillator ground state at each qudit. After state preparation, we first find the ground state of the interacting Hamiltonian when the coupling term f is set to zero by using the algorithm we presented in the previous section. After the ground state of an interacting Hamiltonian is found at each qudit, the $(N+m)\times(N+m)$ two qudit coupling term

$$U_{f_s}^{j,j+1} = e^{-if_s\Delta^2(n_j-N/2)(n_{j+1}-N/2)\delta t}, \tag{27}$$

where $n_j \in [0, N-1]$, is applied to two adjacent qudits. The f_s is adiabatically increased from 0 to the final value f over time T. The algorithm is summarized in FIG.4

We provide results for $q = 3$ qudits in Fig. 3, simulated on a classical computer. The x axis represent the photon number at each cavity. The variational parameters to realize Fourier gate are found by a gradient method, where the details are explained elsewhere. The total simulation time is $T = 2 = (2000)\times\delta t$ where $\delta t = 0.001$. Smaller time-separations δt of less than 0.001 did not noticeably affect the outcome of the simulation.

Conclusions

We discussed application of the SNAP gate method in cavity systems for quantum simulation. Due to the fact that SNAP gates can be photon number dependent, they are excellent candidates for the simulation of field theories. We presented an algorithm to time-simulate a scalar field theory which has ϕ^4 type interaction. Since the phases in the SNAP gates can be arbitrarily manipulated, the field theory simulation with arbitrary coupling strengths g can be simulated in cavity systems.

Acknowledgements

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Enhancing Nursing Skills to Care for Patients with Chronic Obstructive Pulmonary Disease

Dr. Denyce Watties-Daniels, DNP RN

Abstract

Best practices in the care of patients experiencing a deteriorating condition include identifying changes in patient condition and initiating prompt and effective interventions. Nurses frequently fail to recognize deteriorating conditions and serious exacerbation of symptoms and thus are limited in providing appropriate supportive care to patients with COPD. Innovative strategies, such as the implementation of clinical simulations, are reported to be effective in reinforcing essential clinical decision-making skills to assist nurses in developing the knowledge and skills to better recognize and intervene in the care of deteriorating conditions in patients with COPD.

The purpose of this quality improvement project was to develop, implement and evaluate the use of two simulation experiences to assist registered nurses in recognizing and intervening in deteriorating conditions in chronically ill adult patients with COPD. Simulation scenarios included the patient with exacerbation of COPD and the patient with a spontaneous pneumothorax as a result of COPD complications. A convenience sample of seven licensed registered nurses from diverse clinical backgrounds participating in a nursing orientation program at an urban, general adult medicine and surgical hospital in Baltimore, Maryland, engaged in the project. The NLN/ Jeffries Simulation Theory and the INASCL Standards of Best Practices in Simulation provided the framework for the project. Utilizing the three phases of the simulation experience, the seven registered nurses were immersed in the two simulated clinical situations. Baseline knowledge of the care of the patient with COPD and spontaneous pneumothorax was assessed by administering a 10 item, paper-pencil pre-test aligned to the simulation objectives. The simulation experiences were evaluated using the Creighton Competency Evaluation Instrument (C-CEI) and a 10 item posttest. The clinical nurse educator and the project director used the C-CEI tool to separately

evaluate participant performance in each simulation experience. The project director with clinical nurse educator validation, set the competency score for the C-CEI at 75%. The scores on the C-CEI were collected as an aggregate of the nurses delivering care to the simulated patient. All groups of nurses scored above 75%. A T-test (n=7, p =.000) for dependent groups was used to evaluate whether students' performance on the COPD and pneumothorax pre-test improved on the post-test. There was a statistically significant increase in the COPD and pneumothorax mean scores from the pre-test to the post-test. This project supports the use of clinical simulation to train and remediate practicing nurses. The participating nurses were able to immerse themselves in a realistic clinical situation and care for the simulated patients in a safe environment as though the patients were real. The participating nurses could identify significant changes in patient condition and be competent in intervening and caring for the deteriorating conditions of a COPD patient. Evidence from this quality improvement project supports the need for continued clinical work and program evaluation on the development and implementation of hospital-based clinical simulation programs for nurses.

Introduction

Chronic obstructive lung disease (COPD) is a debilitating syndrome of respiratory-related diseases that affect the airways. COPD is listed as the third leading cause of death in the United States, and affects 5.3% of the population in Maryland (Center for Disease Control (CDC), 2012). The incidence of COPD is higher in urban-poor communities at a reported rate of 11. 2% in America (Raju, 2015). COPD is a frequent cause of hospitalization in our aged population, accounting for approximately 65% of discharges in patients 65 years and older in 2010 (CDC, 2012).

Patients with COPD do not receive the same quality of nursing care as patients with other chronic disorders (Griffith, Murrells, Dawoud, & Jones, 2010). Factors that negatively impact the ability of nurses to adequately intervene in deteriorating conditions of chronically ill patients include failure to perform appropriate observations, failure to record pertinent observations, failure

to recognize early manifestations of deterioration, and failure to communicate deteriorating conditions to the provider (Beaumont, Luettel & Thomson, (2008). Nurses caring for patients with chronic conditions need support in recognizing deteriorating patient conditions and serious exacerbation of symptoms (Friese & Aiken, 2008).

Professional development activities traditionally include lecture in classroom and modules online for imparting information. Clinical professional development programs that include hands-on learning opportunities that reflect actual patient care experiences have been found to increase nurse satisfaction with the learning process and improve retention (Patterson, Bayley, Burnell & Rhodes, 2010). Innovative strategies for relating knowledge to practice, such as the implementation of clinical simulations, have been reported to be effective in reinforcing essential clinical decision making skills to assist nurses in developing the knowledge and skills to better recognize and initiate prompt interventions in deteriorating conditions in patients (Bultas, Hassler, Ercole & Rea, 2014). Improved clinical decision making skills in nurses should positively affect patient outcomes.

Hospital-based simulation experiences are an evolving teaching strategy to improve the quality of healthcare delivered to patients. Simulation exercises are an effective strategy to enhance patient safety and strengthen patient safety outcomes (Schmidt, Goldhaber-Fiebert, Ho & McDonald, 2013). Simulation allows healthcare providers to engage in patient care situations and will enable participants to practice technical and procedural actions without posing risks to vulnerable populations. Simulated experiences allow participant learners to engage in clinical situations in a safe and supportive environment (Ackermann, Kenny & Walker, 2007). Simulated clinical experiences may help to address the need for innovation in hospital nursing professional development programs as well as facilitate experiential learning (Belden, 2011; Decker, Sportman, Puetz & Billings, 2008; Liaw, Koh, Dawood, Kowitlawakul, Zhou & Lau, 2013; Roche, Schoen, & Kruzel, 2013). Simulated clinical events are structured to depict realistic patient care situations. Clinical experiences are central to using human patient simulators (HPS) or standardized patient actors that serve as the patients in the clinically-focused scenarios. These structured clinical events allow the participant-learner to gain expertise in clinical situations. These experiences also will enable the learner to develop knowledge, skills, and attitudes relevant to clinical practice in a realistic situation without fear of harming actual patients (International Nursing Association for

Clinical Simulation [INACSL], 2013; Pilcher, Goodall, Jensen, Huwe, Jewell, Reynolds & Karlson, 2012).

The purpose of this quality improvement project was to develop, implement and evaluate the use of two simulation experiences to assist registered nurses in recognizing and initiating prompt and effective interventions in deteriorating conditions in chronically ill adult patients with COPD. It is anticipated that the development and implementation of simulation experiences to foster learning will provide consistent and structured patient care opportunities for registered nurses. The implementation of simulation experiences focusing on patient conditions frequently seen in the urban hospital setting will provide nurses with the expertise to critically think through situations of deteriorating patient conditions in a less threatening and safe environment.

Theoretical Framework

The NLN/ Jeffries Simulation Theory underpins the activities of the quality improvement project (Jeffries, 2012). The NLN/ Jeffries Simulation Theory grew out of the development of the science of clinical simulation. No formal theoretical framework specifically designed to explain the phenomenon of clinical simulation existed prior to developing the NLN/ Jeffries Simulation Theory (Rizzolo, Durham, Ravert & Jeffries, 2012). This middle-range theory articulates the administrative, teaching and clinical aspects of simulation experiences (Durham, Cato & Lasater, 2014).

The NLN/ Jeffries Simulation Theory identifies three phases of the simulated clinical experience: pre-briefing activities, the implementation of the clinical simulation, and a debriefing discussion period (Jeffries, 2012; Jeffries, Rodger & Adamson, 2015). Together, these three phases foster the learners' clinical reasoning and decision-making. The use of a predesigned, peer-reviewed script will guide the clinical situation and will be used to provide background clinical information to learners in the pre-briefing phase of the simulation. During the implementation of the clinical simulation, effort must be taken to make the simulation arena appear as close to the actual patient care environment as possible. Equipment and patient care supplies are needed to enhance the realism and authenticity of the simulated clinical situation. Appropriate moulage and props should be used to enhance the realism of the clinical experience. The use of a quality post-simulation debriefing technique will be used to engage the learner in a dynamic and robust

interaction at the end of the clinical situation. Through this post-simulation discussion, learners discover their strengths and identify opportunities for improved performance in the prescribed clinical situation. These three phases of the theory were used to select, implement and evaluate simulated learning activities in the proposed educational program.

Review of the Literature

The literature review will focus on the management of patients with COPD, the needed training of nurses to care for these patients adequately, and the use of clinical simulation to facilitate that training. The literature review will begin with discussing the recommended treatment for patients with exacerbated COPD. It will proceed with evidence-based programs for training nurses to provide adequate nursing support for COPD patients. Finally, the review will conclude with current evidence on the use of simulation scenarios in nursing practice as a strategy to improve the ability of licensed bedside nurses to care for COPD patients.

A literature review revealed current evidence-based treatment protocols for patients with COPD is directed at physician and nurse practitioners. This includes the administration of corticosteroids, bronchodilators, antibiotics and oxygen with noninvasive positive pressure ventilation, as appropriate treatment for patients in COPD exacerbation (Global Initiative for Obstructive Lung Disease [GOLD], 2015; National Guidelines Clearinghouse [NGC], 2014). Nurses caring for COPD patients in inpatient, direct care settings do not have the authority to initiate these protocols in practice. However, they must recognize the critical condition of patients with exacerbated COPD and make prompt interventions using these treatment protocols as a guide to their practice. Scullion (2008) addressed the role of bedside nurses in the prompt treatment of exacerbations in COPD. Scullion (2008) developed a teaching program to assist British nurses in understanding the importance of prompt intervention in treating patients with COPD. The educational program is based on a COPD quality care standard developed by the National Collaborating Centre for Chronic Conditions and the National Service Framework for COPD. The teaching program consists of four discussion topics related to the nursing care of the patient with COPD; prompting nurses to a) consider the patient's presenting symptoms, b) consider the understanding healthcare professionals and the public concerning the treatment of COPD, c) consider the education and emotional needs of the patient experiencing an acute exacerbation and, d) identify collaborative resources to aide in the care of the COPD patient. Evaluation information

about the program was not included. However, the program employs the use of the effective educational strategies to promote discussion and reflection from the participants.

Cope, Fowler, and Pogson (2015) also identified that a teaching program directed at enhancing nurses' knowledge caring for COPD patients would positively impact patient outcomes. Cope et al. (2015) implemented a nurse-led COPD support program to reduce the length of stay in patients in an England-based hospital. Nurses engaged in a teaching program designed to increase their knowledge and skill in caring for patients with COPD. COPD patients cared for by nurses participating in the study reported receiving an improved quality of care. Cope et al. (2015) compared patients' length of stay in 2013 to patients in 2014 (n=464). The researcher identified the average length of stay for COPD patients in a hospital in England was reduced by 2.53 days for patients cared for by nurses that participated in the educational program.

Professional development programs directed at nurses caring for a patient with COPD will strengthen nurse-patient and family relationships and provide information directed at enhancing COPD patient and family satisfaction with the care they receive. Gardiner et al. (2009) in a literature review of 15 articles, determined that open communication with COPD patients and their families, directed at alleviating fear and providing emotional support, was reported by patients as relevant to their satisfaction with the care received. However, it was identified that the nursing staff did not routinely give this type of emotional support. Based on this review, there is a need for the development and implementation of professional development programs and interactive learning strategies to increase the knowledge and skill of nurses to provide emotional support to patients with COPD.

Structured learning opportunities for nurses caring for patients with COPD can improve their recognition of a deteriorating respiratory condition. COPD exacerbation can be a rapidly deteriorating and complicated situation for patients. A complication in the deteriorating COPD patient is the development of a pneumothorax (Currie, Alluri, Christie, & Legge, 2007; Rawal, Yadav, Garg & Wani, 2015). The ability of nurses to appropriately monitor patients, identify changes in patient conditions and initiate prompt interventions are critical to the survival of patients experiencing a deteriorating condition (Chua, Mackey, Ng & Liaw, 2013; Miller 2015). However, nurses may not recognize the significance of minimal changes in the respiratory rates of patients, causing a delay in appropriate interventions. The development and implementation of

the use of simulation in a clinical education program has been reported to improve the recognition of deteriorating patients (Waldie, Tee & Day, 2016).

The Institute of Medicine (IOM) report, To Err is Human: Building a Safer Health Care System (2000) supports the use of clinical simulation to improve patient safety (Kohn, Corrigan, and Donaldson, 2000). Simulated clinical experiences can provide learners with opportunities to experience clinical situations and provide interventions within a safe, supervised setting without posing a risk to a patient (Durham & Alden, 2008). High-quality, simulated exercises with mandatory periodic updates are recommended to train and remediate nurses in implementing practice standards and improving recognition of deteriorating conditions in patients (Waldie, Tee & Day, 2016). For example, Cooper et al. (2011) used a simulated clinical experience focusing on the care needs of a deteriorating patient (n=35). The participant achieved minimal situational awareness scores of 50% after engaging in the simulated experience. Performance scores and situational awareness scores improved with repeated exposure to the scenario. The result of the study is limited by its small sample size. However, the result is consistent with similar studies related to situational awareness and simulation.

A synthesis of the literature reveals that structured learning programs for nurses, such as simulation experiences, can improve safety in the care given to patients (Cope, Fowler and Pogson, 2015; Kohn, Corrigan, and Donaldson, 2000). These educational programs should be designed to support the acquisition of knowledge in the care of patients with specific health conditions and should include activities that assist the nurse in developing skills to meet the physical and emotional needs of patients (Gardiner, et al., 2009). Simulated clinical experiences effectively approve nurses' recognition of deteriorating conditions in patients and support the initiation of prompt interventions that are critical to the survival of patients experiencing deteriorating conditions, such as those with COPD (Chua, Mackey, Ng & Liaw, 2013; Miller 2015). The structured, simulated clinical experiences should be periodically updated to maximize the benefits of remediation in supporting the recognition of deteriorating patients (Waldie, Tee & Day, 2016). Current evidence based treatment protocols for patients with COPD supports the implementation of repetitive training of physician providers and nurses using simulated clinical simulation scenarios to improve skills in the prompt and appropriate intervention of the deteriorating patient with COPD (Global Initiative for Obstructive Lung Disease [GOLD], 2015; National Guidelines

Clearinghouse [NGC], 2014). The continued development of evidence-based programs involving structured clinical experiences, such as simulation, is needed to assist professional registered nurses in caring for patients with deteriorating conditions such as those with COPD.

Methods

Design, Setting and Sample

The setting of the quality improvement project was an urban, adult medicine and surgical general hospital in Baltimore, Maryland. The hospital census for September 2016-May, 2017 identified 140 patients were admitted with COPD. These admissions culminated in 716 total days of inpatient care, with an average length of stay of 5.1 days (Census report, Bon Secours Health System Baltimore, May 2017).

A convenience sample of seven licensed registered nurses participating in a general nursing orientation program at the hospital participated in the project.

Procedures

Introduction and Training

The project leader met with the clinical nurse educator responsible for facilitating the nursing orientation program and the Director of Nursing of the hospital to explain the project's objectives. The project leader shared copies of the introductory script, the COPD and pneumothorax pre-test and posttest, the demographic data collection survey, the simulation scenarios and the Creighton C-CEI tool with the clinical nurse educator and Director of Nursing

The project leader and the clinical nurse educator met two weeks prior to implementing the project to complete training for the Creighton C-CEI tool and prepare the simulation laboratory and the high fidelity manikin for the simulation exercises. The training program's content was based on the International Nursing Association for Clinical Simulation and Learning [INACSL] (2013) standards of best practices for simulation. It included a review of all assessment tools to be used in the simulations. The training required the project leader and the nurse educator to complete the online instructional program to use the Creighton Competency Evaluation Instrument (C-CEI) (https://nursing.creighton.edu/academics/competency-evaluation-instrument/training). The project leader reviewed the use and scoring of the C-CEI tool with the clinical nurse educator to clarify questions for the educator. The project leader reviewed the simulation scenarios; guided the clinical nurse educator in preparing the simulator and the equipment used in the scenarios; reviewed the process to guide participants through the three phases of the simulation experience; and assisted the educator in performing a test of each of the simulations. The pre-testing of the simulations helped the educator and the project leader coordinate each simulation's activities and increased the comfort level of both in implementing the scenarios during the orientation. The project leader functioned as a simulation mentor and supported the clinical nurse educator in facilitating and administering the simulation experiences. Training of the nurse educator supported the sustainability of the project.

Together, the project leaders and the clinical nurse educator agreed on which behaviors on the C-CEI tool were applicable to the simulation scenarios to be implemented. The project leader and the clinical nurse educator agreed that items six- documents clearly, concisely and accurately; and seventeen-delegates appropriately, did not apply to the anticipated actions of the simulation participants. The project leader and the clinical nurse educator agreed that these behaviors will be excluded from the evaluation process.

Implementation

The simulation scenarios were implemented from February 2017 to May 2017, during the second and third weeks of the orientation sessions. During this orientation period, the newly hired nurses were paired with a preceptor and were engaging in patient care on the nursing units. Delivering simulation experiences as the newly hired nurses engage in actual patient care supported the direct patient care experiences of the nurse orientees.

The clinical nurse educator scheduled nurses during their new hire orientation to participate in the simulation activities. There were times when the simulation experiences had to be re-scheduled from the dates identified due to changing activities during the orientation period. Some of the nurse participants required shortened orientation periods due to their level of patient care experience. Their participation in the simulated experiences needed to be scheduled earlier because their orientation period was shortened. Other participants were working the night shift and special scheduling was needed to have them participate in the daytime simulation activities.

The nurse participants assembled at the simulation center, and were greeted by both the clinical nurse educator and the project leader. During the pre-briefing segment of the simulation experience, each participant was given a dated packet that included a demographic survey, the pre and post-knowledge assessment of content related to the simulation, an overview of the simulated client and the Creighton Competency Evaluation Instrument. Before the implementation of the simulations, the project leader prepared slips of paper with ten numbers and letters to be randomly selected by the participants. The numbers and letters were used to code the tests of the participants. Participants were asked to choose a slip of paper from a box and to write the letter or number on their pre and post-test. Once a slip of paper was selected, it was not returned to the box to ensure that no participants received the same code. Pre and posttest forms were coded to distinguish pre and post test data.

A statement was read prior to the beginning of each simulation session explaining the objectives of the simulation experiences and that participation in the simulation would not affect employment.

Simulation Scenarios

The simulation scenarios used in the project were peer reviewed, developed by Laerdal® and were designed to be used with the 3G SimMan simulator. Each scenario included specific objectives and included programing and implementation guidelines to be used by simulation

facilitators. The seven nurses participating in the simulation project formed simulation teams of 1 to 4 nurses participating in each scenario.

The first simulation exercises were delivered in February, 2017. Four nurses participated in the simulation exercises. Two nurses in the team of four participants were randomly selected to be direct care givers in the scenario. The remaining two nurses were active observers during the simulations. The direct caregivers worked as a team to identify signs of the deteriorating patient with COPD and deliver care to the simulated patient. The simulation objectives guided the nurse observers. The same nurses participated in the simulation scenario focusing on the patient's care developing a pneumothorax. The four nurses exchanged roles during the second simulation; those nurses who functioned as direct caregivers in the previous scenario now assumed the role of observers. Those nurses who were active observers functioned as direct care givers.

The second implementation of the simulation project was conducted in March, 2017 and consisted of one newly hired nurse. This nurse functioned as the sole direct caregiver during both of the scenarios. The third implementation of the simulation project was conducted in May, 2017 and consisted of two newly hired nurses. Both nurses stated behavioral health as their most recent area of clinical nursing experience. These nurses were willing to participate in the medically focused simulation scenarios but preferred to work together. The project director and the clinical education agreed with the nurses. Therefore, no nurse observers participated in their simulation experiences.

Application of the NLN/ Jeffries Model

Using the NLN/Jeffries model, three phases of the simulation experiences were conducted. During the pre-briefing phase, the nurse educator, with the assistance of the project director, read a script describing the simulation environment and read the objectives of the simulation experience. The script included statements referring to the psychological safety and non-competitive environment of the simulation arena (INACSL, 2013). The script included information on the roles of the direct caregivers and the observers. With the support of the project leader, the nurse educator administered a 10 item pre-test to identify baseline knowledge of the care of the patient depicted in the simulation scenario. With the assistance of the project leader, the educator read a script containing background history and current admission information on "Henry Williams", the simulated patient with COPD. The nurse educator and the project leader reviewed the use of the C-CEI tool with the nurse orientees. They explained that the assessment

information collected with the tool will be shared with the participants during the debriefing portion of the simulation exercise.

During the second phase of the simulation, the participants cared for Henry Williams, the simulated patient. The participants functioning as direct caregivers were oriented to the simulation environment before the intervention. The high-fidelity human patient simulator was labeled with lung sounds heart sounds and indicated blood pressure and pulse rate. In the first scenario, a patient with chronic COPD is admitted to a nursing unit in minor distress. As the scenario progresses, changes in the vital signs, oxygen saturation rates, and patient breathing pattern indicate the patient is deteriorating and developing respiratory distress and G).

In the second scenario, the previous patient with COPD is re-admitted to the unit 5 days after discharge and has a spontaneous pneumothorax. The patient presents with chest pain, shortness of breath, increased respiratory rate, and no breath sounds on the effective side of the chest. With the support of the project director, the nurse educator presented the patient's background history to the nurse orientees. The simulator was assembled to reflect the changing vital signs of a patient with a spontaneous pneumothorax. Participants were expected to recognize the signs and symptoms of spontaneous pneumothorax and initiate the appropriate interventions. With the assistance of the project leader, the clinical educator used the C-CEI to evaluate the care given by the direct caregivers. The direct caregivers were assessed as an aggregate.

All participants took part in the guided debriefing exercises post the simulation experiences to explore nursing actions and critical thinking that occurred within the simulation experiences. The 10 item post-test was administered post the simulations and the debriefing exercise to assess the improvement in patient care knowledge with COPD or spontaneous pneumothorax. During debriefing, the nurse educator and the project leader shared the information collected using the C-CEI tool with the participants.

Data Collection

Pre-simulation, baseline knowledge of the care of the patient with COPD and spontaneous pneumothorax was assessed by administering a 10 item, paper-pencil pre-test. The items on the test were aligned to the simulation objectives. Validity was established by review of an expert in the area of chronic diseases. The expert was given the objectives and questions and asked if the test items were congruous with the objectives and if the questions were relevant and clearly written.

Questions receiving a positive response from the expert were included on the test. The same tool was administered as a post-test during the debriefing segment of the simulation exercise. Responses were anonymous.

Participant demographic data was collected to describe the sample of participants. The demographic data was collected via a paper-pencil questionnaire that was separate from the pre-test. Information collected included age, years of registered nursing experience, primary nursing area of expertise-med/surg, ICU, ED, PACU, ER, educational level and shift hired to work. No identifying information was collected on the forms, and participants submitted completed forms in a drop box to support anonymity and protect the human rights of the participants.

Simulation outcomes were evaluated using the C-CEI. Educators developed the C-CEI tool at Creighton University College of Nursing in Omaha, NE, to assess student competency in clinical performance using simulation (Todd, Manz, Hawkins, Parsons & Hercinger, 2008). The C-CEI assesses 23 general nursing behaviors, divided into four categories-assessment, communication, clinical judgment and safety. The C-CEI has reported content validity scores ranging from 3.78 to 3.89. The tool has a reported Cronbach's alpha score >.90 when used to score three different levels of simulation performance during the National Council of State Board of Nursing National Simulation Study and in studies conducted to evaluate the tool's internal consistency (Adamson, Kardong-Edgren, 2012; Hayden, Keegan, Kardong-Edgren, Smiley, 2014). Permission to use C-CEI was granted by completing an online tutorial sponsored by Creighton University. Although the C-CEI tool allows the evaluator to list the name of individuals participating in the simulated clinical experience, no names were recorded during the clinical experiences related to this project.

The C-CEI has a two-point grading rubric that assigns a score of zero when a desired nursing action is not performed and one when the desired nursing action is performed. The passing score for the C-CEI is calculated by adding the total number of behaviors achieving a score of 1 and multiplying that number by 0.75 (Creighton Simulation Evaluation, n.d.). Scores for the C-CEI can range from zero to 23. The developers of the C-CEI recommend that users of the tool adapt the possible observed behaviors to meet their clinical situation. It is recognized that not all behaviors included on the C-CEI tool may be applicable to all clinical situations. The project director and the clinical education reviewed the C-CEI tool and agreed to eliminate items six and 17 when evaluating the caregiving behaviors of the nurses participating in the scenarios. The scenarios involving "Henry Williams" did not require the nurses to delegate care to ancillary staff

or to document care delivered to the simulated patient. Therefore, these two behaviors were not considered during the evaluation of the simulations. To be considered proficient, the participants must achieve a total score of at least 75 % (15.75). The scores were collected as an aggregate of the nurses delivering care to the simulated patient. Each item used on the C-CEI tool was divided into 100 and assigned a weight of 4.45%. The total number of behaviors receiving a one were multiplied by 4.45 to convert the outcome scores to conventional test scores based on a perfect score of 100%.

Data Analysis

The data collected represents the group of seven participants and was analyzed using Statistical Package for Social Sciences (SPSS) version 24. The participant sample includes one male representing 14.3% of the sample; and six female participants (85.3%). Participant ages range from 26 to 51+ years, with 42.9% of the participants between 32-35 years of age. Approximately 86% of the participants have 1-5 years of nursing experience. Two participants (28.6%) are graduates of ADN programs; and five participants (71.4%) possess BSN degrees. Six participants (85.3%) state they participated in simulation experiences while in nursing school. One participant (14.3%) responded that they engaged in simulation experiences with other employment. Table 1 represents the descriptive data of the participants.

Baseline knowledge of the care of the patient with COPD and spontaneous pneumothorax was assessed by administering a 10 item, paper-pencil pre-test aligned to the simulation objectives prior to engaging in the simulation. The participants completed a post-test after the debriefing segment of the simulation. The nurse educator and the project leader evaluated the responses on the pre- and post-test. Items on the 10 question tests were valued at 10 points each. Proficient knowledge was determined with the achievement of a score of at least 80 %.

Summarized Findings

The simulation experiences were evaluated using the Creighton Competency Evaluation Instrument (C-CEI) and a 10-item posttest. The clinical nurse educator and the project director used the C-CEI tool to evaluate participant performance in each simulation experience. The project director with the clinical nurse educator validation set the competency score for the C-CEI at 75%. The scores on the C-CEI were collected as an aggregate of the nurses delivering care to

the simulated patient. C-CEI scores for the COPD and pneumothorax scenarios ranged from 84.74 to 89.20.

A T-test for dependent groups was used to evaluate whether students' performance on the COPD and pneumothorax post-test differed significantly from the pre-test scores as a result of the simulation. The alpha level was set at 0.05. There was a statistically significant increase in the COPD mean scores from the pre-test (M= 80.0, SD= 12.9), with t (16.39), to COPD post-test scores (M = 84. 28, SD= 12.72), with t (17.52), p= .000. The mean increase in COPD knowledge scores was 4.28 with a 95% confidence interval ranging from 68.06 to 91.93 on the COPD pre-test and 72.51 to 96.05 on the COPD post-test. Table 2 represents the pre and post test scores.

There was a statistically significant increase in the pneumothorax mean scores from the pre- test (M= 77.14, SD= 17.99), with t (11.34) to pneumothorax post-test scores (M= 92.85, SD = 7.55), with t (32.50), p= .000. The mean increase in the pneumothorax knowledge scores was 15.33 with a 95% confidence interval ranging from 60.50 to 93.78 on the pneumothorax pre-test and 85.86 to 99.84 on the pneumothorax post-test. Table 3 represents the t-test analysis of the pre and post tests.

Discussion

This evidence-based, quality improvement project supports findings in the literature that suggest simulation can improve nursing knowledge in the care and recognition of deteriorating patients. COPD and pneumothorax post-test mean scores improved after participants engaged in the simulated patient care experiences and debriefing activities. There was a statistically significant change in the mean scores of the knowledge level pre-and post- test for each simulation scenario. The project director and the clinical nurse educator compared their observations of the simulation activities after each simulation event. They agreed that each group achieved a passing score on the C-CEI.

The prior exposure to simulated clinical experiences potentially supported the comfort level of the participants. All participants had prior experience with simulation. No one asked questions regarding performance expectations during the pre-briefing portion of the simulation. Participants seem relaxed when administering care to the simulated patient. Those that functioned

as active observers during the simulation seemed to understand their role. They took notes and were actively engaged in the debriefing discussions.

The debriefing segment was an essential component of the simulation experience. All of the participants actively engaged in the discussion of nursing observations, actions and outcomes during each of the simulated encounters. The participants used clinical reasoning skills to identify clinical cues in deteriorating patients with COPD and for patients with a pneumothorax. The participants were able to discuss appropriate nursing actions to improve the condition of these type of patients. They were able to identify assessments and interventions that were missed during the actual engagement in patient care. The nurses agreed that they could have performed a more thorough respiratory assessment and should have notified the provider sooner of the patient in distress. They were able to agree that the actions needed to be included when delivering care to these types of patients.

Several factors affected the implementation of this project. Each participant's individual work schedules and orientation needs made it difficult to arrange for the nurses to participate in the project. Scheduling participants during the first week of orientation presented fewer obstacles than arranging participation during the second week. Orientation activities for newly hired nurses were offered during the day shift for the first week of orientation. After the first week, nurses work with a preceptor on their assigned nursing unit. Nurses with more than 1-2 years of previous nursing experience are scheduled to complete the remaining portion of their orientation on the shift they were hired for. One of the participants in this project was hired to work from 7:00 pm to 7:00 am, and two of the participants were hired to work on the weekends. The project director and the clinical nurse educator worked diligently with the nurse managers to secure the availability of the participants. Conducting simulation experiences during the first week of orientation and during the annual competency validations may be a more effective strategy to secure the participation of nurses.

There was a limited number of nurses hired during the time the project was implemented. Peak hiring times for new graduate nurses occur 4-6 months after graduation, between September and October (American Association of Colleges of Nursing, 2013). According to Monster.com, companies may implement hiring initiatives near the end of year and at the end of the summer (Rossheim, 2017). Only seven nurses were oriented during the time the project was implemented.

Four of the participants were in the first cohort of nurses who took part in the February simulation experiences.

Due to renovations in the nursing education area, the simulations were conducted in converted conference rooms instead of the nursing education lab. This limited the availability of equipment, usually in the patient care areas. This affected the level of realism during scenario implementation, possibly affecting outcomes of one of the criteria on the C-CEI. Participants were evaluated if they performed hand hygiene before approaching the patient. This behavior was included on the C-CEI evaluation tool. No sink was available in the conference room; however, bottled hand sanitizer was available. Several participants did not perform hand hygiene and thus did not receive points for completing this task in the C-CEI. It cannot be determined if the participants omitted the action. They were negligent or because they overlooked the sanitizer or did not react because they did not see a sink. The INASCL Standards of Best Practices in Simulation (2016) encourages the creation of a simulation environment that resembles an actual clinical setting. This will maximize the ability of the participant to react to situations that realistically occur in the simulation.

Sufficient time is needed to set the simulation environment and prepare the manikin for use. Each simulation experience required approximately 45 minutes of preparation time. Due to the renovations, a designated simulation room could not be maintained. The manikin was stored on another floor. The supplies were kept in a closet within the nursing education area and needed to be restocked after each simulation experience. After each simulation, the room used for the simulation needed to be converted back to a conference room. Intravenous pumps and oxygen tanks needed to be returned to nursing units. Twenty minutes or more was needed to clean up the simulation room. The INACSL standards (2016) support the design and use of a designated clinical laboratory for simulation. Implementing strategies to reduce the mentioned limitations may enhance the simulation experience.

Conclusion

This quality improvement project focused on developing and implementing two simulation experiences to assist registered nurses in recognizing and initiating prompt and effective interventions in deteriorating conditions in chronically ill adult patients with COPD. The participating nurses were better able to recognize manifestations of a deteriorating patient with

COPD after engaging in the simulation experiences. The completed project supports clinical simulation to train and remediate practicing nurses. The participating nurses were able to immerse themselves in a realistic clinical situation and care for the simulated patients in a safe environment as though the patients were real. Participant clinical behaviors included using communication skills and engaging in clinical decision-making. The participants were able to work in care teams to deliver appropriate nursing care to the simulated patients. Anecdotal responses by the participating nurses included more opportunities to engage in simulated experiences.

The mean scores on the COPD and pneumothorax knowledge test improved after the nurses participated in the simulation experiences. Evidence supports that this knowledge and these skills will transfer into the actual clinical setting.

The literature supports the need to implement strategies to improve the early recognition of deteriorating patients. Simulation is supported as an effective strategy to reinforce safety and improve the quality of care given to patients. The pre-test provided information on the baseline nursing knowledge for each simulation scenario. The post-test evaluated the improvement of knowledge after the simulation experiences. The simulation experience provided an opportunity for the participants to care for a deteriorating patient in a safe environment. The evaluation each simulation experience using the C-CEI tool provided feedback on participant engagement during the three phases of the simulation experience. Clinical nurse educators can be mentored by nurse educators experienced in simulation design, implementation, and evaluation to implement quality-simulated experiences to enhance patient safety. Much of the literature is directed at using simulation in academic settings. Further exploration is needed in the use of clinical simulation with licensed nurses. Evidence from this project supports continued clinical work, and program evaluation is need on the development and implementation of hospital-based clinical simulation programs for nurses.

Nursing practice supports the use of innovative technologies to improve patient care delivery. Evidence supports the use of simulation to improve patient outcomes. However, developing and implementing an effective hospital-based simulation program is a complex project to undertake. The project will require a significant commitment from hospital and nursing administrators. The commitment to develop a clinical simulation program will be costly. The establishment of a fully functioning hospital simulation center will require significant space renovation. High fidelity manikins, computer, monitoring and recording equipment must be

purchased. Educational staff will require extensive simulation scenario design, technical support, implementation, debriefing, scenario, and program evaluation. McIntosh, Marcario, Flannagan and Gaba (2006) estimated the start-up cost to purchase equipment, train staff, and develop an existing space to support simulation as $876,485. The development and continued support of a simulation center must be a part of the hospital organization, nursing, and ancillary department strategic plans to be a successful and fully supported innovation.

Further development of a sustainable clinical simulation program is recommended. The innovation project should expand beyond nursing and take a multidisciplinary, interprofessional approach to simulation-based education. The innovative team must be supported by the organizational executive leaders and should include nurse managers, the clinical nurse educator, staff nurses, constituents from ancillary departments, and a doctorally prepared nurse should be led.

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Table 1

Characteristics of the participants (N=7)

	n	%
Sex	7	
Male	1	14.3
Female	6	85.7
Age	7	
26-30 years	1	14.3
31-35 years	3	42.9
36-40 years	1	14.3
41-45 years	1	14.3
51+ years	1	14.3
Education	7	
Associate Degree prepared (ADN/AA)	2	28.6
Baccalaureate prepared (BSN)	5	71.4
Nursing Experience	7	
1-5 years	6	85.7
5-10 years	1	14.3
Expertise	7	
Med/ Surg	3	42.9
Emergency Department (ED/ER)	2	28.6
Other	2	28.6
Experience with Simulation	7	
Sim in nursing school	6	85.7
Sim with other employment	1	14.3

Table 2

Pre- and Post-test scores (N=7)

	n	Range	Mean (SD)
COPD Pre	7	68.06-91.93	80.00 (12.90)
COPD Post	7	72.51-96.05	84.28 (12.74)
Pneum Pre	7	60.50-93.78	77.14 (17.99)
Pneum Post	7	85.86-99.84	92.85(7.55)

Table 3

T-test COPD & Pneumothorax (N=7)

	t	df	Sig. (2 tailed)	95% Confidence Interval Range
COPD Pre	16.395	6	.000	68.06-91.93
COPD Post	17.526	6	.000	72.51-96.05
Pneum Pre	11.342	6	.000	60.50-93.78
Pneum Post	32.50	6	.000	85.86-99.84

Table 4

Creighton University

Creighton Competency Evaluation Instrument (C-CEI)

Scenario:	0 = Does not demonstrate competency 1 = Demonstrates competency		Date:
ASSESSMENT	(Circle Appropriate Score for all Applicable Criteria)		**GROUP COMMENTS***
Obtains Pertinent Subjective Data	0	1	
Obtains Pertinent Objective Data	0	1	
Performs Follow-Up Assessments as Needed	0	1	
Assesses in a Systematic & Orderly Manner Using the Correct Technique	0	1	
COMMUNICATION			
Communicates Effectively w./Providers (delegation, medical terms, SBAR, WRBO)	0	1	
Communicates Effectively with Patient and S. O. (verbal, nonverbal, teaching)	0	1	
Writes Documentation Clearly, Concisely, & Accurately	0	1	
Responds to Abnormal Findings Appropriately	0	1	
Promotes Realism/Professionalism	0	1	
CRITICAL THINKING			
Interprets Vital Signs (T, P, R, BP, Pain)	0	1	
Interprets Lab Results	0	1	
Interprets Subjective/Objective Data (recognizes relevant from irrelevant data)	0	1	
Formulates Measurable Priority Outcomes	0	1	
Performs Outcome-Driven Interventions	0	1	
Provides Specific Rationale for Interventions	0	1	
Evaluates Interventions and Outcomes	0	1	
Reflects on Simulation Experience	0	1	
TECHNICAL SKILLS			
Uses Patient Identifiers	0	1	
Utilizes Standard Precautions Including Hand Washing	0	1	
Administers Medications Safely	0	1	
Manages Equipment, Tubes, & Drains Therapeutically	0	1	
Performs Procedures Correctly	0	1	

Student Participants

_____

_____

_____

_____

Faculty Evaluator:

Total Score → ☐

Passing Score → ☐

If not applicable, no score is given.

Passing score = 0.75 x number of items used.

*Individual comments on clinical evaluation form

Revised: 1/1/09

Characterization and Comparison of DSSCs Fabricated with Black Natural Dyes Extracted from Jamun, Black Plum, and Blackberry

Ahmed Sikder[1], William Ghann[1], Md. Rafsun Jani[2], Saquib Ahmed[3] and Jamal Uddin[1]*

[1]Center for Nanotechnology, Department of Natural Sciences, Coppin State University, Baltimore, MD 21216, USA

[2]Department of Materials and Metallurgical Engineering (MME), Bangladesh University of Engineering and Technology (BUET), East Campus, Dhaka-1000, Bangladesh

[3] Department of Mechanical Engineering Technology, SUNY – Buffalo State, 1300 Elmwood Avenue, Buffalo, NY 14222

[4]Chemistry Department, King Abdulaziz University, Jeddah, Saudi Arabia

[5]Inorganic Synthesis Lab, Department of Natural Sciences, Coppin State University, Baltimore, MD 21216, USA

[6]Department of Pharmaceutics, College of Pharmacy, King Saud University, Riyadh 11451, KSA

[7] Department of Chemistry, University of Chittagong, Chittagong 4331, Bangladesh

[8]Department of Chemistry, Khulna University of Engineering & Technology, Khulna 9203, Bangladesh

[9]Department of Chemistry, American International University-Bangladesh (AIUB), Dhaka, Bangadesh

[10]Department of Pharmaceutical Sciences, North South University, Dhaka, Bangladesh

Correspondence: Jamal Uddin (juddin@coppin.edu)

Abstract

In this report, natural dyes extracted from three different black-colored fruits were used as photosensitizers for the construction of dye-sensitized solar cells (DSSCs). The natural dyes were extracted from the dark-colored peels of Jamun (also known as Indian Black Plum), black plum, and blackberry fruit. These natural dyes contain polyphenolic compounds – most prominently anthocyanins – which interact strongly with the titanium dioxide semiconductor, and accordingly enhance the efficiency of dye-sensitized solar cells. The natural dyes extracted from the various fruits were characterized using UV-Vis and Fluorescence Spectrocopy. The interaction between the dyes and titanium dioxide was monitored with FTIR and Raman Spectroscopy. The fabricated dye-sensitized solar cells were characterized via current-voltage measurements and electrochemical impedance analysis. Dye-sensitized solar cell fabricated with Jamun produced the highest efficiency of 1.09 % with a short-circuit current of 7.84 mA/cm^2, an open-circuit voltage of 0.45 V, and a fill factor of 0.31. The efficiencies of the dye-sensitized solar cells from black plum and blackberry were 0.55% and 0.38%, respectively. The flow of charge occurring at the interfaces between the natural dye and the TiO_2 layers were investigated using electrochemical impedance spectroscopy (EIS). This study, to the best of our knowledge, is the first on the comparison of the three different black-colored dye-sensitized solar cell devices. Computation analysis was also carried out utilizing SCAPS-ID software which revealed how the type of defects in the devices impacts their performance.

Keywords: Dye-sensitized solar cell (DSSC), Natural dye, Titanium dioxide , Current, Voltage, Electrochemical impedance spectroscopy (EIS), SCAPS-ID

1. Introduction

There is an ever-growing need for energy in every country, and the main sources of energy in the world are fossil fuels such as natural gas, coal, bituminous sand, and oil. However, these materials are not ideal sources of energy as they are considered the main sources of pollution, which make their continuous use a cause of serious environmental problems.[1-3] The development of renewable energy is thus very important in solving the growing demand for energy in the world.

Solar, wind, hydro, biomass, and geothermal are the main sources of renewable energy that have been explored in recent times, and solar energy is by far the most abundant of them all.[1-3] Solar cells convert sunlight to electricity, and it is harnessable by people from all parts of the world.

Dye-sensitized solar cells (DSSCs) convert solar energy into electrical energy by photosensitization of the cell[4-11] The efficiency of this conversion depends, to a large extent, on the quality of the dye sensitizer used in the fabrication of the solar cell.[12-15] Over the past two decades, several classes of dyes – including Ruthenium compounds,[15-20] Porphyrins,[21-23] and Cyanines[24,25] – have been synthesized, characterized, and applied in the design of efficient DSSCs. However, these dyes are at times expensive and not completely safe for the environment. Consequently, there is a growing interest in the use of natural dyes extracted from plants as photosensitizers in the construction of dye-sensitized solar cells.[26-35] The use of natural dyes in DSSCs is a promising development as a result of the following reasons: 1) Most of the natural dye pigments such as anthocyanins, carotenoids, flavonoids, and chlorophylls, have anchoring groups which strongly bind the dye to the titanium dioxide electrode, which allows for an easy charge transfer; 2) They are more economical since they are obtained through a simple extraction process (cold press, solvent extraction), as opposed to an expensive chemical synthesis process in the case of synthetic dyes; 3) Plants are abundant in supply and the natural dye can be extracted from several parts of the plants including fruit, flowers, leaves, roots, and bark.

In this study, natural dyes from three black fruits, as shown in Figure 1, were explored for use as sensitizers in the design of a solar cell. Since the pigment is mostly concentrated in the peels of the fruits, the dye for the sensitization was extracted from the peels.

Figure 1. Jamun, Black Plum, and Blackberry fruits from which dye were extracted for the study.

In addition to the experimental study, we also accomplished computational analysis of the three DSSCs by SCAPS-1D software and predicted different types of defects present in the three devices and also their energy positions, densities, and their influence on the photovoltaic performance of the devices. Numerous types of defects, such as oxygen vacancies (V_o), Ti interstitials (Ti_i), and hydroxyl groups, are commonly present during the synthesis of TiO_2 semiconductors[36-40] These defects change the electronic structure of TiO_2, especially the oxygen vacancy (V_o) which affects the optical and electronic properties of TiO_2 [40-42] V_o is primarily found in TiO_2 at the subsurface level, though with an applied electric field, it can be stable at the surface level of TiO_2 [43,44] Transformation of Ti^{4+} to Ti^{3+} accelerates with the increasing defect density of V_o [45]. The Ti atoms also get relaxed around the V_o by reducing the Ti – O bond length [38].

2. Experimental Section

2.1 Materials

Colloidal graphite was used to prepare the counter electrode that was purchased from Ted Pella, INC, (CA, USA). Titanium dioxide powder (Degussa P-25) and Iodide/triiodide redox couple were used as the electrolyte medium and were purchased from the Institute of Chemical Education, University of Wisconsin-Madison, Department of Chemistry, (Madison, WI, USA). Fluorine tin oxide (FTO) conducting glass slides were purchased from Hartford Glass Company, (Hartford City, Indiana, USA.) Sodium hydroxide (NaOH), acetone (C_3H_6O), ethanol (C_2H_5OH), and acetic acid (CH_3CO_2H) were purchased from Sigma-Aldrich (St. Louis, MS, USA), and were used without further purification.

2.2 Characterization Techniques

TiO_2 paste was printed on FTO glass using WS-650 Series Spin Processor from Laurell Technologies Corporation, (PA, USA). The cell performance was measured using a 150 W fully reflective solar simulator with a standard illumination of air-mass 1.5 global (AM 1.5 G) having an irradiance of 100 mW/cm^2 (Sciencetech Inc. London, Ontario, Canada). Reference 600 Potentiostat/Galvanostat/ZRA from GAMRY Instruments (Warminster, PA). HOMO and LUMO calculations were carried out using Spartan ‘14 software from Wavefunction, Inc. (Irvine, CA, USA). Fourier transform infrared spectroscopy (FTIR) spectra were obtained with a Thermo Nicolet iS50 FTIR. The samples were placed on crystal of ATR-FTIR and the spectra were scanned

on the wavenumber range of 600-4000 cm^{-1}. Raman studies were conducted with a model DXR smart Raman spectrometer (Thermo Fisher Scientific Co., Ltd., USA). Morphological and elemental analysis of the titanium dioxide photoanode was carried out with a Field Emission Scanning Electron Microscope (JSM 7100F, JEOL.COM, USA) equipped with an Energy Dispersive X-ray spectroscopy for elemental analysis.

2.3 Natural Dye Extraction

Jamun is a fruit which has a very light-colored flesh surrounded by a rich, dark purple skin. The dye was extracted from the peel of the fruit due to its high concentration of anthocyanin.

The blackberries and black plum were handled in a similar fashion and the natural dyes were extracted using a commercial blender extractor. The dye extraction process was performed through a sequence of steps that includes a high speed of blending (~2K RPM), filtration, centrifugation, and finally decantation to remove any precipitate present in the crude extract.

2.4 Fabrication of Jamun, Black Plum, and Blackberry DSSC

The electrodes were prepared according to a previously published procedure with some modifications.[46-50] The photoanode was prepared by depositing a thin film of TiO_2 on the conductive side of a fluorine-doped tin oxide (FTO) glass using a spin coater and annealing the film at 380°C for 2 hours. The TiO_2 coated FTO glass was subsequently dipped in $TiCl_4$ solution for an hour and annealed again for 30 minutes. The substrate was then immersed overnight in a freshly prepared dye solution. The counter electrode (cathode) was prepared by plastering colloidal graphite on the conductive side of the FTO glass. The respective dye-sensitized photoanodes and the carbon electrodes were assembled to form a solar cell by sandwiching a redox iodine/iodide electrolyte solution.

2.5 Simulation Methods

SCAPS is a one-dimensional solar cell simulation program developed at the University of Gent's Electronics and Information Systems (ELIS) department. [51-53] SCAPS captures the analytical physics of the solar cell device but it is not restricted to transport mechanisms, individual carrier current densities, electric field distributions, and recombination profiles. SCAPS has the

most AC and DC electrical measurements when compared to other simulation software which includes open-circuit voltage (Voc), short circuit current density (Isc), fill factor (FF), power conversion efficiency (PCE), quantum efficiency (QE), spectral response, generation, and recombination profile. These physical quantities can be computed at different illumination and temperature levels and also in both light and dark conditions. Three coupled differential equations serve as a basis for it, Poisson's (1) and continuity equations for holes (2) and electrons (3) as follows:

$$\frac{d}{dx}\left(-\varepsilon(x)\frac{d\psi}{dx}\right) = q[p(x) - n(x) + N_d^+(x) - N_a^-(x) + p_t(x) - n_t(x) \quad (1)$$

$$\frac{dp_n}{dt} = G_p - \frac{p_n - p_{n_0}}{\tau_p} - p_n\mu_p\frac{d\xi}{dx} - \mu_p\xi\frac{dp_n}{dx} + D_p\frac{d^2p_n}{dx^2} \quad (2)$$

$$\frac{dn_p}{dt} = G_n - \frac{n_p - n_{p_0}}{\tau_n} + n_p\mu_n\frac{d\xi}{dx} + \mu_n\xi\frac{dn_p}{dx} + D_n\frac{d^2n_p}{dx^2} \quad (3)$$

Here, ψ is electrostatic potential, q is the electron charge, D is diffusion coefficient, G is generation rate, ξ is permittivity, and n, p, n_t, and p_t are free holes, free electrons, trapped holes, and trapped electrons, respectively. N_a^- refers to ionized acceptor-like doping concentration, and N_d^+ stands for ionized donor-like doping concentration.

2.6 Device Architecture

A schematic representation of the DSSC is displayed in Figure 2. The default operating temperature is set to 300 K and the illumination condition is set to the global AM.1.5 standard. The device consists of an anode and a cathode separated by the electrolyte. The anode is made up of a fluorine-doped tin oxide coated glass plate with a layer of dye sensitized titanium dioxide film. The cathode comprises of a fluorine-doped tin oxide coated glass plate with a layer colloidal graphite. This set-up allows for the generation of current when light in incident on the device.

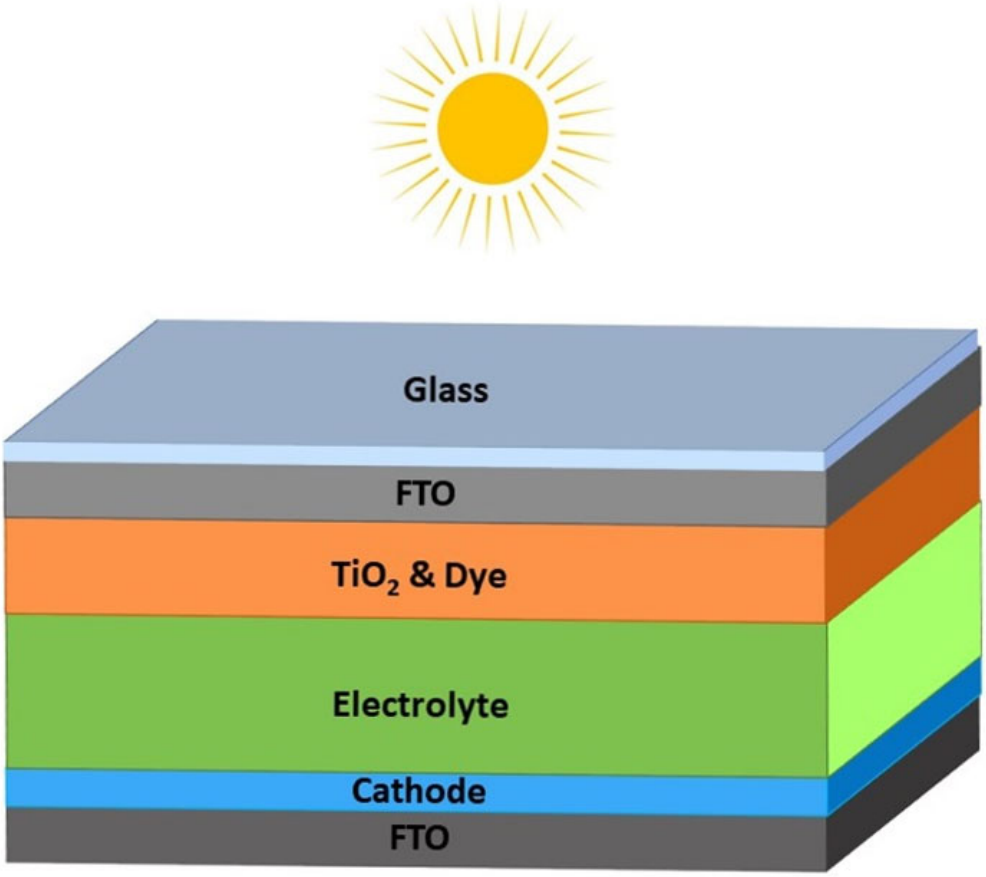

Figure 2. A schematic representation of the DSSC.

Different key parameters of the different layers of the DSSC used in the SCAPS-1D software are illustrated in Table 1. The parameters were gathered from a variety of experimental works, some reasonable estimates, and published literature. [54-61] The defect properties of the three-natural dye-sensitized TiO_2 films used for our simulation study are also shown in Table. 2.

Table 1. Parameters of different layers of the DSSCs used in SCAPS-1D.

Parameters/Layers	**FTO**	**TiO_2 & Dye**	**I^-/I_3^- (Electrolyte)**
Relative Permittivity, ε_r	9	10	30
Bandgap energy (eV)	3.5	3.2	1.3
Electron Affinity (eV)	4	4.2	2.22
Electron Mobility ($cm^2/V.s$)	33	200	200
Hole Mobility ($cm^2/V.s$)	8	50	100
Donor Concentration, N_d (cm^{-3})	2.0×10^{16}	1.35×10^{11}	0
Acceptor Concentration, N_a (cm^{-3})	0	0	1.35×10^{11}
Conduction Band Density of States/N_c (cm^{-3})	2.2×10^{18}	1.8×10^{19}	1.0×10^{18}
Valence Band Density of States/N_v (cm^{-3})	1.8×10^{19}	3.5×10^{19}	1.0×10^{19}
Radiative Recombination(cm^3/s)	2.3×10^{-5}	2.3×10^{-5}	5.0×10^{-6}

Table 2. Parameters of defects in different dye-sensitized TiO2 films used in SCAPS-1D.

Parameters/Dyes	Jamun	Black Plum	Blackberry
Defect type	Neutral	Single Donor	Single Donor
Capture cross section electrons (cm^2)	1.0×10^{-15}	1.0×10^{-15}	1.0×10^{-15}
Capture cross section holes (cm^2)	1.0×10^{-15}	1.0×10^{-15}	1.0×10^{-15}
Energetic distribution	Single	Single	Single
Reference for defect energy level E_t	Above E_v	Below E_c	Below E_c
Energy level with respect to Reference (eV)	2.2	0.2	0.1
Characteristic energy (eV)	0.1	0.1	0.1
Defect density, N_t (cm^{-3})	2.5×10^{17}	1.0×10^{20}	1.0×10^{22}

3. Results and Discussion

3.1 Absorption Spectroscopy Measurements

The UV-Vis absorption spectra show the tendency of the dye to absorb photons in order to make a transition from the ground state to an excited state for the ejection of electrons into the TiO_2 semiconductor. UV-Visible spectroscopy was carried out to determine the photophysical charcteristics of the natural dyes extracted from the three black fruits. The UV-Vis spectra are displayed in Figure 3. The spectrum shows a wavelength with maximum absorption for the dye extracted from Jamun at 550 nm, whilst the absorptions of black plum and blackberry were shifted to a *hypsochromic* region and appear at 514 nm and 513 nm, respectively. The maximum absorption that occur in the near-visible region (400-525 nm) is indicative of the presence of anthocyanin in the natural dyes.[61] On the other hand, the band of absorption corresponding to Jamun was slightly red-shifted.

In addition, the band of transition corresponding to the dye extracted from the Jamun was broader than that of the other two fruits, which suggests that this dye has the capacity to absorb more energy, thus improving the performance of the cell.

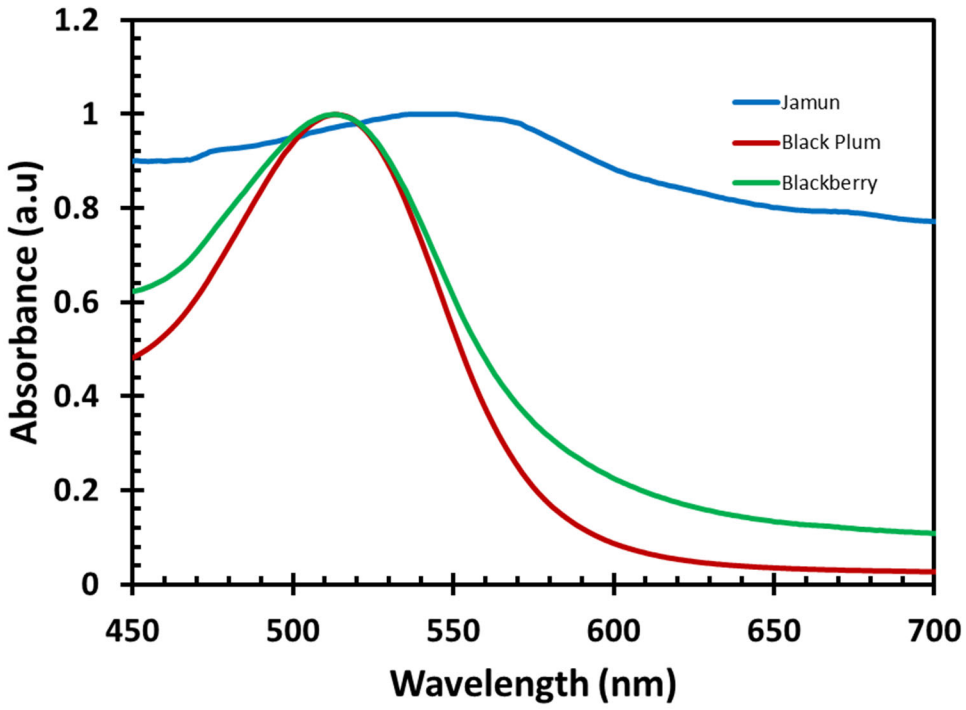

Figure 3. Absorption spectra of Jamun, black plum and blackberry fruit extract.

3.2 Field Emission Scanning Electron Microscopy and Energy Dispersive X-Ray Spectroscopy

Field Emission Scanning Electron Microscopy (FESEM) imaging was carried out on the Jamun dye-sensitized titanium dioxide to study the porosity and morphological features of the titanium dioxides and how it allows for adsorption and retention of the dye sensitizer. The FESEM image of the Jamun dye-sensitized titanium dioxide together with its mapping analysis as well as the Energy Dispersive X-Ray Spectroscopy of both the sensitized titanium dioxide film and and that of bare titanium dioxide is displayed in Figure 4. The image of the Jamun slide (a) displays a sponge-like structure of the titanium dioxide film comprising of spherical nanoparticles consistent with reports.[62] The nanoparticles are bound to each other in an unordered fashion but without fractures or gaps, ensuring a good interparticle connectivity that allow for the transport of charge.

The mapping analysis (b) shows the presence of titanium, carbon, oxygen, and phosphorus. The titanium dioxide is the main component and it revealed in the color of the image.

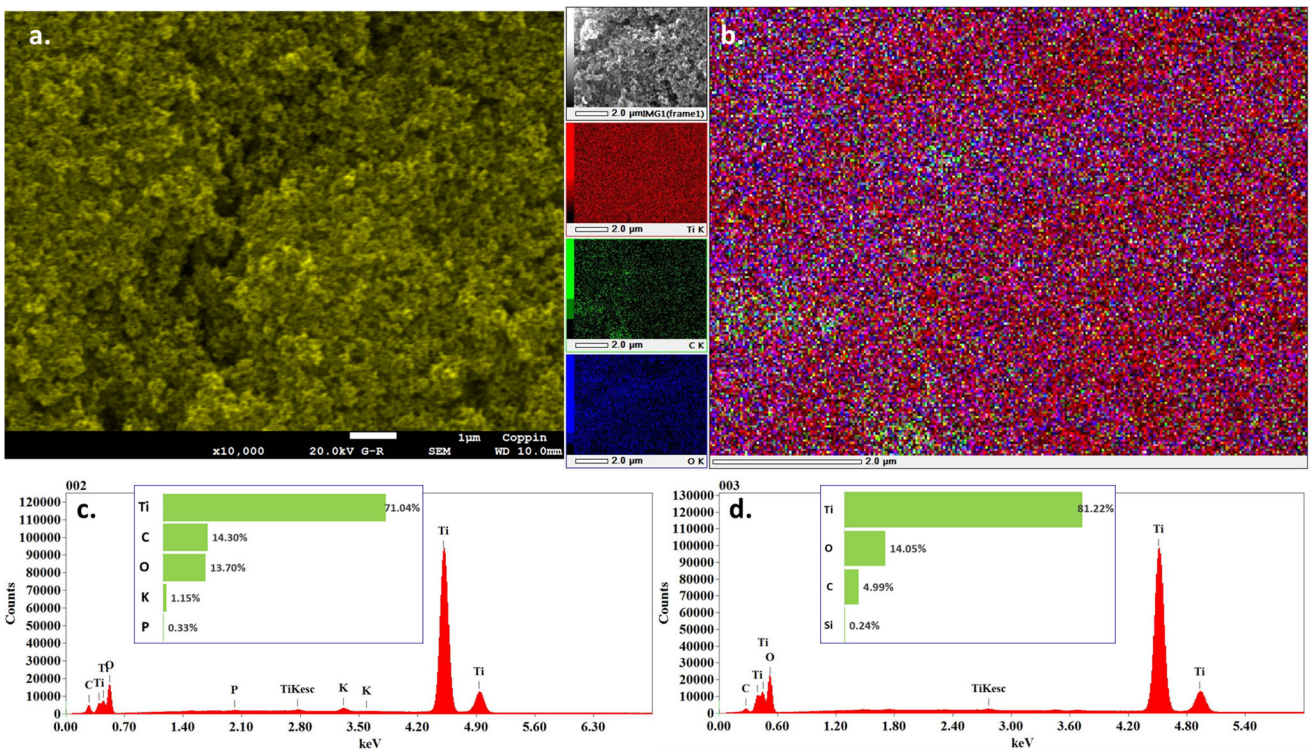

Figure 4. Field Emission scanning electron microscopy image of Jamun sensitized TiO_2 (a) with its elemental mapping analysis (b) and the Energy Dispersive X-Ray analysis of Jamun sensitized TiO_2(c) and bare TiO_2 (d)

Energy Dispersive X-Ray Spectroscopy (EDS) of Jamun dye-sensitized titanium dioxide(c) and that of the bare titanium dioxide (d) provide information about the attachment of the dye to titanium dioxide. In the case of Jamun dye-sensitized titanium dioxide film the percentage of carbon present was 14.3% where as that of the bare titanium dioxide, the percentage of carbon was 4.99%. The difference in the percentages is due to the presence of the dye on the titanium which increase the amount of carbon present. The Jamun dye has several carbon-rich organic molecules which are responsible for the difference in the carbon content between the dye-sensitized film and the bare titanium dioxide.

The DSSC fabricated with Jamun gave the highest solar-to-electric power of efficiency of 1.09%, with an open-circuit voltage of 0.45 V, short-circuit current of 7.84 mA/cm^2, and a fill factor of 0.31. In the other hand, little efficiencies were determinate on Black Plum and Blackberry dyes with values calculate to be 0.55% and 0.38%, respectively. These results are consistent with the UV-Vis, FTIR, and Raman analysis. Also these experimental data are consistent with values obtained through the simulation as demonstrated in the inset in Figure 5. The high congruence between the experimental and simulation numbers provide confidence in the validity of these results.

Table 3. Comparison of the Photovoltaic performance of Jamun, Black Plum and Blackberry based DSSCs.

	V_{oc} (V)	I_{sc} (mA/cm^2)	V_{mp} (V)	I_{mp} (mA/cm^2)	Fill Factor	Efficiency (%)
Jamun	**0.45**	**7.84**	**0.26**	**4.25**	**0.31**	**1.09**
Black Plum	**0.48**	**3.63**	**0.25**	**2.16**	**0.32**	**0.55**
Blackberry	**0.45**	**2.96**	**0.24**	**1.58**	**0.29**	**0.38**

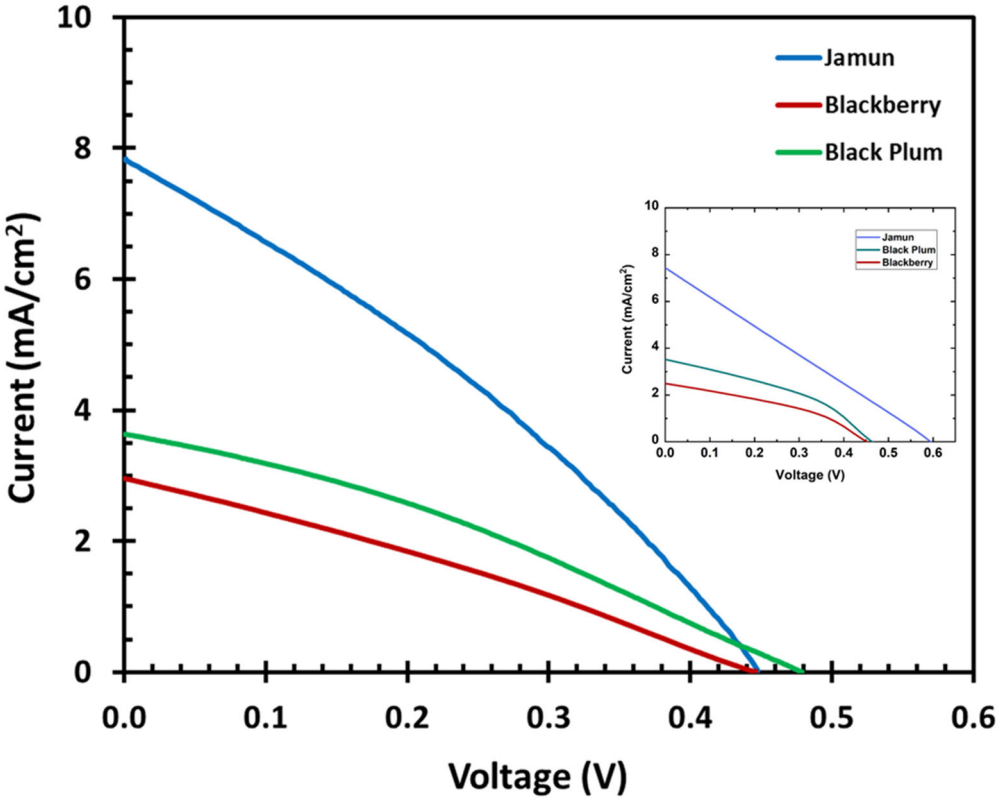

Figure 5. Current and Voltage measurement of DSSC fabricated with natural dye extracted from Jamun, Black Plum, and Blackberry under 1 sun illumination at 100 mW/cm^2 (Inset: Current vs voltage graph of the three DSSCs from the simulation study).

3.8 Correlations between Simulation and Experimental Data

The experimental data obtained were consistent with that of data generated through computation analysis. In our simulation study, we induced different types of defects in the dye-sensitized TiO_2 films which are illustrated in Table 2. One of the major reasons for dye-sensitized TiO_2 films' low efficiency is the formation of various types of point defects during their fabrication.[63] Both shallow and deep level defects can be presented during the synthesis of TiO_2. Oxygen vacancy (V_o) at the surface level of TiO_2 is one of the deep level defects which has an energy level above 2.2 eV from the valance band maximum (VBM) of TiO_2 [64]. The coupling between the 3d orbitals of the two under-coordinated Titanium atoms creates a σ bond that generates these deep-level defects. [65] To match the simulation values with experimental results, were used deep level defects in the proposed simulation study for DSSC fabricated with Jamun dye. For these purposes was used the defect density parameter with 2.5×1017 cm^{-3} at the energy level for 2.2 eV above the

VBM of TiO_2, and this simulation provided approximately the same efficiency as found with the experimental data. On the other hand, it was reported that subsurface level oxygen vacancy (V_o), hydroxyl group, and Ti interstitial (Ti_i) also create shallow level defects in TiO_2. These shallow defects can be hypothesized to occur at 0.1 – 0.2 eV below the conduction band minimum (CBM) of TiO_2. In our computational analysis of the other two DSSCs, we have induced shallow level defects in them. For DSSCs of black plum and blackberry, shallow level defects with the concentration of 1.0×10^{20} cm^{-3} and 1.0×10^{22} cm^{-3} generated nearly the same photovoltaic outputs as the experiment, respectively. All the solar cell outputs from the experimental and computational analysis have been shown in Table 4.

Table 4. Comparison of the experimental and computational Photovoltaic performance of Jamun, Black Plum, and Blackberry based DSSCs.

Dye	Voc (V)	Jsc (mA/cm^2)	Vmp (V)	Imp (mA/cm^2)	Fill Factor	Efficiency (%)
Jamun (experimental)	0.45	7.84	0.26	4.25	0.31	1.09
Jamun (simulation)	0.59	7.42	0.3	3.7	0.25	1.11
Black Plum (experimental)	0.48	3.63	0.25	2.16	0.32	0.55
Black Plum (simulation)	0.46	3.54	0.3	2.08	0.38	0.62
Blackberry (experimental)	0.45	2.96	0.24	1.58	0.29	0.38
Blackberry (simulation)	0.45	2.5	0.3	1.42	0.38	0.43

4. Conclusion

Natural dyes extracted from Jamun, Blackberry, and Black plum were characterized and utilized in the fabrication of dye-sensitized solar cells. The DSSC fabricated with Jamun provided the

highest solar-to-electric power conversion efficiency of 1.09%, an open-circuit voltage of 0.45 V, a short-circuit current of 7.84 mA/cm^2, and a fill factor of 0.31. The efficiency of Black Plum and Blackberry were 0.55% and 0.38%, respectively. The Electrochemical Impedance Measurements, in terms of Nyquist and Bode plots, were consistent with the current and voltage measurement. Furthermore, the results are also consistent with the UV-Vis measurements. Natural dyes from three black fruits could be potentially used as sensitizers in the design of a solar cell. The simulation results almost match with the experimental values by using the only possible defect properties shown in Table 2. It can be predicted that deep level defects were present in DSSC fabricated with Jamun and shallow level defects were present in DSSCs fabricated with black plum and blackberry. Defect density was highest in the DSSC with blackberry and lowest in DSSC with Jamun. Low absorbance of the three natural dyes was also responsible for the low PCE of the devices.

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Healing City Baltimore: A Perspective of Micro and Macro Social Work Practice

Melissa E. Buckley, PhD, MSW, LMSW
mbuckley@coppin.edu

Abstract

Social work as a profession is generalist in its approach, providing a range of service to individuals, groups and communities. Historically, social work pedagogy has emphasized individual, or micro practice, and did not adequately demonstrate the integration of community,or macro practice, which resulted in students believing they had to choose one area of practice over the other. Additionally, it has been found that many accredited social work programs, undergraduate and graduate programs alike, do not offer robust macro practice training. Instead, the emphasis tends to be on micro practice training. Healing City Baltimore and Coppin State Univeristy, a Historically Black University in Baltimore, Maryland formed a partnership that offered emerging social work students with a unique approach and perspective of merging micro and macro practice.

Keywords: *Antiracist, pedagogy, Critical Race Theory (CRT), social work; Healing City Baltimore*

Healing City Background

The Council on Social Work Education (CSWE) is the sole accrediting body of baccalaureate and master's social work programs in the United States. The CSWE utilizes its Educational Policy and Accreditation Standards (EPAS) to guide social work programs in the development of their curriculum. The EPAS provides nine education competencies that each

social work program must integrate in its curriculum to establish professionalism in emerging social work scholars. The nine competencies are as follows: 1) demonstrate ethical and professional behavior; 2) engage diversity and difference in practice; 3) advance human rights and social, economic and environmental justice; 4) engage in practice informed research and research informed practice; 5) engage in policy practice; 6) engage with individuals, families, groups, organizations, and communities; 7) assess individuals, families, groups, organizations, and communities; 8) intervene with individuals, families, groups, organizations, and communities; and 9) evaluate practice with individuals, families, groups, organizations, and communities. Though the EPAS speaks to the need for policy considerations in social work curriculum, students have been found to have graduated from accredited programs with very little exposure to social work policy training but have a wealth of training that has prepared them for case management.

According to research, competency 5 tends to be the competency where most social work educators find challenge in engaging emerging social work scholars (Pawar & Nixon, 2020; Tropman & McBeth, 2019; Wilfong, 2020). Students find it difficult to engage in macro and policy classes due to what they perceive as a disconnect between the applied practice which is hands-on and policy which can be abstract. Pawar & Nixon recommend structuring the curriculum in a way that engages scholars in macro topics that are closely related to their needs and personal experiences, thus not only making it more relatable but also helping keep them engaged (2020). This was the approach of a macro class in a bacculerate social work program in Baltimore, Maryland. The students were enrolled in the program's Methods III class which teaches community and policy practice skills. The Capstone assignment provided students with the opportunity to demonstrate competent analytical skills in the critical analysis of the Elijah Cummings Healing City Act, Trauma Informed Care (TIC) and antiracism. With this foundational knowledge, students were required to evaluate the needs of specific Baltimore City communities by conducting a TIC needs assessment. This needs assessment required the scholars to identify a trauma that is prevalent in Baltimore City. Many of the scholars used the Adverse Childhood Experiences (ACEs) as their guide in identifying trauma likely to be faced by individuals living in Baltimore City. ACEs is a study conducted by the Center for Disease Control (CDC) and Kaiser Permanente that investigated childhood abuse, neglect and other maladaptive conditions that impacted the likelihood of overall wellbeing (CDC-Kaiser ACE

Study, 2021). The study suggests that 61% of adults have reported at least one type of ACE and 1 in 6 have reported more than 4 different types of ACEs (CDC-Kaiser ACE Study, 2021). There are three types of ACEs, abuse, neglect and household dysfunction. Examples of abuse are physical, emotional or sexual abuse. Examples of neglect are physical and emotional. Examples of household dysfunction are mental illness, domestic violence, divorce, relative incarceration or substance abuse. The study has been replicated throughout the years and the findings remain consistent; there is a direct correlation between adversity faced in childhood and adult illness (Hillis, Anda, Felitti, & Marchbanks, 2001; Susser, Struening, Link, 1997). The Abell Foundation reported in 2019 that Baltimore City "has some of the highest incidence rates of ACEs in Maryland" (2019).

Following the needs assessment, students were required to provide recommendations for how the Elijah Cummings Healing City Act, through its emphasis on TIC, would respond to the individual and community needs, most of which were in some way tied to ACEs. These recommendations had to be research informed.

The need to bridge micro and macro social work practice is relevant throughout various aspects of the profession of social work, all of which have an impact on emerging social work scholars. For example, when it comes to licensure examinations, the bulk of questions on any of the license exams is geared towards individual social work practice. This implies that the need for licensure for macro workers is not as great as the need for licensure of clinicians and that macro social workers do not require the same level of supervision and accountability as micro social workers.

On a more grassroots level, through their mandatory and direct participation in the Healing City Baltimore movement and the passage of the Elijah Cummings Healing City Act as a Capstone requirement, these emerging social work scholars were able to experience the merger of micro and macro practice through the collaboration of their social work program and a partnership with a local elected official and a community based program. The students had direct contact with many of the community members who participated in Healing City Day at their university. They were able to conduct intake assessments and offer referrals to the most appropriate community resource that was at the event. This experience also provided the students with the opportunity to experience the necessity of antiracist social work. With its history of racist social policy, Baltimore must make recompense for it's racist legacy. This can only be

done by adopting an antiracist perspective that dismantles oppressive systems and introduces public policy that speaks to the oppression of its citizens. To date, the Elijah Cummings Healing City Act is the first of its kind in any city throughout the United States to take this stance, thus creating an opportunity for social work students in Baltimore City to have yet another example of the need to merge micro and macro social work practice. Students were not given case studies and vignettes to learn about racism. Through the intakes they conducted and the referrals they made, they were able to see how harmful it is to the health and public safety of disenfranchised groups, such as Black people, to not have public policy at the city and state level that will require the implementation of a task force intended to ensure all city agencies are operating from a TIC perspective that is also antiracist in its approach. It is imperative to the safety of the individauls and communities these emerging social workers will work alongside that social workers are trained not only in the theories of behavior science, but they are also trained to confront racism in public policy (Martin & Martin,1995).

According to Vanidestinea & Aparicio, programs need to "explore ways to explicitly identify structural conceptualizations of racism, whiteness, social power, and our intersecting systems as concepts to guide our future interventions. We must highlight racism and whiteness (white supremacy) as ethical issues" (2019, p. 440). This partnership afforded students the opportunity to confront whiteness, structural racism and oppressive entities and emphasize these as matters of ethical professional behavior.

Baltimore City has historically been plagued by trauma and violence. There have been many grassroots efforts to address this legacy and there have been varied results. Healing City Baltimore, a local grassroots initiative was formed to confront trauma and violence in the city. With partnerships and collaboration as its guiding principle, the partnership with local universities was inevitable. Coppin State Department of Social Work is a Healing City Baltimore partner. This partnership, which will be celebrating its third year in February 2022, affords students with rich micro and macro exposure. Social work education tends to offer rich learning experiences in individual or micro practice. Rarely do students graduate from social work programs feel they have had adequate exposure to community practice. Additionally, social work pedagogy on a whole has inadequately embraced antiracist pedagogy, often leaving emerging social workers ill equipped to offer services and support to their clients of diverse backgrounds. The Healing City and Coppin State University partnership empowered the social

work students to engage in trauma-informed work in their city not only as Baltimore residents but also as emerging social work professionals.

Abstracts of Presentations

Knowledge of Alzheimer's Disease, Alzheimer's Association Availability, and Awareness of Alzheimer's Disease-Related Services in the African American and Hispanic Community

Dr. Crystal Day-Black
Adedoyin Akingbade, Breona Bushrod, Daniel Harris, Laurencia Hutton-Rogers, Shaitia Moore, Ashley Patterson, Daniela Reader, Johanna Salazar, Godfrey Thomas, Krystal Yizar, and Donald Zapanta, Jr.
Senior level Accelerated Community Health Nursing Students
Coppin State University

The purpose of the study was to investigate factors associated with Alzheimer's Disease (AD)-related knowledge and service awareness among African Americans and Hispanics in the Baltimore city community. Considering the importance of social resources in the lives of ethnic minorities, the focus of this study was on exploring the populations' knowledge and service awareness of the Alzheimer's Association in the Baltimore area. Data were collected from n=151 African Americans and Hispanics between the ages of 40-64. Findings highlight the critical roles of both prior exposure to AD and a social network influencing Alzheimer Association availability in the community, AD knowledge and service awareness with activity participation. Most of the respondents reported limited knowledge of the Association. Since African American and Hispanic communities are not aware that the organization exists, they are less likely to access its resources. The results indicated that the top three methods of receiving health information in African American and Hispanic communities were the internet, television, and hospital/doctor's office. These findings suggest that the Association should increase efforts to promote resources and services to African American and Hispanic communities. Results also suggest that more attention should be directed toward individuals who are culturally and socially isolated when considering services.

Fabrication of Dye-sensitized Solar Using Rhodamine Rye

William Ghann
Dr. Jamal Uddin
Coppin State University

Dr. Oyedoyin Aduroja
Dr. Fasil Abebe
Morgan State University

Beatrice Asante
Student
Coppin State University

Dye-sensitized solar cells (DSSCs) are a special kind of low-cost solar cell that efficiently converts visible light into electrical energy. In this study, Rhodamine 6g-Isophthalaldehyde, highly soluble fluorescent dye, and its metal complex were used in the fabrication of sensitized solar cells. The photophysical studies of the Rhodamine 6g, including UV-Vis spectroscopy, fluorescence spectroscopy, and fluorescence lifetime measurements were also carried out. Measurements of current-voltage characteristics and electrochemical impedance of dye-sensitized solar cell fabricated with Rhodamine 6g-Isophthalaldehyde and its metal complex were carried out to assess the performance of the solar cell.

Healing City Baltimore, a Perspective of Micro and Macro Social Work Practice

Melissa E. Buckley, PhD, LMSW
Coppin State University

Objectives:

1. Learn about a community intervention that included community members, baccalaureate social work programs, and city government.
2. Learn tools to integrate micro and macro social work practice.
3. Learn the importance of macro-based partnerships for social work programs.
4. Learn about the city and state legislation that came about because of the Healing City initiative.
5. Learn the importance of Antiracist social work practice.

Description: Baltimore has historically been plagued by trauma and violence. There have been many grassroots efforts, which have produced varied results, to address this legacy. In 2019, following a Baltimore school shooting, Healing City Baltimore, a local grassroots initiative, was formed to confront trauma and violence in the city. Healing City introduced the Elijah Cummings Healing City act, city legislation that will hold the city of Baltimore and local service agencies accountable to address trauma and create opportunities for healing in the city. The Coppin State Department of Social Work is a Healing City Baltimore partner. This partnership affords students with rich micro and macro exposure. Social work education tends to offer rich learning experiences in individual or micro practice. Rarely do students graduate from social work programs feeling they have had adequate exposure to community practice. Additionally, social work pedagogy on a whole has inadequately embraced antiracist pedagogy and often leaves emerging social workers ill-equipped to offer services and support to their clients of diverse backgrounds. The Healing City and Coppin State University partnership empowered the social work students to engage in trauma-informed work in their city not only as Baltimore residents but also as emerging social work professionals.

Pandemic Effect on Taxes

Loretta Baryeh, PhD

This study examines the impact of the pandemic on taxes. Taxes have been a good source of revenue for most economies. The coronavirus pandemic disrupted most economies in 2020. Disruptions were a result of total lockdowns, restrictions in certain sectors, health constraints, and many other problems. Since this was a global issue and most economies were affected, this study aims to ascertain how taxes were impacted and the consequential impact on revenues (GDP) in general. Results of the study can be used by regulatory bodies and others to enable planning to mitigate unexpected future eventualities.

Perception of University Enforcement Officials on Unsubmitted and Untested Sexual Assault Kits (SAKs)

Darlene Brothers-Gray, PhD

This qualitative research study examines the perceptions of university law enforcement officials on unsubmitted and untested sexual assault kits (SAKs). Sexual assault nurse examiners use SAKs to collect evidence from sexual assault victims and pass them to law enforcement officials; however, many SAKs remain unsubmitted and untested once in police custody. Without such evidence, law enforcement officials cannot apprehend perpetrators of sexual assault. Sexual assault is a problem worldwide, including on university campuses where there are higher rates of sexual assault than in the general population. The generic qualitative inquiry study was the means of exploring why many officials do not test SAKs in police custody and to assess the perceptions of 10 university police officers in 2 Middle Atlantic university police departments regarding unsubmitted and untested SAKs. Semi-structured interviews, conducted in person, digitally recorded, and transcribed, elicited the experiences of the law enforcement officers. Following the interviews, thematic analysis (i.e., inductive analysis) was used to analyze the data, from which 4 thematic categories emerged: (a) finances, (b) resources, (c) manpower, and (d) reoccurrence. The research shows that the provision of resources, finances, and manpower is necessary to reduce single and reoccurring sexual assault crimes and to promote the proper functions of the criminal justice system, collective engagement of members of society, and equal value of citizens, regardless of gender. The study indicated the need for stakeholders to collectively engage, acknowledge the systemic gaps, and provide resolution so that officials properly utilize SAKs to apprehend offenders and empower victims to live healthy, functional lives.

Semi-Critical Assisted Extraction: A Highly Thermochemical Technology Apply to Clean Environmental Contaminants from Fossil Fuels Raw Material - Bituminous, Lignitic-Coal

Tulio Chavez-Gil, PhD

The extraction of raw material from crude petroleum, bituminous, and lignitic coal (gas, hydrocarbon) and their hazard contaminants (ash, heavy metals, poly-aromatic hydrocarbons, PAHs) are challenging processes regarding addition of economic value to fossil fuels used to produce energy in thermoelectric power plants, industry, transportation, etc. Supercritical fluid extraction (SFE) (high pressure, high temperature dependent) and modified Soxhlet (solvent density dependent) are technologies that had dominated PAH extraction for more than three decades. Parallel methods, however, show similar results as those obtained by these technologies, so an urgent need to address the short stage of methods emerges for the extraction of hazardous contaminants from fossil fuels as economical and efficient technologies are claimed from long ago.

Herein, we present an overseas recognized but under-developed advanced thermochemical method termed "semi-critical assisted extraction" (SmCAE), which has a broad scope of applications in scientific, technological, and academic fields regarding extraction and separation of hydrocarbon(s), ashes, heavy metals, and PAHs from crude petroleum and dirty coal. The physics, chemistry, and technological approaches of this proposed technology has been tested on a recently patented innovation (Ch-G extractor), which we hypothesize works to generate a laminar flow, with the fluid being composed by a biphasic state (gas/liquid) that coexists in an isothermal equilibrium. The novel aspect of the technology is related with the Ch-G facile operation, less time/solvent consumed, and, most importantly, for *in situ* thermodynamic property measurements (temperature, pressure, pH, viscosity), impossible to be determined with either extractor available in the market. Our results show an increase (MW %) on C, H and a decrease on O, heavy metals, and Sulfur (S) after bituminous coal is treated by SmCAE, using a "green solvent."

After/before -a/b- SmCAE treatment: C, 88/83; H, 1.4/0.01 (calculated by difference); O, 4.73/6.98; S, 0.56/0.77; Heavy metals 5.32/8.26.

Ethics and Governance of Artificial Intelligence for Health, WHO 2021 Report Review

Dr. Ericka Covington

Dr. Atma Sahu

Dr. Lidan Ha

A global economic ethic with legitimate, just, and fair underpinnings relies on moral principles and values. In global society today several ethical challenges are emerging particularly with the use of technology for health care. These challenges must be dealt with if technologies are to support the achievement of health care for all, which should address the persistent digital divide, the lack of good-quality data, the collection of data that incorporate clinical biases, and the lack of treatment options after diagnosis.

Secondly, the presenters in this session explore with participants the WHO's data governance framework that introduces the necessary standards, solutions, and structures to ensure the quality and integrity of data, from its collection, storage, analysis, and validation to its use. Finally, the impact of AI on the health workforce is examined with equal optimism and pessimism. If time permits, AI applications in the development and design of medical device will be discussed.

Reference: WHO 2021, Ethics and Governance of AI Report
https://apps.who.int/iris/bitstream/handle/10665/341996/9789240029200-eng.pdf

Mentoring As a Way of Advancing Tenure and Promotion in Higher Education Institutions in the United States: A Systematic Review

Dr. Patience Ebuwei

Tenure positions have come under increasing attack in American higher education institutions. Some have called for the total abolishment of tenure, while others have advocated strengthening higher education tenure practices. Tenure criteria are often blurry and not well understood. The tenure process and practices may also allow bias and discrimination. Using Social Cognitive Theory by Albert Bandura as the theoretical lens provided evidence that individual knowledge or skill can be developed by observing others. This study utilizes a systematic review of the literature to rigorously search for relevant literature in answering the research question: How can faculty mentoring be used as a mechanism in creating a practical feedback loop during the pre-tenure evaluation process in attaining tenure and promotion in higher education institutions in the United States? The purpose of this study is to examine tenure and promotion practices and to consider how mentoring can be used as a vehicle to lessen the tenure and promotion barriers and obstacles in attaining a tenured rank in higher education. A realist synthesis epistemological approach and a thematic analysis of the literature provided evidence of how faculty mentoring can be used as a mechanism in creating a practical feedback loop for pre-tenure faculty. The American Association of University Professors (AAUP) emphasized that, as of 2016, in the United States, combining all the higher education institutions, nontenure-track positions have increased to 73%. This study's findings are significant and will benefit higher education in the United States. Mentoring of pre-tenure faculty play a pivotal role for faculty careers and institutional advancement. The findings show that faculty mentorship in academia creates institutional knowledge about the tenure and promotion process that junior faculty typically lack.

The Shared Concepts of Mulla Sadra and James on Mystical and Religious Experiences

Dr. Sayed Hassan Akhlaq Hussaini

This paper explains the shared views of Mulla Sadra (1571-1636) and William James (1842-1910) on religious experiences. They came from two different traditions: Shia and Iranian Islam and American pragmatism. Through "The Transcendental Wisdom" and "Pragmatism," they made important philosophical contributions in the concept of truth. They turned away from ratiocinative philosophy, verbal solutions, fixed principles, and closed systems. By looking for the commonalities among various philosophical and religious tradition, they attempted to overcome the dichotomy of philosophies.

After an introduction, the paper illustrates how Sadra and James view mysticism as the heart of religious experience. In their views, the founders of the reveled religions based their teachings in their exceptional, personal, and immediate experience of the sacred reality. Then, it elaborates the characteristics of the mystical experiences. They are noetic and passive, neither rational nor irrational, moving beyond the dichotomy of subject-object, ordinary language, and the mind. Finally, it looks at the development and criticism of these perspectives in Iranian Shi'ism and in the West.

Assigning Faculty to University Committees by Considering Priorities: An Optimization Approach

Dr. Gazi Md Daud Iqbal
Dr. Lidan Ha
Dr. Sadie Gregory
Coppin State University

Dr. Jay M. Rosenberger
University of Texas at Arlington

University faculty members need to serve in different committees as part of their job requirements. However, assigning faculty to different committees is a complicated process because of the faculty preferences, departmental/college/university rules, and committee requirements. Not all faculty members can or want to serve in certain committees. In this research, we use Coppin State University as a case study and ask faculty to choose their agreement levels to serve in each committee using a Likert Scale. We then calculate the weights of each committee from the Likert Scale using Analytical Hierarchy Process (AHP). AHP provides a numerical scale for prioritizing the alternatives where a decision process is affected by feelings, ideas, and emotions. These weights are used in the objective function of a goal programming optimization problem where higher weights are assigned to faculty members' most preferred committees and lower weights are to their least preferred committees. University-, college-, and/or departmental-level requirements for faculty committee engagements are incorporated as constraints in the optimization problem. Finally, we show an optimal assignment of faculty members to university-wide and college committees that are consistent with their preferences.

Synthesis of Silver Nanoparticles and Studies of Their Antibacterial Activity

Dr. Dominique Dotson
William Ghann
Dr. Jamal Uddin
Coppin State University

Chika Iwuji
Student
Coppin State University

Hritaal Saha
Student
Urbana High School

Silver nanoparticles have been used in various fields ranging from health care to consumer products. Their specific characteristics and properties make them significantly useful in these various applications. The effectiveness of silver nanoparticles depends on a range of factors, such as size, shape, and size distribution. A method for synthesizing silver nanoparticles of a specific size that involves altering the concentration of the reducing agent, tannic acid, is presented here. The synthesized silver nanoparticles were characterized using UV-Visible spectroscopy, dynamic light scattering, and field emission scanning electron microscopy. The synthesized silver nanoparticles were subsequently used in antibacterial studies and were found to inhibit the growth of bacteria.

Describing the Effectiveness of Culturally Tailored Diabetes Self-Management Educational Intervention and Improvement of Type 2 Diabetes Mellitus Outcomes in Sub-Saharan African Countries: An Integrative Literature Review

Ihuoma Ezebuihe, DNP, MBBS, MPH, MS
Coppin State University

Montria Martin, BSN, RN, MSN-FNP
Jerrikka Burrell, RN, BSN, MSN-FNP
Graduate Students, School of Nursing
Coppin State University

Introduction: Sub-Saharan Africa countries are experiencing the high morbidity and mortality impact of diabetes. Like other developing countries, these sub-Saharan Africa countries face challenges in reducing the high mortality and morbidity rates associated with type 2 diabetes mellitus. Such challenges include access to care, health literacy, lack of culturally competent care and treatments from health care providers and researchers, inequities in healthcare, and the lack of diabetes self-management educational intervention opportunities to properly self-manage diabetes. This integrative literature review aims to determine the effectiveness of culturally tailored diabetes self-management educational interventions in three sub-Saharan African countries (Kenya, Nigeria, and South Africa), particularly Nigeria.

Method: Relevant databases, including PubMed, Google Scholar, and EBSCO were searched for articles written after 2010, which generated approximately 97 articles. There were 10 studies, including qualitative and quantitative designs, descriptive studies, and quasi-experimental studies, that met the inclusion criteria. Polit & Beck (2017) evidence-levels hierarchy was used to select high-quality relevant articles and evidence-based treatment guidelines to be included in the review.

Results: A good number of studies support culturally based diabetes self-management educational interventions, stemming from evidence of diabetes-positive outcomes in sub-Saharan Africa. Additionally, all the questionnaires, pamphlets, and materials used in the studies were written in English as there was no mention of various versions of pamphlets or questionnaires in the native vernaculars/languages of the participants. Researchers should endeavor to use/develop appropriate psychometric testing and culturally accepted instruments for data collections to accurately measure self-management of the indigenes who cannot understand, read, speak, or write English, but understand, write, read, and speak their native vernacular. These outcomes of culturally tailored diabetes self-management educational interventions can be included in diabetes self-management education (DSME) to gain knowledge and skills needed to manage and improve diabetes outcomes.

Key words: Type 2 diabetes mellitus, sub-Saharan Africa, self-management.

A Holistic Framework Examining Multifoci Justice and Trust Perceptions on Work Outcomes

Dr. Shingirayi M. Mushonga

Organizational justice research has often focused on the organization while overlooking the influence of the supervisor's role in shaping employees' perceptions of fairness in the workplace. This study examines a cognitive and affective trust model to better understand the impact of organizational and supervisory justice perceptions on work outcomes. Perceptions of

justice from the role of supervisor were compared to those associated with the organization. It was hypothesized that cognitive trust would mediate the relationship between organizational justice and work outcomes (i.e., organizational commitment and job satisfaction), while affective trust would mediate the relationship between supervisory justice and work outcomes (i.e., job satisfaction, organizational citizenship behavior (OCB), and leader-member exchange (LMX). Overall, the study's findings provide support for the hypothesis and indicate that cognitive trust and affective trust both mediate the respective relationships that organizational justice and supervisory justice have on work outcomes.

Key words: Multifoci justice, cognitive trust, affective trust, organizational commitment, job satisfaction, OCB, LMX

Can We Predict the Occurrence of Heatwaves to Save Lives?

Dr. Gazi Md Daud Iqbal
Dr. Lidan Ha
Dr. Sadie Gregory
Coppin State University

Dr. Jay M. Rosenberger
University of Texas at Arlington

Global temperature is increasing at an alarming rate, which increases the number of heatwaves. Many people die as a direct or indirect consequence of a heatwave, and elderly people are most affected by a heatwave. Predicting the occurrence of a heatwave can save lives. Because of its geographical location, Bangladesh is one country that is particularly vulnerable to heatwaves. The Bangladesh Meteorological Department collects temperature data at ten weather stations. Data shows that a majority of heatwaves occur in summer months, namely, April, May, and June. In this research, we develop Classification and Regression Tree (CART) models to predict the likelihood of a heatwave in the next 7 days and 28 days using previous two weeks' daily temperature. We compare different model parameters for these two models.

An Examination of the Leadership Frames of African American Graduates of the Thomas Lakin Institute Who Aspire to Become Community College Presidents

Dr. Tenyo Pearl

Senior-level African American administrators continue to be an emergent group of leaders within academia. Leadership positions at higher education institutions is an area in which racial, class, and gender diversity and inclusivity are still significant. African American men and women who aspire to become senior-level leaders and presidents in higher education are disadvantaged and underrepresented since they do not have the same opportunities as their white counterparts despite affirmative action laws. Further, the logistical restraints of available senior-level African American leaders to mentor the existent and the future burgeoning community, impacts leadership styles, frameworks, and growth.

The purpose of this research was to examine the perceived leadership frames of the Thomas Lakin Institute graduates. In essence, this study sought to determine if gender, age, and academic discipline relate to the perceived leadership frames (human resources, structural, symbolic, political) of the Thomas Lakin graduates as measured by the Bolman and Deal (1990) Leadership Orientation Instrument (LOI, Self). Bolman and Deal's (2008, 2013) Four Frames Leadership Theory undergirded this study and addressed the complex nature of academic institutions. This study utilized a non-experimental, cross-sectional survey design that was considered the best approach for assessing the perceived dominant leadership frame of the graduates at Thomas Lakin Institute. Descriptive statistics utilizing means and frequencies determined the dominant leadership frame and leadership style (no frame, single frame, paired-frame, and multi-frame).

There were several major findings related to how Thomas Lakin graduates perceived themselves as exhibiting characteristics of the human resource frame. In terms of gender, both male and female graduates perceived themselves as exhibiting characteristics of the human resource frame. Overall, eighty-one percent of the graduates in this study were identified with a multi-frame leadership style. This study has contributed to the body of literature

regarding the leadership frames of African American senior-level administrators interested in becoming college presidents. The results are promising and motivate future qualitative and quantitative research. The truth is as more and more African American senior-level administrators continue to obtain executive-level positions, there will be a need to assess and research leadership frames in theory and practice.

Density Functional Theory Calculations Using Transmon Qudits on Superconducting Radio Frequency Cavity Based Quantum Information Processor

Stephen Providence, PhD
Coppin State University

Background: Coppin State University, a Historically Black Institution in a dynamic urban setting, serves a multi-generational student population and provides education
opportunities while promoting lifelong learning. The university fosters leadership, social responsibility, civic and community engagement, cultural diversity and inclusion, and economic development. Computer science students at Coppin State University are the potential workforce for this research. It has been stated by experts in industry, academia, and commerce that the emerging trend in quantum computing will require a workforce that is prepared to work in and conduct research in the area. HBCUs have not addressed this massive emerging opportunity. Students that are prepared for this revolution in computing will be prepared for computing broadly and the opportunities are vastly greater than that of a standard, classical computing education. Coppin State University is uniquely positioned to give diverse populations training in such fields of study.
Motivation: The impetus for this project is to affect transformational change in computer algorithms by amelioration of calculations for density functional theory problems found in the scientific domains of materials science, computational and quantum science, and computational mathematics. Succinctly, the design of fast and stable algorithms that translate into scripts to perform the empirical or experimental part of basic science in silico is the primary goal. These

scripts run on actual superconducting quantum computers and classical heterogeneous cluster computers in series within a feedback loop where improvements are made after each iteration. Currently, use of an on-site and accessible heterogeneous cluster computer system that entails two multi-core CPUs, a many-core GPU, and (with expected funding) a custom configurable FPGA (field programmable gate array) facilitate the classical computing side of this project. The intent is to use current principles in quantum computing and quantum information science to extend well-known problems in the domains of the sciences listed above. Specifically, examination of density functional theory (DFT) which has the shortcoming of having an unknowable wave function will be addressed. In practice, using classical computers, multiple computational and mathematical paradigms are employed to mitigate the lack of a reliable wave function. The goal is to produce algorithms for a more feasible DFT and thereby speed up computations to facilitate investigations of larger more complex models.

Intellectual Merit: The intellectual motivation comes from the consideration that quantum systems are well suited for encoding sampling problems where given a quantum state, in an orthonormal basis, yields a random sample drawn from a probability distribution. According to the literature, this observation is useful in demonstrating quantum advantage over classical computers by sampling from a probability distribution defined in terms of a quantum gate sequence. This has already been written and scripts are run that exploit this concept quantitatively.

Exploring the Impact of COVID-19 on the Cardiovascular System

Dr. Vaple I. Robinson

Problem: COVID-19 is largely considered a highly communicable respiratory infection that causes pneumonia and subsequent death. The infection is so virulent that over four million deaths have occurred worldwide and more than 670,565 deaths in the US. In addition to the damage to the respiratory system, there are many physiological manifestations that goes beyond the lungs. Clinical studies have reported an association between COVID-19 and cardiovascular disease (CVD) linked with worse outcomes and increased risk of death in patients.

Method & Design: A literature review of the latest research from the Center for Disease Control and Prevention (CDC), the American Heart and Stroke Association (AHA), the recent research update from the National Institutes of Health (NCBI: severe acute respiratory syndrome-2 database), and other web resources were consulted. This inquiry provides an overview of the epidemiology of COVID-19 in adults and explore its effect on different organ systems, particularly the heart and the vascular system. The examination is critical because the significance of these effects is not yet known.

Findings: Patients with COVID-19 and CVD had a much more uncertain outcome than those who did not. Some COVID-19 patients developed CVD during their illness. People who had COVID-19, no matter how mild, continue to have symptoms months after the initial illness. While most persons with COVID-19 recover and return to normal health, 20-30% of patients have lingering symptoms 6-9 months after the illness.

Conclusion: There is still more to learn about the long-term consequences of COVID-19, the different paths to recovery, and getting back to normalcy. The AHA, Society of Cardiovascular Angiography and Interventions (SCAI), and several universities and hospitals have opened post-COVID monitoring clinics to further study lingering, post-infection symptoms and the increased susceptibility of COVID-19 to CVD.

Synthesis, Spectroscopic Characterization and Detection of Cyclopropyl Fatty Acids and Esters Stereoisomers in Biological Matrix of Tissue and Plasma

Dr. Hany F. Sobhi
Coppin State University

Dr. Sean Adams
University of California, Davis

Kaylah Castillo, Brittany Henly, Jordan Johnson
Students
Coppin State University

Fatty acid profiles have been used as a biomarker for the clinical diagnoses of metabolic disorder diseases, such as medium- and long-chain acyl- CoAdehydrogenase (MCAD, LCAD) deficiency by using tandem mass spectrometry analyses. Acyltransferace enzymes reversibly interconvert acyl-COA and acylcarnitine derivatives, thereby it catalyzes the translocation of the fatty acyl moiety across the mitochondrial membrane. Current investigations found that acylcarnitine induced oxidative stress and insulin resistance have been reversed by applying antioxidant treatment and concluded that incomplete fatty acid β-oxidation in muscle tissues result in accumulation and increase in acyl carnitine levels in different skeletal muscle tissues. We present a developed method for the synthesis of less common medium chains Cyclopropyl fatty acids and its stereoisomers that formed during gut microbe metabolism. We synthesized *cis*-3,4-methylene-heptanoylcarnitine and its stereoisomer *trans*-3,4-methylene-heptanoylcarnitine, the synthesis will be presented, based on O-Acylation of carnitine chloride, and replacement of the acid chloride by thionyl chloride followed by the addition of carnitine chloride. Furthermore, the spectroscopic characterization of the free fatty acids and the two acylcarnitine stereoisomers will be achieved using 400 MHz NMR, GC/MS EI-QQQ, and LC/MS QTRAP 5500. Both synthesized stereoisomers will be purified by solid phase extraction –SPE-, followed by high performance liquid chromatography-HPLC. Additionally, we identified *cis* -3,4-methylene-heptanoylcarnitine, and its *trans* isomer in plasma and skeletal muscle tissue by liquid chromatography-mass spectrometry analyses.

A Shaky Ground for HBCUs: Predicting Sustainability for Historical Black Colleges and Universities through Student Retention: A Systematic Review

Dr. Yolanda N. Savoy
Dr. Patience Ebuwei

Historical Black Colleges and Universities (HBCUs) are having challenges in student retention compared to predominantly white institutions (PWI). HBCUs rely heavily on federal government funds that come with restrictions, making it more difficult for historically black colleges and universities to compete and mitigate student churning when compared with their counterparts. Additionally, accreditation agencies and college ratings have often been shown to influence student retention. HBCUs lack college programs, endowment funds, and structural resources that can increase retention. While most HBCUs' missions are tailored towards first-generation students and students from low-income families, these missions have also played a role in HBCUs' retention rate. Using a Theory of Action (Double-loop learning in Organizations) by Chris Argyris as a theoretical lens provided evidence that HBCUs need to reevaluate policies and practices that inhibit the effectiveness of retaining students and correct errors in existing methods without altering their mission statements to be more competitively viable in the current environment.

This study utilizes a systematic review of the literature to rigorously search for relevant literature in answering the research questions: Do the structural resources in historically Black colleges in the United States serve as a vehicle in retaining students? How can historically Black colleges leverage their structural resources in mitigating student churning? The purpose of this study is to investigate factors that influence student retention in HBCUs. An epistemological approach using aggregate and configurative synthesis of the literature and a thematic analysis of the literature provided evidence that HBCUs lack the vision to be competitive in the current environment. This study's findings are significant and will benefit HBCUs by playing a pivotal role in student retention and sustainability in the new-age generation as structural resources are the determining factors in student retention and sustainability of any higher education institution.

Characteristics of Unintentional Drug-related Intoxication Deaths in Baltimore City 2011-2020: A 10-year Epidemiological Study

Dr. Min Zhang
Dr. Hany F. Sobhi
Coppin State University

Objective: To analyze the types of drugs and trends associated with the intoxication deaths in Baltimore in the past decade.

Methods: Data on unintentional drug-related intoxication death in Baltimore from 2011 to 2020 was collected retrospectively from the Maryland Department of Health. The data was stratified according to the types of drugs. Aggregate data analysis and individual drug trend analysis were conducted.

Results: The number of unintentional drug-related intoxication deaths in Baltimore has increased every year for the past decade, with a growth rate of 598.4% during the decade. The related drug types include heroin, cocaine, prescription opioids, benzodiazepines, and other prescribed and unprescribed drugs. The deaths of different drug types all have increased in the past decade, with heroin-related deaths having the lowest rate of increase and fentanyl-1 related deaths having the highest rate of increase.

Conclusion: The death rate from the overdose, especially fentanyl, is rising at an alarming rate in Baltimore. Efficient forensic detection method of fentanyl and its new psychoactive substances (NPS) analogues is urgently needed, together with a drug task force to reduce Baltimore's overdose death rate.

Curriculum, Faculty, and the College Graduate: A Recipe for Success?

Talon Center 214

Aerian Tatum, DBA, MSHCA, RHIA, CCS, CPHIMS

This session will share the findings of a systematic review conducted to identify whether a relationship exists between college curricula and the expectations of those who hire college graduates. It was found that there is a gap in the perceptions and expectations of stakeholders (higher education institutions, graduates, and industry leaders). This presentation provides a guide to management recommendations regarding the gap found between the expectations of key stakeholders. This research is valuable for all three stakeholders involved in enhancing and improving college curricula, the employability of college graduates, and the relationship between college-level educators and industry leaders. This research is unique in that it does not specify one industry but is comprehensive in its effort to analyze the data found.

Learning Objective: What will attendees learn during or take away from this session? Participants can expect to hear ideas that will cause academic programs to reflect on and review their current curriculums. Participants can also expect to listen to techniques to assist with updating curricula when necessary. Participants will learn how the human capital theory and the competence-based theory of the firm underpin this study to effectively produce workable solutions for colleges and universities to enhance curricula and produce desirable graduates in the eyes of hirers.

Session Process: A PowerPoint presentation will be utilized to discuss all aspects of the research study and its findings. Time will be strategically allotted as needed to explain each area sufficiently.

The Advancement of Nanotechnology and Its Application in Medicine, Energy, and the Environment

Dr. Jamal Uddin

Nanotechnology is one of the rapidly growing technologies in our present time. It involves the manipulation of materials at atomic, molecular, and macromolecular levels. These are materials with at least one dimension sized from 1 to 100 nanometers for applications in medicine, energy and storage, electronics, drug delivery, cosmetics, biotech, among others. Several nanotechnology research projects with diverse applications are being carried out at the center of nanotechnology. The presentation will focus on the synthesis and characterization of gold, silver, and copper nanoparticles and their applications in energy production, imaging, drug delivery, antibacterial activity, antifungal activity, detection, and removal of contaminants.

The Comprehensive Transition Project: Lessons Learned and Examining Self-Esteem of CTP Students at Coppin State University

Dr. Sabrina Taylor
Dr. Janet Spry
Dr. James Stewart

Coppin State University is the first university in the state of Maryland to obtain funding from the Maryland Department of Health Developmental Disabilities Administration to establish a Comprehensive Transition Program for transitioning youth with intellectual disabilities on a college campus. This presentation discusses lessons learned from establishing a Comprehensive Transition Program (CTP) for transitioning youth with intellectual disabilities on a university campus and shares data collected from CTP students using the Rosenberg Self-Esteem Scale. Participants were administered the Rosenberg Self-Esteem Scale prior to the students completing their coursework and again at the end of the second year of the project. A non-parametric Wilcoxon test was utilized to assess pretest/post-test scores for two related groups due to a low sample of 9 students. A qualitative survey was also administered at the same two periods. At the completion of the study, it was found there was a significant increase in self-

esteem scores during the second year of the CTP program. Findings also indicated students believed the CTP program impacted their self-esteem positively.

Using Advanced Data Mining and Data Analytics Tools to Find More Golden Nuggets in a Heart Disease Dataset

Dr. Liangjun You
Dr. Gazi Md Daud Iqbal
Coppin State University

Ting Li, MD
University of Maryland Upper Chesapeake Health

Data analytics (DA) and data mining (DM) are becoming more important for both practitioners and researchers in business, health, government, science and technology, security, and public safety in the context of big data. DM is the essential tool to find the valuable hidden knowledge in the sea of data. As of 2019, "the world's biggest killer is ischemic heart disease, responsible for 16% of the world's total deaths[.]" Since coronary artery disease (CAD) develops over a long time, it is important to detect and treat in early stage of the illness.

There are many research findings and evaluation systems trying to detect CAD in its early stage; however, the use of noninvasive diagnostics in CAD is still underdeveloped. Currently, there is no simple and inexpensive approach to a reliable diagnosis. Detrano et al. present a discriminant function model for estimating probabilities of angiographic coronary disease with 303 cases as the training set and 3 datasets as the testing sets. We perceive that when we make full use of these data sets (1071 cases) from the research of Detrano et al. by applying the contemporary DA and DM methods, we are highly likely to find more hidden knowledge from these partially used data sets.

In this research, we develop classification and regression tree (CART) models to predict the likelihood of a patient's developing heart disease. The dataset contains many missing values and variables. We impute those missing values to preserve the use of as much data as possible and de-bias the statistical results. Previous researchers used 13 variables from this dataset to predict the probability of patient's developing heart disease. We develop four CART models using these 13 previously used variables, and other variables based upon conversations with domain experts. We finally compare different model parameters among four CART models to improve the prediction accuracy.

Enhancing Nursing Skills to Care for Patients with Chronic Obstructive Pulmonary Disease

Dr. Denyce Watties-Daniels

Best practices in the care of patients experiencing a deteriorating condition include identifying changes in patient condition and initiating prompt and effective interventions. Nurses frequently fail to recognize deteriorating conditions and serious exacerbation of symptoms and thus are limited in providing appropriate supportive care to patients with chronic obstructive pulmonary disease (COPD). Innovative strategies, such as the implementation of clinical simulations, are reported to be effective in reinforcing essential clinical decision-making skills to assist nurses in developing the knowledge and skills to better recognize and intervene in the care of deteriorating conditions in patients with COPD.

This Doctor of Nursing Practice (DNP) quality improvement project developed, implemented, and evaluated the use of two simulation experiences to assist registered nurses to recognize and intervene in deteriorating conditions in chronically ill adult patients with COPD. Simulation scenarios included the patient with exacerbation of COPD and the patient with a spontaneous pneumothorax as a result of COPD complications.

A convenience sample of seven licensed registered nurses from diverse clinical backgrounds participating in a nursing orientation program at an urban, general adult medicine and surgical hospital in Baltimore, Maryland engaged in the project. The NLN/Jeffries Simulation Theory and the INASCL Standards of Best Practices in Simulation provided the framework for the project. Utilizing the three phases of the simulation experience, the seven registered nurses were immersed in the two simulated clinical situations.

Baseline knowledge of the care of the patient with COPD and spontaneous pneumothorax was assessed by administering a 10 item, paper-pencil pre-test aligned to the simulation objectives. The simulation experiences were evaluated using the Creighton Competency Evaluation Instrument (C-CEI) and a 10-item post-test. The clinical nurse educator and the DNP project director used the C-CEI tool to separately evaluate participant performance in each simulation experience. The project director, with clinical nurse educator validation, set the competency score for the C-CEI at 75%. The scores on the C-CEI were collected as an aggregate of the nurses delivering care to the simulated patient. All groups of nurses scored above 75%. A T-test (n=7, p =.000) for dependent groups was used to evaluate whether students' performance on the COPD and pneumothorax pre-test improved on the post-test. There was a statistically significant increase in the COPD and pneumothorax mean scores from the pre-test to the post-test.

The completed DNP project supports the use of clinical simulation to train and remediate practicing nurses. The participating nurses immersed themselves in a realistic clinical situation and cared for the simulated patients in a safe environment as though the patients were real. The participating nurses identified significant changes in patient condition and were competent in intervening and caring for the deteriorating conditions of a COPD patient. Evidence from this project supports the need for continued clinical work and program evaluation on the development and implementation of hospital based clinical simulation programs for nurses.

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The Faculty Research & Development Committee would like to thank all those who labored with us to make this day a success. We could not have done it without you.

Research Mini-Grant Recipients

Summer 2007

1. Drs. Vonda Smith- Hill and Shirley Newton-Guest
2. Dr. Virletta Bryant
3. Dr. Ibrahim Kargbo
4. Dr. Gerald Powell
5. Dr. Diala-Ogamba
6. Dr. Atma Sahu
7. Dr. Philbert Aaron
8. Dr. Felix Abeson
9. Dr. Lidan Ha
10. Dr. Carmelle Rogers
11. Dr. David Scott
12. Dr. Doug Reardon

Summer 2008

1. Dr. Chris Brittan-Powell
2. Dr. Ibrahim Kargbo
3. Dr. Harry Legum
4. Dr. Cheng Lou
5. Dr. Michelle Pointer
6. Prof. Gail Satchell
7. Dr. Roger Stritmatter
8. Dr. Liangjun You

Summer 2009

7. Dr. Michael Berlin
8. Dr. Chris Brittan-Powell
9. Dr. Blessing Diala-Ogamba
10. Prof. Hyacinth Ezeka
11. Prof. Vanessa Jackson
12. Dr. Shawyn Jenkins
13. Prof. Amini-Johari-Courts
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16. Dr. George Taylor
17. Dr. M. Jamal Uddin
18. Dr. Kokahvah Zauditu-Selassie

Distinguished Faculty Award: Dr. Katherine Bankole-Medina

Summer 2010

1. Dr. Katherine Cameron
2. Dr. Elaine Howell
3. Dr. Brian Schmitt
4. Dr. Ibrahim Kargbo
5. Dr. Felix Abeson
6. Dr. Moses Wekesa
7. Dr. Liangjun You

Distinguished Faculty Award: Dr. George Taylor

Summer 2011

1. Dr. Blessing Diala-Ogamba
2. Dr. John Newman
3. Hany Sobhi
4. Cheng Luo
5. Liangjun You

Distinguished Faculty Award: Dr. Judith Kehe

Summer 2012

1. Dr. Shingirayi Mushonga
2. Dr. Cheng Luo
3. Dr. Harry Legum
4. Ibrahim Kargbo
5. Drs. Mousumi Chattaraj and Rogers Carmelle
6. Liangjun You
7. Min A
8. Prof. Delores Smith and Dr. Wanda McCoy

Summer 2014

1. Dr. Blessing Diala-Ogamba
2. Dr. John Newman
3. Dr. Erica Smith
4. Dr. Cheng Luo
5. Dr. Sean Brooks

Summer 2022

1. Dr. Ihuoma Ezebuihe
2. Dr. Gazi Md Daud Iqbal
3. Dr. Min Zhang
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5. Dr. Laura Anderson and Dr. Johnny Rice II

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SAVE THE DATE!

NOVEMBER 17, 2022

9th Annual Faculty Research Conference