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Editorial Board

Contents

Acknowledgement

The Editorial Board and Management Committee of the Journal of Arts, Science, and Technology (JAST) express our heartfelt appreciation and thanks to Ms. Camille Jackson for her exceptional service as Assistant Editor from 2018 to 2023. Her unwavering commitment to ensuring the publication of high-quality research, meticulous review of several papers, and invaluable insights have played a vital role in selecting impactful and relevant articles for publication in JAST. Additionally, her dedication to improving the journal's content and active participation in team discussions have greatly influenced our operations and the overall direction of the journal. We are truly grateful for her outstanding contributions to JAST's success.

Editorial

Dear Reader,

The clutch of papers in this issue of JAST, Volume 15, Issue 1, covers a range of topics that affirms the multidisciplinary nature of the journal.

The lead paper, **Analysis of the Psychometric Properties of the Mathematics Diagnostic Test Designed for Prospective Secondary School Mathematics Teachers in Jamaica,** deploys the Classical Test Theory (CTT) and the Item Response Theory [IRT] (Rasch model) to analyze some key psychometric properties of the test administered to Jamaican students desirous of becoming teachers of mathematics and reports findings that have implications for their training.

The second paper, **Retrospectively Using Discrete Mathematics Concepts to Develop a Robust Ranking System for the 2019 ICC Cricket World Cup,** autopsies this international competition and, using concepts from the field of discrete mathematics, recommends a scoring method for ensuring that the strongest teams play in the final match, for the cup; the paper also recommends that the group stage of the FIFA Football World Cup use the same scoring method.

Paper three, **Assessing the Antibacterial Activity of Extracts Obtained from Tamarind** (Tamarindus indica), concerns the question of whether the compounds present in certain plant species are biologically active against bacteria. The paper presents the results of the inhibition of certain types of bacteria by extracts from the plant studied.

The authors of the fourth paper, **The Effects of Virgin Coconut** (Cocos nucifera) **Oil Supplementation on Blood Cholesterol Levels: A Preliminary Pilot Study,** tackle the controversial topic of whether there is any correlation between the consumption of coconut oil and blood cholesterol profile. The results of this study add to the body of information on this disputed issue.

Paper five, **The Perceptions of Habitat Heterogeneity, Complexity and Structure – Their Relevance with Threat of Predation in Seagrass Prey Fish Species,** examines the phenomenon that occurs in ecosystems whereby an organism's habitat preference may change to maximize protection from a predatory attack.

In the sixth paper, **The Natural Products Research Laboratory at UTech, Jamaica: Context, Concept and Achievements,** the authors reflect on the work of this facility since its inception and provide a comprehensive overview that includes research on plants found within the Cockpit Country of Jamaica.

Paper seven, **Evaluating Drug Related Problems and Pharmacists' Interventions at a Paediatric Hospital**, addresses the important issue of drug related problems (DRPs) that may arise during medication validation, and underscores the critical role of Pharmacists in preventing DRPs such as drug overdose with potential adverse drug reactions and suboptimal treatment of the patient.

Paper eight, **Continuing Education: The Practices, Attitudes, and Needs of Pharmacists in Belize,** based on its findings, makes recommendations that are directed to relevant stakeholders about the development of a structured Continuing Education Programme (CEP) in Belize that would be supported by pharmacists in that country.

Paper nine, **The Impact of Email on the Productivity of Staff Members in Higher Education Institutions (HEIs) in Jamaica,** reports a significant difference in the frequency of email checking by different categories of staff members and recommends that a deliberate culture change in email management for HEIs to maximise worker productivity and organisational efficiency.

The tenth paper, **Change Management: Implementing Curriculum Mapping in a Higher Education Institution in Jamaica,** presents the results of the use of Kotter's eight-step change management model (KCMM) to guide the implementation of a new requirement (curriculum mapping) as a supporting component of the Programme Development policy of the subject HEI.

In the eleventh paper, **Identifying My Teaching and Learning Preferences in the Online Environment: A Reflection,** the author introduces the VARK (visual, aural, read/write & kinaesthetic) Questionnaire as a tool that has utility in identifying an individual's dominant learning style/s or to suggest the learning style/s most suitable for an individual.

Paper 12, **Carnival in Jamaica 2022: Is the Current Model Viable?** used an ethnographic approach to examine the return of the Jamaica Carnival in 2022 and interrogate its viability.

The thirteenth paper, **Banana or Cho Cho: Food and Sexual Normativity in Jamaican Popular Music,** adroitly inserts scholarly probes into the Jamaican context to ascertain the role of food vis-à-vis sex and power relations in dancehall music, and how the trope, still prepared and served mainly by male

chefs, is now undergoing surprising female culinary approaches to exude a flavour menacing to male cooks.

The author of the fourteenth and final paper**, Using the Design Science Approach to Develop and Analyse the Effectiveness of Text Mining Techniques to Detect Malicious Activities in Chatlogs on Social Media,** investigated how machine learning can be employed in the social media domain to identify malicious activities.

Paul W. Ivey, PhD
Editor-in-Chief

Journal of Arts, Science and Technology

An Analysis of the Psychometric Properties of the Mathematics Diagnostic Test Designed for Prospective Secondary School Mathematics Teachers in Jamaica

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Abstract

This study analyzed the major psychometric properties of the 2020 mathematics diagnostic test designed by the Ministry of Education, Youth, and Information (MOEYI), for prospective secondary school mathematics teachers in Jamaica. A quantitative descriptive design was used in the collection and analysis of the performance data of 100 prospective secondary mathematics teachers from across teachers' colleges. The Classical Test Theory (CTT) and the Item Response Theory [IRT] (Rasch model) were used to analyse key psychometric properties of the test. The findings revealed that the majority (70%) of the test items were within the optimum difficulty range. However, 55% of the items ranged from marginal to poor in their ability to differentiate between high- and low-ability test-takers. The test recorded a relatively high distractor efficiency of 80.6%. It is considered to be highly reliable with reliability measures of 0.80 for the KR-20 reliability and 0.94 for the Rasch item reliability coefficient. The findings of the study have implications for the validity of the use of test results in the teaching and learning process of mathematics courses offered in the teacher-training programme in Jamaica.

Keywords: Prospective Secondary Mathematics Teachers, Classical Test Theory, Rasch Model

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Introduction

Background

Over the last two decades, the training of mathematics teachers in Jamaica has improved significantly with a greater emphasis on both content and pedagogy. Recently, a part of the initiative for mathematics teacher training in Jamaica was to administer a mathematics diagnostic test to prospective mathematics teachers. The Jamaica mathematics policy document in 2013 stated that all candidates entering teacher education programmes to be trained as mathematics teachers, whether prepared to teach at the primary or secondary level of the education system, are required to sit the diagnostic mathematics test.

The mathematics diagnostic test designed for prospective secondary mathematics teachers in Jamaica is a multiple-choice test that consists of 60 items, testing the major topics similar to those on the Caribbean Secondary Education Certificate (CSEC) mathematics 2018 syllabus. These major topics include number theory, measurement, algebra, relations, functions, relations and graphs, and geometry and trigonometry. The test addresses three levels of the cognitive domain: knowledge, conceptual understanding, and critical reasoning. The purpose of this test is to identify areas of weakness among trainee teachers and implement strategies to address these areas.

Diagnostic testing is the process adopted to locate and identify students' learning difficulties or weaknesses in a subject or skills and causes (Ketterlin-Geller & Yavanoff, 2009). Esomonu and Eleje (2020) stated that diagnostic tests involve assessing the components of underlying skills in the context of the curriculum. They further stated that diagnostic testing tends to expand students' knowledge and achievements. Diagnostic testing has proven to have several benefits in education. This enables teachers to determine the nature and causes of students' learning difficulties. In education, the teacher carries out a diagnostic test in an effort to ensure the quality of learning and to know what specific action should be taken in order to obtain the desired results.

The MOEYI has been administering a mathematics diagnostic test to prospective mathematics teachers with the aim of identifying weaknesses in various areas of the subject among teachers' college students. The aim was to improve the quality of learning in teacher training colleges. This study analyzed the psychometric properties of the test using CTT and the IRT Rasch model. The psychometric properties of a test are directly linked to its reliability, as well as the validity of the interpretations and intended use of its results. Though the

study did not thoroughly investigate the validity of the interpretations of the test results, any analysis of the psychometric properties of the test can provide important evidence that speaks directly to validity. Reliability and validity are critical to test development and continue to be important areas of discussion in education. The development and application of theories and computer software used to develop and evaluate test instruments have gained more attention over the past three decades. In this study, the combined application of CTT and the Rasch model enabled a more comprehensive analysis, understanding and description of the major psychometric properties of the mathematics diagnostic test designed for prospective secondary school mathematics teachers in Jamaica.

Problem Statement

In addition to how mathematics is being taught, students' general ability levels, and their comprehension and reasoning skills in mathematics have become a major concern to educators at all levels of the education system in Jamaica. An analysis of the CSEC mathematics test overall results indicates that the percentage of students who obtained a passing grade (Grades I-III) since 2010 has not changed significantly up to date. In most cases, between 2010 and 2022, CSEC mathematics pass rates remained below 50%, ranging from 44.7% in 2010 to 37% in 2022.

At the teachers' college level, students who matriculate into the Bachelor of Education in Mathematics programme are required to have a grade I or II in the subject at the CSEC level. It has often been the view of teachers' college mathematics lecturers that although students may have passed the CSEC mathematics exam with a grade I or II, they often lack many basic mathematics skills required to learn more advanced mathematics concepts. As a result, the MOEYI developed and administered a mathematics diagnostic test for mathematics teacher training in Jamaica. This study analyzed the major psychometric properties of the test.

Purpose of the study

The purpose of this study was to conduct an analysis of the major psychometric properties of the mathematics diagnostic test designed for prospective secondary mathematics teachers in Jamaica, using CTT and the IRT Rasch model.

Research Questions

The study was guided by the following research questions:

1. What are the difficulty levels of the items on the mathematics diagnostic test designed for secondary mathematics prospective teachers?
2. To what extent do the test items differentiate between the high and low ability test-takers?
3. How informative is the test about the test-takers' ability levels based on its information function (TIF) values?
4. How reliable is the test based on its CTT and Rasch reliability estimates?

Significance of the Study

The relationship between the psychometric properties of a test and the validity of the interpretations and use of the test results has not been widely studied in Jamaica. Therefore, this study is timely and of great significance not only to examination bodies, but its methodological approach of applying the combined use of the CTT and the IRT Rasch model should provide further knowledge and understanding to practitioners in the field of psychometrics.

This study focuses on mathematics as much as it is about the applications of the CTT and the IRT Rasch model. Its findings are of great significance to the teaching and learning of mathematics at teacher training institutions, especially to mathematics educators who hope to gain a deeper understanding of the applications of measurement theories in the assessment of test-takers in mathematics.

Literature Review

Since the development of psychometric theories, much attention has been paid to their use in the development, analysis, and validation of educational tests. There is a close relationship among three key areas of the teaching and learning process of mathematics. These areas are the instruction, the assessment process, and students' achievement. Both the instruction and the assessment processes can impact how much students achieve. Suurtamm et al. (2016) agreed that current perspectives on assessment encourage the use of a range of assessment strategies, tools, and formats that will provide opportunities for students to demonstrate their learning.

Alafaleq and Fan (2014) reiterated that researchers in the field of education,

as well as policymakers in many countries across the world, have increasingly realised the need for improvement in the assessment methods and practices in classrooms. They further stated that to deal with the inadequacies of traditional assessment methods effectively, many educational researchers have introduced additional assessment methods, and have worked on reforming assessment tools to achieve the desired goals for education. In this study, the review of the literature is focused mainly on the applications of the CTT and the IRT Rasch model in the analysis of item-level data. The review also includes an examination of previous studies carried out using CTT and the IRT Rasch model.

Classical Test Theory

Shultz et al. (2014) describe item analysis as a set of statistical procedures used to assess the properties of tests and test items. These statistics often include properties such as item difficulty, item discrimination, correlation measures, and other reliability coefficients within CTT and IRT. The CTT was developed and became quite useful and popular in the early 20th century and is still considered to be one of the easiest and most widely used methods in item and test analysis today. The conceptual foundations, assumptions, and extensions of the basic premises of CTT have allowed for the development of excellent psychometrically sound scales in both psychological and educational assessments (Eleje et al., 2018).

CTT assumes that systematic effects among test-takers' responses are only due to differences in ability. All other potential sources of variation that can be found in the testing material, such as the internal and external conditions of the test-takers, are assumed to be either constant through standardization or to have an effect that is non-systematic or random in nature (van der Linden & Hambleton, 1980). The Education Testing Service (2019) described CTT as a statistical theory that forms the basis for many calculations performed with test scores, especially those involving reliability.

Although CTT has been described as having weak assumptions, mathematical calculations are critical in providing useful information to address the research questions and purpose of the study. The main purpose of the CTT is to determine the degree to which a test is influenced by random errors. Several methods have been developed to estimate the reliability of tests within the CTT framework (Shultz et al., 2014; Haiyang, 2010; Croker & Algina, 2008; Moses, 2017). When a test is administered, the CTT assumes that a test-taker's observed score (X) is a function of two main factors: true score (T) and measurement error (E). The theoretical foundation of CTT is based on the formula: $X = T + E$.

Item Difficulty Index

In understanding the difficulty index for the multiple-choice test, many early researchers have explained the difficulty level of an item as simply the percentage of test-takers who answer the item correctly (Thorndike et al., 1991). Item difficulty is reported in a range of 0–100% or 0–1.00. The higher the item's difficulty level, the easier the item is interpreted to be. Sabri (2013) used a mathematical formula and stated that item difficulty (*p-value*) refers to the proportion of test-takers who responded correctly to the item. It is calculated using the following formula: $p = \frac{R}{T}$, where *p* is the item difficulty index, *R* is the number of test-takers' correct responses to the test item and *T* is the total number of test-takers responses.

One of the earliest, and still used, interpretation guidelines for the item difficulty index is from Ebel (1972). According to Ebel (1972), items with difficulty levels of .90 and above are considered very easy, those with difficulty levels ranging from .76–.89 are easy, those with difficulty levels ranging from .26–.75 are at an optimum level, those with difficulty levels ranging from .11–.25 are difficult, and those with difficulty levels below .10 are very difficult.

Item Discrimination Index

Part of the fundamental argument that forms the basis of item discrimination is the idea that high-performing test-takers are more likely to answer a good item correctly than low-performing test-takers (McCowan & McCowan, 1999). Brookhart and Nitko (2019) defined item discrimination index as the extent to which a test item is able to differentiate higher-scoring test-takers from those with lower ability.

The general formula for calculating item discrimination index for the multiple-choice item is: $DI = \frac{HAG - LAG}{n}$, where DI is the discrimination index, HAG represents test-takers in the high-ability group who respond correctly to the item, LAG represents test-takers in the low-ability group who respond correctly to the item, and n represents the number of test-takers in either of the groups. The item discrimination index ranges from -1.00 to 1.00, where a negative discrimination index indicates that more test-takers in the lower ability group respond correctly to the item.

The method of calculating item discrimination index for the multiple-choice test item remains quite similar to that of other researchers. It should be noted that while some studies used the upper and lower 25% of test-takers, 27% is

more often used in the calculation of item discrimination index. Quaigrain and Arhin (2017) suggested the use of the upper and lower 27% of test-takers who responded correctly to the item, where *n* is the number of test-takers in the larger of the two groups.

One of the earliest, and still used, interpretation guidelines for item discrimination index is from Ebel (1972). According to Ebel (1972), items with discrimination level of .40 and above are considered excellent, those with discrimination levels ranging from .30–.40 are good, those with discrimination levels ranging from .20–.29 are marginal, those with discrimination levels ranging from.01–.19 are considered poor items and should be revised, and those with discrimination levels below .01 should be discarded.

Reliability

Test reliability has undergone its own phases of changes in terms of how it is defined and used in the field of psychometrics. Many writers have focused their discussions about reliability on measurement error and the precision of the measurement procedure. Shultz et al. (2014) stated that reliability is the degree to which test scores are free of measurement error for a given group of test-takers. Other authors have also described reliability as the degree to which a test is free from measurement errors, stating that the greater the occurrence of measurement errors, the less reliable the test is (Fraenkel & Wallen, 2003; McMillan & Schumacher, 2006; Neuman, 2014).

Danner (2016) argued that the reliability of a measurement procedure is relevant when the relationships between different variables are examined or when a single individual's value is the focus. Danner (2016) defined reliability as the precision of the measurement. An important point to note in Danner's (2016) argument on reliability is that reliability is always a property of a measurement procedure, rather than of the measurement instrument. An instrument may yield measurements of different levels of reliability in different samples.

Within the CTT framework, the Kuder-Richardson (KR-20) formula and Cronbach's alpha are most often used to calculate the internal consistency of a scale or test as a reliability coefficient. Of these two reliability measures, the KR-20 reliability formula is often used to calculate the internal consistency of dichotomously scored tests. The use of internal consistency coefficient is common in research. Consequently, several studies provided criteria for interpreting the reliability coefficients of a test. A reliability coefficient of less than .50 is considered to be a low reliability measure, between .50 and .80 is moderate

or acceptable, and greater than .80, is a high reliability measure (Salvucci et al., 1997; Kline, 2000; Griethuijsen et al., 2015; Rosaroso, 2015; Nehring et al., 2015; Pallant, 2016). According to Erturk (2015), a reliability coefficient of .70 or greater is acceptable.

The IRT Rasch Model

The Rasch model was developed in the 1960s by the Danish mathematician, Georg Rasch. Rasch model analysis is a modern method of measurement that overcomes some of the limitations of CTT. The Rasch model is a probabilistic model that uses an analytical model developed by Georg Rasch (Robinson et al., 2019). Linacre (2019) described the Rasch model analysis as a method for obtaining objective, fundamental additive measures from stochastic observations of ordered category responses. The mathematical theory underlying the Rasch model is a special case of IRT. While the Rasch model is a one-parametric logistic (1-PL) model, there are clear philosophical and theoretical differences separating it from the traditional IRT 1-PL model (Linacre, 2005; Zamora-Araya et al., 2018).

Rasch Dichotomous Model

The Rasch model is often introduced as a model for binary data. In that case, 0 is considered an indicator of a negative or incorrect response, while 1 is considered as indicating a positive or correct response. In the Rasch dichotomous model, the probability of a person's response to an item is a function of the difference between two model parameters, the item location (δ—difficulty in assessment of proficiency) and the person's location (β—proficiency in the assessment of proficiency). In the Rasch dichotomous model, an item characteristic curve (ICC) shows the probability of a correct response to an item with locations of persons on the latent variable (ability) scale (Andrich & Marais, 2019). One of the frequently used formulas for the Rasch dichotomous model used $e = 2.71828$, and is formulated to be: $P_{ni} = \frac{e^{\delta_n - D_T}}{1+e^{\delta_n - D_T}}$.

Rasch Reliability Estimates

Rasch item reliability focuses on the items and addresses the critical question of whether the test separates the items into enough levels of difficulty; the Rasch item reliability is dependent on two major components. According to Linacre (2019), a low item reliability under the Rasch calculation means that the sample

is not large enough to precisely locate the items in the latent variable. In the WINSTEPS software, Linacre (2019) also suggested that Rasch item reliability depends mainly on: (1) the item difficulty variance – a wide range of difficulty normally produces a high reliability, (2) person sample size – a large person sample size normally produces a high reliability. The item reliability estimate calculated under the Rasch model is also dependent on the length of the test that is being analyzed. The larger the test, the higher the reliability value.

Another important reliability estimate discussed in this study is the Rasch person reliability. This reliability estimate focuses on the examinees and addresses the critical question of whether the test discriminates the sample into enough ability levels. Linacre (2017) reported a .90 reliability measure for three or four levels of person measure, .80 for two or three levels of person measure, and .0.50 for one or two levels of person measure. The Rasch person reliability depends on three main areas: (1) person sample ability variance – The higher the ability range, the higher the person reliability, (2) the length of the test that is being analyzed – the longer the test, the higher the reliability value.

Previous Research

In this section of the literature review, a number of previous studies are examined in light of their relevance to the present study. Sealy (2011) assessed the construct validity of the CSEC mathematics multiple-choice test using the Multidimensional Item Response Theory (MIRT). In that research, the full information of item factor analysis was used through the software program, TEST-FACT, to determine the dimensionality of three item-response data sets: TOTAL, which included the entire sample of the test data; FIRST-HALF, which included the upper half of the sample ranked by CTT; and SECOND-HALF, which included the lower half of the data set analysed in the study.

Results of the analysis of the FIRST-HALF of the dataset showed evidence of construct validity for that group. The results from the study also showed that there was a lack of similarity between statistical dimensions and the test constructs for the TOTAL dataset, which suggested that the interaction between the test-takers and the test items affected the profile dimensions. The behaviour of the SECOND-HALF affected the construct validity relating to the entire group. The information gathered from a closer examination of the SECOND-HALF of the dataset could have provided information on the conceptual difficulties encountered by lower ability test-takers. In comparison to Sealy's (2011) study,

the present study sought to examine a number of areas using CTT as well as different features within the IRT Rasch model.

In another study that was focused on using CTT and the IRT Rasch model analysis, Manapsal (2017) compared the CTT and the Rasch model results for a Comprehensive Mental Ability Test (CMAT), which included a mathematics component. In that study, Manapsal (2017) investigated whether the poor items analysed in CTT would still be the poor ones using the Rasch model. The study used 33 participants with a 60-items CMAT administered in one hour. The results from the study showed that with the CTT analysis five of the items were found to be poor and with the Rasch analysis, 17 of the 60 items misfitted the model. Manapsal (2017) concluded that the Rasch model becomes stricter than the CTT in the analysis of test items. While both studies used the CTT and Rasch analyses and produced acceptable reliability measures, Manapsal's (2017) study used a considerably small sample size that may not be appropriate for use with the Rasch model. The literature suggests that sample sizes appropriate for studies using the CTT and or the IRT to be 100 or more. In fact, some researchers suggested at least 500 for studies using IRT.

In addition to Manapsal's (2017) study and those discussed earlier, several other recent studies which made use of the CTT and IRT-related models (Khairani & Razak, 2015; Idowu et al., 2011; Bichi & Talib, 2018; Morales, 2009; Ayanwale et al., 2018) are mainly focused on the psychometric properties of test items and the comparison of the CTT and the IRT models.

Methodology

The Design of the Study

This study used a quantitative descriptive approach with its methods of data collection and analysis grounded in the theoretical frameworks of the CTT and the IRT Rasch model. Quantitative design involves sets of variables that are controlled through statistical analysis and provides measures or observations for testing a theory or a set of theories. Objective data results from empirical observations and measures and the validity and reliability of scores lead to meaningful interpretations of data (Creswell, 2014).

The data collection and analysis processes involved in this study are suited for the quantitative descriptive design as they mainly involved the collection and analysis of objective measures in the form of numerical items and test level data. In the context of this study, these analyses included psychometric

properties or parameters such as item difficulty, item discrimination, distractor efficiency, and various reliability measures within the CTT and the IRT Rasch measurement frameworks.

The Study Population and Sample

The study acquired and used the test performance data for 100 prospective secondary school mathematics teachers who were enrolled in teachers' colleges across Jamaica in 2020. The 100 prospective secondary trainee teachers represented approximately 90% of the population of prospective mathematics teachers in that academic year.

Three of the most commonly used models in psychometric studies are the traditional IRT 1-PL, the IRT Rasch model (the Rasch model is a 1-PL model), and the IRT 3-PL model (Wright & Stone, 1979). With regard to the selection of the samples used in research involving the use of CTT and IRT analysis, there are no set standards or universally accepted number suggested (Morizot et al, 2007). Bond and Fox (2015) noted that regarding the analysis of tests with dichotomous responses, 100 respondents would be enough for analysis with the traditional 1-PL model or the Rasch model. More recently, Chen et al. (2014) reiterated that extreme caution must be taken when attempting to apply the Rasch model with small samples of data. They concluded that the Rasch analysis based on small samples (less than 50) identified a greater number of items with incorrect ordered parameters than larger samples (100 or more).

Data Collection and Analysis

The data used in this study were collected from the MOEYI. In addition to using descriptive statistics, a greater portion of the data analysis process was primarily embedded in the CTT and IRT Rasch measurement frameworks. The data analysis process involved the use of CTT to analyze three major psychometric properties: item difficulty, item discrimination and test reliability. The data analysis methods also used a number of techniques from the IRT Rasch statistical framework. These include the IRT Rasch reliability coefficient and the test information function.

Two computer software programs were used in the data analysis process. These include the statistical package for the social sciences (SPSS, version 22) and WINSTEPS (version 4.0.1). SPSS was mainly used in the analysis of the descriptive statistics. The WINSTEPS was used in the analysis of both reliability coefficients and the test information function (TIF).

Findings

The Item Difficulty

To analyze the difficulty indices for the diagnostic test items, the difficulty index for each item was calculated and categorized using Ebel's (1972) item difficulty interpretation guidelines. The difficulty level of each item was calculated using the following formula: $p = \frac{R}{T}$, where p is the item difficulty index, R is the number of test-takers' correct responses to the test item and T is the total number of test-takers responses. Table 1 shows the interpretations of the difficulty levels of the items on the 2020 mathematics diagnostic test designed for Jamaican secondary prospective mathematics teachers. Based on test-takers' responses to the items, the statistics in Table 1 show that most of the test items (42 of 60 or 70%) were within the optimum range of .26–.75. Seven of the 60 items (11.7%) were interpreted as easy or very easy while 11 of the 60 items (18.3%) were interpreted as difficult or very difficult.

Table 1: Item Difficulty Analysis for the 2020 Mathematics Diagnostic Test Designed for Prospective Secondary Mathematics Teachers in Jamaica

Item Difficulty Index Interpretations	Number of Items and Their Difficulty Levels
.90 and Above: Very Easy	1(1.7%)
.76–.89: Easy	6 (10%)
.26–.75: Optimum Difficulty	42 (70%)
.11–.25: Difficult	7 (11.7%)
.10 and Below: Very Difficulty	4 (6.6%)

Table 2 shows some examples of items on the test at different difficulty levels. From Table 2, it could be noted that students tended to find items tested under basic algebra and number concepts easier compared to those tested under functions and graphs and measurement.

The Item Discrimination

To analyze the discrimination indices for the diagnostic test items, the discrimination index for each item was calculated and categorised using Ebel's (1972) item discrimination interpretation guidelines. The discrimination measure for each item was calculated using the formula: $DI = \frac{HAG - LAG}{n}$, where DI is

Table 2: Examples of Items at Various Difficulty Levels on the 2020 Mathematics Diagnostic Test Designed for Prospective Secondary Mathematics Teachers in Jamaica.

Item Difficulty Index Interpretations	Examples of Items
.90 and Above: Very Easy	**Item # 38:** On Monday morning, Mark and Kay sent a total of 90 messages. Mark sent x text messages per hour and Kay sent y messages per hour. If Mark spent 4 hours messaging and Kay spent 5 hours, which of the following represent the total number of text messages sent by Mark and Kay on Monday morning? A. $9xy = 90$ C. $x + y = 90$ B. $20xy = 90$ D. $4x + 5y = 90$
.76–.89: Easy	**Item # 1:** Calculate the exact value of, 0.92 – 0.290.825 ÷ 0.5) A. 0.59 C. 0.887 B. 0.61 D. 1065
.11–.25: Difficult	**Item # 51:** Which of the following equations does NOT cut the x-axis? A. $y = x^2 - 2x + 2$ C. $y = 2x + 1$ B. $y = x^2 - 3$ D. $x = 5$ **Item # 48:** For the straight line given the equation $f(x) = 2x - 3$, which of the following equations forms a line perpendicular to f(x)? A. $h(x) = \frac{x+3x+3}{}$ C. $i(x) = 6 - \frac{xx}{22}$ B. $i(x) = \frac{x}{2} + 4\frac{x}{2} + 4$ D. $k(x) = 2x + 3$
.10 and Below: Very Difficult	**Item # 13:** Which of the following would be equivalent to 1.2 metres? A. 0.012cm C. 120cm B. 12cm D. 1200cm

the discrimination index, HAG represents those test-takers in the high-ability group who respond correctly to the item, LAG represents test-takers in the low-ability group who respond correctly to the item, and n represents the number of test-takers in either of the groups.

Table 3 shows the interpretations of the discrimination levels of the items on the 2020 mathematics diagnostic test designed for Jamaican secondary prospective mathematics teachers. Based on the test-takers' responses to the items, Table 3 shows that 18 of the 60 items (30%) were within the discrimination range above .40. Eight of 60 items (13.3%) were good in terms of how well they discriminated. The other 34 items (56.7%) were in the discrimination category that range from marginal to poor with 22 items (36.7%) needed to be revised.

Table 3: Item Discrimination Analysis for the 2020 Mathematics Diagnostic Test Designed for Prospective Secondary Mathematics Teachers in Jamaica

Item Discrimination Index Interpretations	Number of Items and Their Discrimination Levels
> .40 (Excellent)	18 (30%)
.30–.40 (Good)	8 (13.3%)
.20–.29 (Marginal)	12 (20%)
0–.19 (Poor, Revise Item)	22 (36.7%)
< .01 (Discard Item)	0

The Distractor Efficient (DE)

Distractor efficiency (DE) speaks to the quality of distractors on a multiple-choice test. It indicates how functional the distractors are based on the test-takers' responses to the item. The DE measurement ranges from 0 to 100%. A non-functional distractor (NFD) is an option, other than the key, selected by less than 5% of test-takers, and the functional or effective distractor is the option selected by 5% or more test-takers (DiBattista & Kurzawa, 2011; Hingorjo & Jaleel, 2012; Gajjar et al., 2014).

If an item contains three, two, one or zero NFDs, then the DE would be 0%, 33.3%, 66.7% or 100% DE, respectively. Items with three NFDs should be discarded and those with two NFDs should be revised (Tarrant et al., 2006).

Table 4 shows the DE of the 2020 mathematics diagnostic test designed for

Table 4: Item Distractor Efficiency Analysis for the 2020 Mathematics Diagnostic Test Designed for Prospective Secondary Mathematics Teachers in Jamaica

Statistics	Distractor Efficiency Statistics
Total Number of items	60
Total Number of Distractors	180
Total Number of Functional Distractors (FD)	145 (80.6%)
Total Number of Non-Functional Distractors (NFD)	35 (19.4%)
Total Number of Items with 3 FD (DE = 100%)	41
Total Number of Items with at Least 1 NFD	19
Number of Items With 1 NFD (DE = 33.3%)	10
Number of Items With 2 NFD (DE = 66.7%)	2
Number of Items With 3 NFD (DE = 0%)	7
Test Distractor Efficiency	80.6%

Jamaican secondary prospective mathematics teachers. The total number of distractors on the test was 180. This was so since each of the 60 items on the test carried three distractors. The data in Table 4 shows that of the 180 distractors on the test, 145 or 80.6% were functional. This means the DE of the test was 80.6%. It is to be noted that these 145 functional distractors spread across the whole test and indicate the DE of the test. The study further examined individual items and noted that 41 of the 60 items (58%) on the test had all three distractors functional. Nineteen of the 60 items (31.7%) on the test had at least one NFD. Of the 19 items, 10 items (6%) had one NFD, two items (3.3%) had two NFDs, and seven items (11.7%) had three NFDs.

The statistics in Table 4 show that the 2020 mathematics diagnostic test designed for Jamaican secondary prospective mathematics teachers recorded a relatively high overall DE, which generally speaks positively to the reliability of the test. However, there are still a considerable number of items with at least two and three NFDs that need to be re-examined or discarded.

Table 5 shows some examples of items on the test with two and three NFDs.

Table 5: Examples of Items with Different Number of Non-Functional Distractors on the 2020 Mathematics Diagnostic Test Designed for Prospective Secondary Mathematics Teachers in Jamaica

Number of Non-Functional Distractors	Examples of Items
Three NFDs	**Item # 38:** On Monday morning, Mark and Kay sent a total of 90 messages. Mark sent x text messages per hour and Kay sent y messages per hour. If Mark spent 4 hours messaging and Kay spent 5 hours, which of the following represent the total number of text messages sent by Mark and Kay on Monday *morning?* *A. 9xy = 90* C. $x + y = 90$ B. *20xy = 90* D. *4x + 5y = 90*
Two NFDs	**Item # 1:** Calculate the exact value of, $0.92 - 0.2(90.825 \div 0.5)$ A. 0.59 C. 0.887 B. 0.61 D. 1065 **Item # 7:** Given that a sum of money was shared in the ratio of 2:3:4 and that the sum of the 2nd and 3rd shares is $840. How much money was shared? A. $653.30 C. $1080.00 B. $840.00 D. $7560.00
One NFDs	**Item # 13:** Which of the following would be equivalent to 1.2 metres? A. 0.012cm C. 120cm B. 12cm D. 1200cm

A further examination of the items in Table 5 reveals that those with two and three NFDs are the easier items while those with one NFD tend to be the more difficult items.

The Test Information Function (TIF)

According to Shultz et al. (2014), the TIF of a test is a mathematical function of the relationship between the ability level and the reciprocal of the conditional measurement error variance. They further stated that TIF is equivalent to the reliability measures in CTT. TIF explains how precisely a test estimates test-takers' ability over the whole range of the ability scale.

The analysis of the TIF for the mathematics diagnostic test designed for Jamaican secondary prospective mathematics teachers is focused on the preciseness of the test in measuring test-takers' abilities. This speaks to the amount of information that the test provides on how well it measures the latent trait it was designed to measure. The TIF graph in Figure 1 is analyzed both vertically and horizontally.

From a vertical view, Figure 1 shows that the graph peaks at an information value of approximately 11.5. This information value corresponds to a high reliability measure within the CTT framework. The information value for the test corresponds to a CTT reliability coefficient of .90.

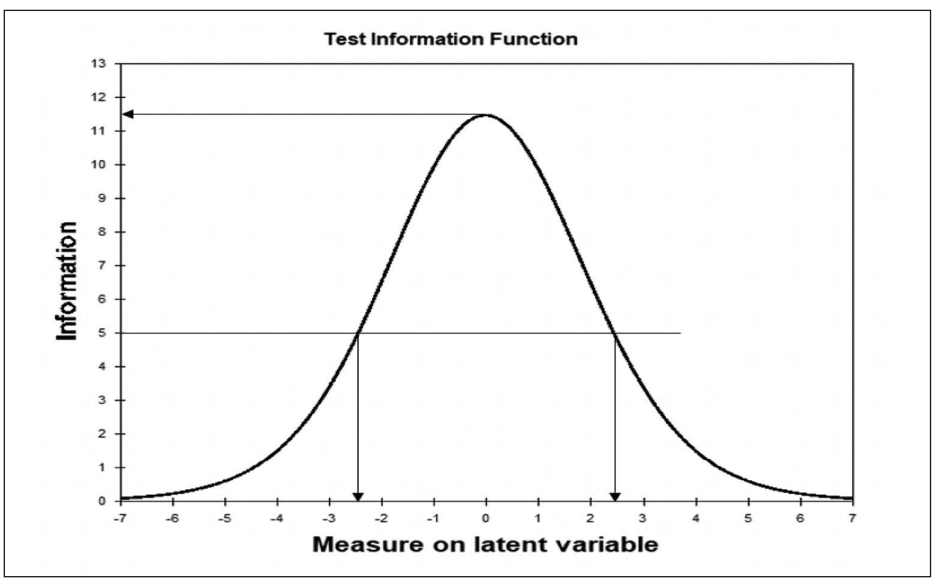

Figure 1: The Test Information Function Analysis for the 2020 Mathematics Diagnostic Test Designed for Prospective Secondary Mathematics Teachers in Jamaica

The horizontal analysis of the TIF is focused on the range of ability for which the test is reliably informative. Figure 1 shows the estimated range of ability levels over which the 2020 mathematics diagnostic test designed for Jamaican secondary prospective mathematics teachers is informative at an information value of 5. The TIF graph shows that the test was highly informative over an ability range of approximately -2.50–2.40 ability levels at an information value of 5. The test became gradually less informative beyond these ability levels.

The Reliability Estimates for the Test

This section of the study analyzed some of the common reliability estimates that are associated with test analysis. Based on the interpretation of the ranges of the KR-20 reliability measures, a coefficient less than .50 is considered a low reliability measure, and a coefficient between .50 and .80 is considered a good reliability measure (Rosaroso, 2015; Nehring et al., 2015). As indicated in Table 6, the KR-20 reliability measure is .80 for the 2020 mathematics diagnostic test designed for Jamaican secondary prospective mathematics teachers.

Table 6: Reliability Estimates for the 2020 Mathematics Diagnostic Test Designed for Secondary Prospective Mathematics Teachers

Reliability Estimates	
KR-20 Reliability Coefficient	.80
Rasch Item Reliability	.94
Rasch Person Reliability	.79

Table 6 also shows the Rasch item reliability value for the mathematics diagnostic test designed for Jamaican secondary prospective mathematics teachers. The Rasch item reliability measures calculated for the test recorded .94 which is considered high and speaks positively for the reliability of the test. Table 6 also shows the Rasch person reliability value for the test. The Rasch person reliability measures calculated for the test recorded .79 which is also considered a high reliability measure.

Discussion

In this study, a full-scale investigation into the validity of the interpretation of the test results was not carried out. The study, therefore, does not make a

definite claim about the overall validity of the interpretations of the test results. However, an analysis of the psychometric properties of a test does provide critical information about the appropriateness, meaningfulness, and usefulness of the test results, which speak to validity (Brennan, 2006; AERA et al., 2014; Hambleton et al., 2000; Thorndike, 2005).

An analysis of the psychometric properties of a test is only part of a full-scale validation study. If a test is considered to be psychometrically sound, that speaks positively to the validity of the appropriateness, meaningfulness, and usefulness of the test results, though a claim still cannot be made about the overall validity of the appropriateness of interpretations and usage of the results. However, if there are psychometric issues with the test/test items, then immediately the concept of validity is brought into question.

Part of the discussion about the validity of the interpretations or inferences made from a test results was developed on the basis of Messick's (1989) definition of test validity. He made the point that test validity is the appropriateness of interpretations and usage of the results of the assessment based on support from empirical evidence and theory. Based on Messick's (1989) definition of validity, there is an emphasis on the interpretations of the test results, and these are to be supported by empirical evidence and theory.

Messick's (1989) validity argument is focused on the interpretations of the test results, and not so much on the test itself. The point must be made, however, that the validity of the interpretations of the test scores is not separate from, or in isolation of the psychometric issues associated with the test itself. Messick's validity argument would have assumed that all the processes involved in the development, administration, and scoring of the test are all done according to established test standards. The empirical evidence and theory would include an analysis of the psychometric properties of the test as well as any other issues relating to the development, administration, and scoring of the test. As was alluded to earlier, part of the reason why this study is not able to make a definite conclusion about the validity of the inferences made about the mathematics diagnostic test designed by the MOEYI for prospective secondary school mathematics teachers in Jamaica results is the fact that only the psychometric properties of the test were analysed. Some of the areas that were analysed and now further discussed here include the item difficulty levels, the item discrimination levels, the item distractor analysis, the test information function (TIF), and the CTT and Rasch reliability estimates of the test.

Item difficulty is one of the most commonly used psychometric properties in items/test analysis. Suruchi and Rana (2014) emphasized that for a test to

be reliable, and the interpretations and intended use of its results to be valid, a systematic selection of items regarding the subject content and the degree of item difficulty is necessary. An analysis of the item difficulty levels of the items on the mathematics diagnostic test designed for prospective secondary mathematics teachers in Jamaica showed that the majority of items fall within the optimum difficulty range of .26–.75. According to Thompson and Levitov (1985), the ideal difficulty for a test item should be about half-way between the percentage of pure guess (25%) and 100% and is calculated to be .63. While the majority of items on the test were within the optimum difficulty range, a number of items were considered to be too easy or too difficult. These inconsistencies, however, may not pose serious concerns for the test reliability and the validity of the interpretations and use of the test results.

Item discrimination is another commonly used psychometric property in item analysis. Haladyna et al. (2002) suggested that the discrimination index is a basic measure of the validity of an item. It indicates the extent to which the overall knowledge of the content is related to the response to an item. Masters (1988) stated that a high item discrimination measure can be an indication of a special kind of measurement disturbance introduced by an item that gives a test-taker of higher ability a special advantage over those with lower ability. He continued that this situation in measurement can be interpreted as a kind of item bias that is encouraged, interpreting highly discriminating items as the best items on a test. In this study, the findings revealed that a considerable number of items (over 50%) on the test could be considered marginal or poor based on their discrimination values. These findings are not in keeping with Master's (1988) idea that items that discriminate well are good items. In comparison to other psychometric properties of the mathematics diagnostic test designed for prospective secondary mathematics teachers, there are more concerns with the discrimination indices of the test items.

One of the basic properties of multiple-choice test items is the effectiveness of their distractors. The effectiveness of an item's distractors can impact the difficulty and discrimination measures of the item. Item distractor analysis is a common method of evaluating validity and reliability. The findings in this study showed that the mathematics diagnostic test designed for prospective secondary mathematics teachers recorded a relatively high DE of 80.6%.

The analysis of the findings relating to the DE showed that a mean of 19 items on the test had at least one NFD. Of these 19 items, nine items had two or three NFDs. Further analysis of the findings revealed that more of the items with two or three NFDs were found to be easier based on their difficulty

indices. More of the items with two or three NFDs were also found to be less discriminating. These findings are supported by Hingorjo and Jaleel (2012), who found in their study that NFDs make an item easier, thereby affecting the assessment of the test-takers. If an item has a distractor or a number of distractors that are non-functional, then the test-takers would have less plausible options from which to select the key. This should make the item easier, even for a test-taker who may guess the answer, since the probability of guessing the correct answer is now higher. This idea of item DE and item difficulty is also supported by Gajjar et al. (2014), who stated that an increased proportion of NFDs in an item makes it easier. It is the general idea that items with fewer NFDs are better able to discriminate between high- and low-ability test-takers. Another psychometric property examined in this study was the TIF. The TIF speaks to the level of precision with which the test estimated the test-takers' ability levels. While there is no rule of thumb as to what level of information is acceptable, different test developers may accept different levels of information based on the purpose of the test. Regardless of the purpose of the test, however, if the information value is large, it means that a test-taker whose true ability is at that level is estimated with high precision. A large information value suggests that all the estimates are reasonably close to the true values. On the other hand, a small information value means that the ability cannot be estimated with precision. A TIF value of 10 corresponds to a CTT reliability coefficient of .90, a TIF value of 5 is equivalent to a CTT reliability estimate of .80, and a TIF value of 10 is equivalent to a CTT reliability estimate of .90 (Hambleton & Lam, 2009). Based on the ranges of information values for the mathematics diagnostic test designed for prospective secondary mathematics teachers; and considering Hambleton and Lam's (2009) suggestion for their corresponding reliability measures, the CTT reliability estimates for the test would generally range between .80 and .90. These corresponding TIF and CTT reliability values suggest that the test was very precise in estimating the test-takers' ability levels.

The study also examined a number of reliability estimates for the mathematics diagnostic test designed for prospective secondary mathematics teachers in Jamaica. Two of the major reliability estimates discussed in this section include the Rasch item and person reliability estimates. The Rasch item reliability estimate is dependent on two major components. According to Linacre (2017), a low item reliability under the Rasch calculation means that the sample may not be large enough. In WINSTEPS, Linacre (2017) also suggested that the Rasch item reliability depends on the item difficulty levels. A wide range of item difficulty levels normally produces a high reliability. Another factor is

the person sample size. A large person sample size normally produces a high reliability. The length of the test also affects the reliability of the test. The larger the test, the higher the reliability value is.

The mathematics diagnostic test designed for prospective secondary mathematics teachers recorded a high item reliability estimate. The test recorded a wide range of item difficulty levels; and a large enough sample size used is accounted for in the high item reliability estimates.

Conclusion

The following conclusions were made based on the findings of the study:

1. Though some of the item difficulty levels of the test are inconsistent with what is considered ideal, the difficulty levels of the test items do not pose serious concerns or threats to the reliability of the test and the validity of the interpretations and use of its results.
2. A considerable number of the items on the test were poor in their ability to differentiate between high and low ability test-takers. These items should be re-examined with a view to revise or discard the items where necessary.
3. Though the overall test is considered highly efficient in terms of the functionality of its item distractors, there is still a notable number of items with NFDs that need to be re-examined with a view to revise or discard.
4. The test information function (TIF) for the mathematics test indicated that the test was precise in measuring test-takers' ability levels.
5. The reliability analysis concluded that the 2020 mathematics diagnostic test designed for secondary prospective mathematics teachers was highly reliable.
6. The overall conclusion made from the findings of the study is that the mathematics diagnostic test designed by the MOEYI for prospective secondary school mathematics teachers in Jamaica test is psychometrically sound.

Implications

The analysis of the psychometric properties of a test is an important part of test development and validation. The analysis of the psychometric properties of the mathematics diagnostic test designed by the MOEYI for prospective secondary school mathematics teachers in Jamaica has implications for test

and item analysis as well as for the understanding of test-takers' performance. Though the study does not make a definite claim about the overall validity of the inferences or interpretations of the test results, one important point to reiterate is that an analysis of the psychometric properties of a test provides information about the appropriateness, meaningfulness, and usefulness of the test results (validity). The impact of any questionable issue associated with the psychometric properties of a test can have far-reaching implications for the accuracy of the interpretations and consequences of the test results.

Based on the analysis of the psychometric properties of the test/test items, the study concluded the test to be generally psychometrically sound. Part of the psychometrical soundness of the test includes the test being highly reliable in measuring the proficiency levels of its test-takers. This test results provide critical information on test-takers' performance characteristics and is reliable in identifying specific areas of misconceptions or misunderstandings among test-takers.

Recommendations

While the majority of items on the diagnostic test designed for secondary prospective mathematics teachers are psychometrically sound, it is recommended that the psychometric properties of some items be re-examined with an aim to review or discard the items. For example, items with 3 NFDs should be replaced and those with 1 or 2 NFDs be revised. This is to be done in order to ensure improvement in the test reliability level and the validity of its results and intended use.

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Retrospectively Using Discrete Mathematics Concepts to Develop a Robust Ranking System for the 2019 Ice Cricket World Cup

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Abstract

The 2019 ICC Cricket World Cup was held from May 30 to July 14 in England and Wales with a new tournament format being used. The competition was reduced to ten teams, in a single pool, with each team scheduled to play every one of the other nine teams. The purpose of such a tournament is to identify the strongest or most dominant teams, but this was thwarted in the 2019 Cricket World Cup by the scoring system, in particular the use of net run rate to rank teams tied on points awarded for wins, draws and 'no result' matches. Concepts from discrete mathematics, in particular graph theory, are applied to create a ranking system better suited to this type of tournament. The dominance graph for matches between the top five teams shows that the team which came fourth, under the current system, was dominated by the team placed in fifth position. This paper shows how the use of net run rate may be replaced by calculating one stage, two stages and if necessary three stage dominances, to rank teams. These calculations are easily done using a dominance matrix. Recommendations to ensure that the strongest teams play in the final match, for the cup, are made and it is suggested that the group stage of the FIFA Football World Cup use the scoring method explained in this paper.

Keywords: Tournament, Net Run Rate, Dominance Graph, Dominance Matrix

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Introduction

The International Cricket Council (ICC) hosts the Cricket World Cup of one day matches every four years. The 2019 ICC World Cup was held from May 30 to July 14 in England and Wales with a new tournament format being used in the competition [1]. For the 2015 World Cup, fourteen teams were divided into two pools of seven with a team playing a match against each of the other teams in their pool. The top four teams from each of the two pools competed in quarter-final matches with the winners going to semi-final matches and ultimately Australia won the final and was named world champions.

Objective of Paper

The result in 2015 was not entirely satisfactory since Australia, who came second in Pool A, never played South Africa, who came second in Pool B and lost their semi-final match by the Duckworth-Lewis method. An explanation of the Duckworth-Lewis method is given in [2]. For 2019 the competition was reduced to ten teams, in a single pool, with each team scheduled to play every one of the other nine teams. The objective of this paper is to give a perspective on how successful this new tournament format was in determining a champion and make recommendations for changes to the way the teams are ranked, and the finalists determined.

Description of What Happened in the 2019 Tournament

The ten teams in the tournament were Afghanistan, Australia, Bangladesh, England, India, New Zealand, Pakistan, South Africa, Sri Lanka and the West Indies. A total of forty-eight matches, which included two semi-finals and one final, were scheduled. Four of the matches were not completed because of bad weather, these were 'no result' matches, and this had an impact on who played in the final match, as will be discussed below. The results of all matches are shown in Appendix A and may be found online at [3]. When a team won a match, they were awarded 2 points, each team was awarded 1 point in the case of a draw or 'no result' and 0 points were awarded for a loss. The final standings of the ten teams are shown in Table 1.

New Zealand won five matches and their match against India was rained out so they were awarded eleven points. By winning five matches and being part of a match with Sri Lanka which was rained out Pakistan was also awarded eleven

Table 1: Standings of the Ten Teams after Completion of 45 Match Tournament

Team	Matches Won	Matches Lost	Draw/No Result	Points	Net Run Rate
India	7	1	1	15	+0.809
Australia	7	2	0	14	+0.868
England	6	3	0	12	+1.152
New Zealand	5	3	1	11	+0.175
Pakistan	5	3	1	11	−0.430
Sri Lanka	3	4	2	8	−0.919
South Africa	3	5	1	7	−0.030
Bangladesh	3	5	1	7	−0.410
West Indies	2	6	1	5	−0.225
Afghanistan	0	9	0	0	−1.322

Source [4]

points. The tie for fourth place was critical as the top four teams competed in the two semi-final matches.

The Problem with Implementation of the Tournament

The net run rate was used to place New Zealand fourth over Pakistan, sending New Zealand to the semi-finals and ultimately to the final and sending Pakistan out of the competition, after forty-five matches as shown in Table 1. A good explanation of how the net run rate is calculated may be found on the webpage with the URL given in [5]. On that webpage, some of the disadvantages of using net run rate to rank teams tied on points are discussed and other possible methods to break a tie are mentioned and then discredited. This paper provides a solution to the problem discussed on the net run rate webpage.

The purpose of a tournament, in which each team plays every other team, is to identify the strongest or most dominant teams. This purpose was thwarted in the 2019 Cricket World Cup by the scoring system, in particular the use of net run rate, as evidenced by New Zealand being ranked above Pakistan. A close look at the results in Appendix A and Table 1 shows that all of New Zealand's wins came against the five lowest teams in the standings along with three loses to top teams and 'no result' against India. On the other hand, Pakistan defeated two of the top five teams, England and New Zealand. The dominance graph for matches between the top five teams illustrates this point in Figure 1.

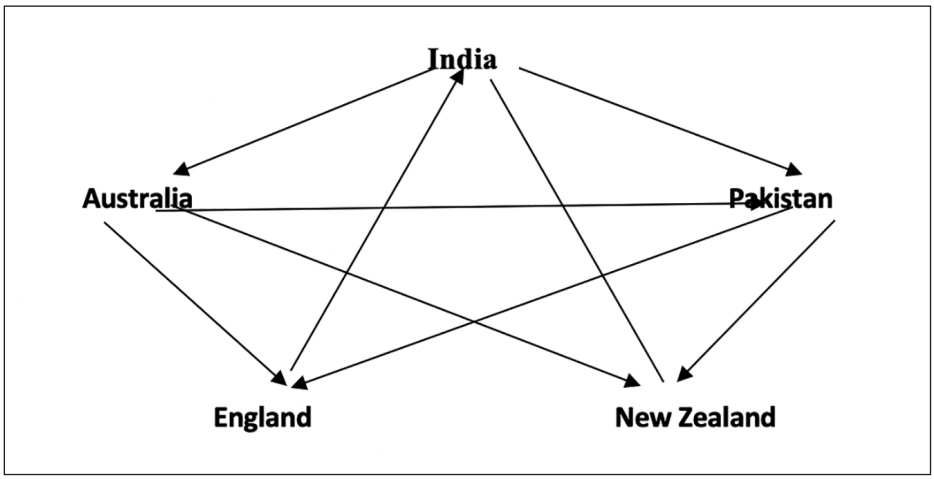

Figure 1: Dominance Graph for the Top Five Teams in the 2019 Cricket World Cup

Proposed Solution to the Problem

An arrow between two teams shows that the team at the head of the arrow was defeated by the team at the tail. An edge between two teams, with no arrowhead, represents a draw or match with 'no result.' From Figure 1 it is easy to see that every top five team, except New Zealand, defeated at least two other top five teams. Is there a way to assign a numerical value to distinguish between a victory over a top ranked, dominant, team and a victory over a weaker team? The answer is yes and the discussion that follows explains how the numerical value is determined.

England defeated India and India defeated both Australia and Pakistan. We say that England dominated India in one stage and dominated Australia and Pakistan in two stages. In Figure 1, a single arrow shows a one stage victory or domination while a path of arrows from a first team to a second and from a second to a third team shows domination in two stages. An arrow followed by an edge, or an edge followed by an arrow shows a draw or 'no result' in two stages. A victory over a team that has numerous victories over other teams will yield many two stage dominances whereas a victory over a weak team will result in a few or no two stage dominances.

A ranking of all the teams in the 2019 Cricket World Cup may be found using the dominance graph for the ten teams. That dominance graph is a bit overwhelming visually and is therefore not included in this article, however, it was used to determine the example given below. The interested reader may

use the results in Appendix A to create their own dominance graph for the ten teams.

Continuing to use England as an example, they dominated six teams directly and obtained 20 dominances and five 'no result' matches in two stages, as explained by the following. England defeated Afghanistan while Afghanistan defeated none of the other teams, so England obtained zero two-stage dominances through Afghanistan. By defeating Bangladesh England earned three dominances and a 'no result' in two stages because of Bangladesh's three victories and one match, against Sri Lanka, with 'no result'. Similarly, England obtained seven dominances and a 'no result' in two stages from India, five dominances and a 'no result' in two stages from New Zealand, three dominances and a 'no result' in two stages from South Africa and two dominances and a 'no result' in two stages from the West Indies.

An analysis of victories and dominances or 'no results' in two stages may be found for each of the other nine teams, however, using a dominance graph to do this is tedious and inefficient. A better method is to create the dominance matrix by assigning a value of 1 to a victory, a value of $^1/_2$ to a draw or 'no result' and 0 to a loss. Dominance matrix D is shown in Figure 2.

In matrix D the sum of the values across the row labeled ENG is 6 indicating that England won six matches while the sum down the ENG column is 3 indicating that they lost three matches. The rows labeled New Zealand and Pakistan both have a sum of $5^1/_2$ because they each won five matches and had one match with 'no result,' while the sum of the respective columns both have a sum of $3^1/_2$ from three loses and one 'no result' match. To break the tie, we

		AFG	AUS	BAN	ENG	IND	NZ	PAK	SA	SL	WI
	AFG	0	0	0	0	0	0	0	0	0	0
	AUS	1	0	1	1	0	1	1	0	1	1
	BAN	1	0	0	0	0	0	0	1	½	1
	ENG	1	0	1	0	1	1	0	1	0	1
D =	IND	1	1	1	0	0	½	1	1	1	1
	NZ	1	0	1	0	½	0	0	1	1	1
	PAK	1	0	1	1	0	1	0	1	½	0
	SA	1	1	0	0	0	0	0	0	1	½
	SL	1	0	½	1	0	0	½	0	0	1
	WI	1	0	0	0	0	0	1	½	0	0

Figure 2: Dominance Matrix D

		AFG	AUS	BAN	ENG	IND	NZ	PAK	SA	SL	WI
	AFG	0	0	0	0	0	0	0	0	0	0
	AUS	6	0	3½	2	1½	2	1½	4½	2	4
	BAN	2½	1	¼	½	0	0	1¼	½	1	1
	ENG	5	2	2	0	½	½	2	3½	3½	3½
D × D =	IND	6½	1	3	3	¼	2	2½	3	3½	4
	NZ	4½	1½	1	1	0	¼	2	2	2	3
	PAK	4½	1	2¼	½	1½	1	¼	3	2½	4
	SA	2½	0	1½	2	0	1	2	¼	1	2
	SL	3	0	1½	½	1	1½	1	2½	½	1½
	WI	1½	½	1	1	0	1	0	1	1	¼

Figure 3: The Product of Matrix D

want to calculate the total number of dominances or 'no results' in two stages. This is done by calculating D×D, the product of matrix D with itself, which is shown in Figure 3.

In Matrix D×D the sum across the England row is 22½ because they had twenty dominances and five 'no results' in two stages. Now the tie between New Zealand and Pakistan may be decided. Because Pakistan defeated stronger teams their row sum over two stages is 20½ while the sum across the New Zealand row is 17¼. We now have numerical values to distinguish between victories over dominant teams versus weak teams. Table 2 shows the standings of the ten teams using this scoring method.

Table 2: Standings of the Ten Teams Using Dominance Matrices

Team	Matches Won	Matches Lost	Draw/No Result	One Stage Dominances	Two Stage Dominances
India	7	1	1	7½	28¾
Australia	7	2	0	7	27
England	6	3	0	6	22½
Pakistan	5	3	1	5½	20½
New Zealand	5	3	1	5½	17¼
Sri Lanka	3	4	2	4	13
South Africa	3	5	1	3½	12¼
Bangladesh	3	5	1	3½	8
West Indies	2	6	1	2½	7¼
Afghanistan	0	9	0	0	0

By comparing Table 1 with Table 2 it is seen that one stage dominances serve the same purpose as the point system currently in place. It is hoped that the above explanation has shown the reader the benefit of using two stage dominances, rather than net run rate to rank teams tied on one stage dominances. If two teams are tied on both one stage dominances and two stage dominances, then three stage dominances may be calculated from the matrix D×(D×D). If there is still a tie, then go to four stage dominances and so on.

Conclusion

At the end of a tournament, in which each team plays every other team, the most dominant team could be declared the champion. However, a major sporting event without semi-finals and a final match would probably not be satisfactory to the fans. In the 2019 Cricket World Cup New Zealand, as the fifth most dominant team, faced the most dominant team, India, in the first semi-final. By defeating India, New Zealand earned their first win over a team ranked in the top five and went to the final. England, as the third most dominant team, defeated Australia, the second most dominant team in a second semi-final match. England defeated New Zealand in the final and were crowned champions. It is unfortunate for teams like India and Australia who dominated the competition throughout a tournament of matches to be eliminated by a single semi-final match.

Recommendations

The use of net run rate to rank teams tied on points should be discontinued and replaced by two stage and, if necessary, three stage dominances as calculated by a dominance matrix. In addition, a fellow cricket fan [6] suggested that the ICC should adopt the same semi-final format as is used in the Indian Premiere League T-20 competition. In that format the two top ranked teams play a first semi-final match with the winner going to the final. The third and fourth ranked teams play a second semi-final with the winner playing the loser of the first semi-final in a third match to determine the second team playing in the final. In this way, the top two teams have two pathways to the final, with at least one of them playing in the final. The third and fourth place teams have a pathway to the final with at most one of them playing in the final.

Ranking teams by the dominance method described here can also be applied to the Federation Internationale de Football Association (FIFA) World Cup

group stage. Teams tied on points, from wins, draws and losses, are ranked by a series of criteria starting with goal difference then goals scored and so on. These methods currently used by FIFA have the same short comings as net run rate in cricket in that they do not rank a team based on its dominance over rival teams.

Appendix A

- Match 1 May 30 England 311/8 50 overs South Africa 207 39.5 overs
  England won by 104 runs
- Match 2 May 31 Pakistan 105 21.4 overs West Indies 108/3 13.4 overs
  West Indies won by 7 wickets
- Match 3 June 1 Sri Lanka 136 29.2 overs New Zealand 137/0 16.1 overs
  New Zealand won by 10 wickets
- Match 4 June 1 Afghanistan 207 38.2 overs Australia 209/3 34.5 overs
  Australia won by 7 wickets
- Match 5 June 2 South Africa 309/8 50 overs Bangladesh 330/6 50 overs
  Bangladesh won by 21 runs
- Match 6 June 3 Pakistan 348/8 50 overs England 334/9 50 overs
  Pakistan won by 14 runs
- Match 7 June 4 Sri Lanka 201 36.5 overs Afghanistan 152 32.4 overs
  (41 allotted)
  Sri Lanka won by 34 runs (D/L method)
- Match 8 June 5 South Africa 227/9 India 230/4 47.3 overs
  India won by 6 wickets
- Match 9 June 5 Bangladesh 244 49.2 overs New Zealand 248/8 47.1 overs
  New Zealand won by 2 wickets
- Match 10 June 6 Australia 288 49 overs West Indies 273/9 50 overs
  Australia won by 15 runs
- Match 11 June 7 Pakistan Sri Lanka Match Abandoned No ball bowled
- Match 12 June 8 England 386/6 50 overs Bangladesh 280 48.5 overs
  England won by 106 runs
- Match 13 June 8 Afghanistan 172 41.1 overs New Zealand 173/3 32.1 overs
  New Zealand won by 7 wickets
- Match 14 June 9 India 352/5 50 overs Australia 316 50 overs
  India won by 36 runs
- Match 15 June 10 South Africa 29/2 7.3 overs West Indies did not bat
  No Result
- Match 16 June 11 Bangladesh Sri Lanka No ball bowled due to rain
  No Result
- Match 17 June 12 Australia 307 49 overs Pakistan 266 45.4 overs
  Australia won by 41 runs

- Match 18 June 13 India New Zealand No ball bowled due to rain
  No Result
- Match 19 June 14 England 213/2 33.1 overs West Indies 212 44.4 overs
  England won by 8 wickets
- Match 20 June 15 Sri Lanka 247 45.5 overs Australia 334/7 50 overs
  Australia won by 87 runs
- Match 21 June 15 South Africa 131/1 23.4 overs (48 allotted) Afghanistan 125 33.4 overs
  South Africa won by 9 wickets (D/L method)
- Match 22 June 16 India 336/5 50 overs Pakistan 212/6 40 overs (target 302)
  India won by 89 runs (D/L method)
- Match 23 June 17 West Indies 321/8 50 overs Bangladesh 322/3 41.3 overs
  Bangladesh won by 7 wickets
- Match 24 June 18 England 397/6 50 overs Afghanistan 247/8 50 overs
  England won by 150 runs
- Match 25 June 19 New Zealand 245/6 48.3 overs (49 allt) South Africa 241/6 49 overs (49 allt)
  New Zealand won by 4 wickets
- Match 26 June 20 Australia 381/5 50 overs Bangladesh 333/8 50 overs
  Australia won by 48 runs
- Match 27 June 21 England 212 50 overs Sri Lanka 232/9 50 overs
  Sri Lanka won by 20 runs
- Match 28 June 22 India 224/8 50 overs Afghanistan 213 49.5 overs
  India won by 11 runs
- Match 29 June 22 West Indies 286 49.0 overs New Zealand 291/8 50 overs
  New Zealand won by 5 runs
- Match 30 June 23 Pakistan 308/7 50 overs South Africa 259/9 50 overs
  Pakistan won by 49 runs
- Match 31 June 24 Bangladesh 262/7 50 overs Afghanistan 200 47 overs
  Bangladesh won by 62 runs
- Match 32 June 25 England 221 44.4 overs Australia 285/7 50 overs
  Australia won by 64 runs
- Match 33 June 26 New Zealand 237/6 50 overs Pakistan 241/4 49.1 overs
  Pakistan won by 6 wickets
- Match 34 June 27 West Indies 143 34.2 overs India 268/7 50 overs
  India won by 125 runs

- Match 35 June 28 Sri Lanka 203 49.3 overs South Africa 206/1 37.2 overs South Africa won by 9 wickets
- Match 36 June 29 Pakistan 230/7 49.4 overs Afghanistan 227/9 50 overs Pakistan won by 3 wickets
- Match 37 June 29 New Zealand 157 43.4 overs Australia 243/9 50 overs Australia won by 86 runs
- Match 38 June 30 England 337/7 50 overs India 306/5 50 overs England won by 31 runs
- Match 39 July 1 West Indies 315/9 50 overs Sri Lanka 338/6 50 overs Sri Lanka won by 23 runs
- Match 40 July 2 India 314/9 50 overs Bangladesh 286 48 overs India won by 28 runs
- Match 41 July 3 England 305/8 50 overs New Zealand 186 45 overs England won by 119 runs
- Match 42 July 4 West Indies 311/6 50 overs Afghanistan 288 50 overs West Indies won by 23 runs
- Match 43 July 5 Pakistan 315/9 50 overs Bangladesh 221 44.1 overs Pakistan won by 94 runs
- Match 44 July 6 Sri Lanka 264/7 50 overs India 265/3 43.3 overs India won by 7 wickets
- Match 45 July 6 Australia 315 49.5 overs South Africa 325/6 50 overs South Africa won by 10 runs
- First Semi-final July 9 India 221 49.3 overs New Zealand 239/8 50 overs New Zealand won by 18 runs
- Second Semi-final July 11 Australia 223 49 overs England 226/2 32.1 overs England won by 8 wickets
- Final July 14 England 241 50 overs New Zealand 241/8 50 overs Super over England 15/0 New Zealand 15/1 England won the super over and the Cup

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Assessing the Antibacterial Activity of Extracts of Tamarind (Tamarindus Indica)

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Abstract

This study tested whether extracts of Tamarindus indica had antibacterial properties. Extracts from the stems and leaves of Tamarindus indica were carried out using methanol, hexane, and ethyl acetate as solvents. The antibacterial properties/activity of these extracts were then tested by using the agar well-diffusion method to measure their effect on the growth of Pseudomonas aeruginosa, Escherichia coli, Aerococcus Viridans and Staphylococcus aureus. The results showed that the ethyl acetate extract resulted in the largest average zone of inhibition for all bacteria tested against (30.9 mm); this was followed by the methanol and then hexane. The most susceptible organism to the ethyl acetate extract was Aerococcus (41.9 mm). The methanol and hexane extracts were most effective against Staphylococcus with their zones of inhibition measuring 14.4 mm and 13.1 mm, respectively. Augmentin (1g) was used as a positive control and had zones of inhibition of 37.4 mm for Staphylococcus, 29.1 mm for E. coli and 12.5mm for Pseudomonas. Aerococcus Viridans was resistant to the control (0.0mm). The results showed that the ethyl acetate and methanol extracts had broad spectrum antibacterial activity against gram-positive and gram-negative bacterial species.

Keywords: Antibacterial Activity, Extracts, Tamarind

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Introduction

The *Tamarindus indica* or tamarind plant is a leguminous plant that has been used in medicines for years to treat various illnesses/disorders. An example of this is boiling the leaves of the tamarind plant in water and using the water to relieve the pruritic symptom of chickenpox. The *Tamarindus indica* is native to Africa but also grows in India, Pakistan and other tropical regions of the world. The tamarind plant may be considered a medicinal plant that could be a part of our traditional healthcare system as it is consumed in the orm of foods and beverages and is considered to be safe for individuals (Nwodo, 2011).

There have been reports worldwide of the plant having antimicrobial effects, specifically antibacterial and antifungal activities (Escalona-Arranz, 2010 and Moncrieffe, 2019). In Northern Nigeria, the fresh stem bark and fresh leaves are used as decoction mixed with potash for the treatment of stomach disorder, general body pain, jaundice, yellow fever and as blood tonic and skin cleanser, (Doughari, 2007). According to Kuru (2014), Tamarindus indica has a rich source of essential amino acids and phytochemicals that enables it to have antimicrobial, antimalarial, antidiabetic, antivenomic, antioxidant, anti-hyperlipidemic, hepatoprotective, cardioprotective and laxative properties. Kuru also purported that the fruit can be used as a source of nutrition for patients as it is relatively affordable.

Research on medicinal plants is as important as that on conventional drugs due to the beneficial phytochemicals from plants and the shift towards natural products in pharmaceutical and cosmeceutical industries (Fotsing Yannick Stéphane, F. 2021). In the present investigation, the leaves and stems of *Tamarindus indica* were extracted with hexane, ethyl acetate and methanol and screened for anti-bacterial activity against *Pseudomonas aeruginosa, Escherichia coli, Aerococcus viridans* and Staphylococcus *aureus*. The extract with the most potent antibacterial activity was determined.

Extraction of the bioactive constituents from plants has always been challenging for researchers. As the target compounds may be from non-polar to polar and thermally labile, the suitability of the extraction methods must be considered. The study on medicinal plants starts with extraction procedures that play a critical role in the extraction outcomes and the consequent assays. (Fotsing Yannick Stéphane, F. 2021)

The type of solvents utilized in the extraction process will influence the solutes extracted. Polar solvents have partial positive and negative charges and so they are capable of attracting and dissolving other polar substances, for example ethyl acetate. Non-polar substances (e.g. Methanol) tend not to have either negative or positive charges and therefore will only dissolve other non-polar compounds. PSIBERG, 2022, Polar vs Non-Polar Solvent: identification and examples, para 2, 3). There are also semi-polar solvents (e.g. Benzene) that can induce polarity into non-polar molecules.

Justification

In 2021, the World Health Organisation (WHO) declared: "antimicrobial resistance (AMR) is one of the top 10 global public health threats facing humanity. It is a global health and development threat. It requires urgent multisectoral action in order to achieve the Sustainable Development Goals" (WHO, 2021, antimicrobial resistance, para 1, 2). This declaration articulates the need for the development of new antimicrobial agents for the treatment of different types of infections.

Plants have long been the primary source of numerous pharmaceutical agents used to treat many illnesses including infections. The ability to identify the medicinal value of crude plant material is an initial essential step. Understanding how to extract active pharmaceutical ingredients from the crude plant is essential to the drug development process. The ideal method of extracting the antimicrobial agent from the Tamarind plant is therefore of value to the research fraternity. It sets the foundation for the development of new antimicrobials for the treatment of topical and systemic infections.

This research is a continuation of previous work by Moncrieffe et. al., (2019), where it was determined that Tamarind has antibacterial properties.

Materials and Method

Materials: Bacterial samples (*Pseudomonas aeruginosa, Escherichia coli, Aerococcus viridans* and *Staphylococcus aureus*), Tamarind stems and leaves, distilled water, 95% ethanol, nutrient broth, nutrient agar, Standard Methods agar, water, and AMC (amoxicillin and clavulanate 875mg/125mg), ethyl acetate, hexane, methanol and 1% DMSO.

Part 1 – Preparation of T. indica Extract

1. Stems and leaves from the *Tamarindus indica* were harvested from a mature tree at the University of Technology, Jamaica Papine campus.
2. The stems and leaves were washed with tap water, drained and then finely grounded.
3. The ground material was then washed with tap water followed by distilled water and left to air dry for five (5) days in a cool dry place.
4. Two hundred grams (200 g) of the grounded material were weighed and transferred into a 2000 ml conical flask; after which the net weight of the grounded material and a 2000 mL conical flask was recorded.

Part 2 – Extraction and Concentration of Extract

Extraction Using Hexane

1. Hexane was added to cover the 200g of dried stems and leaves and then covered with a conical stopper.
2. The mixture was left to stand for seven (7) days and then filtered into an empty 1000 ml conical flask using 150 mm Whatman filter paper and a filter funnel.
3. The residue (grounded died stems and leaves) was then put aside for extraction using ethyl acetate.
4. The hexane extract was attached to a rotary evaporator and spun at medium revolution for 45 minutes with a water bath temperature set at 55 ^{0}C. This was repeated until a concentrated filtrate was obtained.
5. The concentrated hexane extract was placed in a labelled 120 ml amber bottle and left to stand to remove any remaining solvent by evaporation.

Extraction Using Ethyl Acetate

1. The residue (from step 3 above) was covered with just enough ethyl acetate for full immersion and left to stand for eight (8) days.
2. The liquid was then filtered into an empty 1000 ml conical flask.
3. The residue was then put aside once more for extraction using methanol.
4. The extract was attached to a rotary evaporator and spun at medium revolution for 45 minutes with a water bath temperature set at 55^{0}C. This was repeated until a concentrated filtrate was obtained.

5. The concentrated extract was placed in a labelled 120 ml amber bottle and left to stand to remove any remaining solvent.

Extraction Using Methanol

1. The residue (from step 9 above) was covered with just enough methanol to ensure full immersion and left to stand for six (6) days.
2. The methanol extract was filtered using the same technique above and the filtrate collected in a 1000 ml conical flask.The methanol extract was attached to a rotary evaporator and spun at medium revolution for 45 minutes. With water bath temperature set at 40^{0}C, this was repeated until a concentrated filtrate was obtained.
3. The concentrated extract was placed in a labelled 120 ml amber bottle and left to stand to remove any remaining solvent.

Part 3 – Preparation of the agar plates

Twenty-eight (28) petri dishes were divided into quarters and each quarter labelled either methanol, hexane, dimethyl sulfoxide (DMSO) or ethyl acetate. Another eight (8) petri dishes were labelled Augmentin.

1. A total of nine petri dishes were grouped and labelled *A. viridians*. Seven of which were divided into quarters, two were labelled Augmentin. This was repeated with labelled S. *aureus, P. aeruginosa*, or *E. coli*.
2. Five hundred mililitres (500ml) of nutrient agar and 100 ml of Standard Methods Agar were prepared.
3. Both agar preparations were autoclaved at a pressure of 15 psi and a temperature of 120^{0}C for 15 minutes.
4. The 36 dishes were each aseptically filled with 20ml of Standard Methods Agar.
5. The agar plates were then left to solidify.

Part 4 – Determining the Zones of Inhibition

1. Subcultures of *Pseudomonas aeruginosa, Escherichia coli, Aerococcus viridans* and *Staphylococcus aureus* were prepared and then incubated at 37^{0}C for approximately 24 – 48 hours.
2. Four (4) test tubes of nutrient broth were inoculated with the named bacterium and incubated at 37^{0}C for approximately 24 hours.
3. The test tubes were examined using a spectrometer and adjusted as needed

to 0.5 McFarland standard using more nutrient broth.

4. Each agar plate was labelled and inoculated with 0.5 mL of bacterial culture using spread plate technique.
5. An aseptic cork borer was used to create a central well in each labelled quarter of the agar plates.
6. The well in each quarter was filled with the labelled extract and was then incubated at 37^0C for 24–48hrs.
7. The zones of inhibition of each agar plate were then observed, measured, tabulated and the standard error calculated from the replicate results.

All extracts were diluted to a concentration of 10% (w/v) in 1% DMSO (dimethyl sulfoxide)

Results

Table 1: Shows the Zone of Inhibition in Millimetres for the Selected Organisms in *Tamarindus indica* extracts.

Solvent	Average Zone of Inhibition in mm ± SE (Well-Plate Method)			
	Escherichia coli	Pseudomonas aeruginosa	Aerococcus viridans	Staphylococcus aureus
Methanol	**10.0** ± 0.4	**5.7** ± 2.0	**9.1** ± 2.4	**14.4** ± 0.5
Hexane	0	0	0	**13.1** ± 1.3
Ethyl Acetate	**26.6** ± 0.6	**25.4** ± 1.2	**41.9** ± 0.5	**29.6** ± 0.3
1% DMSO (Control)	0	0	0	0
Augmentin	**29.1** ± 1.1	**12.5** ± 0.9	0	**37.4** ± 0.4

DMSO = dimethyl sulfoxide
SE = Standard error

The most active extract against all microorganisms was ethyl acetate with a total average zone of inhibition of 30.9 mm. The methanol extract was also active against all four organisms with a total average zone of inhibition of 9.8 mm. The hexane extract was inhibitory to *Staphylococcus aureus* only. The most susceptible bacteria to Augmentin were Staphylococcus, followed by *E. coli* and Pseudomonas.

Discussion

The results showed that the ethyl acetate and methanol extracts had broad spectrum antibacterial activity against gram-positive and gram-negative bacterial species. This result is similar to previous studies by Doughari (2006) and Escalona-Arranz, (2010) where organic solvent (acetone and ethanol) extracts had bacteriostatic and bactericidal properties against *Escherichia coli, Pseudomonas aeruginosa,* and *Staphylococcus aureus.*

Ethyl acetate had the largest zone of inhibition across the board for all the microorganisms followed by methanol and then hexane showing little to no zone of inhibition. This indicated that ethyl acetate was the most appropriate or effective solvent for the extraction of antibacterial compounds from *Tamarindus indica* of those tested. It can further be stated that ethyl acetate extracted the most potent antimicrobial component(s) found in the stem and leaves of the *Tamarindus indica*. In the case of the methanol and hexane extracts, minimal inhibiting activities were seen against *A. viridans, P. aeruginosa, E. coli* and *Staphylococcus.*

Based on the zone of inhibition, the ethyl acetate extract was generally more effective against the gram-positive bacterial species in the study when compared to the gram-negatives. The largest zone of inhibition was due to *A. viridans* followed by *S. aureus*. This observation coincides with previous studies by Gupta (2014) that showed that the *Tamarindus indica* has a greater antimicrobial activity against gram positive bacteria than gram negative.

The Augmentin control had no activity against *A. viridans* and a zone of inhibition of 12.5 mm for *P. aeruginosa.* The inactivity of Augmentin against *A. viridans* may be due to the intrinsic resistance which is typical of this bacterial species as well as their evolving resistance to penicillin containing antibiotics (Mohan, 2017). Augmentin showed a larger zone of inhibition for *S. aureus* than the ethyl acetate extract with an average measurement of 37.4 mm. This may be because of their different mechanisms of antibacterial activity. Augmentin is known to disrupt bacterial cell wall synthesis while the *Tamarindus indica* plant is said to disrupt cytoplasmic membrane function, preventing the synthesis of nucleic acid (Abukakar, 2008). The *S. aureus* bacteria has efflux pumps on its cytoplasmic membrane which can remove biocides from the cytoplasm (Costa, 2013). This adaptation however would be ineffective against Augmentin as it does not need to enter the cell in order to carry out its antibacterial activity.

The ethyl acetate extract was significantly more effective against *P. aeruginosa* and *A. viridans* when compared to the Augmentin control. The *Tamarindus*

indica plant could therefore potentially be a source of new types of antibiotics against these and other organisms that exhibit varying levels of resistance to penicillin.

Conclusion

Components of the leaves and stems of the *Tamarindus indica* plant were successfully extracted using polar, nonpolar and medium polar solvents. It was also demonstrated that the components extracted from stems and leaves of the *Tamarindus indica* had broad spectrum antibacterial properties. Of the components extracted, the extract in the ethyl acetate solvent displayed the largest zone of inhibition across the board, and was the most potent, based on the average zone of inhibition obtained; whereas the extract in the hexane solvent displayed the smallest or least potent zone of inhibitions of the three solvents used.

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The Effects of Virgin Coconut (*Cocos Nucifera*) Oil Supplementation on Blood Cholesterol Levels

A Preliminary Pilot Study

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Abstract

The health benefits of Virgin Coconut Oil (VCO) is a controversial topic in the academic community globally. This study provides data on the effect virgin coconut oil has on the blood cholesterol levels of subjects tested locally. The effects of virgin coconut oil (VCO) on blood cholesterol were investigated by randomly placing six (6) healthy individuals into a test group that received VCO supplementation and another six (6) participants in a control group that did not receive any VCO, making 12 participants that were recruited using the snowball method. Blood cholesterol levels were measured at the start of the experiment and one month later for all participants. Paired t-test statistical analysis was done using the before and after results for each group which showed that consuming 10 ml of VCO twice daily for a month is associated with a statistically significant reduction in total cholesterol (p=.0045), LDL "bad cholesterol" (p=.0026), cholesterol/HDL ratio (p=.0073) and risk of coronary artery disease (CAD). There was no significant change in triglycerides, VLDL, HDL, and HDL/LDL ratio in the test group. There was no statistically significant change in the blood cholesterol levels amongst the participants in the control group who did not receive VCO. The fatty acid profile for the VCO used was found to be normal except for the lauric acid content (37.78%)

which was below the internationally accepted standard of 45.1%. Based on the preliminary results obtained in this pilot study, it recommended that a randomized clinical trial using a larger sample size over a longer period be done to assess the effects of VCO on blood cholesteral levels.

Keywords: Virgin Coconut Oil (VCO), High Density Lipoprotein (HDL), Low Density Lipoprotein (LDL), Very Low Density Lipoprotein (VLDL), Cholesterol, Triacylglycerol (TAG)/Triglycerides

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Introduction

The oil of the coconut (*Cocus nucifera*) contains 92% saturated fatty acids of which lauric acid, a medium-chain fatty acid, or lipid, is the major fatty acid, approximately 50% (Peedikayil, Sreenivasan and Narayanan, 2016). It is this lauric acid that gives rise to the oil's characteristic properties. Coconut oil is extracted from the kernel by a variety of procedures that include wet processing, dry processing and solvent extraction. Usually, wet processing is used. It incorporates grating of the coconut meat and extraction of the oil by cooking. The recovery of the oil by this method is normally 30%–40% with poor quality and a minimised shelf life. Dry processing is used commercially and consists of the drying and crushing of copra, which is the coconut kernel dried by smoking, solar heat, or a combination of both. The oil acquired at this stage is not befitting for consumption.

It must be deodorized, bleached and refined. Virgin coconut oil is extracted by pressing, heat application and expelling, without the modification of the oil. As such, virgin coconut oil withholds all its natural phytochemicals and contains vitamin E and antioxidants (which are nil or inconsiderable in regular coconut oil). 1,2,3-trilauryl glyceride, 1-capro,2,3-dilauryl glyceride and 1-capro,2-lauryl,3-myristyl glyceride are the most abundant medium-chain triacylglycerols (TAGs) present in virgin coconut oil. It is important to note that the position of the lauric acid in TAGs affects the digestibility of the oil. Fifty- four percent (54%) of coconut oil TAG has lauric acid in the sn-1 and sn-2 positions. Oral lipase is suitable for metabolizing medium and short chain TAGs which accounts for the speedy absorption of coconut oil by the body in comparison to long chain triglycerides. For the purposes of this study, virgin coconut oil was deemed better for application as it is more likely to give a better

representation of the effects of pure unaltered coconut oil within the human body (Clarke, Goldson-Barnaby & Reid, 2018).

Currently, as it pertains to the effect of coconut oil on blood cholesterol, research presents a mixed conclusion. For years, the effects of coconut oil on blood cholesterol have long been debated. Researchers have struggled to conclude whether or not coconut oil usage has a positive or negative impact on users. For example, Dr. Willett (2006) states that coconut oil has a negative effect on users due to the increase in LDL-C ("bad cholesterol") levels that it exhibits, while Kevin Klatt (2018) and Khaw, Chinwong et al. (2017) believe it has a positive effect on users due to its tendency to increase HDL-C ("good cholesterol") levels. Therefore, this project seeks to gain an understanding of whether or not coconut oil is beneficial, particularly as it relates to blood cholesterol and whether or not it contributes to the risk of developing Coronary Artery Disease *(CAD).*

Hypothesis

Virgin Coconut (Cocos nucifera) Oil Supplementation has no effect on Blood Cholesterol.

Purpose of the Study

The purpose of this preliminary pilot study was to provide scientific evidence about the effects of virgin coconut (*Cocos nucifera*) oil consumption on blood cholesterol levels and the risk of developing Coronary Artery Disease. This study will provide current data on the chemical composition of coconut oil manufactured in Jamaica from Jamaican coconuts and the health effects it will have on our local population. Data specific to Jamaica is needed due to our uniqueness in culture, diet, soil type and socioeconomic conditions, which could all impact the outcome of this study and produce different outcomes than what is seen in other countries. This study will ensure Jamaica contributes to the body of research on this topic that can be used for meta-analyses in the future.

Research Questions

1. Does dietary supplementation with cold pressed, Jamaican made virgin coconut oil have an effect on total blood cholesterol levels of members of the local population?

2. What effect does Jamaican virgin coconut oil supplementation have on HDL levels?
3. What effect does Jamaican virgin coconut oil supplementation have on LDL levels?
4. Does Jamaican coconut oil supplementation increase or decrease the risk of coronary artery disease?
5. What is the current chemical quality of locally produced virgin coconut oil from coconuts grown in Jamaica by the largest local producer of virgin coconut oil?

Definition of Key Terms

Virgin Coconut (Cocos nucifera) oil (VCO): Oil extracted from the coconut kernel without the use of chemicals or radiation and normally contains a minimum of 45 % lauric acid which is credited for most of the medicinal properties of the oil (Clarke, Goldson-Barnaby & Reid, 2018).

High density lipoprotein cholesterol (HDL-C): A class of lipoproteins, with a high degree of compactness, the main function of which is to transport cholesterol from the tissues to the liver for excretion. Approximately only 20 percent of the weight of an HDL particle consists of cholesterol, and 50 percent is protein. Since protein is denser than fat, HDL particles are denser than LDL particles, hence the name "high-density" lipoprotein. It is known as the "good cholesterol" as it assists with the clearance of other forms of cholesterol from the blood by returning cholesterol from other parts of the body to the liver, which then removes the cholesterol (2020 U.S. National Library of Medicine).

Low density lipoprotein cholesterol (LDL-C): A class of lipoproteins, with a low degree of compactness as they contain fewer particles, the main function of which is to transport cholesterol in the blood and around the body, for use by the cells. Approximately 50 percent of the weight of an LDL particle is cholesterol and only 25 percent is protein. Since protein is more dense than fat, and LDL particles contain more fat than proteins, LDL particles are less dense than HDL particles, hence the name "low-density" lipoprotein. It is known as the "bad cholesterol" as it is implicated in the deposition of cholesterol into the lining of the artery (2020 U.S. National Library of Medicine).

Very low density lipoprotein cholesterol (VLDL-C): A type of fat that is considered to be "bad cholesterol", along with LDL-C and triglycerides, and of which 60% is triglycerides. High levels of VLDL-C and LDL-C are usually

cardiovascular disease (CVD) risk indicators (2020 U.S. National Library of Medicine).

Cholesterol: A waxy substance made by the liver and is derived from food from animals. It has the ability to combine with other substances in the body and form hard deposits which settle on the inside of the arteries, leading to narrowing and hardening of the arteries (atherosclerosis) (2020 U.S. National Library of Medicine).

Triglycerides or triacylglycerols (TAG): The major form of fat stored by the body, consisting of three molecules of fatty acid combined with a molecule of the alcohol, glycerol (2020 U.S. National Library of Medicine).

Significance of the Study

To provide scientific evidence about the effects of virgin coconut (*Cocos nucifera*) oil consumption on human blood cholesterol levels and the risk it poses to developing CAD. This information could be used to inform the local population and guide national policies on nutritional recommendations.

Literature Review

Michels (2018), in a lecture, stated that "Coconut oil is one of the worst oils that you can actually intake. There is not a single human study that shows a single positive element for the help of a person." She further went on to compare coconut oil to pork fat suggesting that coconut oil is more dangerous than pork fat given that the coconut oil contains more saturated fatty acids than the pork fat. She stated that coconut oil has almost no essential fatty acids and is composed of approximately 92% saturated fatty acids. Regardless of its lauric acid content, Michels (2018) implied that at the end of the day coconut oil is mainly saturated fats, which are known for clogging arteries and increasing the risk of myocardial infarctions (Whittel, 2018). The claim of Michels (2018) is supported by the American Heart Association, which released a science advisory recommending against the ingestion of coconut oil. This advisory took the form of an analysis of more than one hundred (100) published research studies, dating as far back as the 1950s, and reaffirming that saturated fats raise LDL or "bad cholesterol" blood levels. The authors of the study reported that coconut oil raised LDL levels in seven controlled trials (American Heart Association, 2017).

Dr. Willett of the Harvard School of Public Health (2006) stated that when viewed in isolation, coconut and coconut oil cannot be considered as heart healthy foods. He further stated that a 2-ounce piece of fresh coconut contains more than 13 grams of saturated fat, which is nearly two-thirds of the recommended daily limit for the average person. He stated that ounce-for-ounce coconut oil delivers more saturated fat than butter, lard, or margarine. Feeding studies in humans, monkeys and rabbits show that coconut oil substantially elevates LDL (bad cholesterol) levels. Dr. Willett also pointed out the beneficial uses of coconut oil in his article but ultimately concluded that coconut should not be ingested every day but rather occasionally, as a treat (Harvard Public School of Health, 2006).

Kevin Klatt (2018), a molecular nutrition researcher studying the molecular effects of coconut oil at Cornell University, says that enough evidence or data does not exist for a conclusion to be made regarding the effects of coconut oil. He described coconut oil as "half lauric acid, which is a little bit unique," as the acid seems to raise HDL more than other saturated fats and is rarely found in such high amounts in foods (Cable News Network (CNN) Health, 2018).

An article published by the Harvard Public School of Health (2006) states that though the increase in HDL seen with the consumption of coconut oil may offset some of the disease risks, it is still not as good as consuming unsaturated oils, which not only raise HDL but lower LDL, according to Dr. Willett. Dr. Willet brought forward another interesting point, namely that confusion also surrounds the health benefits associated with HDL. This is due in part to the fact that there are different forms of HDL, each of which has different purposes. Dr. Willet further stated that though it is the job of one type of HDL to remove LDL from the bloodstream, not all types of HDLs do this, therefore it is not certain that a higher HDL level translates to better health. In the same breath, the Harvard School of Public Health (2006) acknowledged one of the benefits of coconut oil, stating that coconut oil serves as an effective moisturizer for skin and hair.

The Effect of Coconut Oil on Total Cholesterol

Boateng, Ansong, Owusu & Steiner-Asiedu (2016) stated that triglycerides are the most abundant fats found in foods. Triglycerides are molecules made of fatty acids and are linked in groups of three to a glycerol backbone. Upon consuming fats, the fatty acids are separated from glycerol during digestion. This makes fats and oils available to the body in the form of fatty acids. Fatty acids differ

from each other based on chain length and degree of saturation. In regards to the degree of saturation, fatty acids may be classified as monounsaturated (MUFA), saturated (SFA) and polyunsaturated (PUFA) fatty acids (Boateng, Ansong, Owusu & Steiner-Asiedu 2016). According to the International Food Information Council Foundation (2014), the cardiovascular effects of coconut oil in humans are complicated and still unfolding. Compared to diets high in unsaturated fats, diets high in saturated fats from coconut oil have been shown in clinical trials in a variety of populations to increase total and LDL cholesterol, but also improve HDL cholesterol (Assunção, Ferreira, dos Santos, Cabral & Florêncio, 2009). Cardosa et al. (2015), based on results from their study, concluded that a diet rich in extra virgin coconut oil increases HDL cholesterol and decreases waist circumference and body mass in individuals possessing coronary artery disease. There is still controversy surrounding coconut oil and its effects on the lipid profile of consumers, given that it is a source of saturated fat. The group placed on a coconut oil diet received 13 ml extra virgin coconut oil in sachets (30 units per month), totaling 90 sachets per patient. In each visit, a 12-hour fasting blood sample was drawn, 24-hour dietary recall was obtained, an anthropometric assessment was made, and systemic blood pressure (BP) was measured. The results of this research experiment indicated that a diet rich in coconut oil increases the level of serum high-density lipoprotein (HDL) cholesterol and decreases body mass, neck circumference, body mass index (BMI) and glycemic profiles. Note too that at the beginning of the study (day 0), all patients were given an adequate nutritional status diet and instructed to follow it until the end of the study. Limitations of the study included the use of a small sample size of 22 persons, especially when compared to the sample size of the patients put on a coconut oil diet, which was 99 people. Additionally, for more favourable results, virgin coconut oil would have been more suitable given that it would not have undergone any processes to alter its biological composition.

In another article by Chinwong et al (2017), it was concluded that daily consumption of 30mL of virgin coconut oil in young healthy adults significantly increased HDL-C levels and showed no adverse effects, with the exception of mild diarrhea in some patients. This study took the form of an open label, randomized, controlled, cross over trial that aimed to assess the effect of virgin coconut oil supplementation on plasma lipoprotein levels and adverse effects. Being a cross-over study, the same participants used for the control group were also used as the test group. The cross-over study consisted of two periods, each lasting for eight weeks, separated by an eight week "wash out" period. At

week 0 otherwise known as the baseline, participants were randomly selected to take either 15mL VCO or 2% control solution twice daily for eight weeks. Total cholesterol, triglycerides, HDL-C and LDL-C levels were determined for each patient at the baseline visit and at week 8. After the first eight weeks, participants entered the wash out period where they were required to stop taking their assigned regimen (either the 15 mL VCO or 2% CMO). At week 16, the participants crossed over to take the alternative regimen for eight weeks, twice daily. The lipid profile parameters were taken at the start of the alternate regimen. Participants were encouraged to continue with their usual daily diet and activities, such as exercising, while participating in the study. This was done to ensure that any changes in their lipid profiles were due to the study supplements as opposed to a change in diet. The use of the cross-over method was advantageous in that the participants acted as their own control. In so doing, the accuracy of the obtained results was increased as the limitation afforded by biological variability was eliminated. The VCO supplementation showed no serious adverse effects. Among the group of healthy participants, HDL-C levels significantly increased upon VCO supplementation, whereas there was no significant change in HDL-C levels when participants were supplemented with the control. The article mentions that an observational study and a meta-analysis of individual data have shown that HDL-C levels are inversely associated with risk of cardiovascular disease (CVD) and cardiovascular mortality. In addition to the aforementioned article, this article references six coconut oil studies where the HDL-C levels are significantly increased upon dietary coconut oil supplementation. Therefore, according to some literature sources, coconut oil supplementation increases HDL-C levels, which may be used in the treatment of cardiovascular disease.

Cox et al. (1998) in their study, determined the plasma levels of lathosterol, lipids, lipoproteins and apolipoproteins in forty-one (41) healthy Pacific Island Polynesians during diets rich in coconut fat, butter and safflower oil. The results showed that cholesterol synthesis was reduced (leading to lower lathosterol plasma levels) when butter was replaced with coconut fat in the diet. An earlier study performed from the same lab (Cox et al, 1995) suggested that plasma lipid and lipoprotein levels had attained equilibrium by four weeks after a change of fat in the diet.

Khaw et al. (2018) conducted a randomized trial on coconut oil, olive oil, or butter on blood lipids and other cardiovascular risk factors in healthy men and women. Participants were randomized and asked to consume 50g of either extra virgin coconut oil, extra virgin olive oil, or unsalted butter daily for four

weeks. The results showed that LDL levels were significantly increased from butter in comparison to coconut oil and olive oil. Of note is the fact that the results obtained show coconut oil to be more comparable to olive oil with respect to LDL-C. The results of this study suggest that the effects of dietary fats on lipid profiles cannot be determined solely by the classification of their main components as saturated or unsaturated fats, but the different profiles of fatty acids, dietary patterns, the foods in which the fats are consumed and the method of processing the fats, should also be considered.

Harvard Medical School (2018) released an article stating that a popular claim associated with coconut oil is that it is good for the heart. This, the author stated, is surprising given that coconut oil contains more than 90% of "bad" or saturated fats, the kind that is recommended we decrease our intake of. This is because LDL-C is correlated with the risk of cardiovascular diseases and saturated fats usually increase LDL-C levels. Vasudevan (2010) believed differently and sought to analyse the lipid profile in blood and in plaque material from diseased Coronary Artery. In the study he conducted, he stated that coconut oil consists of roughly 90% saturated fats. He found that epidemiological reports usually accredit a rise in the likelihood of a person having coronary artery disease (CAD) to increase concentrations of serum cholesterol, which is sequentially caused by increased consumption of saturated fats. He highlighted that the public has been falsely led to believe that consumption of coconut oil results in elevated cholesterol levels. He believed that this misconception was fundamentally why coconut oil was being associated with saturated fats without understanding that the saturated fats found in coconut oil are short-chained and medium-chain fatty acids, while the fats responsible for CAD are saturated fats with long-chain fatty acids. In an attempt to prove this, he determined the lipid profiles of 302 normal healthy persons, 152 of which were consuming coconut oil and 150 were using sunflower oil; 76 coronary artery disease patients, out of which 41 were using coconut oil and 35 were using sunflower oil; and 130 patients suffering from diabetes mellitus, out of which 69 were using coconut oil and 61 were using sunflower oil. The participants had been consuming the corresponding oil primarily for preparing meals for a timeframe of six (6) years. Their blood cholesterol levels had been ascertained, and for the participants with CAD, the plaques from their diseased arteries were taken and the composition determined.

The findings from the CAD participants who had been consuming coconut oil revealed that the coronary artery plaques did not contain any of the saturated fatty acids found in coconut oil, and therefore, it cannot be deduced

that coconut oil has any success in producing coronary plaque or heart disease. Furthermore, he concluded his study by stating that the routine ingestion of coconut oil may not increase the probability of CAD by directly altering the lipid profile nor indirectly, by provoking oxidative stress. Vasudevan (2010) stated that sufficiently strong proof now exists to disprove allegations about coconut oil consumption and its relation to enhancing the risk of CAD. He referred to a study conducted by Kurup and Rajmohan (1995) on 64 volunteers where no statistically significant alteration in the serum total cholesterol, HDL cholesterol, LDL cholesterol, and triglycerides from the baseline values was found. Hostmark et al. (1980) compared the effects of diets containing 10% coconut fat and 10% sunflower oil on lipoprotein distribution in rats. Coconut oil feeding produced significantly lower levels of LDL and significantly higher HDL relative to sunflower oil feeding, which other previously mentioned studies have also reported. Sundaram et al. (1994) fed coconut oil containing diets to healthy males. Their findings indicate that a favorable alteration in serum lipoprotein balance was achieved when coconut oil was included in the diet. Saturated fats are acclaimed contributors to CAD by causing hypercholesterolemia, a known risk factor for CAD. However, approximately half of the saturated fats of coconut oil are medium-chain fatty acids having 6 to 12 carbon atoms, which are preferentially transported through the portal venous system to the liver and are not implicated in the accumulation of body fat (Tsuji et al, 2001)

Methodology

The effects of VCO on blood cholesterol levels was determined in this experiment targeting a sample of healthy individuals from Kingston and St. Andrew between the ages of 19–53 who also completed a registration questionnaire (see Appendix A) to confirm their health status. Persons on medication, diagnosed with any medical condition were excluded from the experiment. The average age of the participants was 28 years old, with 33.3% of the sample being males, and the remaining 66.7% being females. The snowball sampling method was used to recruit 12 participants who were then randomly assigned to the control group that received no VCO and the test group that received VCO supplementation in their diet. Therefore six (6) persons were in each group. While random sampling was attempted several times, due to the fear of contracting the novel COVID-19 virus, randomly selected participants refused to participate in the study, which also impacted the available sample size. Participants fasted for 12 hours before blood samples were collected at the start of the experiment

to establish baseline cholesterol levels for everyone. Persons in the test group were given 10ml of VCO twice daily for four (4) weeks which they drank from sterile single use measuring cups. Participants were called by the researchers each time they were to consume the required amount of coconut oil which contributed to the 100% compliance rate in this study. Participants in both the test and control groups were asked to fast again 12 hours before blood samples were collected at the end of four (4) weeks. The participants that started the project all successfully completed the study. Blood collection and testing was done by Microlabs Medical Laboratory which is International Organization of Standardization (ISO) 15189 accredited. Within each group, a comparison of the before and after results was done using paired t-test. Statistical analysis was executed using the latest version of Statistical Package for the Social Sciences (SPSS). The VCO used in this experiment was purchased from the Coconut Industry Board and sent to the Bureau of Standards Jamaica (BSJ) for the fatty acid profile to be obtained. The BSJ is ISO 9001:2015 certified and ISO 17025 accredited. The Coconut Industry Board uses the cold press method to produce their virgin coconut oil.

Ethical Considerations

Ethical approval was obtained from the University of Technology Jamaica's Ethical committee. The project was explained to each participant who then signed the informed consent form. The participants were also informed that they could withdraw from the project at any time without any penalty and the findings of the research was shared with them. Code names were used for each sample to protect the identity of the research subjects. Only the required biochemical test that the participants agreed to were carried out on their blood samples.

Results

The group that received VCO paired t-test at 95% confidence level indicated that there was a statistically significant reduction in total cholesterol (p=.0045), LDL (p=*.0026)*, and cholesterol/HDL ratio (p=*.0073)*. There was no significant change in triglycerides, VLDL, HDL, HDL/LDL ratio. For the group that did not receive VCO there was no statistically significant change in total cholesterol, HDL, LDL, VLDL, triglycerides, cholesterol/HDL ratio, and HDL/LDL ratio as $p>.05$.

Table 1: Fatty Acid Profile of the VCO Used Throughout the Experiment, Obtained from the Bureau of Standards Jamaica.

Fatty Acids (Scientific Name)	Fatty Acids (Common Name)	Fatty Acid	Percentages (%)
Hexanoic Acid, Methyl Ester	Caproate Acid	C6:0	0.25
Octanoic Acid, Methyl Ester	Caprylic Acid	C8:0	5.76
Decanoic Acid, Methyl Ester	Capric Acid	C10:0	6.36
Dodecanoic Acid, Methyl Ester	Lauric Acid	C12:0	37.78
Methyl Tetradecanoate	Myristic Acid	C14:0	20.94
Hexadecanoic Acid, Methyl Ester	Palmitic Acid	C16:0	12.42
9, 12-Octadecadienoic Acid (Z,Z)	Linoleic Acid	C18:2	1.01
9-Octadecenoic Acid, Methyl Ester	Elaidic Acid	C18:1	9.49
Octadecanoic Acid, Methyl Ester	Stearic Acid	C18:0	5.26
Methyl Icosanoate	Arachidic Acid	C20:0	0.05
Saturated Fatty Acid	–		**88.82**
Monounsaturated Fatty Acid	–		**9.49**
Polyunsaturated Acid	–		**1.01**

Table 2: Summary of Initial and Final Results Obtained for the Control Group

Initial Blood Cholesterol Control Group							
Sample Name	**Total Cholesterol (mmol/L)**	**Triglycerides (mmol/L)**	**HDL (mmol/L)**	**VLDL (mmol/L)**	**LDL (mmol/L)**	**CHOL/ HDL Ratio**	**HDL/LDL Ratio**
UTECH04	4.47	0.83	1.12	0.17	2.51	4.0	0.45
UTECH05	4.23	0.57	1.10	0.11	2.35	3.80	0.47
UTECH06	5.21	1.52	1.04	0.30	3.13	5.0	0.33
UTECH10	5.17	0.23	1.04	0.05	3.10	5.0	0.34
UTECH11	4.19	1.04	1.10	0.21	2.32	3.8	0.47
UTECH12	4.72	0.24	1.26	0.05	2.60	3.7	0.49
Final Blood Cholesterol Control Group							
UTECH04	4.23	0.89	1.09	0.18	2.36	3.9	0.46
UTECH05	4.92	0.59	1.20	0.12	2.79	4.1	0.43
UTECH06	4.19	0.82	1.05	0.16	2.36	4.0	0.45
UTECH10	4.46	0.66	1.10	0.13	2.52	4.1	0.44
UTECH11	3.99	0.40	1.05	0.08	2.21	3.8	0.48
UTECH12	4.12	0.18	1.18	0.04	2.21	3.5	0.54

Table 3: Summary of Initial and Final Results Obtained for the Test Group

Initial Blood Cholesterol Test Group							
Sample Name	**Total Cholesterol (mmol/L)**	**Triglycerides (mmol/L)**	**HDL (mmol/L)**	**VLDL (mmol/L)**	**LDL (mmol/L)**	**CHOL/ HDL Ratio**	**HDL/ LDL Ratio**
UTECH01	4.99	0.65	1.06	0.13	2.95	4.7	0.36
UTECH02	5.31	0.79	1.21	0.16	3.08	4.4	0.39
UTECH03	3.06	0.40	1.04	0.08	1.52	2.9	0.69
UTECH07	5.79	0.80	1.12	0.16	3.50	5.2	0.32
UTECH08	5.15	0.24	1.20	0.05	2.96	4.3	0.41
UTECH09	4.18	0.52	1.04	0.10	2.36	4.0	0.44
Final Blood Cholesterol Test Group							
UTECH01	4.70	0.44	1.04	0.09	2.75	4.5	0.38
UTECH02	4.35	0.64	1.14	0.13	2.41	3.8	0.47
UTECH03	2.30	0.46	1.04	0.09	0.95	2.2	1.10
UTECH07	4.78	0.84	1.04	0.17	2.81	4.6	0.37
UTECH08	4.80	2.55	1.28	0.51	2.64	3.8	0.48
UTECH09	3.75	0.42	1.06	0.08	2.02	3.5	0.53

Discussion

According to Boateng, Ansong, Owusu & Steiner-Asiedu (2016), coconut oil is unique in that it is made up of approximately 90% saturated fats and 9% unsaturated fats. The VCO consumed by members of our treatment group was submitted to the Bureau of Standards Jamaica for its composition analysis. The analysis revealed results similar to that of Boateng, Ansong, Owusu & Steiner-Asiedu, 88.82% and 9.49% saturated and unsaturated fats respectively. Boateng et.al also stated that over 50% of the fats in coconut oil are medium chain fatty acids, primarily lauric acid (12:0). Our VCO displayed this characteristic as 50.15% of its makeup was medium chain fatty acids, with lauric acid comprising 37.78% of the oil. However, according to the Codex Alimentarius, the minimum standard for lauric acid in coconut oil is 45.1%. Our VCO profile indicates that its lauric acid composition is 37.78% and is therefore below standard. Our VCO profile also revealed a small increase in palmitic acid (16:0). Our lauric and palmitic acid results were similar to those obtained by Clarke, Goldson-Barnaby & Reid (2018) in their study which investigated the fatty acid content of coconut oil from different geographic locations. They postulated that the low lauric acid content may have been due to the processing of dry coconuts

that had been removed from the tree for extended periods of time. The lauric acid content decreases within the endosperm as fatty acids are transported to other parts of the coconut, namely the haustorium, to facilitate germination (López-Villalobos, Dodds & Hornung, 2001). Therefore, what this means is that long periods of time between the harvesting of coconuts and extraction of the oil may result in decreased lauric acid concentrations. To prevent this, fresh coconuts for the oil extraction process must be utilised. The low lauric acid content could also be due to genetic changes in the coconut plants that the coconuts were harvested from. The stearic acid (18:0) content was also slightly increased while all other fatty acids present in our VCO met the standards of the Codex Alimentarius. The low concentration of lauric acid is possibly the explanation as to why the treatment group did not experience a grander reduction of blood cholesterol levels.

In another publication by Chinwong et al (2017), it was concluded that daily consumption of 30mL of virgin coconut oil in young healthy adults significantly increased HDL levels. Our results showed no change in HDL levels, however, it showed a decrease in the LDL levels which is still a positive outcome. The difference in results obtained could be due to significant differences in the method used such as the fact that our participants consumed 20 ml of coconut oil per day compared to the 30 ml per day consumed in that study. In this study 10ml of coconut oil twice per day was used to ensure the comfort of the participants, because when 30ml per day is consumed it has been shown to cause mild diarrhoea. Chinwong et. Al. (2017) did their study on a population that is known for consuming a diet rich in coconuts compared to our local context where unsaturated vegetable oils are more commonly consumed. There have been reports of increased HDL levels with coconut oil supplementation of 13 ml per day for three (3) months (Cardosa et. al. 2015). While this is less than the quantity of oil used in our study, our study was over a much shorter period, one (1) month. This pilot trial did not show that coconut oil was associated with increasing blood cholesterol levels or an increased risk of CAD which are important findings but needs deeper investigation.

Limitations

The sample size was significantly affected by the COVID-19 pandemic which the world knew very little about at the time and caused individuals to rescind their participation out of fear of contracting the virus which caused the researchers to use a non-random sampling method.

Conclusion

Our research showed that consuming 10 ml of VCO twice daily is associated with a statistically significant reduction in total cholesterol (p=.0045), LDL "bad cholesterol" (p=.0026), cholesterol/HDL ratio (p=.0073) and risk of CAD. There was no significant change in triglycerides, VLDL, HDL, HDL/LDL ratio. Based on the results obtained in this small study it would be interesting to find out what the results would look like if a much larger random sample is used over a longer period.

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Habitat Heterogeneity, Complexity and Structure

Their Relevance with Threat of Predation in Seagrass Prey Fish Species

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Abstract

An organism's habitat preference may shift to one of greater structural complexity to maximize protection from predatory attack. In south-eastern Australian coastal seascape, seagrass beds, sandy substratum and/or rocky algal reef border each other forming a matrix of varying habitat configurations with varying protection potential. We investigated the change in habitat selection in four Australian seagrass fish species, Stigmatopora argus, Acanthaluteres spilomelanurus, Pelates sexlineatus and Atherinosoma microstomata with the inclusion of predatory threat using tank experiments. The 250L, 90 cm internal diameter experimental tank contained three habitats – seagrass, sand and rock arranged in an unbroken circular path creating three distinct edge combinations and resulting in six sections of varying levels of complexity and heterogeneity. A transparent inner wall separated the habitat matrix from the central test chamber, which contained and demarcated "zone of decision". Each test fish (n=123) was placed in the tank centre for 2–3 minutes in an isolation tube to acclimatize before being released to make its selection. This was repeated for each test fish first without predatory threat

then with threat. S. argus spent significantly more time in the rock section (paired t-test: p= 0.038) and less time in the seagrass-sand section (paired t-test: p=0.05) when under threat. A. spilomelanurus spent significantly less time in homogeneous seagrass when threatened (paired t-test: p = 0.016) and displayed a non-significant increased selection of sections containing rock when threatened. Shifts to the complex rocky substratum preference with predatory threat was demonstrated along with the importance of a suite of different habitats for a species' survival.

Keywords: Heterogeneity; Habitat Complexity; Seagrass Fish; Predator; Rocky-Reef

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Introduction

An organism's location in a mosaic of different habitats is driven through a combination of the availability of its prey, and the threat posed by predators (Cheminée 2012; Grol et al., 2011; Sih, 1980). In many cases, prime foraging areas also pose a high risk of predation, and trade-off between foraging efficiency and minimizing predation risk can lead to the selection of inferior nutritional quality locations for the sake of avoiding predation (Gullström et al., 2011; Schmitz, Krivan & Ovadia, 2004). While some organisms may deem the trade-off too detrimental to their own survival and risk foraging in predator rich environments (Schmitz, Krivan & Ovadia, 2004), several studies have noted habitat shifts, strategy adjustments and shifts from activities, such as feeding and territory defence, with added predator risk (Creel et al., 2005; Gotceitas & Brown, 1993; Scheibling & Hamm, 1991; Schmitz, Krivan & Ovadia, 2004) to shelter seeking behaviour. This has been coined as the "threat sensitive predator avoidance hypothesis" (Helfman, 1989). Such effects of predators on habitat selection are noted to even extend beyond the level of the individual and influence distributions at the population (Schmitz, Krivan & Ovadia, 2004; Madin, Madin & Booth 2011), community (Schmitz, Krivan & Ovadia 2004) and ecosystem level (Ripple & Beschta, 2004; Hammill, Atwood & Srivastava 2015).

Previous studies clearly illustrate the importance of predatory threats in habitat selection in prey species. Grass shrimp (*Palaemon elegans*) in one study were found to display an increased choice of vegetation in fragmented landscapes in the presence of the juvenile cod (*Gadus morhua*) which in this case was the active predator (Ljungberg et al., 2013).

Similarly, Creel et al. (2005) observed a shift in elk's (*Cervus elaphus*) use of the preferred grassland foraging habitat in the Greater Yellowstone Ecosystem in Montana, USA, for the wooded area that offered more protective cover in the presence of wolves over a relatively short time scale (days). These experiments, along with others like it, give credence to the movement of prey organisms from one habitat type/ structure to another in an attempt to escape predation. The current research seeks to go a step further with the presentation of different habitat configurations simulating that which occurs at habitat interfaces of various complexities and levels of heterogeneity, to determine the impact of predatory threat on the choice of these habitat configurations.

Organisms may benefit from a suite of different habitats, for instance, using a certain location or habitat edge for feeding but retreating to another location when faced with the threat of predation. This new location may contain inferior quality prey or be devoid of prey, which may lower food intake, but will be essential for evading predation.

Coastal marine systems, including seagrass beds, represent important foraging and nursery habitat for a whole community of marine species (Middleton et al. 1984; Gullström et al. 2011; Levin et al. 1997; Jenkins & Wheatley 1998). Seagrasses add structure to the otherwise bare substratum, enhancing the complexity of the habitat. Complexity has in many cases also been linked to the number or available spaces, holes, cracks, or crevices available (Hackradt, Félix-Hackradt & García-Charton 2011) for appropriately sized fauna to shelter within, especially when faced with the threat of predation. Increasing numbers of these spaces, along with several other metrics, is akin to increased structural complexity and has been associated with elevated species richness and abundance in several studies (Nagelkerken et al. 2000; Berg 2002; Cocheret de la Morinière et al. 2004; Hackradt, Félix-Hackradt & García-Charton 2011). The size of these spaces has also been reported as having a predator-excluding effect (Johnson, Beaumier & Lynch Jr, 1988; Gotceitas & Brown 1993; Scheibling & Hamm 1991). Some authors go as far as to suggest that the number of available spaces and hence habitat complexity is a limiting factor to the growth and survival of species (Scheibling & Hamm, 1991).

One study by Cheminee et al. (2013) for instance, reported a higher survival rate of larval fish in highly complex seagrass arrangements. What is not clear is the relative importance of habitat complexity (the structural complexity of a single habitat) versus habitat heterogeneity.

Habitat heterogeneity refers to a break in habitat continuity and the incorporation of more than one habitat patch in a given region.

While increasingly complex habitats may offer benefits in the form of reduced predation, areas with high habitat heterogeneity may allow individuals both protection from predators and sufficient foraging opportunities. This is due to the specific services provided by component habitat types. Consequently, the inclusion of more than one habitat type in a common geographical space, each providing its own specific services, provides even further benefits beyond that derived from its level of complexity.

Habitat heterogeneity has also been reported to offer a greater range of resources and microclimate conditions for exploitation by more species (Collinge, 1996) than a homogenous one. Its importance, however, has received mixed reviews in published research. Jackson et al. (2006) for instance, reported a decrease in the total diversity of fish and decapod species within sub-tidal *Zostera marina* beds with increased heterogeneity, attributed by the authors to its loss of nursey function with the lack of habitat continuity (Jackson et al., 2006). Other studies, however, have noted that heterogeneity offers a greater edge surface which would be better able to intercept planktonic prey and hence build fish assemblages (Smith et al., 2008, 2011; Macreadie et al., 2009). The cited studies above, however, speak primarily to seagrass habitats being fragmented and hence represented heterogeneity. The manipulative experiment seeks to further tease out the importance of the actual unique habitat structures creating heterogeneity, particularly with regard to the threat of predation.

In this manipulative experiment, a suite of habitat combination choices (six in total, mimicking choices in estuaries) are offered in tank experiments to four seagrass fish species, namely the spotted pipefish, *Stigmatopora argus*, bridled leatherjacket, *Acanthaluteres spilomelanurus*, eastern striped trumpeter, *Pelates sexlineatus* and the small-mouthed hardyhead, *Atherinosoma microstomata,* in the presence and absence of predatory threat. The fish species in this study are among those common in the New South Wales *Posidonia australis* and *Zostera marina* seagrass beds, which were frequently taken in seine net catches in field studies run in conjunction with this current research (unpubl. work). All four species are small-bodied prey species, commonly found cryptic among the seagrass blades or associated at or near to, the benthos (*S. argus* – Jenkins and Wheatley, 1998; *A. spilomelanurus* – Bray and Gomon, 2017; *P. sexlineatus* – Paxton et al., 1989) or schooling in the water column above (*A. microstomata* – Connolly, 1994) New South Wales seagrass meadows. While the endemic syngnathid, *S. argus*, may acquire lengths of 25 cm TL (Bray, 2020), it is a slender shoe-string shaped creature which often wraps its body around thin-leaved seagrass blades (Jenkins & Wheatley, 1998). These

features, outlined above, rendered the test individuals suitable for eliciting an evasive response from imposed predatory threats. Additionally, with three of the four test species being usually associated with the benthos, as opposed to being pelagic schooling individuals, they are expected to associate themselves with the base of the tank in close proximity to the habitat sections rather than spending most of their time swimming through the water column of the test tank. The former would enable their habitat choice to be more discernible by the researcher.

Our main goal was to determine whether the habitat section preference, exhibited by each tested species, varied with the inclusion of a predator model in the test individual's domain or space. Habitat preferences were evaluated using two metrics (a) percentage time spent in each habitat section to be supported by (b) the most common first habitat section selected by tested fish species.

Methodology

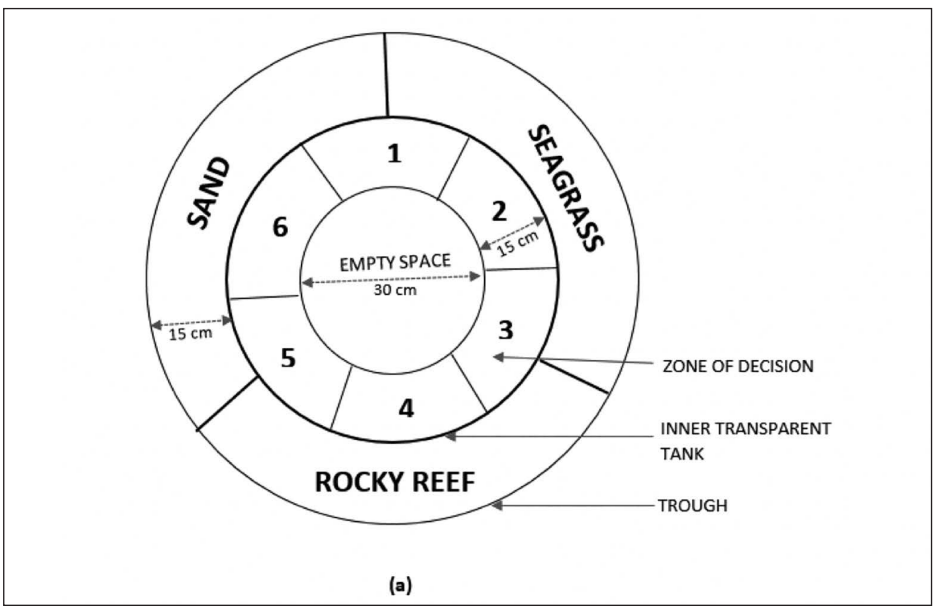
Fish collection

A total of 159 fish were collected from within seagrass beds in two estuaries along the New South Wales coastline. Thirty-five (35) individuals were collected from Careel Bay, Pittwater (33°36'47.88"S 151°19'15.79"E) from within a *Posidonia australis* bed and the majority – one hundred and twenty-four (124), were collected from Kurnell in Botany Bay (34° 0'20.31"S 151°12'50.60"E). The Kurnell collection site supported a mixed seagrass bed of *Posidonia australis* and *Zostera marina*. The fish were collected with a seine net and transported in containers of fresh seawater fitted with aerators.

On reaching the laboratory the fish were immediately placed in holding tanks that had been set up two days prior to their arrival. The species collected include: *Atherinosoma microstomata* (n=68), *Pelates sexlineatus* (n=46), *Stigmatopora argus* (n=28), *Acanthaluteres spilomelanurus* (n=11), the remainder being incidentals (i.e. insufficient numbers of several species) that were not included in the final data analysis. The test individuals used in tank experiments included those that appeared fit after collection and acclimatization within the aquarium holding tank and included: *A. microstomata* (n=37 tank experiment; n=24 predator model validation experiment), *P. sexlineatus* (n=46), *S. argus* (n=28) and *A. spilomelanurus* (n=11). Any fish showing signs of stress, such as being immobile or sluggish in its movements, were deemed "unfit" and were not used in the experiment.

Experimental tank

The experimental tank apparatus consisted of a circular/cylindrical 250L, 90 cm internal diameter water trough. The three habitats (collected seagrass, *Posidonia australis,* blades; rocks and sand) were arranged in a circular continuous fashion of equal area in the outermost section of the tank, with each habitat having contact with the next (Figure 1a). The habitats extended from the inner walls of the trough to approximately a uniform 15 cm into the centre of the tank (Figure 1a).



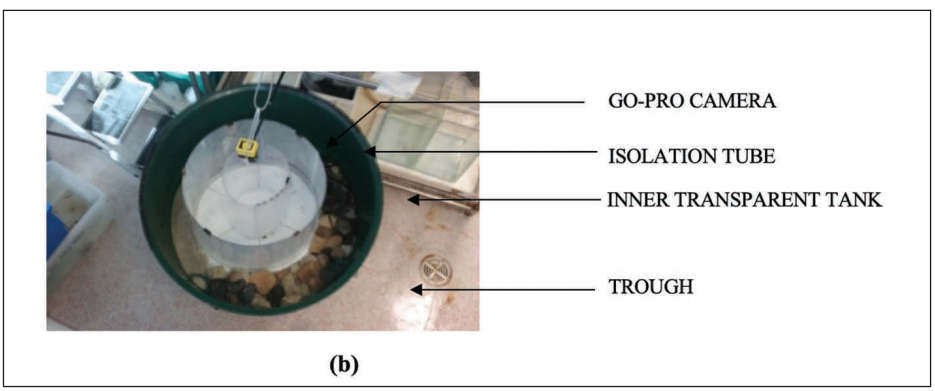


Figure 1. Design of experimental tank showing (a) dimensions and habitat sections and (b) experimental set up with GoPro camera (Hero3 range) and isolation tube (Depth 20–25 cm).

The seagrass blades were cleaned of epiphytes by scraping with a blade, the rocks were washed and scrubbed, and the sand was washed thoroughly before being used in the experiment. The washing of the structures was meant to ensure that the choice of the habitat was based on the rudimentary structure itself and not potential food items. Individual seagrass blades were threaded through a dark plastic mesh at the base of the tank in the seagrass section. The blades were attached to the mesh with cable ties in four rows to best represent the shoot density typical of the New South Wales *Posidonia australis* seagrass beds encountered in field observations. Rocks were arranged in a fashion to represent the rocky reef habitat. Each rock measured between 8 to 10 cm, at the widest point, and were all arranged to provide obvious crevices for retreat. The sand was placed at the base of the three habitat types with the "sand" sector having sand only and devoid of any structure. A 60-cm diameter transparent tank was fixed in the centre of the larger tank 15 cm away from the inner walls of the trough and fitted with a white base with the outer walls of the transparent tank making contact with the habitats. On the white base, a 15-cm wide circular section was marked off spanning from the inner walls of the transparent tank protruding into the tank centre, leaving a 30-cm diameter centre corresponding with the centre of the entire test aquarium. The 15-cm wide inner circular section was divided into 6 equal parts corresponding to the habitats immediately facing it.

Each of the three habitats was spatially divided into four equal parts with the two outermost parts of each being considered as constituting the "edge" with its neighbouring habitat, and the inner two quarters as the "interior". This resulted in six (6) habitat sections as illustrated in Fig 1a (**1** – seagrass-sand, **2** – seagrass only, **3** – seagrass-rock, **4** – rock only, **5** – rocky-sand and **6** – sand only)

Each individual test fish was deemed to have made a choice once it entered these sections i.e. within 15 cm of the transparent inner tank and relevant habitat combination section. This application of a "zone of decision" is similarly applied in rectangular tank experiments (Igulu et al. 2011). Keeping the test fish separate from the habitat sections, which were on display through the transparent inner tank walls, prevented the need to dismantle the elaborate habitat sections after each test fish to remove any chemical cues left by each test individual and in order to remove the fish itself, which may easily become well-hidden within the habitat sections. Consequently, only the water in the inner sealed-off tank would need to be removed and the walls washed between each test fish, instead of the contents of the entire test aquarium.

The 30cm diameter centre of the circular tank in the current study was bare

and devoid of any sand or other structure. The test tank was filled with seawater of depth between 20 cm to 25 cm with water temperatures maintained between 21 and 22°C (i.e. within the range of that found in their natural habitat at the time of collection). A GoPro camera was fixed directly above the centre of the test tank without having contact with the tank itself and attached by an extendable rod to a fixed shelf in the laboratory, just next to the tank itself (Fig 1b).

The Experiment – Overview

The experiment consisted of two phases: a no-predator phase followed by a predator phase. The predator phase or trials involved the use of a predator model which was an intact carcass of a fish market-purchased yellowfin bream (*Acanthopagrus australis*). The predator model was approximately 26.6cm TL while that of the test fish were on average 5.24 ± 0.52cm (mean ± SD) TL (*A. microstomata*), 7.22 ± 0.92cm TL (*A. spilomelanurus*), 13.02 ± 3.49cm TL (*S. argus*) and 4.7 ± 2.49cm TL (*P. sexlineatus*). *Acanthopagrus australis* is an estuarine predator (Taylor, Becker & Lowry, 2018) known to feed on benthic invertebrates and fish (Kailola et al. 1993). This species was also observed in video footage taken with *Posidonia australis* seagrass beds in field experiments undertaken by authors (unpubl. work). Presentation of predator models to elicit a response from prey species has been used in previous research (Helfman 1989). Also documented is the importance of visual over chemical cues which the prey utilizes to assess threat-level and formulate a response (Helfman 1989; Chivers et al., 2001). This use of a predatory model was deemed sufficient for our research needs based on the suitability of this approach, as outlined in the previously cited research. Additionally, no actual predation was intended for ethical reasons. Test individuals were returned to the seagrass habitat at the end of tank experiments which was the original intent.

No-Predator Trials

In the no-predator phase, fish were placed individually in the centre of the test tank within the inner transparent tank. The fish were held (individually) in a transparent isolation tube (Fig 1b) of approximately 25 cm diameter for 2–3 minutes to settle and view the habitat choices. After the acclimatization period, the camera was switched on and the inner isolation tube was removed. The fish were each videoed for 15 minutes for determination of percent time spent in each habitat section (% time) with special notes taken of the first habitat selected upon release from the isolation tube.

Predator Trials

Immediately following the no-predator trial, the test fish was returned to the central isolation tube and allowed to settle again for 2 minutes. The predator model was placed upright in a clear plastic bag filled with seawater and sealed to prevent mixing with water within the tank. It was submerged in the tank and manoeuvred in a circular path around the isolation tube containing the fish for 4–5 revolutions simulating active hunting mode. The camera was switched on and the isolation tube was then removed. The predator model was left hanging in the centre of the inner tank immersed in the water on a horizontal pole, assuming a "sit-and-wait" hunting mode (Schmitz, Krivan & Ovadia 2004) without impeding the test fish's movement. The test fish was then recorded for another 15 minutes. This was repeated for each fish with the water being changed after each fish and the side of the inner tank washed. The researcher left the lab in all 15-minute recordings to avoid human interference with the fish's choices.

The tank was turned between 90 to 120 degrees clockwise after every 3–4 fish. Fish were only used once and were returned to their natural habitat within each estuary at the end of the experiment. Fish were not fed within 12 hours of the trials and all experiments were conducted within daylight hours (9:30 to 19:30). The windows of the aquarium room were covered to avoid differential illumination of the habitat sections within the tank with time of day, with the light primarily coming from artificial sources from the ceiling above the tank.

Validation experiments were performed to ensure the predator model used in this study was generating a strong enough "scare factor" for at least one species of the test fish. Twenty-four (24) of the collected small-mouthed hardyhead, *A. microstomata* (average 6.50 ± 0.44 cm TL), not previously or subsequently used in the above experiments, were used in these control experiments. Each fish was videoed for two 15-minute trials, one with the model of the predator being introduced and the other with an empty seawater-filled bag lacking the predator. The order in which the models were introduced was changed for approximately half of the fish used, with 13 fish having the predator model introduced before the empty bag model and the other 11 having the reverse. The level of agitation or excitability (low, medium or high) displayed by each fish during the manoeuvring of both model types (predator in bag and empty bag) was recorded. The level of agitation or excitability was determined by visual observation of the behaviour of the fish upon the introduction of each stimulus (i.e. the empty seawater filled bag and the predator model, as described

in Section 2.1.3.2 above). Determining the level of agitation as low, medium or high was a feature of the following: sharpness of body movement, speed of movement after the agitation (i.e. swift sharp swimming as opposed to regular slower, smoother movements) and the degree to which the test fish was zipping from side to side of the tank.

Video Analyses

The section of the tank occupied by each test fish was noted every 5 seconds for each 15-minute video for a total of 181 recorded position points per treatment. The percentage of the total time spent in each section (i.e. 1–6 as well as the tank centre), for each fish was then calculated by dividing the number of times a fish was observed in each section by 181. Percentages were then recalculated removing the time spent in the centre position as (i) the relative time spent in each habitat section by each species did not change with this removal, (ii) assessment of relative time spent in each habitat section is the main aim of the experiment and (iii) average time spent in the centre of the tank between both no-predator and predator trials was low for all four species (5.1% - *A. microstomata*, 1.19% - *A. spilomelanurus*, 5.36% - *S. argus*, 6.22% - *P. sexlineatus*). The percentage of time spent in each habitat section by each species was assessed to determine habitat preference. This was supported by data on the percent of fish (of each species) selecting each section as their first choice upon removal of the isolation tube for each treatment.

Statistical Analysis

Paired samples t-tests were performed for each habitat section to test for a significant difference in % time spent between "no-predator" and "predator" trials. This statistical analysis allowed for the test of significant difference in a "before" and "after" scenario for each species for each habitat combination. Each pair consisted of the same individual tracing its choice in both trial conditions. The Shapiro-Wilk test was used to ascertain an approximate normal distribution in the differences between the paired groups. This was done separately for each species on untransformed data. The McNemar's Chi-square test for binary matched pairs (Agresti & Kateri 2011) was used to test for a significant difference in the first habitat selected upon release in "no-predator" vs. "predator" trials by tracing the choices of each individual test fish. This again was done separately for each test species. The paired samples t-tests, Shapiro-Wilk and McNemar's Chi-square tests were all performed in SPSS Statistics 22.

For statistical comparison of time spent in each habitat section for each species, PERMANOVA analyses were performed separately for "no-predator" and "predator" trials in each case in PRIMER 6 version 6.1.13 and PERMANOVA + version 1.0.3. The fixed independent factor was "Habitat structure" having 6 levels – seagrass, seagrass-sand, seagrass-rock, rock, rock-sand and sand. All data were log-transformed to achieve homogeneity of variances around each factor. Where homogeneity was not achieved even after log transformation the significance level was set at $p \leq 0.01$ (Underwood 1981). All significant differences illustrated in a graphical representation of results represent analysis performed on log-transformed data.

Pairwise comparisons of each possible pair of habitat combinations were performed also in PRIMER 6 version 6.1.13 and PERMANOVA + version 1.0.3. The Bonferroni correction was applied to pairwise comparisons at the habitat combination level as there were fifteen possible pairwise comparisons resulting in an adjusted alpha value of $p<0.0033$. All percentage time data were log-transformed, and the homogeneity of variances was tested using the PERMDISP (Homogeneity of Dispersion) function in PRIMER 6 version 6.1.13 and PERMANOVA + version 1.0.3.

Results

Validation experiments – Efficacy of Predator Presentations

The validation experiments demonstrated that the predator model produced a sufficient scare factor. Approximately 91.7% (22 of 24) of the individuals displayed either medium or high-level agitation with the "predator in bag" trials compared to 27.3% (6 of 22) with the "empty bag" trials. The corruption of video files for two test individuals accounted for the lower number of individual data points in "empty bag" trials (i.e. 22 instead of 24).

Fish Choice of Habitat Section (No-predator vs. predator trials)

Two of the four test species (i.e. *Acanthaluteres spilomelanurus* and *Stigmatopora* argus) displayed a shift in habitat preference upon introduction of the predatory threat. A third species (*Atherinosoma microstomata*) appeared to also display behavioural changes, however, these alterations in behaviour were not statistically significant.

Acanthaluteres spilomelanurus spent significantly less time in the seagrass-only section upon predator inclusion compared to no-predator trials (paired t-tests: p = 0.016) (Table 1; Fig 2a). The species also spent less time in the seagrass-sand section and displayed a non-significant increase in time spent in the rock and rock-sand sections with predator inclusion (Table 1; Fig 2a). The lack of statistical significance in this latter case is likely due to the low numbers of this species (paired t-test: p=0.078; n=11). Overall, first choice data for this species illustrate an increase in the percentage of individuals initially selecting seagrass-rock (50%) and rock-sand (30%) with predatory inclusion compared to no-predator trials (18.18% and 0% respectively) (Fig 2b). Additionally, whereas just over 50% of individuals initially chose the seagrass section upon release in no-predator trials, with predator inclusion, no individual of this species made seagrass their first habitat combination choice (Table 2; Fig 2b). Tracing of the test fish's first choice for this and the other test species via the supplementary McNemar's Chi-square tests yielded no statistically significant relationships, which was not surprising owing to the relatively large number of possible "before" and "after" treatment pairs for consideration in this design. The sample size of one hundred and twenty-three (123) fish would likely not be sufficient to overcome the possibility of a Type I error. Nonetheless, individual tracing of each individual fish's choice between trials is made available in Appendix A and is not further discussed.

Stigmatopora argus individuals displayed a decline in the time spent in the seagrass-sand section (paired t-test, *seagrass-sand*: p = 0.05) (Table 1; Fig 2e). The species also spent significantly more time in the complex rock habitat section (paired t-test, *rock*: p = 0.038) (Table 1; Figure 2e). As with *A. spilomelanurus*, this species displayed an increase (albeit non-significant) in percent time spent in the seagrass-rock habitat combination.

Atherinosoma microstomata and *Pelates sexlineatus* displayed no statistically significant trend for any of the habitat sections with the introduction of the predator model. Nonetheless, *A. microstomata* exhibited a decline in time spent in the seagrass-only section with predatory inclusion (paired t-test: p=0.155) (Table 1; Figure 2c).

The outcome of the statistical comparison of the time spent in each habitat combination section for each species performed separately for both the no-predator and predator trials are reported in Appendix B (Tables 1–2; Figures 1–2). The percentage of all fish (i.e., pooling all four species) making each habitat section its first choice upon release in both treatments is presented in Appendix C.

Discussion

A shift in habitat preference was observed in a subset of the test species, which displayed a greater attraction to more complex habitats (*S. argus*) and/or shunned a less complex one (*A. spilomelanurus*, *S. argus*) with the introduction of predatory threat. What made these results interesting is the interaction between habitat complexity, habitat heterogeneity and the actual structure of the habitat forming the heterogeneous habitat sections, and by extension the seascape. A heterogeneous habitat that contains sand for instance, may not be considered as complex as a homogeneous one, such as a rocky reef environment. The latter is comprised of numerous crevices and hiding places which was represented by the "rock" section in this study. Additionally, the "usefulness" of a habitat for the purpose of seclusion or exclusion to evade predation may differ depending on the prey species. Nonetheless, the presence of a rocky substratum containing crevices for exclusion appears beneficial generally, whether found in a homogeneous or a heterogeneous setting.

A. spilomelanurus test individuals displayed less preference for the homogeneous seagrass habitat with increased predation threat. To reinforce this statistically significant trend, none of the test individuals who made the seagrass section their first choice in no predator trials selected the seagrass section upon release from the isolation tube with the inclusion of predatory threat. This coincided with an apparent increased preference for (increased % time spent in) those habitat sections containing the rocky substratum. The latter was not statistically significant, likely due to low power.

While the seagrass offers shelter in inter-shoot spaces, below-canopy shelter and camouflage for similarly coloured individuals such as *A. spilomelanurus*, the rocky substrate may be preferred by this and other species as it offers crevices of varying sizes into which prey may achieve complete exclusion from the surrounding threat (Gotceitas & Brown, 1993). Additionally, as the females and juveniles are mottled brown in colour with black spots (Bray, 2018), the rocky substrate likely offers both camouflage and exclusion from the surrounding environment, making it more attractive to the prey under threat of predation. These features may also become increasingly relevant in the field where rocks are often covered with algae of varying shades of green and brown offering even greater camouflage for the green individuals.

S. argus individuals spent significantly more time in the complex rocky reef replication (paired t-test: $p=0.038$), with predator inclusion and less time in the seagrass-sand (paired t-test: $p=0.05$) position suggesting the increased

importance of the structural formation of the rock in predatory evasion. *S. argus*, is more frequently associated with the seagrass-sand interface (Jelbart, Ross & Connolly 2006; Macreadie et al., 2010) and filters incoming zooplankton being trapped in this location (Macreadie et al., 2010). A switch to rock, which would greatly reduce this capability, is most likely an evasive measure to attain seclusion. If the seagrass-sand habitat sections, for instance, were to represent the seagrass-sand habitat edges in the seascape, it may be extrapolated particularly for the *S. argus* individuals, that increased perceived predatory threat may lead to these prey fish abandoning their preferred position, rich in their food source, for a habitat containing rocky substratum. It may then return to its "preferred" position at the seagrass-sand edge (Jelbart, Ross & Connolly 2006; Macreadie et al. 2010) in the absence or reduction of this threat. A similar shift in habitat position with the removal of predator stress was observed in experiments performed on juvenile Atlantic cod, *Gadus morhua*, with individuals moving progressively back to the water column from their hiding place within interstices of cobbles on predator withdrawal (Gotceitas & Brown, 1993).

In the case of *S. argus* in this study, it was not a matter of a heterogeneous habitat (seagrass-sand) being less useful than a homogeneous one (rocky substrate), but more so the complexity and structure of the rock habitat itself providing the additional advantage.

The lack of statistically significant trends for the latter two species is not surprising due to the characteristics of these two species noted in the literature. *A. microstomata* is a schooling species which feeds near the water surface and is not strongly associated with the benthos (Connolly; 1994, Thompson and Bray, 2011). Connolly reported this species in high abundance over both unvegetated and vegetated *Zostera spp.* beds. The individuals were here noted to feed near the surface of the water column, during the day time hours of the study, having no association with the benthos. This coincided with observations in this study, with more of these individuals remaining in the water column within the zone of decisions in the test tank, compared to the other test species which usually remained at the tank base. Its decreased association with the benthos would make the allocation of a certain section of the tank as its "selection" more difficult to decipher and validate. *P. sexlineatus*, also displayed no distinct trend in terms of habitat selection between no-predator and predator trials and even between individual habitat sections within treatments. Lack of observable trends for this species were also reported in the published field studies in Pittwater, New South Wales where no significant variation in occurrences was observed between seagrass-sand edge and seagrass interior seagrass patches

of six *Zostera capricorni* beds ranging in size from 2290 to 211 170 m^2 (Jelbart, Ross & Connolly, 2006). Additionally, Biro and Booth (2009) found that this species attempted to consume food in risky situations when deprived of food. Even though the food deprivation (Biro and Booth 2009) was over the scale of a few days, this gives some insight into why a pronounced trend may not be observed for this species. The introduction of predatory threat may not alter its modus operandum in the new risky environment, as fish were also not fed within 12 hours of the start of the current experiment.

Conclusion

Based on the results from this study, the degree of habitat complexity, which is a subset of the unique structure of the habitat, proved to be an influential factor in whether or not the habitat will be forsaken or preferred in the face of predation. This factor seemed to play a greater role than habitat heterogeneity, as heterogenous habitats may include habitats that are devoid of structure, while a homogeneous one will have sufficient complexity and crevices for seclusion.

Results from this study clearly indicate that a fish's position in a relatively narrow seascape may vary with predator stress. This supports the findings of previous studies (Chivers et al., 2001). As such, consideration of an appropriate range of habitat types, combinations and levels of complexities is essential when determining boundaries for marine protected areas for a particular fish community. The findings of this study also highlight that, as habitat preference is also species-specific, knowledge of the fishes' intrinsic characteristics, behaviour and habitat shifts when threatened with predation, is essential to ensure their protection in designated areas. This is so, as we will be more informed as to the identity of the suite of habitats which will provide the greatest benefit (i.e. enable survival).

Further research on a larger number of species may tease out the relative importance of habitat heterogeneity and complexity for a range of species within a geographic region. Such studies may then illustrate how closely related the importance of these two measures are and how dependent they are on the actual structure of the unique habitats within these regions itself. These investigations would necessitate the use of designs that would be able to capture preferences of habitat types and configurations with predatory risk (if indeed they do exist) for schooling taxa and other species where habitat preference trends are known to be more difficult to decipher.

Table 1: Summary of Paired Samples T-tests in SPSS between Percentage Time Spent in "No-predator" and "Predator" Trials for Individual Habitat Combinations for each Tested Species.

Habitat Combination	*Acanthaluteres spilomelanurus*			*Atherinosoma microstomata*			*Stigmatopora argus*			*Pelates sexlineatus*		
	p value	**t**	**df**	**p value**	**t**	**Df**	**p value**	**t**	**df**	**p value**	**t**	**df**
seagrass	**0.016(-)**	2.964	9	0.155	1.452	36	0.787	-0.273	26	0.438	0.782	44
rock	0.185	-1.436	9	0.943	-0.073	36	**0.038* (+)**	-2.182	26	0.653	0.453	44
sand	0.114	-1.753	9	0.263	1.137	36	0.132	1.556	26	0.953	-0.060	44
seagrass-rock	0.777	-0.291	9	0.413	-0.829	36	0.229	-1.231	26	0.277	-1.101	44
seagrass-sand	0.078	1.989	9	0.752	-0.319	36	**0.05 (-)**	2.055	26	0.954	-0.059	44
rock-sand	0.058	-2.167	9	0.410	-0.083	36	0.880	-0.153	26	0.647	0.461	44

**It should be noted that in this instance i.e. difference in % time for S. argus in "rock" only, the assumption of normal distribution was not met and the appropriate parallel non-parametric Wilcoxon signed rank test did not a yield a significant difference between the two trials in this habitat section; "-" decrease in % time with predatory threat, "+" increase in % time with predatory threat*

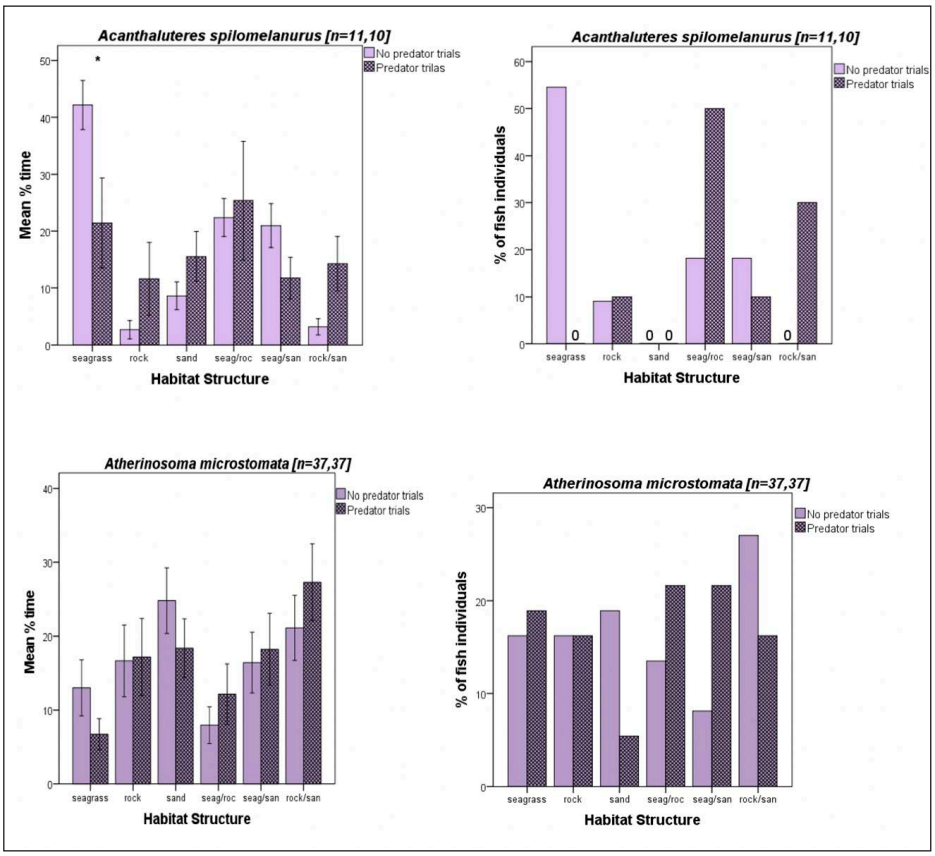


Figure 2: Mean percentage time spent in (a,c) and percentage of fish of tested species initially choosing (b,d) habitat sections; [n=NP, P]; broken lines denote the level of expected observations (i.e. 100%/6 = 16.6667% for each section); letters above bars represent the results of pairwise comparisons of log-transformed data with sections lacking similar letters being significantly different;* - significant paired t-test result.

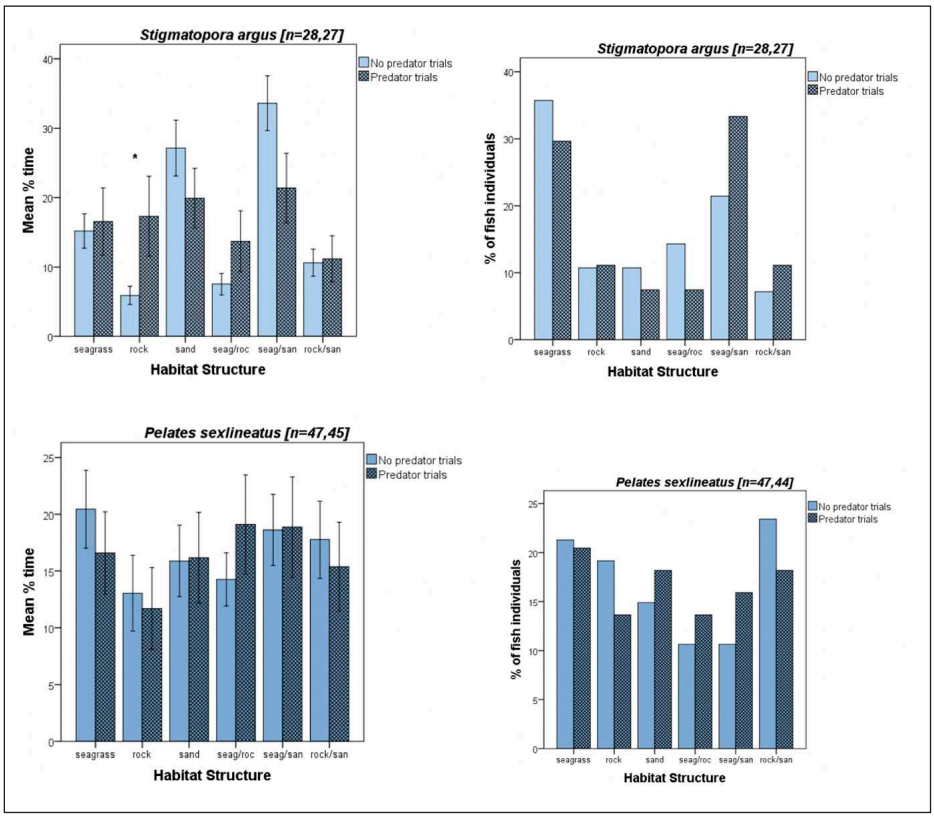


Figure 2: *(cont'd)* Mean percentage time spent in (e,g) and percentage of fish of tested species initially choosing (f,h) habitat sections; [n=NP, P]; broken lines denote the level of expected observations (i.e. 100%/6 = 16.6667% for each section); letters above bars represent the results of pairwise comparisons of log-transformed data with sections lacking similar letters being significantly different;* - significant paired t-test result.

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Appendix A

First habitat section selected by each individual of each of four tested species in "no predator" and "predator" trials.

Each row represents an individual fish and its choice in both trials. N/A – loss of data due to corrupted GoPro file for that trial. o – no section chosen by that individual (remained at the centre of tank for duration of trial).

Species	First habitat section selected upon release	
	"No Predator" trials	"Predator" trials
A. spilomelanurus	Seagrass	N/A
A. spilomelanurus	Seagrass	seagrass-rock
A. spilomelanurus	Seagrass	seagrass-rock
A. spilomelanurus	Seagrass	seagrass-rock
A. spilomelanurus	Seagrass	seagrass-rock
A. spilomelanurus	Seagrass	rock-sand
A. spilomelanurus	Rock	rock-sand
A. spilomelanurus	seagrass-rock	Rock
A. spilomelanurus	seagrass-rock	rock-sand
A. spilomelanurus	seagrass-sand	seagrass-sand
A. spilomelanurus	seagrass-sand	seagrass-rock
A. microstomata	Seagrass	seagrass
A. microstomata	Seagrass	seagrass
A. microstomata	Seagrass	seagrass
A. microstomata	Seagrass	seagrass-rock
A. microstomata	Seagrass	rock-sand
A. microstomata	Seagrass	Rock
A. microstomata	Rock	seagrass-sand
A. microstomata	Rock	seagrass-sand
A. microstomata	Rock	seagrass-sand
A. microstomata	Rock	Sand
A. microstomata	Rock	seagrass-rock
A. microstomata	Rock	seagrass-rock
A. microstomata	Sand	Rock
A. microstomata	Sand	Rock
A. microstomata	Sand	seagrass
A. microstomata	Sand	seagrass

A. microstomata	Sand	seagrass-sand
A. microstomata	Sand	seagrass-sand
A. microstomata	Sand	seagrass-rock
A. microstomata	seagrass-rock	seagrass-sand
A. microstomata	seagrass-rock	seagrass-rock
A. microstomata	seagrass-rock	seagrass-rock
A. microstomata	seagrass-rock	Rock
A. microstomata	seagrass-rock	rock-sand
A. microstomata	seagrass-sand	rock-sand
A. microstomata	seagrass-sand	rock-sand
A. microstomata	seagrass-sand	seagrass
A. microstomata	rock-sand	Rock
A. microstomata	rock-sand	Rock
A. microstomata	rock-sand	seagrass-rock
A. microstomata	rock-sand	seagrass-rock
A. microstomata	rock-sand	seagrass
A. microstomata	rock-sand	seagrass-sand
A. microstomata	rock-sand	seagrass-sand
A. microstomata	rock-sand	Sand
A. microstomata	rock-sand	rock-sand
A. microstomata	rock-sand	rock-sand
S. argus	Seagrass	seagrass-rock
S. argus	Seagrass	seagrass
S. argus	Seagrass	Seagrass
S. argus	Seagrass	Rock
S. argus	Seagrass	seagrass-sand
S. argus	Seagrass	Seagrass
S. argus	Seagrass	seagrass-sand
S. argus	Seagrass	Seagrass
S. argus	Seagrass	seagrass-sand
S. argus	Seagrass	Sand
S. argus	Rock	Seagrass
S. argus	Rock	seagrass-sand
S. argus	Rock	seagrass-sand
S. argus	Sand	seagrass-sand
S. argus	Sand	rock-sand
S. argus	Sand	Sand

S. argus	seagrass-rock	seagrass-sand
S. argus	seagrass-rock	Seagrass
S. argus	seagrass-rock	Seagrass
S. argus	seagrass-rock	rock-sand
S. argus	seagrass-sand	seagrass-sand
S. argus	seagrass-sand	Rock
S. argus	seagrass-sand	Seagrass
S. argus	seagrass-sand	seagrass-sand
S. argus	seagrass-sand	seagrass-rock
S. argus	seagrass-sand	rock-sand
S. argus	rock-sand	N/A
S. argus	rock-sand	Rock
P. sexlineatus	Seagrass	seagrass-rock
P. sexlineatus	Seagrass	seagrass-sand
P. sexlineatus	Seagrass	Seagrass
P. sexlineatus	Seagrass	0
P. sexlineatus	Seagrass	Sand
P. sexlineatus	Seagrass	Sand
P. sexlineatus	Seagrass	seagrass
P. sexlineatus	Seagrass	rock-sand
P. sexlineatus	Seagrass	seagrass-sand
P. sexlineatus	Seagrass	seagrass-rock
P. sexlineatus	Rock	seagrass-sand
P. sexlineatus	Rock	Rock
P. sexlineatus	Rock	seagrass-rock
P. sexlineatus	Rock	Rock
P. sexlineatus	Rock	Sand
P. sexlineatus	Rock	Sand
P. sexlineatus	Rock	rock-sand
P. sexlineatus	Rock	Rock
P. sexlineatus	Rock	Sand
P. sexlineatus	Sand	seagrass-sand
P. sexlineatus	Sand	Rock
P. sexlineatus	Sand	seagrass-sand
P. sexlineatus	Sand	Rock
P. sexlineatus	Sand	N/A
P. sexlineatus	Sand	rock-sand

P. sexlineatus	Sand	seagrass
P. sexlineatus	seagrass-rock	rock-sand
P. sexlineatus	seagrass-rock	seagrass
P. sexlineatus	seagrass-rock	seagrass
P. sexlineatus	seagrass-rock	Rock
P. sexlineatus	seagrass-rock	seagrass
P. sexlineatus	seagrass-sand	seagrass
P. sexlineatus	seagrass-sand	Sand
P. sexlineatus	seagrass-sand	seagrass-rock
P. sexlineatus	seagrass-sand	seagrass
P. sexlineatus	seagrass-sand	rock-sand
P. sexlineatus	rock-sand	Sand
P. sexlineatus	rock-sand	seagrass-rock
P. sexlineatus	rock-sand	seagrass-sand
P. sexlineatus	rock-sand	Sand
P. sexlineatus	rock-sand	rock-sand
P. sexlineatus	rock-sand	seagrass
P. sexlineatus	rock-sand	N/A
P. sexlineatus	rock-sand	seagrass-rock
P. sexlineatus	rock-sand	rock-sand
P. sexlineatus	rock-sand	seagrass-sand
P. sexlineatus	rock-sand	rock-sand

Appendix B

Table 1: Summary of PERMANOVA results comparing percentage of time spent in each habitat section for indicated species in Experiment A ["no-predator" trials – NP] and Experiment B ["predator" trials – P]. *Number in brackets represents homogeneity of multidispersions permdisp p-value; [n=Experiment A, Experiment B]; *Disparity in numbers between trials due to corruption of video data files for four individuals in "predator" trials.*

Test Species		df	MS	pseudo-F	p value
Acanthaluteres spilomelanurus [n=11;10]*	**NP**	5	14.71	20.873	**0.0001** (0.196)
	P	5	1.322	0.71943	0.6067
Atherinosoma microstomata [n=37;37]	**NP**	5	6.1654	2.5054	**0.0293** (0.298)
	P	5	6.8211	2.6702	**0.0201** (0.077)
Stigmatopora argus [n=28;27]*	**NP**	5	14.925	13.113	**0.0001** (0.495)
	P	5	2.3567	1.0033	0.4186
Pelates sexlineatus [n=47;45]*	**NP**	5	2.0261	1.0822	0.3774
	P	5	1.5956	0.59802	0.6871

Appendix B *(cont'd)*

Table 2: Pairwise comparisons of all possible combinations of habitat structure sections. *Numbers in brackets represent p-values for "predator" trials (Experiment B); bold p-values represent significant pairwise comparisons after Bonferroni correction (alpha value set at p<0.0033) for multiple comparisons; n.s. – no significant difference.*

Pairwise Comparisons		*Acanthaluteres spilomelanurus*	*Atherinosoma microstomata*	*Stigmatopora argus*	*Pelates sexlineatus*
seagrass-sand	Seagrass	0.0065	n.s.	0.0052	n.s.
	seagrass-rock	n.s.	n.s.	**0.0001**	n.s.
	Rock	**0.0001**	n.s.	**0.0001**	n.s.
	rock-sand	**0.0001**	n.s.	**0.0006**	n.s.
	Sand	0.0326	n.s.	n.s.	n.s.
Seagrass	seagrass-rock	0.0095	n.s.	0.0268	n.s.
	Rock	**0.0001**	n.s.	0.0075	n.s.
	rock-sand	**0.0001**	(**0.0027**)	n.s.	n.s.
	Sand	**0.0004**	0.0472 (0.0155)	0.006	n.s.
seagrass-rock	Rock	**0.0002**	n.s.	n.s.	n.s.
	rock-sand	**0.0005**	0.0075	n.s.	n.s.
	Sand	n.s.	0.0038 (0.0147)	**0.0001**	n.s.
Rock	rock-sand	n.s.	n.s.	0.0285	n.s.
	Sand	0.008	n.s.	**0.0001**	n.s.
rock-sand	Sand	0.028	n.s.	**0.0004**	n.s.

Figure 1: Mean percentage time spent in each of six habitat sections by test fish individuals (tested singly) for four different species (Experiment A – no predator). Broken lines denote the level of expected observations (i.e. 100%/6 = 16.6667% for each section); letters above bars represent the results of pair-wise comparisons of log-transformed data with habitat combinations sections lacking similar letters being significantly different.

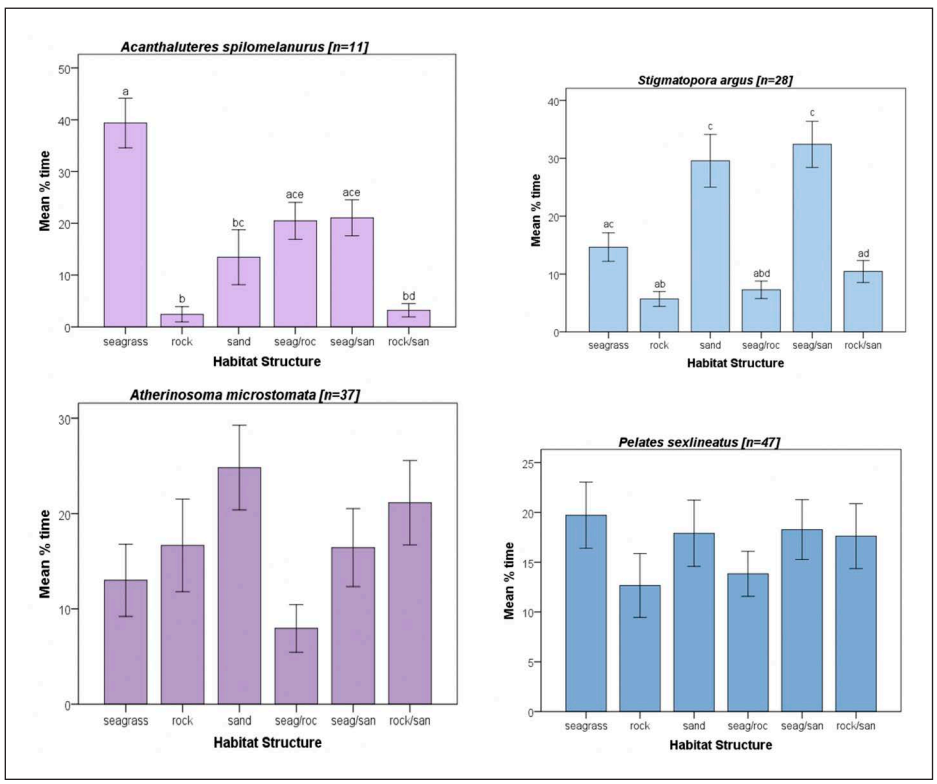
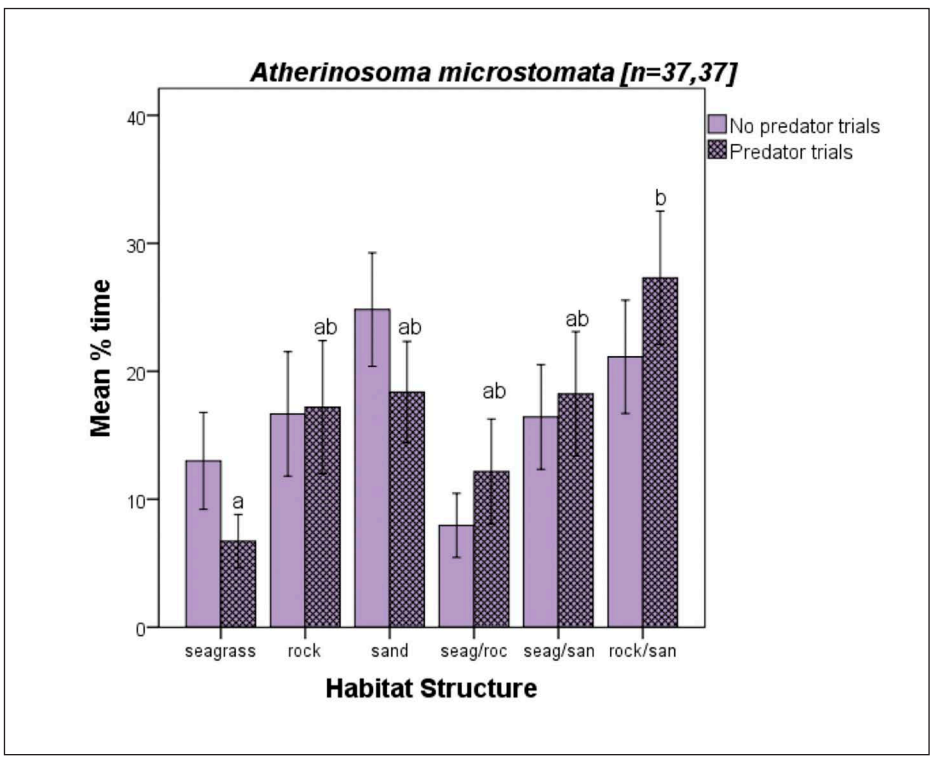


Figure 2: Mean percentage time spent in habitat sections by *A. microstomata* displaying results of pairwise comparison in predator trials; *[n=Expt A, Expt B]; broken lines denote level of expected observations (i.e. 100%/6 = 16.6667% for each section); letters above bars represent the results of pairwise comparisons of log-transformed data with sections lacking similar letters being significantly different;* - significant paired t-test result.*



Appendix C

Descriptive statistics (non-significant) for percentage of fish initially selecting indicated habitat sections pooling all individuals [n=123, 118] of all four tested species in "no-predator" (NP) and "predator" (P) trials.

Habitat Section	% fish initial choice [NP; n=123]			% fish initial choice [P; n=118]		
	Mean	N	S.D. (S.E.)	Mean	N	S.D. (S.E.)
seagrass	31.94	4	17.19(8.59)	17.25	4	12.43(6.22)
rock	13.79	4	4.70(2.35)	12.74	4	2.77(1.39)
sand	11.13	4	8.14(4.07)	7.75	4	7.63(3.81)
seag-rock	14.16	4	3.11(1.55)	23.17	4	18.81(9.41)
seag-sand	14.59	4	6.25(3.13)	20.22	4	9.95(4.97)
rock-sand	14.39	4	12.92(6.46)	18.88	4	7.99(4.00)

The Journal of Arts Science and Technology

The Natural Products Research Laboratory at UTech, Jamaica

Context, Concept, and Achievements

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Abstract

The Natural Products Research Laboratory (NPRL) at the University of Technology, Jamaica was established in the Faculty of Science and Sport between 2010 and 2012 through competitive internal and external grant funding. The context and purpose behind the creation of the laboratory are outlined in this paper as well as some of its accomplishments. Emphasis on the need for the exploration of Jamaica's biodiversity especially as it relates to the Cockpit country is discussed. Over the relatively short existence of the NPRL, it has uncovered several interesting compounds in keeping with its mission to investigate the unexplored natural product resources within the Cockpit Country; train and develop scientists; disseminate its findings through publications ad public forums; and influence policy formulation.

Keywords: Natural Products, Cockpit Country, Jamaica, Endemic Plants, Biodiversity, Conservation.

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Introduction

The Global Need for and Impact of Natural Products Research

Natural products are chemicals synthesised by living organisms as secondary metabolites. While not essential to core biological processes, they are produced

as responses to external environmental stimuli, such as predation or disease mitigation.[1] However, their impact on human life is unquestionable. Since their initial use in ancient civilizations, the use of natural products has evolved through their combination with modern science and they have been put to a variety of human applications such as medicines, flavourings, agrochemicals, food additives and biopesticides.[2]

Today, natural products form a major part of the healthcare systems in most of the world's developed nations. Added to this, the use of natural products reduces and, in some cases, eliminates the barrier to accessing healthcare for poorer populations.[1, 3]

With the exponential increase in microbial resistance to conventional treatments, the resurgence of old diseases (such as tuberculosis, syphilis, gonorrhoea, etc.) and the emergence of new ones, the scientific community is hard pressed to develop newer and more effective treatments. For example, there has recently been a resurgence in tropical diseases (e.g. Ebola virus) along with the emergence of new diseases (e.g. Chikungunya, Zika and SARS COV2 viruses). With each of these diseases, health systems globally have been dealt significant blows of increasing severity as scientists grapple with finding the way forward.

The path forward lies in the practices of former times and the fields of medicine and pharmacology may benefit from the use of natural products. In the face of current challenges, natural products have formed the basis of new drug development with almost half of the drugs approved by the United States' Food and Drug Administration between 1940 to 2014 derived from, or inspired by natural products.[1, 4-6] This includes drugs such as morphine, vinblastine and paclitaxel, which have had immeasurable impacts on modern medicine. Barring the significant contribution of plant-based natural compounds, any discussion on the subject would be remiss in not mentioning the impact of those products originating from microbes. In fact, microbe-based natural products have been a chief source of anti-infective medicines.[7] Also of note are marine-based drugs such as the anticancer drug trabectidin.[7]

Natural Products Research in the Caribbean

The Caribbean comprises approximately 0.15% of the Earth's land area.[8] This size, however, should not be used as an indicator of its inherent value as the area contains a significant quantity of endemic species. These include 3.0% (180 species) of the world's amphibians and 6.3% (520 species) of the world's known reptiles.[9, 10] Owing to this, the area is the fifth highest ranking biodiver-

sity hotspot across the globe. A biodiversity hotspot is a geographical region which meets the dual criteria of containing at least 1,500 endemic plant species and having lost 70% of the original natural habitat.[9] The Caribbean Islands Biodiversity Hotspot consists of over 7,000 islands, islets, reefs and cays joined by inextricable geographical and historical linkages.[11, 12] Though significantly impacted by the mass clearing of lands to facilitate the sugar plantations and timber industry, the practices which made use of endemic and indigenous plant species have transcended generations.[12] However, while anecdotal references continue to be made about the ethnomedicinal practices of Caribbean people, scientific research continues to lag in empirically documenting these practices.

Since its launch in 1982, the Traditional Medicine in the Islands network (TRAMIL) has undertaken over 50 surveys within the Caribbean Islands Biodiversity Hotspot. The aim of these surveys has been to document the ethnopharmacological practices in the region with a view of providing scientifically proven alternatives to patented drugs, which are increasingly beyond the reach of most of the population.[12, 13] From their surveys, TRAMIL researchers have examined over 150 plants across 18 countries and have made the findings available in various forms.

Another significant contributor to the development of Natural Products Research within the Caribbean is the Caribbean Herbal Business Association (CHBA). Formed at the Caribbean Herbal Business and Science Forum held in 2002 in Jamaica, the CHBA currently has chapters in Barbados, Dominica, Grenada, Guyana, Haiti, Jamaica, St. Lucia, Suriname and Trinidad & Tobago. Through the work of the CHBA, approximately 100 herbal enterprises in the Caribbean have been working with no less than 20 commercially significant plants. An array of products, which include medicines, cosmetics, herbal tonics and nutraceuticals, have been developed.[12]

Significance of the Cockpit Country

Toward the western end of the Caribbean Islands Biodiversity Hotspot is Jamaica and in the north-western region of the island lies an area of approximately 600km^2, which includes the contiguous wet limestone forest known as the Cockpit Country.[14] The Cockpit Country holds a unique place in Jamaica due in large part to its historical, cultural, geomorphological and biological significance.

The region first rose to prominence in Jamaica's history in the 1700's during the Maroon wars and has become inextricably linked with the Maroons, partic-

ularly the Accompong Maroons, since then.[15] These Maroons believe strongly that they have exclusive ownership of the Cockpit Country, having gained sovereign ownership of it in 1783. This ownership was conferred upon the Maroons by the signing of the Maroon Treaty between the British forces and the Maroon captain Cudjoe signalling the beginning of a critical partnership between the two groups and the end of the first Maroon War.[16]

From a geological perspective, the Cockpit Country is believed to have emerged from the sea over fifteen million years ago and consists of varying types of limestone (mainly white limestone and yellow limestone) which form layers atop the igneous rock in the area.[17] In sections of the region there are "bauxitic" layers covering some of the limestone.[18] Over time, the hydrological conditions of the area have made the landscape predominantly karst. The region consists of crater-like depressions, with average depths of 100–120 m and diameters of up to1 km which have been carved into the landscape.[18, 19] The craters are flanked by hills with diameters of approximating 1 km and heights of between 30–130 m.[19] This alternating hill and crater topology is believed to be one of the reasons why the Cockpit Country is so called, as it resembles the shape of cockfighting dens.

Rainfall in the region is particularly high though the amount of surface water in the region would lead the novice explorer to believe otherwise. Though some water may be visible as ponds at the bases of some of the cockpits in rare areas[18], the majority of the water is located below ground in the water table on which the region sits, and in caves which are found throughout the region. The island's main watershed is found in the Cockpit Country and several of the island's main rivers originate from, or pass through, the area. For example, the Martha Brae, Rio Bueno, and Hector's and Black Rivers, whose headwaters originate in the Cockpit Country, service the north, east and south of the island, respectively. These four rivers account for 40 percent of the island's ground water.[17]

Any discussion on the significance of the Cockpit Country would be incomplete without mention of the region's biodiversity. Of the approximately 2,888 known plant species in Jamaica it is estimated that 27% are endemic to the island and approximately 10% of those endemic plants are only found within the Cockpit Country.[20, 21] The area's distinct rainfall patterns and topography creates microclimates which help support the high levels of biodiversity found in the region. Ecologists who have studied the area extensively continue to make a case for the degree to which endemism in the area is highly localised. Some species in the area are confined to individual karst towers.[18] Of note, are

the sixty-five plants which are endemic to the region. The majority of these have only ever been collected a few times and are only known to be located on a single hillock in the region.[17]

With all the critical resources located in the Cockpit Country, it not surprising that there are a number of competing interests for the economic exploitation of the region. The Accompong Maroons and other inhabitants of the Cockpit Country have used plants from this region for their medicinal benefits for centuries. Furthermore, in a 2013 report on consultations discussing the boundaries of, and resource use in, the Cockpit Country, members of the Maroon Council expressed strong interest in the scientific exploration of the plants in the area for their medicinal applications to be documented in literature.[16] The work from the Natural Products Research Laboratory at the University of Technology, Jamaica (UTech, Ja.), discussed further herein, as well as from other entities continue to validate these claims.

The biodiversity found within the Cockpit Country is currently threatened by mining in the region. Several entities, both formal and informal, have been conducting mining in the region, with particular emphasis on extracting bauxite from its hills. Ecotourism, which would see visitors having immersive experiences including but not limited to hikes, treks and camping, has also been mentioned in recent times. The critical point to consider in determining what activities should be permitted in the region is that of a balance between environmental protection and economic interests.

The Natural Products Research Laboratory

Since its inception in 1958 as the Jamaica Institute of Technology (later renamed College of Arts, Science and Technology [CAST] before being further renamed to its current name), the University of Technology, Jamaica (UTech, Ja.) has been a driver of national development in a variety of fields. UTech, Ja. has as its research mandate "to promote applied and commissioned research that will provide solutions to societal needs. This is ensured by aligning research activities with national goals and priorities for development as articulated in the country's long-term development plan, Vision 2030 Jamaica."[22] The Natural Products Research Laboratory (NPRL) within the Faculty of Science and Sport (FOSS) is one of the facilities of UTech, Ja. through which achievement of this mandate is pursued.

The Natural Products Research Laboratory has been undertaking relevant research into endemic Jamaican plant species to identify beneficial compounds

they may possess. The Natural Products Laboratory was established between 2010 and 2012 in the School of Natural and Applied Sciences, Faculty of Science and Sport, with funding obtained from the United Nations Development Programme's (UNDP), Global Environment Facility-Small Grants Programme (GEF-SGP) and the Environmental Foundation of Jamaica (EFJ). The successful grant proposals for the research project titled "Analyses and preservation of endemic Jamaican plants in the Cockpit Country region"[23, 24] were prepared by Dr. Andrew Lamm, with the assistance of Dr. Debbie-Ann Gordon-Smith, (formerly Director of the Center for Science-based Research, Entrepreneurship and Continuing Studies (CSRECS); now a lecturer at the UWI, Mona).[25] Collaborators on the project also included Professor Paul Reese (UWI, Mona)[26] and Dr. Omar Christian (McNeese University, Louisiana, USA)[22]. The work of the NPRL has been consistently expanded by the addition of new collaborators such as with Professor Rupika Delgoda (Natural Products Institute, UWI, Mona) who provides bioassays against various cancer cell lines (such as breast, lung, pancreas and colon cancer). Professor Delgoda has also consulted on endeavours of similar interest.[27, 28] Through other international grants, such as the Queen Elizabeth II Diamond Jubilee Scholarship; the Emerging Leaders in the Americas Program (ELAP); and the Canada-CARICOM Faculty Leadership Program,[29] the NPRL has been able to expand the training and research expertise of students and faculty members. This has included research engagements with St. Mary's University and University of Prince Edward Island in Canada. The NPRL has also provided technical and other support to individuals, groups and entities via workshops, public forums, posters, conference presentations, laboratory tours, practical training experiences, media interviews, various publications, mentorships and consultancies.

Since its creation, the Natural Products Research Laboratory has produced two graduate students who have completed the Master of Philosophy/Doctor of Philosophy (MPhil/Ph.D.) in Chemistry program offered by the Faculty of Science and Sport. The first MPhil graduate, Mr. O'Brien Brown, graduated in November 2016 (co-supervised by Dr. Gordon-Smith). Mr. Jason Solomon was the second student. Mr. Brown's research assessed eight endemic plant species, the phytochemical analysis of which revealed the presence of saponins, quinones, steroids and coumarins. Further work with a specific endemic plant, *Verbesina karsticola,* revealed antimicrobial activity against *Pseudomonas aeruginosa*; *Escherichia coli*; *Staphylococcus aureus*; *Bacillus cereus* and *Bacillus subtilis*. Mr. Brown was also able to isolate and determine the structure of bornyl caffeate and bornyl coumarate using 1D and 2D NMR techniques on

Verbesina karsticola extracts. Bornyl caffeate is of note as it has been shown to induce apoptosis in breast cancer cell line MCF-7.[30]

Mr. Solomon completed his MPhil in 2021 (co-supervised by Dr. Deon Bennett at UTech, Ja) and graduated. His research revealed among other things; antimicrobial active extracts from three endemic plant species against *Klebsiella pneumoniae*. Extracts from two of these three endemic plant species also displayed activity against *Escherichia coli*. Also of note is that Mr. Solomon was able to perform structural elucidation of mearnsitirin from an extract of one of his studied plants using the combined application of HPLC, MS, IR and X-ray crystallography. Mearnsitrin is known for its antioxidant effects.

The NPRL has also supported primary and secondary school students through collaborations with the Ministry of Youth and Education as well as the Scientific Research Council (SRC). The collaboration with the SRC has involved competitive science competitions, national awards, and student development programmes.

Undergraduate and postgraduate research projects have also been facilitated, such as examining the levels of carcinogens in jerked foods, the carotenoid levels in local fruits; investigating the insecticidal properties of caffeine; among many others. Scientists from Canada, the USA, South Africa, Brazil and other countries have visited the lab on collaborative projects. The lab has also cooperated with local and international private companies to conduct research and analyses on various projects.[27, 30]

The research work of other faculty members have also been facilitated at the NPRL via impactful projects such as the **Investigation of Dolphin-Fisher Interactions and the Impact of Dolphins on Fishing in Jamaica** as well as the ongoing international collaboration **Assessing the Diversity and Seasonality of Marine Mammals in Jamaica** both led by Ms. Christine O'Sullivan. The Microbial Diversity in Waterbodies Associated with the Riverton Landfill was led by Dr. Aneisha Collins-Fairclough.[31]

Overall, the NPRL continues to fulfil its original objectives and more. Most notably, it has expanded on the exploration of the rich natural biodiversity of Jamaica to include the fresh water and marine environments; it has created a repository of extracts for further scientific study; it has supported the entrepreneurial and scientific community through data driven research; and has, and continues to train the next generation of scientists at all levels of society. The NPRL highlights the immense potential within Jamaica's ecosystems (its forests, aquatic systems, and even its landfill areas) and by extension the capacity and capability of the University of Technology, Jamaica to undertake bold

projects, successful collaborations and produce outstanding results at the local and international level.

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Evaluating Drug-Related Problems and Pharmacists' Interventions at a Paediatric Hospital

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Abstract

Evidence of the benefits of pharmacists' intervention during drug validation, in developed countries, is well documented in the literature. However, there is no published literature on pharmacists' intervention in Jamaica, although mention has been made anecdotally. This research sought to evaluate pharmacists' interventions regarding Drug-Related Problems (DRPs) at a paediatric hospital in Kingston, Jamaica during the one-year period to bridge the gap in knowledge regarding the impact of pharmacists. Retrospective data of pharmacists' interventions recorded at the Bustamante Hospital for Children during the study period were collected and analysed. A total of 87,529 prescriptions were filled at the institution over twelve months. Two hundred and seventy-seven DRPs were identified, representing 0.3% of the total number of prescriptions. The top three categories for which DRP's were identified were antibiotics, anti-inflammatory and respiratory drugs. The most common DRPs identified were related to incorrect dose/dosage form (73.6%), incorrect or inappropriate drug selection (18.4%), and incorrect treatment duration (7.9%). The most common pharmacists' intervention made

was dose modification. The prescribing physician accepted most (97%) of the pharmacists' interventions. For the remaining interventions initiated by the pharmacist, the prescriber was unavailable to accept and authorize changes to the patient's therapy. Interventions by the pharmacists resulted in positive outcomes, as 94.9% DRPs were completely resolved. This study demonstrated that pharmacists contributed to the prevention of DRPs during medication validation. These interventions prevented drug overdose with potential adverse drug reactions and suboptimal treatment of the patient.

Keywords: Drug-related Problems, Pharmacist Interventions, Jamaica, Paediatric Hospital

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Introduction

Background

The profession of Pharmacy worldwide has evolved from the traditional role of a pharmacist, which predominantly involved the dispensing of medications in both hospital and community practice settings, to one of being an integral member of the healthcare team contributing to the management and monitoring of diseases. While still ensuring that medicines are sourced and dispensed to the highest possible standards, pharmacists have expanded their role to offer clinical services which include identifying and resolving Drug-Related Problems (DRPs) and working closely with the patient and physician to achieve treatment goals. These DRPs have previously been categorized and described by Hepler & Strand (1990) to include an untreated indication, improper drug selection, drug interaction, subtherapeutic dosage or overdose, and drug prescribed but not needed.

In a landmark study conducted by The Institute of Medicine (IOM) in the United States, the high incidence of medication errors that have been occurring in hospital settings was brought to the fore. The IOM study noted that the high number of patients who died annually from medical errors in hospitals exceeded the number of persons who died from motor vehicle accidents, breast cancer or acquired immunodeficiency syndrome (Kohn et al., 2000). This was a clarion call to the medical community resulting in more research into the prevalence of medication errors as well as the types and possible types of

these errors. In developed countries such as Canada and Australia, similar patterns of high incidence rates of DRPs among hospitalized patients have been observed (Baker et al., 2004; Blix et al., 2004; Ruciman et al., 2003). The Pharmaceutical Care Network Europe (PCNE) defines drug- related problems as "an event or circumstance involving drug therapy that actually or potentially interferes with desired health outcomes" (Jamal et al., 2015). These errors may be minor with little to no adverse effects, they may extend the length of stay in hospital or result in increased mortality or morbidity (Classen et al., 1997). Some studies have shown that the costs associated with DRPs may exceed the cost of the medications (Ernst et al., 2001).

Many of the DRPs in hospitals and other clinical settings are preventable and can be avoided by the intervention of a pharmacist. Interventions by pharmacists also result in identifying and resolving DRPs which have been associated with optimized treatment outcomes (Kumar et al., 2013). Examples may also be found in literature of the positive impact of pharmacists' intervention in reducing the occurrence of DRPs in chronically ill patients who are on life-long medications (Slagado et al., 2012; Strong et al., 1993; Viktil et al., 2008). This is of particular importance when we look at the impact of DRPs in paediatric patients who are sometimes unable to articulate the emergence of undesirable drug effects. Abrogoua et al. (2016), analysed the clinical impact of the pharmacist's intervention in identifying DRPs at the point of patient admission, during medical rounds and upon examination of patients' records at a paediatric hospital. They concluded that interventions performed by the pharmacists were appropriate to prevent iatrogenic events and were associated with improved treatment outcomes.

Pharmacists have often spoken about interventions made in hospitals in Jamaica, but there is a paucity of published local data available. Interventions made by pharmacists in Jamaica are often noted on prescriptions or medication charts. However, due to the lack of reporting systems at healthcare institutions or the availability of a national reporting database, the incidence of DRPs occurrence and the extent to which patients are impacted by these events are unknown.

Studies in other countries have reported that although DRPs are often discovered by pharmacists, less than half of them are reported or meaningful actions taken to reduce the incidence or reoccurrence. Cited reasons for inaction included lack of acceptance by society and other health care professionals of the pharmacists' role, lack of proper systems for reporting, lack of incentives for drug intervention services and lack of time due to managerial responsibilities

especially in the retail setting (Jamal et al., 2015; Tamuz et al., 2004).

Pharmacists have often spoken about interventions made in hospitals in Jamaica, but there is a paucity of published local data available. Interventions made by pharmacists in Jamaica are often noted on prescriptions or medication charts. However, due to the lack of reporting systems at healthcare institutions or the availability of a national reporting database, incidence of DRPs occurrence and the extent to which patients are impacted by these events are unknown. Studies in other countries have reported that although DRPs are often discovered by pharmacists, less than half of them are reported or meaningful actions taken to reduce the incidence or reoccurrence. Cited reasons for inaction included lack of acceptance by society and other health care professionals of the pharmacists' role, lack of proper systems for reporting, lack of incentives for drug intervention services and lack of time due to managerial responsibilities especially in the retail setting (Jamal et al., 2015; Tamuz et al., 2004).

Currently, there is no published evidence locally to support the practice of documenting these interventions consistently.

Rationale

Drug-related problems have the potential to harm patients and increased medical costs to correct health problems resulting from DRPs. Pharmacy-initiated interventions address a wide array of potential drug-related problems. Most interventions directly involve patient safety concerns and are aimed at improving patient care. This research sought to evaluate the most common types of DRPs and the pharmacists' interventions in primary care at a specialist hospital in Jamaica.

Purpose of the Study

The purpose of this study was to evaluate the interventions recorded by a team of hospital pharmacists over one year. This was to provide local data on the types of interventions and the outcome of such interventions at a paediatric hospital and propel the need for additional research at other hospitals. It is hoped that this study will contribute to the development of a national standardised document to allow for the collation and analysis of drug-related problems.

Objectives

1. To identify the drugs most involved in DRPs

2. To determine the most common category of drug-related problem
3. To identify the most common types of pharmacists' interventions aimed at reducing drug-related problems
4. To demonstrate the outcome of pharmacists' interventions in reducing drug-related problems

Methodology

Study Design

A retrospective, cross-sectional design was used with a structured data collection instrument used to collect data from the Bustamante Hospital for Children (BHC) in Kingston, Jamaica. BHC is the only paediatric hospital in the English-Speaking Caribbean. At this hospital, interventions for DRPs are routinely documented by staff pharmacists on a clinical intervention form developed by pharmacy administrators. The completed forms are usually affixed to a copy of the medication orders (prescriptions) on which the DRPs were identified.

Study Population

All prescriptions with completed clinical intervention forms during the one-year period from January to December 2018 were reviewed for the study, yielding a total of two hundred and seventy-seven (277) prescriptions with DRPs. All 277 were included in the analysis.

Data Collection

A structured data collection form was designed to capture information on patient demographics, category, and type of the DRP, medication product involved in the DRP, Pharmacist's recommendation, and the overall outcome of the intervention. The category of each DRP were further subdivided into three groups: (1) Drug Selection, (2) Dose/Dosage form selection, and (3) Treatment Duration. Prescriptions were excluded if the completed forms were recorded outside (before or after) the period January to December 2018, fell outside of the stated categories of DRPs or were illegible and/or not clearly documented with regards to the categories outlined in the data collection sheet.

Reliability and Validity of the instrument

The data collection instrument was tested for reliability and validity to collect the required information from scripts outside of the period under review.

Data Analysis

The data collected were inputted and analysed using Statistical Package for Social Sciences (SPSS) software programme (version 24.0) for analysis. Measures of frequency and central tendency were generated with the aid of SPSS and Microsoft Excel 2010.

Ethical Consideration

Ethical approval was received from the Ethics Committee of the Southeast Regional Health Authority (SERHA). After ethical approval was granted, permission to conduct the study at the Bustamante Hospital for Children (BHC) was obtained from the National Health Fund (NHF), the organization that manages all government-owned hospital pharmacies in Jamaica. Confidentiality of all prescription-related details were maintained by the non-disclosure of patient's name, registration number, name of prescriber, and the name of the pharmacist who did the intervention.

Results and Discussion

The seriousness of drug-related problems (DRPs) is well recognized both from a morbidity and a cost perspective (Evans et al., 1998; Kohn et al., 2000; Leape et al., 1991). There are many studies from developed countries which document adverse drug events and medication errors, but comparatively few studies are conducted in developing countries. These studies focus mainly on the adult population with even fewer studies on drug-related problems in the paediatric population. The paediatric population is at greater risk for more severe DRPs as the implication of dosing errors combined with basic pharmacokinetic factors such as inefficient metabolism and excretion can result in drug accumulation and prolonged elimination times. Pharmacists use a variety of drug references which are internationally accepted for the identification of DRPs. At the study site, pharmacists use references such as *The Harriet Lane Handbook* and *Lexicomp Drug Information Handbook*.

The high number of prescriptions over the one-year study period (87,529) indicates the high utilization of this paediatric facility. The number of DRPs per patient was low (277, 0.3%) compared to other studies, that reported DRP rates ranging from 5-51.1% (AlAzmi et al., 2019; Fortesque et al., 2003; Rashed et al., 2012). The wide range for DRP rates may be associated with the different study methodologies, interpretation, and application of the term drug-related problems and under reporting (Tamuz et al., 2004; Wong et al., 2004).Most of the patients for whom a pharmacist intervention was made, were male (55%) and 2% had the gender information missing from the prescription. The mean age of the patients with identified DRPs was 4.0 $\pm$ 3.6 years, with an age range from 1 day to 17 years old. Most of the study population was between 2 to 11 years.

Sixty-six drugs were found to be associated with drug-related problems. Most of the DRPs were related to antibacterial drugs (56%) while less than 5% were related to each of the other therapeutic categories identified. These therapeutic categories were pain and inflammation, asthma, nasal congestion, and gastrointestinal protection. The remaining 26.7% of DRPs occurred with drugs belonging to other therapeutic indications associated with the treatment of cancer, anaemia, or an immunodeficiency disease (Table 1).

Table 1. Frequency of the Most Common Indications for Drugs with DRPs (n=277)

Indication	Frequency (%)
Bacterial Infection	155 (56)
Pain/Inflammation	11 (4.0)
Asthma	9 (3.2)
Nasal Congestion	9 (3.2)
Gastrointestinal Protection	8 (2.9)
Fungal Infection	6 (2.2)
Seizure	5 (1.8)
Other	74 (26.7)
Total	**277 (100)**

The top ten drugs accounting for 172 DRPs included several antibiotics: the top three being Amoxicillin/Clavulanic Acid (68, 24.5%), Erythromycin (21, 7.6%) and Azithromycin (17, 6.1%). The three non-antibiotic drugs in the top ten drugs associated with DRPs were Diclofenac Potassium (11, 4%), Ranitidine (8, 2.9%) and Mometasone (8, 2.9%) respectively (Figure 1). The remaining 56 drugs accounted for a total of 105 drug-related problems with varying therapeutic indications.

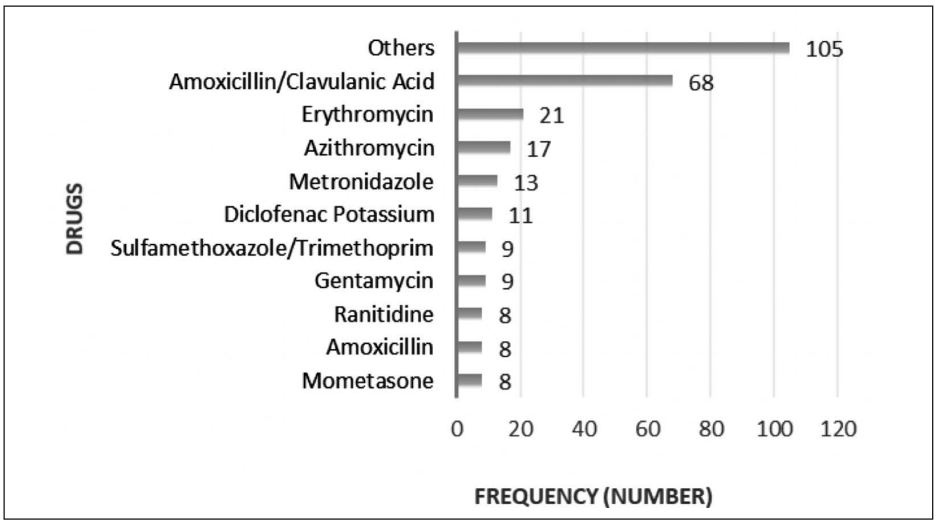

Figure 1: Drug-related Problem Frequency of Top Ten Drugs in a Jamaican Paediatric Hospital (n=277)

Amoxicillin/Clavulanic Acid listed as the number one causative agent aligns with the results from Jose, Shareef, & Shenoy (2016) and Acheampong & Anto (2015) which listed antibiotics and anti-infectives respectively among the drug categories causing the majority of DRPs. Similarly, other studies specific to the paediatric population found antibiotics as the top drug category for DRPs (AlAzmi et al., 2019; Kaushal et al., 2001). The high prevalence of DRPs associated with antibiotics in the paediatric population is expected, as a scholarly search for common illnesses in children found bacterial infections as the number one illness. This is different from studies in the adult population in which the drugs associated with DRPs are drugs used in the treatment of chronic diseases (McDonnell et al., 2002; Ruciman et al., 2003)

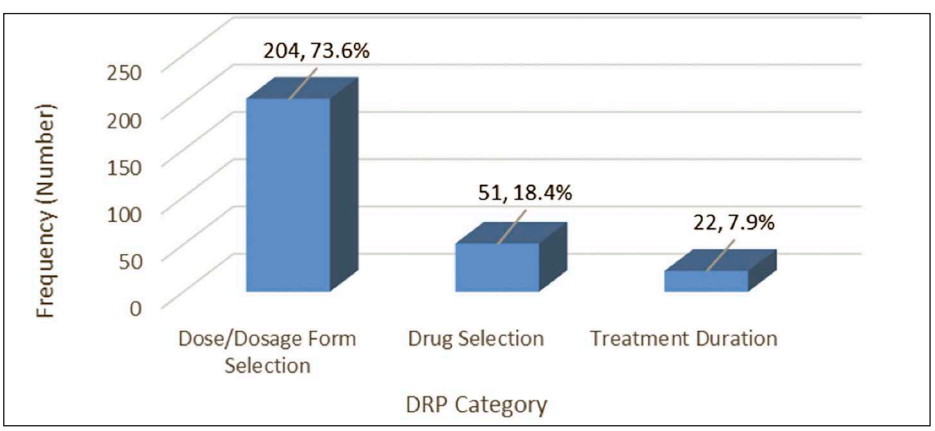

Figure 2: Categories of Drug-Related Problems (n=277)

The categories of DRPs were further subdivided to identify the specific associated factors. In the incorrect dose/dosage form category, the main types of DRPs were due to doses higher than the recommended dosage range (82, 29.6%) or doses lower than the recommended dosage range (80, 28.9%). For the inappropriate drug selection category, 32 (11.6%) of the DRPs were due to prescription/transcription error. There were no incidents of drug-drug interaction and inappropriate drug use according to guidelines. Pharmacist intervention in the treatment duration category was related to shorter treatment duration than therapeutically recommended in 13 (4.7%) of the DRPs and too long in 9 (3.2%) of the cases (Table 2).

Table 2: Categories and Types of DRPs with associated frequencies

DRP Category	DRP Types	Frequency (%)
Dose/Dosage Form Selection	Prescribed dose too high	82 (29.6)
	Prescribed dose too low	80 (28.9)
	Prescribed frequency too high	22 (7.9)
	Prescribed frequency too low	17 (6.1)
	Inappropriate dosage form	3 (1.1)
Drug Selection	Prescription/Transcription incorrect	32 (11.6)
	Contraindication apparent	11 (4.0)
	Drug prescribed not needed	2 (0.7)
	Drug Indicated not prescribed	1 (0.4)
	Drug duplication	1 (0.4)
	Drug-Drug Interaction	0 (0)
	Inappropriate drug according to guidelines	0 (0)
	Drug-Disease Interaction	4 (1.4)
Treatment Duration	Treatment duration too short Treatment duration too long	13 (4.7) 9 (3.2)
Total		**277 (100)**

Overall, the most common types of drug-related problems in descending order were prescribed dose too low or too high (58.5%), prescription frequency too high or low (14%), prescription/transcription incorrect (11.6%), and short duration (4.7%). These results were similar to other studies in this population with dosing error as the primary DRP, ranging from 28-74.7% (AlAzmi et al., 2019; Fortesque et al., 2003; Kaushal et al., 2001; Leape et al., 1999) but were

contrary to the main type of DRPs in the adult population (Patini et al., 2020). Researchers have found that in the adult population, drug interaction (71%) was the most common DRP and only 8.1% of DRPs were due to drug overdose. A dose or frequency above those recommended in drug references was used to define drug overdose (Jose et al., 2016). The DRPs identified in the current study that were associated with the Drug Selection category yielded similar results to a study done in Saudi Arabia (18.5% vs 22.9% respectively) (AlAzmi et al., 2019).

Data analysis of the ten most common drugs associated with DRPs in the study showed that Amoxicillin-Clavulanic Acid was mostly associated with incorrect dose/dosage form selection, with a prevalence of 83.8% (57 out of 68). The main contributory factors being prescribed at either a high dose (29.4%) or low dose (36.8%). Furthermore, of all the top ten drugs associated with high dose DRPs, Amoxicillin-Clavulanic Acid had the highest prevalence (20 out of 54, 37%). The top ten drugs with DRPs requiring intervention were prescribed at inappropriate doses (109 out of 172), with an occurrence of 63.4%. Azithromycin was the only drug among the top ten which was prescribed for a longer duration than recommended by the therapeutic guidelines. Erythromycin was prescribed for a shorter duration than recommended in 4 of the 21 (19.0%) Erythromycin-associated DRPs. Amoxicillin-Clavulanic Acid had the highest prevalence of being dosed too frequently (8 out of 17, 47%) and this drug was associated with the most DRPs (68 out of 172, 39.5%) of all the top ten drugs (Table 3).

Table 3: Characteristics and Occurrence of the Top Ten Drugs Associated with Drug-related Problems (n=172)

Drug	Drug Disease Interaction	Contraindications Apparent	Prescription/Transcription Incorrect	Inappropriate Dosage Form	Prescribed Dose High	Prescribed Dose Low	Frequency High	Frequency Low	Duration Too Long	Duration Too Short	Total
Amoxicillin/ Clavulanic Acid	3	3	3	2	20	25	8	2	0	2	68
Erythromycin	0	0	1	0	4	6	2	4	0	4	21
Azithromycin	0	1	2	0	4	3	0	0	6	1	17
Metronidazole	0	0	0	0	5	6	0	2	0	0	13
Diclofenac Potassium	0	0	0	0	7	2	2	0	0	0	11
Trimethoprim-Sulfamethoxazole	0	0	1	0	3	4	1	0	0	0	9
Gentamycin	0	0	1	0	3	4	1	0	0	0	9
Ranitidine	0	0	0	0	4	3	0	1	0	0	8
Amoxicillin	0	0	1	0	3	2	2	0	0	0	8
Mometasone	0	6	0	0	1	0	1	0	0	0	8
Total	**3**	**10**	**9**	**2**	**54**	**55**	**17**	**9**	**6**	**7**	**172**

Each DRP identified, was accompanied by a pharmacist intervention as summarized in Table 4. The most frequent pharmacist recommendation was dose modification (154 out of 277, 55.6%) followed by a change in dosing frequency (44 out of 277, 15.9%).

Table 4: Summary of Pharmacist Recommendations to Resolve Drug-related Problems

Pharmacist Interventions	Frequency (%)
Dose Increase	79 (28.5)
Dose Decrease	75 (27.1)
Change Frequency	44 (15.9)
Change Duration	21 (7.6)
Change Drug	12 (4.3)
Drug Not Dispensed	12 (4.3)
Change Strength	10 (3.6)
Formulation Change	3 (1.1)
Add Medication	1 (0.4)
Other Intervention	20 (7.2)
Total	**277 (100)**

A DRP related to antibiotic use has potential serious therapeutic implications. Antibiotics not dosed at the right level or with the correct frequency have implications for bacterial resistance and therapeutic failure in an era when resistance is a burgeoning problem (Patini et al., 2020).

There was a high acceptance rate for pharmacist interventions, as 270 (97%) of the interventions were accepted. The remaining 7 (3%) were initiated by the pharmacist but the prescriber was unavailable to accept and authorize changes to the patient's therapy at the time of intervention. This acceptance rate is similar to rates seen in other studies and can be extrapolated to a reduction in costs and morbidity (Evans et al., 1998; Leape et al., 1999; Wong et al., 2004). Acheampong & Anto (2015) and Al Rahbi et. al. (2014) stated that more than 90% and 98.2% respectively of interventions and recommendations by pharmacists were accepted and implemented. This speaks to the acceptance of the role and skill sets of the pharmacist. With this high rate of acceptance, it supports the role of pharmacists as vanguards of drug therapeutic management. This should also encourage pharmacists to document DRPs to advance patient care via lessons learnt from the most frequently occurring problems and their types. It is only through documentation, analysis and dissemination of the information can an impact be made in reducing the number of DRPs.

Studies have shown that the majority (50–80%) of DRPs can be prevented, which strongly supports that these problems should be addressed (Viktil et al., 2008). Data also supports that a pharmacist can effectively identify and prevent clinically significant DRPs. A review article by De Rijdt, Willems,

& Simoens (2008) identified several interventions made by pharmacists in North America inclusive of the detection and prevention of prescribing and transcription errors, implementation and tracking of the use of guidelines for the correct use of drugs and optimized drug dosing.

Interventions by the pharmacist resulted in positive outcomes as 263 (94.9%) DRPs were completely resolved, 6 (2.2%) were partially resolved and the status of 8 (2.9%) were unknown. The pharmacist interventions prevented 267 (96.4%) of the DRP from reaching the patient. The medical outcome of the other 10 was unknown.

Conclusions

This study revealed that at a paediatric hospital in Jamaica, pharmacists' intervention contributed to the prevention of DRPs during medication validation. These interventions resulted in the prevention of drug overdose and potential adverse drug reactions, as well as suboptimal treatment of the patient. The data from this pioneering study on DRPs in Jamaica affirms the key role of pharmacists in the therapeutic management of patients.

Acknowledgement

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Continuing Education

The Practices, Attitudes, and Needs of Pharmacists in Belize

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Abstract

The concept of Continuing Education (CE) for professionals such as pharmacists is increasing globally. The purpose of the research was to investigate the practices, attitudes, and needs of Belizean pharmacists regarding CE. A mixed-method convergent design, using a purposive sampling technique, was employed. Data was gathered using the instruments of a focus group discussion and an online questionnaire yielding responses of 54% (n=73). Qualitative data was analyzed using NVIVO to identify themes. Quantitative data was analyzed using SPSS version 23. Kruskal-Wallis ANOVA test was used to compare the means and examine for differences in the responses of participants. Pharmacists' attitudes towards CE were positive with recommendations for a structured program. Most respondents (70%) have been involved in CE activities; factors that discouraged participation were related to cost and workload. Factors that encouraged participation were related to the benefit of the programs to their performance at work. The preferred method of CE delivery was identified as hands-on workshops and the preferred time of delivery was the weekends. Participants of the focus group indicated that the only way to ensure participation in CE activities was to make it mandatory. This research suggests that the development of a structured CE program in Belize is desired and would be supported by pharmacists in the country. The research also uncovered difficulties facing the profession, such as a lack

of drive and political will to advance the field. Therefore, the research is of primary relevance to all entities interested in designing and implementing such a program.

Keywords: Attitudes, Belize, Continuing Education, Pharmacists

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Introduction

Background

Pharmacists are health care professionals with expertise in medicine. They practise in a wide range of settings, including, community pharmacies, hospitals, and the pharmaceutical industry. It is a profession that is evolving in an ever-changing environment. Advancements in technology, socio-political changes, and greater access to information are a few of the driving forces which have resulted in a paradigm shift in the role of the pharmacist. The role of pharmacists has changed from a product-centered, distribution activity to a patient-centered system in which pharmacists are assuming new responsibilities. These roles, though previously unrecognized, include providing value to patients through pharmaceutical care thereby helping patients achieve healthy outcomes (Hritcho, 2006).

Continuing education (CE), also known as continuing professional education, has been defined as "The education of professional practitioners that follows their curriculum and extends their learning throughout their careers" (Queeney, 2000). It involves structured learning experiences and activities in which professionals engage after they have completed their academic education.

In a labor market that is getting more competitive and is changing quickly, the goal is to preserve professional credential skills and improve one's professional credentials. Given that the healthcare sector is always changing, continual education is crucial. The World Health Organization supports the concept of continuing education for health care professionals and states that health workers should invest in educational opportunities that give them current information and skills in order to provide the greatest patient care (WHO, 2016). As a healthcare practitioner, the pharmacist in particular is continually exposed to new information and technologies about the management of diseases and the administration of both old and new medications.

Therefore, to be most effective, pharmacists must continue learning about advances in research and treatment to obtain and maintain currency of knowledge and skills in caring for their patients. In 2002, the International Pharmaceutical Federation (FIP) released a statement of Professional Standards, Continuing Professional Development CPD). This concept of, and its relation to Continuing Education by definition, CPD is the responsibility of each pharmacist to systematically maintain, improve, and enhance their knowledge, abilities, and attitudes in order to maintain their professional competence throughout their careers. It is a concept which is much broader than continuing education and holds the pharmacist responsible for identifying their educational needs and reflecting on the knowledge gained from the educational sessions. In essence, continuing education is a very significant component of a continuing professional development program. It is essential to ensure that continuing professional development can occur.

In some jurisdictions, the practice of engaging in continuing education (CE) or (CPD) is mandatory for the re-licensure of pharmacists. The World Health Organization (WHO) encourages the practice of continuing education for health professionals to meet education needs relevant to the evolving healthcare needs of their communities (WHO, 2013). Countries, including the United States and Australia, have established comprehensive continuing education or continuing professional development programs (Andreia et al., 2019). This is not the case in Belize as participation in continuing education activities is not mandatory for re-licensure. Healthcare professionals in Belize such as The Nurses and Midwives Council of Belize have mandatory 60 CE hours to complete in 2 years and the Belize Medical and Dental Association must do 24 CE hours per year to complete their registration.

The practice of Pharmacy is currently governed by The Chemist and Druggist Act, Chapter 311 of the Laws of Belize, Revised Edition 2000 which states that persons meet the requirement for registration if they lawfully hold a Diploma or Certificate from a pharmaceutical school that has been recognized by the Board of Examiners. The Board of Examiners must then examine the candidate. Persons who have successfully passed the examination are then issued a Certificate, which must then be presented, to the Registrar General to be registered under The Chemist and Druggist Act. No person can practise legally without being registered. There are currently no requirements for persons registered under this act to engage in continuing education activities in order to maintain registration status nor is there any regulatory body which organises or governs continuing education activities which are occasionally conduced. Because of

this, there are currently no guidelines for the delivery of, nor processes for, accreditation of, CE material. The activities are not assessed for correctness and effectiveness.

Objectives

The objectives of this study were to evaluate continuing education practise among pharmacists in Belize as well as to explore their attitudes towards and needs impacting continuing education.

Problem statement

Many countries around the globe have established a comprehensive continuing education or continuing profession development program for pharmacists. An approximate 24.3% of countries have made the practice of engaging in continuing education or continuing professional development mandatory for the relicensure of pharmacists (Chan & Wuliji, 2006). This is the case for many countries in the Caribbean region including Jamaica (Pharmacy Council of Jamaica, 2007) and the Bahamas (The Pharmacy Act, 2009); however, this is not the case in Belize.

Research questions

1. Do pharmacists in Belize currently participate in continuing education activities?
2. What are some factors that influence participation in continuing education activities among pharmacists in Belize?
3. What are the attitudes and beliefs of pharmacists towards the implementation of a continuing education Program?
4. What factors would encourage pharmacists in Belize to participate in a continuing education program?
5. What are the learning preferences of pharmacists to be addressed by a Continuing Education Program?

Significance of the Study

The findings of this study will be of great value to the community of pharmacists in Belize, particularly to the Pharmacy Association of Belize as well as the Pharmacy Department within the Ministry of Health as they seek to improve

the continuing education efforts and possibly develop a structured continuing education program for pharmacists. The research will investigate the current level of participation in CE activities as well as the overall attitudes, beliefs and factors affecting pharmacists' attendance at CE sessions. The information gained in this research will assist in designing and implementing a practical continuing education program that will meet the needs of all pharmacists.

Methodology

Study Design and Participants

This research study followed a mixed-methods convergent design that aimed to collect qualitative and quantitative information simultaneously in the form of a focus group discussion and questionnaire survey. The population studied was registered pharmacists who were actively working in Belize, in at least one practice setting including hospitals, community pharmacies, drug distribution, education, management, and policy development at the Ministry of Health. The population size was 159 pharmacists. A sample size of 60 was calculated using the Raosoft® Sample Size Calculator software with a margin of error of 10 and a confidence level of 95%. Only pharmacists whose names appeared on the Chemist & Druggist Register[4] and the Ministry of Health's List of Licensed Pharmaceutical Establishments[5] were included in the study.

The study utilized an online questionnaire with twenty-three open-ended, closed-ended, and Likert-scale type questions to gather quantitative data. The questionnaire was pretested by 5 pharmacists. Those involved in pretesting the questionnaire and who participated in the focus group discussion were excluded from responding to the questionnaire. The survey instrument was distributed to 135 pharmacists. Seventy-three persons responded to the survey.

The focus group interview involved eight open-ended questions with a duration of eighty minutes. A guided discussion related to the need for continuing education and a lack of continuing education programs was completed involving 6 pharmacists from 5 areas. These were the education sector, the Ministry of Health, community pharmacy, hospital pharmacy, and the Pharmacy Association of Belize.

Data Analysis

The quantitative and qualitative data were analyzed by the Statistical Package

for the Social Sciences (SPSS) version 23 and NVIVO 12 Pro respectively. Cross tabulations were used to describe the participants by gender, age, marital status, academic qualifications, years of practice, practice setting, districts, and the effect of their participation in CE sessions. Frequency tests were also used to determine whether pharmacists actively participated in CE activities, the attitudes, and needs of pharmacists in Belize regarding CE as well as factors that influence participation in CE activities. Kruskal-Wallis ANOVA test was used to compare the means to examine if there were any differences in the demographic data.

The study was approved by the Research Ethics Committee at the University of Technology, Jamaica and the Ministry of Health, Belize.

Results

Summary of Survey Findings

Demographic data

The study was conducted to determine the practices, attitudes, and needs of pharmacists in Belize as they relate to continuing education. A total of 159 pharmacists were enrolled on the list provided by the Ministry of Health, Belize and Chemist and Druggist Register as of 2019 (N= 159). Eighty-five percent (85%, 135) of the total population was surveyed using an electronic instrument. A response rate of 54% was obtained from the sample population (N=73). Among these 73 respondents, there were 28 (38%) males and 45 (62%) females.

Table 1*:* Academic Qualifications of Respondents

Academic Qualifications	Male	Female	Total (n %)
Associate Degree	21	28	49 (67.1)
Bachelor's degree	7	17	24 (32.9)
Total	**28**	**45**	**73 (100)**

Table 1 depicts the academic qualification of the respondents with 67.1% of respondents having an Associate Degree. The remainder of the respondents (32.9%) held a bachelor's degree. Less than fifty percent (37%) of the respondents had been practising as licensed pharmacists for 6–10 years. Of the seven areas where pharmacists practise, most pharmacists (65.8%) practised in private sector community pharmacies. Others were deployed in primary, secondary,

and tertiary healthcare; wholesale and distribution; pharmacy administration; and pharmacy education.

Table 2: Cross Tabulation between Having Attended a Continuing Education Session and How Often This is Done

Numbers of continuing education sessions attended	Number of Participants (n, %)
Less than once yearly	22 (30.1)
1–3 sessions per year	24 (32.9)
4–6 sessions per year	3 (4.1)
9 or more sessions per year	1 (1.4)
No sessions attended	23 (31.5)
Total (N)	**73 (100)**

Table 2 indicated that more than 50 percent (68.5%) of the participants attended continuing education sessions, whereas 23 (31.5%) never attended a CE session. Of those who attended, 24 (32. 9%) attended 1–3 sessions annually and 22 (30.1%) attended at least one session annually.

Table 3: Preferred Time for Attending Continuing Education Sessions

	n	(%*)
Weekdays (8 am–5 pm)	33	45%
In the Evenings	32	44%
On the Weekends	37	51%

****Respondents were allowed to select multiple responses*

As displayed in Table 3, the most popular time for hosting continuing education sessions among the participants was weekends (n=37, 51%) however, there was not much difference between those who preferred weekdays (8 am–5 pm) and evenings (n=33, 45%, and n=32, 44% respectively).

Most of the participants had an interest in Pharmacovigilance (Monitoring & Reporting Adverse Effects, (75%), Disease Management, and Pharmacy Management (61%). Less than 30% of participants were interested in Pharmaceutical Calculations (28%) as seen in Table 4.

Table 4: Area of Interest for Continuing Education Session

	n	(%)
Pharmacovigilance (Monitoring & Reporting Adverse Effects)	53	75%
Pharmacology	47	66%
Disease Management	43	61%
Pharmacy Management	43	61%
Pharmacy Law	37	52%
Pharmaceutical Care Process	36	51%
Pharmacokinetics	32	45%
Pharmaceutical Calculations	202	8%
Other	2	3%

***Respondents were allowed to select multiple responses*

Table 5: Cross Tabulation between Engaging in Other Practices to Keep Up to Date with New Information and Mediums Used.

	n	%
Reading newsletters and/ or medical journals	53	91.40
Enrolling in an accredited online CE course	7	12.10
Participating in online pharmacists' forums	12	20.70
Browsing the internet for information	53	91.40
Participating in local and regional Health Conferences	22	37.90

****The respondents were allowed to choose multiple answers*

As shown in Table 5, of the 58 pharmacists who responded to this question over 90% (53, 91%) of the Pharmacist were engaged in reading newsletters and medical journals to remain informed of new information related to pharmacy practice and browsing the internet for information respectively. The remaining participants were engaged by participating in local and regional health conferences (37.9%) participating in online forums (20.7%), and enrolling in accredited online CE courses (12.1%).

Table 6: Attitude & Belief towards Continuing Education and Mean Attitude Scores

Variables	N	Strongly Agree	Agree	Neither	Strongly Disagree	Disagree	Mean	SD
		5	4	3	2	1		
Attending CE sessions are an excellent way to update my professional knowledge & skills	73	43 58.9%	29 39.7%	1 1.4%	0 0%	0 0%	4.58	0.525
Attending CE sessions are essential to improving my professional practice	73	39 53.4%	30 41.1%	4 5.5%	0 0%	0 0%	4.48	0.603
CE attendance results in increased confidence in pharmacists by other health care professionals	73	30 41.1%	33 45.2%	9 12.3%	0 0%	1 1.4%	4.26	0.727
CE sessions attendance is an excellent way of building and maintaining a professional network	73	39 53.4%	31 42.5%	3 4.1%	0 0%	0 0%	4.49	0.58
I feel I should attend more CE sessions than I currently do	73	34 46.6%	26 35.6%	13 17.8%	0 0%	0 0%	4.29	0.754
Participation in CE sessions would improve patient outcomes	73	31 42.5%	33 45.2%	9 12.3%	0 0%	0 0%	4.3	0.681
Pharmacists must make sufficient time to engage in CE sessions	73	26 35.6%	35 47.9%	11 15.1%	1 1.4%	0 0%	4.16	0.782
Engaging in CE activities will make pharmacists more confident in their approach to patients	73	33 45.2%	34 46.4%	6 8.2%	0 0%	0 0%	4.37	0.635
CE should be undertaken by pharmacists without additional pay	73	11 15.1%	33 45.2%	22 30.1%	0 0%	7 9.6%	3.66	0.853
There is a need for a structured CE program for pharmacists in Belize	73	50 68.5%	21 28.8%	2 2.7%	0 0%	0 0%	4.66	0.533
The attendance of CE sessions by pharmacists should be made mandatory	73	17 23.3%	26 35.6%	20 27.4%	1 1.4%	9 12.3%	3.67	1.015
Pharmacists who do not participate in a CE should be removed from the Chemist and Druggist register	73	6 8.2%	9 12.3%	32 43.8%	12 16.4%	14 19.2%	2.77	1.124
Attendance of CE sessions results in increased self-actualization	72	24 32.9%	36 49.3%	9 12.3%	0 0%	3 4.1%	4.13	0.786

Respondents were allowed to select multiple responses

Table 6 shows that more than half of the participants mentioned that attending these sessions was an excellent way of updating their professional skills and improving their professional practise (N=43, 58.9%) and (N=39, 53.4%) respectively. For the variables considered in the study, most participants indicated that they strongly agreed with most of the variables except for three variables: (1) CE should be undertaken by pharmacists without additional pay (N= 11,15%), (2)The attendance of CE sessions by pharmacists should be made mandatory (N= 17, 23.3%) and (3) Pharmacists who do not participate in a CE should be removed from the Chemist and Druggist register (N= 6, 8.2%).

Factor analysis was performed by combining Likert items from the attitudes towards continuing education sessions section of the survey to determine the loading of variables to form different areas of analysis. From the initial analysis, 3 factors or components with Eigenvalues >1 were identified which could be grouped as attitudes towards the benefits of continuing education, pharmacists' belief in the seriousness of participating in the continuing education sessions, and finally their belief in the extent of their responsibility to absorb the costs associated with participating in the continuing education sessions. These three factors explain 63.067% of the variance in responses. Parallel Analysis was done to determine if the three components should be accepted as non-random and reliability tests were conducted to determine the validity of the loading results. Cronbach alpha values of 0.880, 0.696, and 0.538 were obtained. To conclude, the reliability of the factors $\alpha \geq 0.70$ hence subsequent analysis indicated three variables were to be removed. These were the need for a structured continuing education program for pharmacists in Belize, attending the continuing education sessions without pay and more frequently. The 10 variable factor analysis consisted of 2 significant factors, explained 62.273% of the variations in responses, and had reliability measures of 0.88 and 0.707. It can be concluded that the factors influencing participation in continuing education activities among pharmacists in Belize are related to the benefits of the programs and the gravity of repercussions for not participating in the continuing education sessions.

As depicted in Table 7 a Kruskal-Wallis ANOVA non-parametric test was conducted to determine if there were any significant differences in attitudes towards continuing education sessions among the different age groups. The analysis found that the null hypothesis of attitude scores being the same across all age groups could be rejected. The pairwise analysis further indicated that there was a positive and significant difference in the attitude of persons aged 18–25 when compared with their pharmacy counterparts aged 26–30.

Table 7: Factors Affecting Participation in Continuing Education Sessions Kruskal-Wallis ANOVA for Age vs Attitudinal Scale

Age	N	Mean	Std. Deviation		Age		Df	Significance Level
18–25	13	4.3615	0.3641		18–25	26–30	1	0.007*
26–30	29	3.9586	0.5220		18–25	31–35	1	0.087
31–35	12	4.0556	0.4979		18–25	36–40	1	1
36–40	12	4.3167	0.4933		18–25	41–45	1	1
41–45	4	4.275	0.3096		18–25	46–50	1	0.678
46–50	3	3.9333	0.7638		26–30	31–35	1	1
					26–30	36–40	1	1
					26–30	41–45	1	1
					26–30	46–50	1	1
					31–35	36–40	1	1
					31–35	41–45	1	1
					31–35	46–50	1	1
					41–45	46–50	1	1

Emergent Themes from Focus Group Discussion

Thematic analysis was employed to summarize information from the focus group discussions. Table 8 summarizes the emergent themes.

Table 8: Factors Affecting Participation in Continuing Education Session

Thematic Categories	Sub-categories
Lack of Structured CE Program	• Lack of Participation • Inconsistent Occurrence • Lack of a Credit Based System
Need for CE's	• Wealth of information available • Changing roles of pharmacists • Valuable member of the health care team • New technologies for treating diseases
Current CE Practices	• Open Invitation • Online CE activities • In house CE activities
Mandatory CE's	• Credit-Based • Legal framework • Requirement of re-licensure • Coordinated by a Pharmacy Council

Barriers to CE Participation	• Lack of time • Lack of motivation • Financial constraints • Lack of political will
Enablers to CE Participation	• Different Venues • Various Methods of Delivery • Offering a Variety of Topics • Self-Growth and Self-Actualization

Six participants were included in the focused group discussion. The emerging themes from the discussions are displayed in Table 8. Discussions revealed that CE sessions organized by the Pharmacy Association of Belize were drastically reduced over the two years prior to the study. It was further revealed that when CE sessions occurred in the past, there was no curriculum nor was there a credit-based system to ensure that sessions were effective in meeting the needs of pharmacists.

The most prevalent theme that emerged during the focus group discussion was the need for mandatory CE activities among pharmacists in Belize. It was the consensus however that the only way to ensure participation in CE activities would be to make it mandatory. It was expressed that the council should be responsible for evaluating and certifying CE sessions. They should be responsible for examination, reregistration, and monitoring of ethical and other issues within the practice.

Nonetheless, there were barriers to participation including lack of motivation, lack of time or inconvenient times, and financial constraints. Additionally, there was a convection among some people that it is better for them to open their own business and make money instead of going to a CE session. It must be mentioned that during the discussion, it was also noted that even when CE sessions were free of cost, they were still generally poorly attended.

Enablers to CE participation appeared to be self-motivation, self-growth, and self-actualization to learn topics germane to pharmacy practice in Belize including antibiotic resistance patterns, and public health issues such as lice infestation among school children. Strategies which will encourage participation include changing venues for face-to-face sessions, making CE activities available through various delivery modalities, and offering a variety of topics.

Discussion

The study indicated that 68.5% of respondents had been engaged in at least one continuing education session within their professional career and that most respondents attended 1-3 sessions per year. This is slightly lower than the reported 70% of Kuwaitian pharmacists and 90.4% of English pharmacists who had attended a CE session with one year of previous studies.[6,7] A likely reason for this is less opportunity for continuing education activities among pharmacists in Belize. This study informed that in recent years the opportunities for continuing education sessions (hosted by the Pharmacy Association of Belize) have significantly decreased. Between 2017 and the time of this study in 2019, there were no formal continuing education sessions.

In assessing attitudes and beliefs towards continuing education, it was found that 94.5% of the respondents believed that attending CE sessions is essential to improving professional practice. A study conducted among pharmacists in Northern Ireland indicated similar findings with 84% of their participants having a positive attitude towards continuing education.[8] Similarly, among laboratory technicians in Canada and nurses in Greece, a positive attitude was seen towards continuing education; 97% and 86.2% respectively.[9,10]

Acknowledging the beneficial role of continuing education, 97.3% or respondents agreed that there is a need for a structured continuing education program; however, only 58.9% supported a mandatory continuing education program for pharmacists. It was suggested that as opposed to sanctions for non-participation in CE's, there should be a culture of incentivizing the process.[9] Nonetheless, the focus group discussion revealed the contrary; The group concluded that unless sanctions are imposed, uptake for CE sessions will remain low. This recommendation was supported by the results of the factor analysis which revealed that the gravity of repercussions for not participating in the CE sessions would be a major factor influencing participation. The group also strongly supported the establishment of a Pharmacy Council, which would have the responsibility of assessing and accrediting CE activities. Noteworthy, this is the practice in several Caribbean nations, including Jamaica and the Bahamas (The Pharmacy Council of Jamaica, 2007; The Pharmacy Act, 2009).[11,12]

As observed in two other studies, workload and cost constraints were found to be major barriers to CE participation.[13,14] As a result, greater employer support and distance learning opportunities are expected to act as enablers to participation. Unlike previous studies which found CE topics of interest to be pharmaceutical care,[15,16], this study indicated that pharmacovigilance was

of greatest interest. A possible explanation for this is the recent launch of the Noti-Facedra Online Notification System, an electronic form for reporting suspected adverse drug reactions in Belize. This demonstrates the need to ensure that CE topics are relevant to the Belizean context with a global significance in addressing emerging pharmacy practice.

Limitations

In ascertaining the study population and by extension the sample size, the document included persons who were possibly not registered. The questionnaire was self-administered through an online format; therefore, there was an opportunity for response bias. Attitudinal bias may have been present since the sample was selected using a convenience sampling method. Additionally, the research did not analyze the responses based on gender or practice setting and thus could not capture differences in challenges and attitudes expressed by each group. Generalization of the results would not be possible due to several factors including lack of data, non-representative sample size, and the inability to reduce inherent biases in this study.

Conclusions

The objective of this research was to explore the practices and needs of pharmacists in Belize and their attitudes towards continuing education. The data collected suggest that pharmacists desire to engage in CE activities. They are therefore likely to benefit from increased investment in CE opportunities and options. Organizers of such CE activities should strive to overcome barriers to participation such as time constraints due to work, cost, and travel. As such, CE activities can be offered via a variety of formats, including distance learning and face-to-face modalities, and should offer a variety of topics that are relevant to the Belizean context.

The research also revealed challenges to the introduction of IC within the profession such as a lack of motivation and political will to move the profession forward. As such, there is a strong recommendation for the establishment of a Pharmacy Council in Belize, the establishment of a comprehensive Chemist and Druggist register, the implementation of a structured CE program with mandatory participation for re-licensure, and an increase in activities by the Pharmacy Association of Belize, the Professional Body that oversees the profession.

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The Impact of Email on the Productivity of Staff Members in Higher Education Institutions (HEIs) in Jamaica

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Abstract

The convenience of email has resulted in productivity gains, but unwanted emails has led to productivity losses. Email is considered the most satisfactory tool and an inexpensive mode of communication for sharing information and knowledge. Within Higher Education Institutions (HEIs) the impact of email on the productivity of staff should be investigated, understood and managed. This study sought to analyse the impact of email on HEI worker productivity levels and examine the factors influencing email turnaround time for HEI workers. A convergent nested parallel mixed methodological approach was used which involves the simultaneous collection of qualitative and quantitative data, followed by the combination and comparisons of these multiple data sources. An online instrument was developed and emailed to 93 academics, administrative, ancillary, and technical staff of selected HEIs. Nineteen participants were interviewed and transcripts of the interviews were analysed for themes. Most respondents (62.6%) checked email during work hours; did not have a set time to check emails (72%); highly rated their productivity level (82%); spent an average of 3.4 hours per day reading and replying to emails; used laptop and desktop computers (73.5%); and employed an email response strategy (49%). The results provide evidence that the difference between the medians of email checking frequency per day between administrative and academic staff is statistically significant. A deliberate

culture change in email management is recommended for HEIs to maximise worker productivity and organisational efficiency.

Keywords: Email, Productivity, Higher Education Institutions (HEI), Technological Modes of Communication.

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Introduction

Electronic mail (email) is the most common form of communication in business and academia supplanting regular mail. The ease with which email is distributed has resulted in a plethora of emails entering the cyber inbox of recipients. It is hardly likely the same would have happened if the traditional physical mail was delivered to individuals. The excess unwanted mail is termed junk mail, and the propensity of this happening in our current work environment has resulted in productivity gains as well as losses.

Within Higher Education institutions (HEIs), email is recognised as an official means of communication. The traditional use of memoranda, posting messages on notice boards, or placing letters in pigeon/letter boxes are now an anachronism. This is even more pronounced recently as higher education work is done in increasingly remote or virtual spaces.

According to The United Nations Education Cultural and Scientific Organization (UNESCO), the higher education space has grown dramatically over the past decades in terms of enrollment, student activity, diversity, student provision, research dynamic and teaching (UNESCO, 2023). Understanding the impact of email on the productivity of the HEI worker in this dynamic environment is therefore important in developing approaches necessary to use and manage this now ubiquitous mode of communication. The impact of email on the productivity of the HEI worker as a population has not been studied and little is known about this communication tool on this category of worker.

This study sought to:

1. Analyse the impact of one technological mode of communication (email) on HEI worker productivity levels,
2. Examine the factors impacting email turnaround time for various HEI worker categories.

Literature Review

In 1971, the first text-based message was sent via a computer from one user's electronic account to another (Russell, 2017). Email has evolved as the most widely used information system in organizations and many organizations are now dependent on the use of emails (Ambra & Vantoorn, 2007). According to the socio-material approach (Mano & Mesch, 2010) technology does not exist in a vacuum. Its application and use represent the reciprocal relationship between the functionality of the technology system, its design limitations and how it is translated and adopted by individuals in pursuit of their goals within any work context (Russell, 2017). The need for efficient but inexpensive modes of communication, for sharing information and knowledge, generates increased electronic interaction (Gupta, Karimi & Somers, 2000) of which email is considered the most satisfactory tool (Davenport & Prusak, 1998).

In their meta-analysis, Nicholas & Watts (2005) identified three metaphors that have guided email research, namely: email as a file cabinet that extends human information processing capabilities, email as a production line and locus of work coordination, and email as a communication genre supporting social and organizational processes.

Nicholas & Watts noted that the research on email as a communication tool is now focussing on the malleability of the medium in terms of its features and use for organizational purposes and that this type of research is confined to the fields of organizational studies and information systems research.

Today, email communication has been firmly integrated into our daily (work) life (Turnage & Goodboy, 2014) and email communication studies have aroused both praise and query regarding the suitability, appropriateness, and effectiveness of electronic messaging information management (Mano & Mesch, 2012). Only a few have the discipline to structure the day in such a way that they plan fixed times to deal with email. The answering of emails is rarely part of job descriptions, but more of an underlying assumption of the functioning in present organizational life (Derks & Bakker, 2010).

Email Communication in Academia

Employee abuse of email technology has been documented along with increases in electronic business activity and the use of email systems. Virus infection arising from email use and deliberate abuse of email facilities are the leading causes of security breaches, suggesting poor controls and policies that govern

email use (Jackson et al. 2003). Almost a decade ago, email systems constituted the main communication method of electronic learning in academia and was considered an emergent strategic business tool (Alturise et al. 2014).

A study by Gillespie et al. (2001) reported that stress levels for academic staff increased over the years due to insufficient funding and resources; work overload; poor management practice; job insecurity; insufficient recognition and reward; information overload due to an increasing amount of electronic mail coupled with the expectation to respond immediately.

Studies of communication through email has raised interest and questions about the adequacy and effectiveness of electronic messages for information management; yet, little is known about the effects of email on work performance (Mano & Mesch, 2010). In an exploratory study of a HEI involving 23 participants, Chase & Clegg (2011) examined the impact of email as a primary communication technology upon the perceptions and work behaviours of higher education professionals who support university administrative functions. They presented their findings on its impact on productivity, social interactions, and well-being. Among the results found was the recognition of the need to manage email sender expectations to deal with their own work stresses, and to temper the negative impact of constant disruption by email on workplace productivity.

The psychological implications of email

Very early in the development of email, Robey (1979) suggested that the psychological implications of email be studied. Alturise et al. (2014) recommended that future research should try to identify the determinants of appropriate behaviours in what concerns the use and management of emails in the work context. An exploratory study done by Williams et al. (2019) on 111 undergraduate students, it revealed that students were able to perceive spam emails in their inboxes and make a decision about them. In 2016, the British Psychological Society's Division of Occupational Psychological Annual Conference researchers reported that email pressure can substantially impact psychological health (The Complementary Medical Association, n.d.).

Newport (2015) posited that the email productivity curve demonstrated a bipolar [sic] reaction to email which is referred to as oddly mixed. Newport observed that when no email is used, productivity is still positive since companies can still produce without digital communication. As email usage increases, productivity increases, reaches a maximum and then declines. Productivity reaches zero when there is nonstop email activity, and no time is left for actual

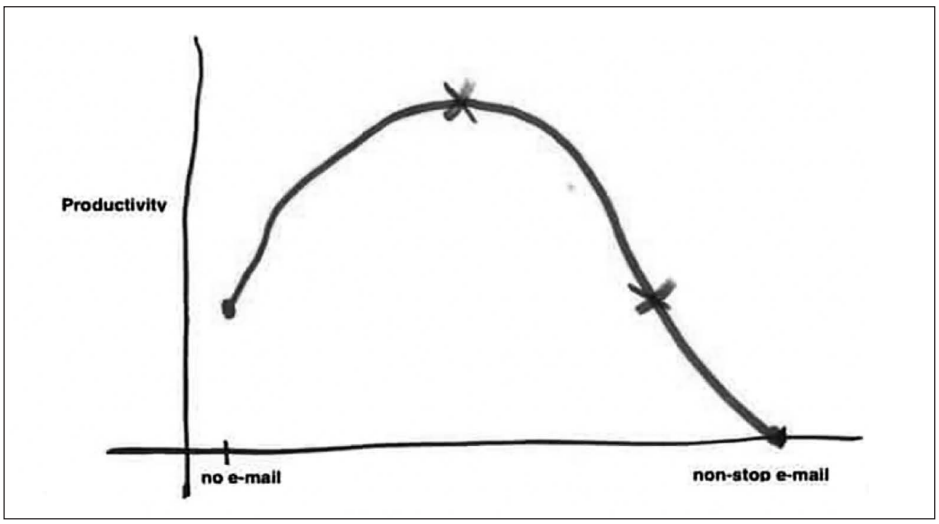

Figure 1. The Email Productivity Curve *Source: (Newport, 2015, p. 1)*

work. Hence the dichotomy of email being either good or bad for productivity (See Figure 1). One possible explanation could be that email has a prevalent cost, it does not provide an inbox structure that facilitates prioritization, information structuring and workflow management (Szostek, 2011).

It can be concluded that email communication is a necessity for the current work environment and has a positive and negative impact on productivity. Previous research done by Sir Cary Cooper, Professor of Organizational Psychology and Health points to the extreme relationship between emails and productivity and his observation showed that male toxicity/bravado increased as they wanted to be seen as being available at all times. (Kelion, 2015). The state of knowledge on email usage is ambiguous and conflicting (Markus & Robey, 1998; Orlikowski, 1992 as cited by Nicholas & Watts, 2005) and the nature of the impact of email on productivity should therefore be examined in HEIs in terms of how employees manage their response to emails.

Methodology

The researchers utilised a convergent nested parallel mixed methodological approach (Creswell & Plano Clarke, 2011; Ziegler 2014) as detailed in Figure 2. This approach involves the simultaneous collection of qualitative and quantitative data, followed by the combination and comparisons of these multiple data sources (i.e., the two methods are ultimately merged). In the research

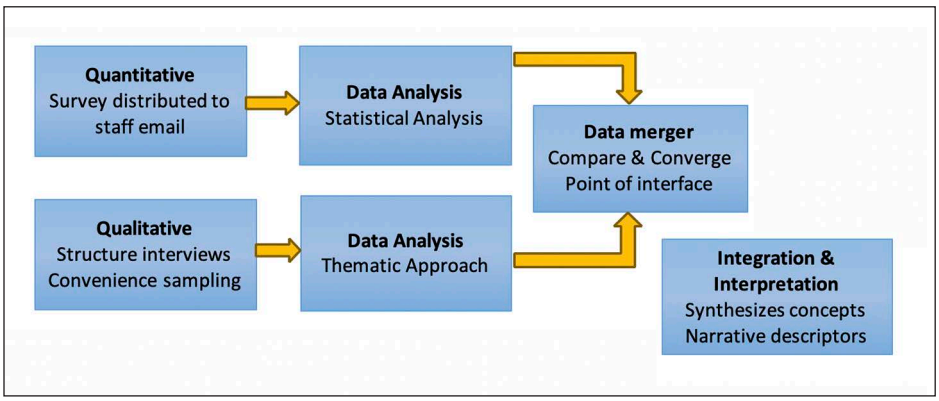

Figure 2: Convergent Parallel Mixed Methods Design

process, two datasets have been obtained, analysed separately, and compared (Pismek & Demir, 2018; Tomasi & Gates, 2019).

Quantitative Approach

An online instrument was developed using Google Forms, and the URL link was circulated primarily via email to members of the selected HEIs. The staff union WhatsApp groups are subsets of the target population for the study and an email reminder was sent 12 days afterwards as a secondary follow-up strategy. The researchers asked the union leaders to share the Google Forms instrument link only to their members. The period of survey distribution and data collection through Google Forms spanned 19 days. Participants were not given the privilege to edit their responses or review the summary of their results after submission.

There were 29 close-ended, non-compulsory items of which eight were demographic. The other 21 questions sought to determine the extent to which work emails were managed in terms of frequency of check, response, device used, availability and location of internet access. There were 3 five-point Likert Scale statements and five open-ended questions which sought to determine the impact of email communication on productivity level, job performance, and the strategies used for increasing the email response rate.

The quantitative data was analysed with Pareto analysis, descriptive and inferential statistical measures employing Microsoft Excel. According to Nachar (2008), the Mann-Whitney U test [an inferential statistical measure] is a non-parametric test that stipulates that two independent groups from the same population are homogeneous and have the same distribution.

The nested qualitative questions in the questionnaire provided an explanation of how productivity affected performance. The qualitative data were collected and analysed using the thematic approach. The quantitative and qualitative results were analysed independently and the point of integration occurred during the analysis of the results.

The population of 1,342 workers drawn from public HEIs operating within the metropolitan region of Jamaica serving over 15,000 students consisted of 527 academics, 511 administrative, 163 technical, and 141 ancillary staff. These HEIs offer undergraduate and graduate degree programmes in areas including business, management, sciences, and engineering.

The recommended sample size was 90 with a margin of error of +/- 10% and a confidence interval of 95%. There were 93 participants representing 3.33% above the recommended sample size resulting in an actual margin of error of +/- 9.807%. This sample represented 7.0% of the target population.

Qualitative Approach

Structured interviews were administered to 19 purposefully selected participants whom the research team believed used email extensively due to their job functions and responsibilities. According to Hennink and Kaiser (2022), the effective sample size for qualitative research for a narrow range of interview is from 9 to 17 when assessing saturation. The sample size for the qualitative component was adequate and above the maximum range. The researchers confirmed that the selected participants for the interview did not participate in the online survey. One member of the research team with the requisite training conducted all interviews to ensure consistency in the administration of the interview. To minimize bias, the selected participants had no reporting or supervisory relationship with the interviewer and other members of the research team. Persons were selected from four categories, academic (n = 6), administrative (n = 8), technical (n = 3) and ancillary (n = 2). All interviews were conducted within a one-week period. The duration of the interviews was between 20 to 30 minutes. Transcripts of the interview responses were analysed for themes.

Results

Profile of survey respondents

Ninety-three respondents participated in the survey. Sixty-one percent (61.3%) were 40 years old and over, while the age range 35–39 had the largest number (18.3 %, n = 17).

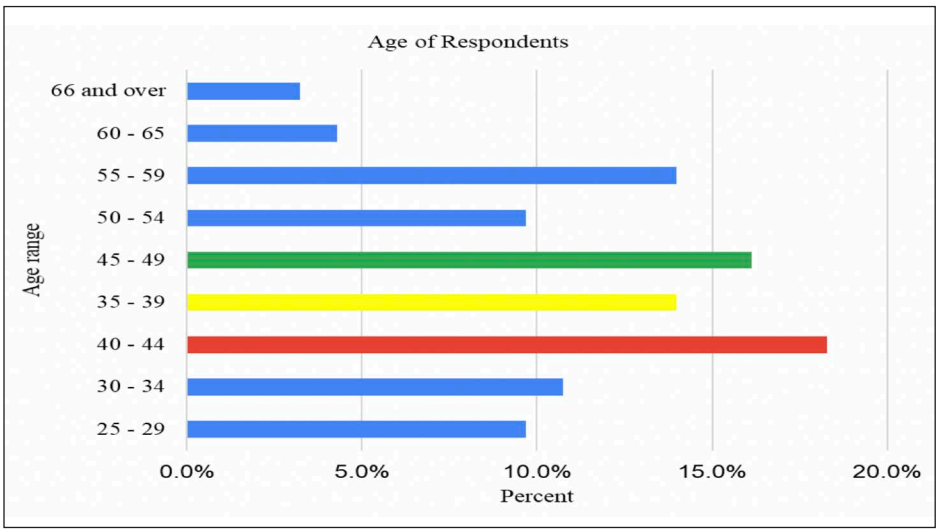

Figure 3: Age of Respondents

Table 1: Tertiary Institution of Employment

Tertiary Institution	(n)	Percent
Institution A	10	10.8
Institution B	80	86.0
Other	3	3.2
Total	**93**	**100**

A significantly large portion (86%, n = 80) of the respondents were employed at Institution A and 10.8% (n = 10) were employed at Institution B; the other (3.2%, n = 3) were affiliated with a HEI in the United Kingdom as illustrated in Table 1.

Figure 4 indicates that one-third of the respondents were lecturers, a little less than a quarter (23.7% n = 22) were administrative staff and 10.8% (n = 11) were senior lecturers. About 1 in 10 (9.7%, n = 9) were technical staff and

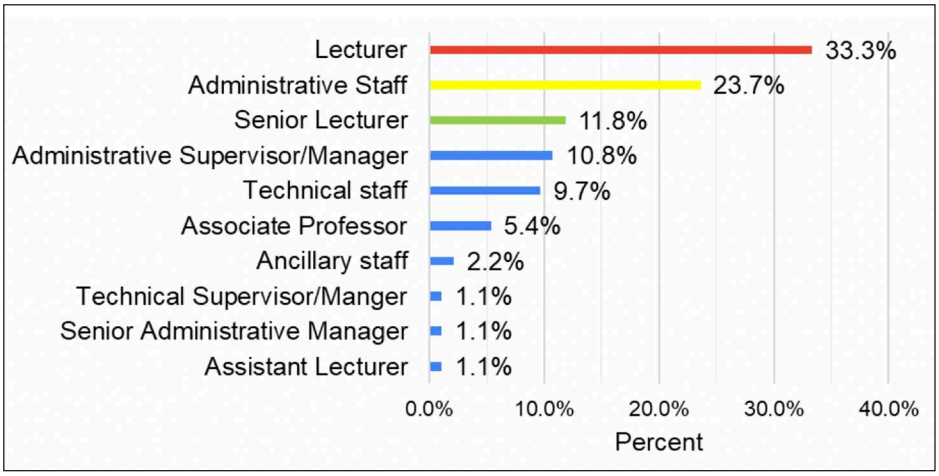

Figure 4: Survey Respondents' Employment Rank or Level

approximately 1 in 5 were associate professors. The other 5.4% were ancillary staff (n = 2), senior administrative manager (n = 1), and assistant lecturer (n = 1).

Quantitative Response

The Pareto chart in Figure 5 indicates that of the 71 respondents to the question on having set times for checking work emails, approximately 8 in 10 (79.3%) of

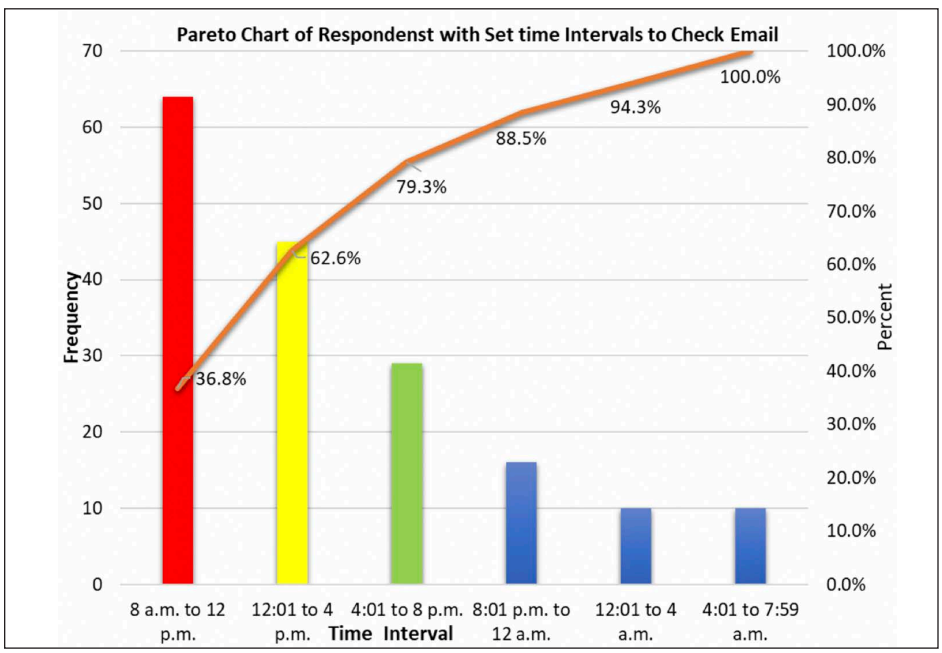

Figure 5: Pareto Chart of Respondents with Set Times to Check Emails

the respondents checked their emails between 8:00 a.m. and 8:00 p.m. during typical workdays, with a majority of 36.8 % (n = 64) checking between 8:00 a.m. and 12:00 p.m., 25.9% (n = 45) checking between 12:01 p.m. and 4:00 p.m., and 16.7% (n = 29) checking between 4:01 p.m. and 8:00 p.m. The remaining 1 in 5 (20.7%) checked their email between 8:01 p.m. and 7:59 a.m. Twenty-two participants did not respond to this question.

Table 2: Email Checking Frequency Per Staff Group Per Day

Frequency	Staff Categories					Percent (%)
	Administrative	Academic	Technical	Ancillary	Sum	
Less than 5	3	21	6	1	31	33.3
5–9	6	18	3	1	28	30.1
10–14	6	4	0	0	10	10.8
15–19	5	1	0	0	6	6.5
20–24	6	1	1	0	8	8.6
> 25	7	3	0	0	10	10.8
Total	**33**	**48**	**10**	**2**	**93**	**100**
Percent (%)	35.5	51.6	10.8	2.2	100	

The email checking frequency per day per staff group as shown in Table 2, indicates that a little over half (51.6%, n = 48) were academics, (35.5%, n = 33) administrative, (10.8%, n = 10) technical and (2.2%, n =2) ancillary staff. The mean daily email checking frequency is approximately 8 (7.904, n = 83) with a standard deviation of 6.36 and the median frequency is 5 – 9 times daily. The median daily email checking frequency indicates that 3 in 10 persons check their email 5 to 9 times per day. Approximately 1 in 5 (19.4%, n = 18) checked their emails over 20 times per day which is less than 3 times in an 8-hour workday. The category with over 25 email frequency checks representing 10.8 % of the total respondents was not included in the determination of the mean and median scores because of the lack of a finite range for that group.

By excluding the frequency check of over 25 emails per day and comparing the administrative and academic staff categories. The question arises, is there a significant difference between the administrative and academic staff's daily checking email frequency? The results from the *Two-tailed Sample Mann Whitney U test* with settings of 5% significance level, 95% confidence interval and outliers' exclusion is shown in Table 3.

Table 3: Statistical Measures Comparing Administrative and Academic Staff Email Frequency Check Per Day

Statistics Measures	Administrative Staff	Academic Staff
Sample average	5.023	12.962
Standard deviation	3.299	6.785
U	930.5	187.5

The results further indicate that the *p-value* equals 0.000001504, which is less than 0.05. The test statistic Z is 4.8107, which is not in the 95% region of acceptance [-1.96, 1.96], and the U is 930.5 which is not in the acceptance region [407.85: 710.15]. The observed *standardized effect size* is 0.58. This value indicates that the magnitude of the difference between administrative and academic group sample size is large. The *observed common language effect* size is 0.83 which indicates that there is an 83% chance that the probability that a random value from the administrative group is greater than a random value from the academic group.

The Pareto chart in Figure 6 indicates that of the 93 participants, 89 responded to the question regarding preferred devices to check email, 73.5% preferred larger screen electronic devices i.e. Laptop computers (37.6%, n = 64) and desktop computers (35.9%, n = 61). The remaining 26.5% (n = 45) preferred checking their work email using mobile phones (22.4%, n = 38), tablet computers (3.5 %, n = 6) and smart watches (0.6%, n = 1). Four participants did not respond to this question.

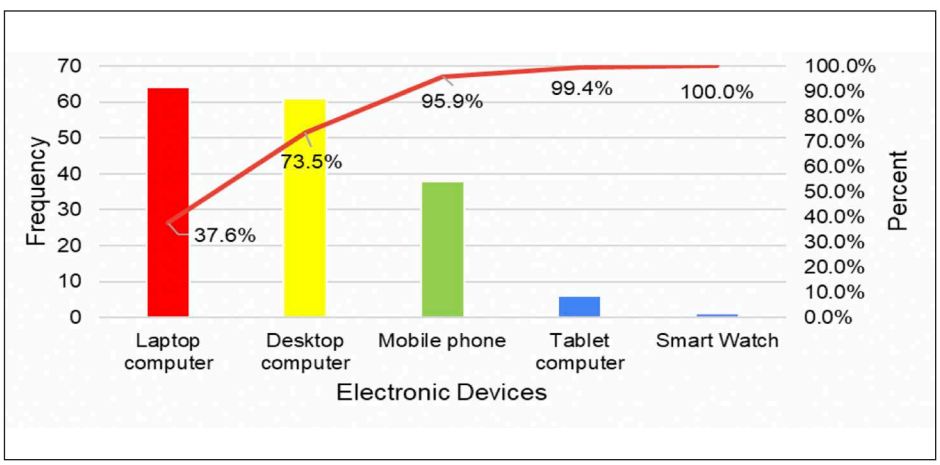

Figure 6: Pareto Chart of Respondents' Preferred Electronic Devices to Check Email

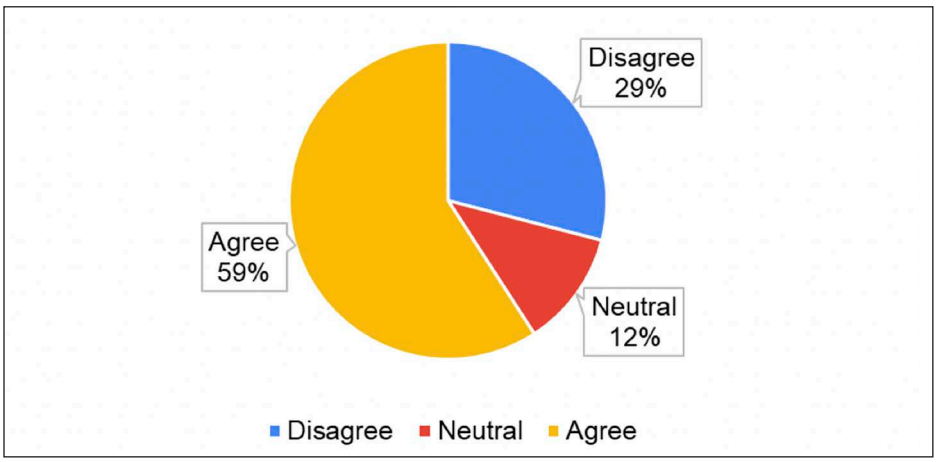

Figure 7: Availability of Internet Access and its Impact on the Ability to Respond to and/or Read Email

Availability of internet access affected 59% (n = 55) of the respondents and their ability to read and respond to emails as indicated in Figure 7. Notwithstanding, 29% (n = 27) of the participants disagreed that the availability of the internet was the cause for not reading or responding to emails, while 12% (n = 11) had a neutral response.

Figure 8 indicates that over 4 in 10 (44.1%, n = 41) participants had no internet problems over a 10-day work period. For those that had some challenges, 9.7% (n = 9) experienced internet challenges that exceeded a 24-hour period. Most internet challenges were less than 30 minutes and impacted approximately 1 in 5 (21.5%, n = 20) participants.

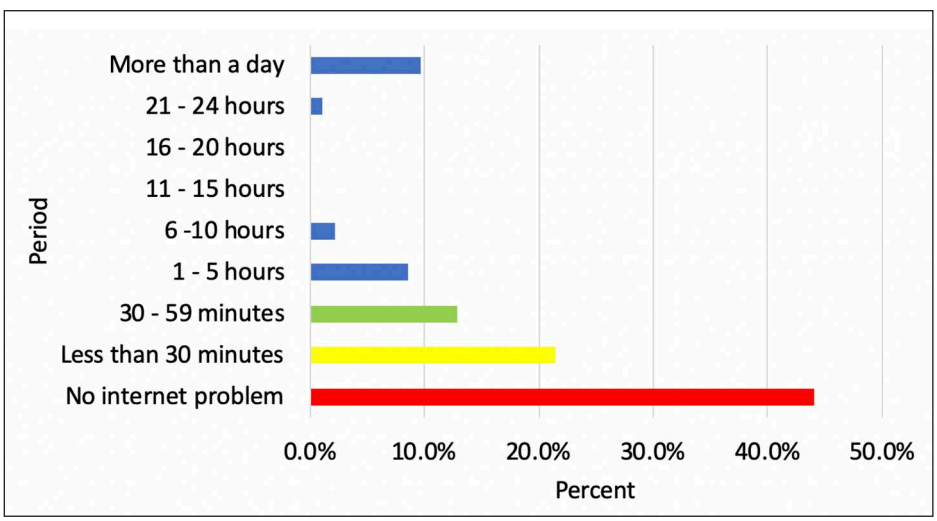

Figure 8: Estimated Time Respondents Were Unable to Access Work Internet Over 10 Days

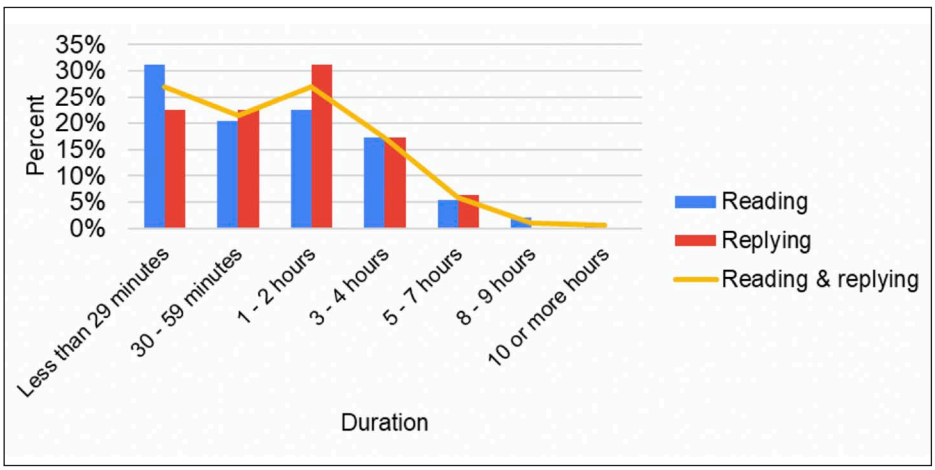

Figure 9: Estimated Amount of Time Respondents Read and Reply to Emails Per Workday

In Figure 9, of the 93 respondents, the mean duration for email reading and replying was 3.40 hours per day. The modal duration for reading emails was less than 30 minutes compared to 1–2 hours for replying. The median duration for reading emails was 30–59 minutes compared to 1–2 hours for replying.

In Figure 10, approximately 60% of the sample reported that both colleagues and supervisors responded to their emails within a 3-day period. However, approximately 1 in 4 (24.7%) reported that their colleagues or supervisors did not respond within the same period, while 15.6% were neutral in their responses. Supervisors are reported to respond to emails within 1-3 days in a greater proportion than colleagues do.

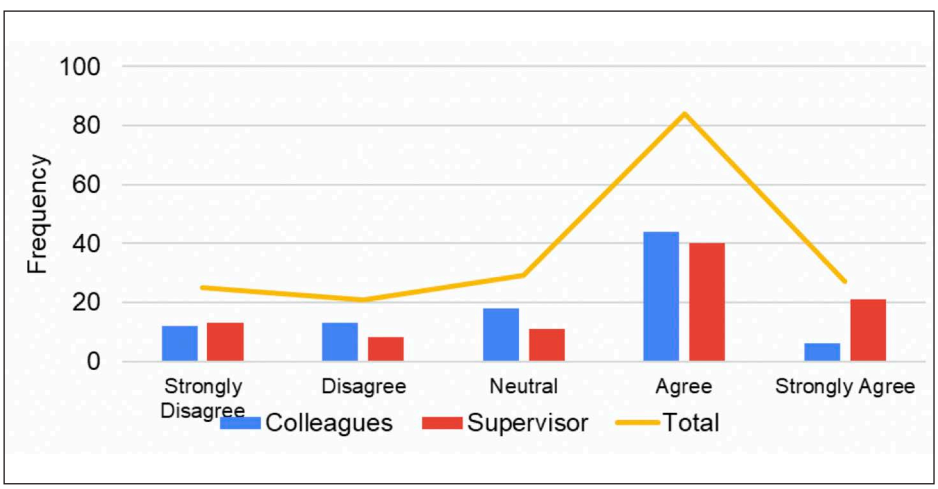

Figure 10: Colleagues and Supervisors' Response to Emails within 1–3 days

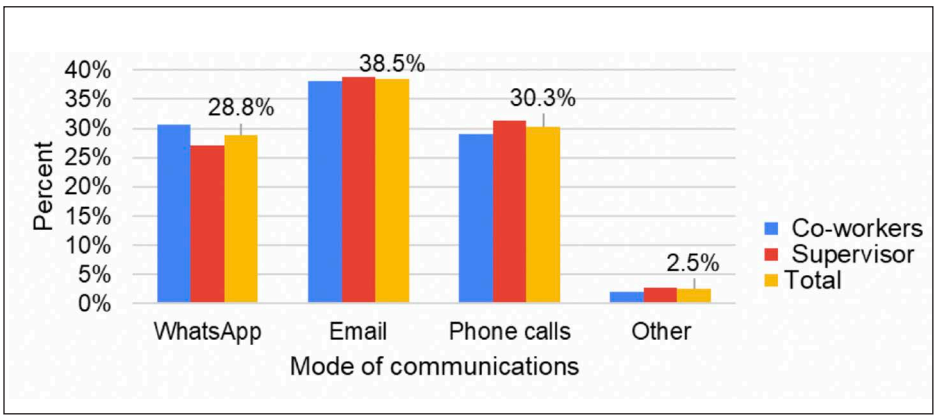

Figure 11: Respondents' Technological Mode of Communication with Co-workers and Supervisors

Figure 11 shows that the participants preferred mode of communication with their co-workers was email (38.5%), phone calls (30.3%) and (28.8%) preferring WhatsApp. A small number of respondents (2.5%) preferred face-to-face communication.

The morning was the most preferred time of day for respondents to read and reply to emails (39.8%) while 12.4% preferred the afternoon. However, 1 in 3 indicated no specific period to read and respond to emails (See Figure 12).

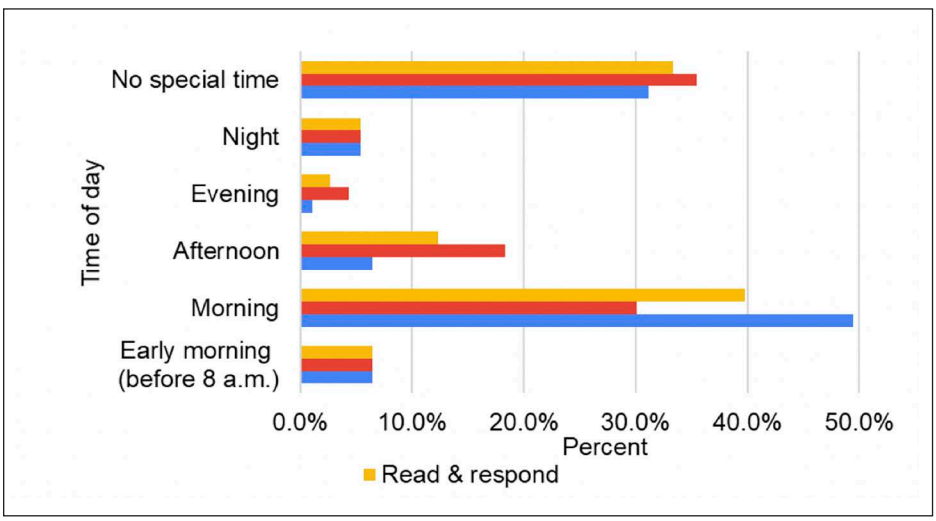

Figure 12: Time of Day Respondents Normally Read and Respond to Most of Their Emails

Nested Qualitative Response

A majority of respondents (70) believed that email communication had a positive impact on their productivity and was the best method to document communication. Nearly a quarter (22 of 93) of the respondents were of the view that email communication had a negative impact on their productivity. The latter respondents indicated that the attention given to answering emails reduced the time for other tasks. Other reasons given were that emails '*impair higher level work'* and that '*emails lacks (sic) detail'* and was a '*waste of time*'.

The impact of email on daily job performance was categorized as positive, negative and neutral. Of the 90 responses given, 62% were positive 21% negative and 17% Neutral. Almost half (47%) of the positive responses were confirmed with statements such as *"I am able to keep abreast of everything going on and respond accordingly. A record is always there whenever we need it to use as a reference"* and *"it is a medium that I use to disseminate messages and seek to obtain answers"*. One respondent acknowledged the usefulness of emails but wished that emails would *"break down sometimes."*

Respondents perceived the effect of emails on their personal productivity levels as either very productive, productive, unproductive, or unsure. There were 93 respondents where 29% perceived their personal productivity level as very productive, 53% as productive, 11% as unproductive, while 7% were unsure of the impact of email on their individual productivity level.

Respondents' perception of their colleagues' productivity levels differed with 6% seeing it as high, 40% as satisfactory, 15% as varying, 32% as low, and 7% as overwhelming low. Respondents mentioned that their colleagues needed to check their emails outside of office hours and that those colleagues who responded to emails within a day of receipt were more productive. Sixty percent of respondents believed that their colleagues' email response time needed to be improved.

Answering emails daily was the favored response given by respondents as a solution for email management (36%), this was followed by an email management system (29%) and then having more than one email account for different purposes. One person was not sure how to manage his/her emails and another believed prioritizing his/her email responses as a suitable management option.

Respondents employed a number of strategies to increase their email response rate. The largest proportion of respondents (49%) employed email management strategies which included the flagging of emails, responding to priority mail first, responding immediately, typing shorter responses, reading the emails

as soon as they are received, and receiving telephone alerts on email. Email follow up was done by 7% of the respondents and mention was made of follow up using social media and telephone calls. Twenty-four percent (24%) did not employ a response strategy. The respondents made no mention of automated email management tools as a strategy to increase their email response rate.

Qualitative Response

Profile of Interviewees

Nineteen (19) interviewees participated in the structured interview from one selected HEI. The instrument consisted of 21 questions of which one-third of the questions were demographic. Of the total participants 12 were female and 7 were males. The four highest respondents' age group were 35–39 years with 26.3% (n = 5), 25–29 and 50–54 years with 15.8% (n = 3) respectively. A little over half (n = 10) of the respondents were either lecturers or administrative staff, senior administrative manager and technical staff was (n = 4), and the others were professor, technical supervisor, ancillary supervisor, and ancillary staff (n = 5).

Interview responses

When asked about email hindrance to their productivity goals, five of 19 respondents stated emails were never a hindrance to their productivity goals. For those who found email a hindrance to productivity, they stated that the email content required them to perform some work or action before responding. There are seasonal times when emails appear to get in the way as reflected in the comment: *"usually during semester 1 with the influx of questions from students"* and *"During busy periods it's hard to answer all emails in a timely manner"*. Irrelevant emails, Wi-Fi service unavailability, and the volume of emails are also hindrances mentioned by the respondents.

Of the 19 interviewees, 11 indicated that emails had a positive impact on their work productivity level. The interviewees stated: *"It [emails] enhances efficiency and is quickly becoming the main mode of communication in the workplace"* and *"[email] has a great impact especially during COVID time. It has increased my productivity somewhat since I don't go into office daily"*. Contrastingly, eight interviewees reported that email reduced the time available for activities. For example, one interviewee reported that *"there are so many emails that once I start to answer I can't do anything else"*.

The majority of interviewees (13 of 19) read all the details in the emails that

they received. Two interviewees read the first line and then decided how to treat the email, while two had a varying response to the emails that they received. However, two interviewees stated that they did not read or use emails.

As it relates to the mechanism used to determine the importance of emails, the most popular prompt interviewees identified was the sender of the email (7 of 19). The subject matter was the second most identified prompt (5 of 19), while the term "Urgent" in the subject heading was the prompt for three (3) interviewees. The overall attitude relating to email priority and spam email was captured by one respondent who stated: *"It depends. If it comes from my department it would be priority, then those from faculty. If it is a general email it goes to the bottom in terms of priority"*.

Nine of the 19 interviewees identified spam, solicitations, junk, re-occurring emails as the biggest turn off with emails. Other turn offs included the use of long signatures at the end, using *reply all* instead of *reply to sender*, and including long conversation threads. A large proportion of interviewees (8 of 19) identified advertisements, promotional materials and predatory journals as the most irritating emails. Junk emails, emails without subject lines and attachments only, and general announcements were also email irritants. One respondent's solution to not being irritated was "*. . . I delete the ones that do not interest me*".

When interviewees were asked to provide a slogan for promoting suitable management of email protocol, the emerging themes of the fifteen slogans presented were *"precise", "concise"* and *"short"*. There were also three *"Do not . . ." and also "politeness"*. The slogans that appeared catchy were *"Be precise, be nice", "Delete the fluff"* and *"Be concise, be polite"*. Although not slogans, two interviewees included advice to email users: *"All emails must have a subject title and something written in the body"* and *"Have a work email different from your school and personal email"*.

The well-being of 12 interviewees were not affected by unanswered emails in their inbox while seven were affected. At one extreme was the respondent who had emails functioning like a "*to do list"* while at the other extreme was the respondent who had a pile up of unanswered email to attend to and pleaded that they were *"only human"*.

Discussion

Objective 1: To analyse the impact of one technological mode of communication (email) on HEI worker productivity levels.

The majority of the respondents (72%, n = 67) did not have a set time to check emails, for those who did, the administrative staff were more likely to have a set time for checking emails (21%, n = 8) marginally more than the academic staff (17%, n = 7), while 10% of the technical staff employed set times. Although HEI workers have access to and spend time on emails (Alturise et al., 2014), the result suggests that job function is not always a consideration in how email is managed.

The median for email checking frequency per day between administrative and academic staff is statistically significant with an absolute percent difference of 16.1% as deduced from Table 2. This result was expected since students tend to engage more with their academic facilitators than with administrative personnel.

Newport (2021) suggests that office opening hour protocols may be a solution to managing emails where fixed time to answer emails are established. The chance of the late-night email being suppressed or superseded by new emails is a strong possibility that a "night" email is not read. It may be better to send emails at night but with a feature to alert the recipient in the morning.

An interviewee expressed that *"email can have a negative impact on well-being if email is not managed".* According to Pagliaro (2020), limiting the number of times people checked their e-mail lessened tension during a particular important activity and lowered overall day-to-day stress. In turn, lower daily stress was associated with higher wellbeing. According to Kuslev and Dunn (2015), checking emails less frequently reduces stress.

The strategies employed for dealing with email are now being built as a direct response to the changing nature of work. This change has been brought about by a more embedded and work critical email culture (Russell, 2017). Lauri and Virkus (2018) point out that although it is not clear yet if the development of institutional literacy of HEI is an institutional level policy, the academic staff was aware of the need of such skills.

Of the 93 respondents, 82% of them thought that their personal email activity was either productive or very productive; while only 11% considered their email activity as unproductive and 7% were not sure. Almost half (46%) of respondents thought that the impact of email on their colleagues' productivity level was either satisfactory (40%) or high (6%). On the other hand, 32% thought the impact of email on their colleagues' productivity level was low. From these data, it appears respondents rated themselves more highly than their colleagues, which suggests there is no objective assessment of email productivity in operation.

Objective 2: To examine the factors impacting the email turnaround time for various HEI worker categories.

From the study, four key factors namely, internet access, time schedule, email response strategy, and available devices impacted email turnaround times of the respondents. These were gleaned from the interviews and questionnaire.

Internet Access

Unavailability of internet access affected 59% (n = 55) of the respondents' capacity to read and respond to emails, while 29% (n = 27) disagreed that unavailability of internet was the cause for not reading or responding to emails. Of the total staff affected, 47.3% (n = 26) were administrative, 38.2% (n = 21) were academics, 7.0% (n =7) were technical and 1.8% (n = 1) was ancillary. Therefore 9.1% of administrative staff were more affected by the unavailability of internet than were academics. Only 1 in 10 (n = 9) participants experienced internet challenges that exceeded a 24-hour period. Internet challenges less than 30-minutes duration affected approximately 1 in 5 (21.5%, n = 20) participants over a 10-day work period.

Time Schedule

Of the 93 respondents, approximately 80% (n = 71) of the respondents checked their work email between 8:00 a.m. and 8:00 p.m. during typical workdays. Of the total, 47.9% (n = 34) were academics, 40.8% (n = 29) were administrative, 8.5% (n = 6) were technical, and 2.8% (n = 2) were ancillary staff. Therefore, 7.0% more academics than administrative staff checked their work emails between 8:00 a.m. and 8.00 p.m. It should be noted that, more staff (36.8 %, n = 34) checked emails between 8 a.m. and 12:00 p.m. than any other period in the workday.

One in five respondents had a set time to check emails (n = 16, 17%). The number was split almost equally between academics (n = 8) and administrative (n = 7) staff. The majority 63.4% (n = 59) of the total respondents checked their emails less than 10 times per workday of which 33.3% checked emails less than five (5) times per workday.

Email Response Strategy

Email productivity is affected by the number of emails that are responded to in a given time. With the nested qualitative questions, approximately half of the

respondents 49% (n = 44) employed strategies to increase their email response rate such as flagging of emails, responding to priority mail first, responding immediately, typing shorter responses, reading the emails as soon as they are received and setting of telephone alerts for incoming emails. Almost one quarter of the respondents (n = 22) did not employ a response strategy.

The majority, 13 of 19 interviewees stated that they read all the details in an email, while two interviewees stated that they read the first line and then decided how to treat the email. Of the 19 interviewees responding to the question, the following signals or prompts were used to prioritise the emails they would read: the sender (n = 7), the subject matter (n = 5), the term "urgent" (n = 3).

Available devices

Multiple devices were used by respondents to check work emails (see Figure 6) where the preferred devices used in ranked order were laptop computers (37.6%, n = 64), desktop computers (35.9%, n = 61), and mobile phones (22.4%, n = 38). Administrative and academic staff used laptops and desktops in approximately the same percentages, 40.9% and 39.8% respectively. In terms of mobile phone use, a majority of 52.6% (n = 20) were academics, with a tie between administrative (21.1%, n = 8) and technical staff of (21.1%, n = 8), and ancillary 5.6% (n = 2).

Recommendations

The following are recommendations based on the findings from the study:

1. HEI employees should have set times for checking and responding to email which should include follow-up by phone calls for clarification to improve response rate within a 3-day period.
2. Since the majority of HEI personnel check their emails in the morning, it is therefore important that essential emails are sent or programmed to be released in the morning, since the default email queue is for the most recent email to appear first.
3. The title of the subject matter selected should be reflective of the email content and selected with the intention of eliciting a timely response.
4. HEI on-boarding exercises for new employees should include email etiquette and protocols to ensure productivity gains from email usage.
5. Less important or trivial communication should have another message board and not bombard email inbox with junk mail. Consider providing

multiple work emails or a means of categorising the types of email that comes into an inbox.

6. WhatsApp and other similar social media platforms are growing means of "informal" communication in the workplace. Therefore, protocols to utilise these platforms should be developed and shared to ensure the communication is effective.

Conclusion

Increasing and sustaining productivity gains in HEIs can be accomplished through a deliberate change in the emailing culture of the institution. For HEIs to be innovative and productive, employers and employees need to develop a strategic and systematic approach for managing emails. These methods should include adopting email protocols that are relevant to the institution, hosting email management seminars and engaging staff in periodic training in effective written electronic communication.

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Change Management in a Higher Education Institution in Jamaica

Implementing Curriculum Mapping

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Abstract

This paper presents the results of the use of Kotter's eight-step change management model (KCMM) to guide the implementation of a new requirement (curriculum mapping) as a supporting component of the Programme Development Policy at the University of Technology, Jamaica. The Programme Development Policy was revised and approved by the Academic Board in 2022, and it guides the development of undergraduate and graduate courses of study at the University. A supporting element of the policy is the newly introduced curriculum map, which encourages the mapping of the courses to the programme goals, programme objectives, and graduate attributes. Kotter's eight-step change process guided the implementation of the map along with qualitative interviews with the chairs of the curriculum committees in each Academic Unit and the Associate Vice President for Quality Assurance at the University. The results showed that the curriculum map was a valuable addition to the programme development policy. However, greater sensitization and training are needed to ensure buy-in from the relevant stakeholders.

Keywords: Curriculum Map, Leadership, Change Management, Kotter's 8-step Change Process

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Introduction

At the undergraduate, graduate, and continuing education levels, many educators and administrators are involved in curriculum or course development, review, implementation, and evaluation (McKimm & Jones, 2018). At the University of Technology, Jamaica (UTech, Ja.), curriculum matters are handled through the Curriculum Unit in the Office of Teaching and Learning (OTL). In preparing several courses of study in the Engineering Faculty for international accreditation, it was discovered that several courses were included in the programme that were not helping to achieve any of the stated programme goals and objectives. The discovery was made with the use of a curriculum map. Therefore, it was considered critical to use the curriculum map across the institution to ensure that all modules within a Programme are helping to achieve at least one of the stated objectives. Change efforts within the higher education landscape may be challenging based on the different layers of approval the curriculum has to go through. Organizational leadership is vital in the change process because organizational transformation can indeed lead to environmental change (Schneider, 2002). Curriculum change efforts can be a necessary part of the transformation of higher education, and policies are used to promote such changes. Incremental or progressive curriculum adjustments are a regular aspect of quality assurance (QA), quality improvement (QI), and quality enhancement (QE) efforts (McKimm & Jones, 2018, p. 520). Leadership plays a pivotal role in implementing change in any organization. Kotter's change management model (KCMM) which promotes change efforts in educational organizations (Haas et al., 2020, p. 66).

The Programme Development policy guides the development and implementation of new and revised courses of study within the institution. The policy was recently revised to include a curriculum map approved by the Academic Board. There are varying but similar definitions of curriculum mapping. English originated the idea of curriculum mapping in the 1980s, according to Hege et al. (2010), who described it as a reality-based record of the content delivered, how long it was taught for, and the alignment between what was delivered and what was evaluated (p. 1). Reniers et al. (2022) cited the work of Harden (2001), defining a curriculum map as creating a graphic representation of the extent to which courses within a program or degree teach and assess the educational objectives, competencies, or required skills for graduates of a program or degree (p. 1).

The curriculum map was first introduced in the Faculty of Engineering and Computing when they applied for accreditation from the Accreditation Board for Engineering and Technology (ABET). According to Hege et al. (2010), developing a curriculum map takes time but provides ample opportunities for all curriculum stakeholders (p. 1). During the preparatory process, the school adopted the ABET a-k objectives for the electrical and mechanical baccalaureate programmes. Each module was mapped to the adopted a-k objectives. The mapping results revealed that three courses were not helping to achieve any of the programme objectives within the mechanical programme. The faculty agreed to remove the courses from the programme and completed the curriculum change process to effect same. The curriculum map was considered for university-wide implementation in 2019. However, since implementing the curriculum map in 2019, evaluation has yet to be conducted to garner its effectiveness and use from academic staff.

Numerous revisions have occurred since the curriculum map was introduced in 2019, but no review of the curriculum map's effectiveness as a component of the Programme Development policy has been undertaken. This research aimed to determine how academic staff perceived the introduction of a curriculum map as a supporting element of the Programme development policy. This paper outlines Kotter's 8-step change process as the mechanism used to implement the curriculum map, including the pilot and distribution across the University, along with feedback from academic staff and some of the Faculty Curriculum Chairpersons. The research aimed to determine the perceptions of academic staff regarding introducing the curriculum map as a supporting element to the Programme development policy. The paper describes the advantages and challenges experienced in the implementation phase, along with feedback received from academic staff and suggestions for the way forward to institutionalise the change.

Literature Review

A curriculum map can be basic or complex (Hermann & Leggett, 2019, p. 530) and is recommended for use by multiple authors to determine if a curriculum is implemented as planned and can achieve the expected learning outcomes (Lam & Tsui, 2016, p. 1371). Curriculum mapping is a cyclical process comprising multiple stages (Uchiyama & Radin, 2009, p. 273). The stages may vary from institution to institution. Lam and Tsui proffered a three-stage process to include using key course documents, embodying a participative delibera-

tion process, and producing deliverables using charts for easy comparison at the course and programme levels (p. 1382). Hermann and Leggett presented a four-stage process that includes creating a template, identifying programme outcomes, identifying programme courses, and completing the matrix (p. 531). Uchiyama and Radin proposed a five-stage process that included developing individual maps for each course, reviewing and aggregating maps horizontally by course, aggregating the maps by course, identifying strengths, gaps, and overlaps and revising courses and implementing revisions, and finally repeating the process (p. 274). Hermann and Leggett posited that programme outcomes could be mapped to courses or can be more intricate to include several variables, including course goals, methods of instructional techniques, and assessment instruments (p. 530). Curriculum mapping, according to researchers, provides a structure that allows everyone to engage in communal conversation regarding teaching and learning (Uchiyama & Radin, 2009, p. 273).

Several authors opined that curriculum mapping is a faculty-led procedure to evaluate the curriculum creation, assessment design, and curriculum revision of an educational programme (Cheung et al., 2019, p. 23; Hermann & Leggett, 2019, p. 532). Curriculum mapping creates links between teaching content and expected student learning outcomes (C.-L. Wang, 2015, p. 1553) while fostering balance and flow throughout the programme, from programme goals and student learning outcomes to course outcomes and evaluation of student learning (Hermann & Leggett, 2019, p. 530). Curriculum mapping should thus be a continuous effort rather than a one-time event (Coombe et al., 2022, p. 568).

Although curriculum maps do not provide a full assessment of the state of a curriculum, either in terms of disciplinary content or graduate competencies (Spencer et al., 2012, p. 220), the technique promotes enhanced cooperation and collaboration among participating faculty members (Uchiyama & Radin, 2009, p. 277). Considering the significance of graduate competencies in student learning outcomes, students must be able to build these capabilities logically and systematically (Spencer et al., 2012, p. 218). Curriculum mapping is a helpful approach for initiating a change process, and with the correct tools and support, it can be achieved on a large faculty-wide scale (Spencer et al., 2012, p. 230). Researchers have noted that curriculum mapping connects all aspects of the school improvement process and sets out a learning journey while preparing students for an unknown future (Wang, 2015, p. 1552).

Methodology

Kotter's 8-step change process (Kotter, 1996) was used to implement the curriculum map as part of the curriculum development process. The eight steps in the model are: (1) create a sense of urgency, (2) create a powerful guiding coalition, (3) create a strategic vision, (4) communicate the vision, (5) empower others to act on the vision (6) plan for and create short term wins (7) consolidate improvements and produce still more change, and (8) institutionalise new approaches. The curriculum map comprised three separate tables with multiple columns and rows. The rows consisted of the programme objectives, programme goals, and university attributes for its graduates, while the columns comprised of the course code. All courses within the programme are listed on each table.

A pilot of the study was conducted using one faculty to develop two new programmes: one graduate and one undergraduate. The courses were mapped against the programme goals, the programme objectives, and the University's graduate attributes. Following the pilot, the map was added to the policy requirement for new and revised programmes. Structured interviews were conducted as part of the research methodology. The target audience for the interviews was the Faculty Curriculum Committee (FCC) Chairpersons. Each of the eight faculties within the University has a curriculum committee, a sub-committee of the University's Curriculum Committee, (The FCC reviews new and revised programmes prior to their presentation to the University Curriculum Committee). The FCC Chairpersons were ideal for the research project because the academic staff would first consult with them concerning any advice or challenges, they would face with developing new programs or revising existing ones. The FCC Chairpersons made an ideal target audience from which to select the sample. Unfortunately, the target group was adjusted to reflect a semi-convenience sample group because there were competing activities for the selected group when the research was being conducted. The revised target group of respondents for the research comprised six persons: three FCC Chairpersons, two lecturers, and the Associate Vice President for Quality Assurance, who was previously a Dean of Faculty. The process began with a sense of urgency.

Establish a Sense of Urgency

The University prides itself on preparing work-ready graduates. As part of

that preparation process, the courses in the programme should align with the programme's goals, programme objectives, and graduate attributes. Traditionally, multiple courses were included in the development of new programmes to cover the required material and fulfill the credit requirements. Despite this, as was discovered, not every course that was included in the programme contributed to the achievement of the designated programme objectives. A curriculum mapping exercise was conducted while preparing a programme for international accreditation. It was revealed that three courses were not contributing to achieving any programme objectives. The curriculum map was used to aid the process and guarantee that this issue does not occur again. The Curriculum Specialist, who is also the Deputy Chair of the University's Curriculum Committee, led the charge to add the curriculum map as a supporting element to the Programme Development policy. The curriculum map was adopted from its initial template used in the Faculty of Engineering and Computing and expanded into three sections: Programme goals, programme objectives, and graduate attributes. The academic staff were identified as the critical stakeholders for using the curriculum map. The map was shared with a random selection of academic staff and selected administrative personnel. The discussions held while sharing the curriculum map template provided the impetus to include the map as part of the continuous improvement efforts within the University. Feedback arising from the initial use of the map in the Faculty of Engineering and Computing was considered for its benefits.

Create a Powerful Guiding Coalition

Preparing the curriculum map was an activity conducted by the academic staff. According to Hermann and Leggett (2019), developing a curriculum map allows faculty members to see the programme curriculum from broad and granular perspectives (p. 531). Because they are an essential element of the programme development process in the faculties, the Curriculum Committee Chairpersons were believed to be perfect for the process's guiding coalition. The Associate Vice President (AVP) of Teaching and Learning was initially asked to support the move. Additional approval was sought from the University's Curriculum Committee, including the Faculty Curriculum Committees Chairpersons. The concept was described during a Curriculum Committee meeting when substantial discussion about the map was held, and explanations were offered.

The Curriculum Specialist provided technical support to the academic units in developing and revising new and existing programmes. A pilot was con-

ducted initially with a team from one Faculty, which was preparing a graduate programme proposal for review at the University's Curriculum Committee and subsequent approval at the Academic Board. During the programme development process, meetings were held with the programme development team to guide the use of the curriculum map. The pilot was completed over two months while the Curriculum Specialist guided the use of the curriculum map. Several explanations were provided to the team to clarify any misunderstandings. A second team from the same Faculty was encouraged to use the curriculum map as they pursued the development of the proposal for an undergraduate programme. Although the period for developing the curriculum map also lasted two months, there were more frequent meetings with the undergraduate team. According to Hermann and Leggett (2019), every faculty member should participate in the mapping process since they are the experts in the field for their courses and provide helpful information (p. 531). Therefore, the guiding coalition must comprise the academic personnel who are integral to the programme.

Create a Strategic Vision

Strategically, the curriculum map, as part of the programme development process, assures that the courses are helping to achieve one or more programme objectives. Keeping the courses streamlined to the programme objectives also ensures that students work towards common goals. Mapping the courses against the graduate attributes ensures that students are prepared for personal and professional work. Using the map is similar to using the backward design curriculum development process, where one starts with the end in mind and works backward to the beginning. The map allows academics to step back and determine what concepts are only nice to know and which are essential for mastery.

The strategic vision for the curriculum unit is to have all courses of study complete a curriculum map to ensure alignment between levels of certification from certificate to doctoral studies. The aim was to start with new courses of study, then move to existing courses of study in keeping with the Programme Development policy, which stipulates that courses of study should be revised every three to five years. Adding the curriculum map as a supporting element to the programme development process should enhance and strengthen the University's quality assurance mechanism. According to Coombe et al., (2022) the differences in competency levels, how they are applied across various pro-

grams, and the credentials that are therefore issued, have an impact on program accreditation. The use of the curriculum map as part of the quality assurance mechanism allows for the streamlining of content and assessments; it also allows for effective planning of teaching and learning activities, which form part of the quality assurance mechanism in higher education. Additionally, institutions are able to meet the demands of the relevant industries and other stakeholders in the programme development and evaluation process. Mapping each module to the Programme goals, Programme objectives, and the institution's graduate attributes would ensure that graduates are both professionally qualified for the workforce and represent the profile of a graduate of the institution. Having achieved institutional accreditation, the institution should continuously show that the internal quality assurance mechanisms are working and are improving.

Communicate the Vision

The concept of the curriculum map was presented to the University's Curriculum Committee. Utilising the Faculty Curriculum Chairpersons was ideal as they provided technical support within the faculties before documents reached the University's Curriculum Committee. Explanations of the purpose and use of curriculum map and the completion process were provided to the Faculty Curriculum Chairpersons at curriculum committee meetings. Teams engaged in developing new courses of study were provided technical support by the Curriculum Specialist through workshops and meetings.

Empower Others to Act on the Vision

Programme development teams within faculties change depending on the new programmes' concept and the expertise in the developed area. Faculties could use the curriculum map when developing or revising a new programme. The Curriculum Specialist has an open-door policy, so faculties requiring additional curriculum map training could request help which is usually provided through training workshops and meetings.

Plan for and Create Short-Term Wins

The two programmes that used the curriculum map in the pilot provided great reviews regarding it use. The reviews were shared with the University Curriculum Committee. The previous success stories provided the impetus

for the Faculty Curriculum Chairpersons to encourage their academic staff to use the curriculum map. In fact each new Programme using the curriculum map, encouraged others to use the map and reap the benefits.

Consolidate Improvements and Produce Still More Change

Feedback on the layout and components of the curriculum map was sought from the University's Curriculum Committee, and suggested recommendations were incorporated. The first iteration of the map included six options that would identify the modules as service learning, applied learning, field-based learning, integrative learning, scholarly activity, or study abroad activities within the Programme. The options were colour-coded, allowing the faculty and the curriculum specialist to determine the strength of the Programme as it relates to the identified options. During the discussion phase, it was determined that the concept of the curriculum map needed more thought and should be scaled back until buy-in was obtained. Subsequently, the map was revised to include three critical options for the classification of modules. A module should be classified as either introductory, reinforcing, or mastery. The revised options were presented to the University's Curriculum Committee, and while there was still some resistance, the revision was more acceptable than the previous iteration. Further feedback was received when the proposal for incorporating the curriculum map went to the Board of Undergraduate Studies and the Board of Graduate Studies. The recommendations from both boards were also incorporated into the policy, and recommendations for acceptance of the curriculum map given due consideration.

Institutionalise New Approaches

The Academic Board approved the recently revised Programme Development policy in February 2022. The addition of the map has been an enhancement to the quality assurance architecture of the institution. When a new Programme is being presented for review at the University's Curriculum Committee, a curriculum map must now accompany the proposal. Although the curriculum map has been used since 2019, its effectiveness has yet to be evaluated. The Curriculum Specialist wanted to determine how academic staff perceived the introduction of the curriculum map as part of the Programme development policy. This research sought to identify how staff felt about the map, what leadership behaviors from the Curriculum Specialist may create more buy-in, and

the view of the academic staff regarding of the execution of the curriculum map as a supporting element to the Programme Development Policy.

Results

Feedback from the Pilot

Feedback from the pilot conducted in the two faculties on two programmes showed that the curriculum map was helpful in the course development process. The first team noted that the curriculum map was helpful as they streamlined the courses in the masters and doctoral programmes , resulting in the elimination of overlaps among courses. While the second team at first struggled with using the map, because were not sure how to use it, they also reported its usefulness in streamlining the courses in the undergraduate Programme. Both teams appreciated the workshops and meetings with the Curriculum Specialist relating to using the curriculum map. Other schools that have used the map have noted that the map is helpful for new programmes.

Use of Kotter's 8-step process

Implementing the curricular map made good use of the eight-step change process. The Kotter model offered a straightforward, step-by-step procedure that was simple to implement. The stages must be carried out sequentially, which presents a difficulty. This strategy puts a high emphasis on employee buy-in and communication and is based on well-established research.

Feedback From the Interviews

After reviewing the interview recordings and transcripts, keywords were recorded. These keywords were essential to the researcher, and some were repeated in the interviews. The data were initially coded with the faculty location of the participants and then recoded to remove any possibility of identifying the participants. The first cycle coding for this study involved descriptive coding.

During the interviews, a few participants mentioned that the curriculum map was helpful and guided the curriculum development process. Some participants spoke about the curriculum map being useful as part of the quality assurance mechanism of the University. However, the academic staff noted that at the time the curriculum map was introduced could have been more

convenience as they were involved in other processes. However, one participant noted that academic staff were constantly engaged in multiple activities, so there was never an ideal time. Some of the staff felt the curriculum map was additional work, was tedious, and the resources, including human resources, were not available to ensure the completion of the map.

The following codes were initially assigned: negative highlights, weaknesses, mandatory, not aware, sensitization, training, resources, deadline, good tool, appropriate, willingness, push back, tiresome, policy, consistency, support benefit, confident, familiar, knowledgeable, and feedback from stakeholders. The codes represented words and phrases used by the participants in the interviews. Another emerging code or theme included communication. The participants suggested that more workshops were needed to educate the academic staff on how to complete the curriculum map to increase communication about the map. Nevertheless, participants were of the view that the curriculum map added value to the programme development process,

After reviewing the transcripts again, some codes initially created were subsumed into other codes. A few themes repeatedly emerged after the researcher listened to the tapes a third time. The revised codes were helpful, guide, quality assurance, university-wide, mandatory, communication, training, sensitization, feedback, and additional work. The categories or themes that strongly emerged were communication, training, sensitization, and feedback. The participants noted that although there was communication, it could be stronger sometimes, more training is required for the effective use of the curriculum map; more sensitization of the staff both at the managerial and lower levels to get "buy-in," and the need to garner feedback from the stakeholders who use the curriculum map. The causes and explanations proffered by the participants included that the academic staff viewed the curriculum map as additional work; they were tired, and the timing appeared to be off as they were involved in other demanding activities at the time of the introduction of the curriculum map. The academic staff also felt they needed to be sufficiently equipped to complete the map. The FCC Chairpersons spoke emphatically about the curriculum specialist's relationship with the faculties who, despite being the only technical person in the curriculum unit, was accommodating to the requests of the academic staff for more training and support. Finally, in spite of the perceived challenges, the concept of the map being a tool for guiding the staff was emphasized by almost all participants.

Table 1: Excerpt of Curriculum Map

Curriculum Map									
	ISM5001 Cr	ISM5026 Er	ISM5004	ISM5005 St	New ISM	ISM5008	New Research Methods in Information Systems	ISM5027	New Digital Transformation & Change
Course of Study									
1. Promote the efficay of effective and structured information systems management at the tactical and strategic levels and how such an approcah can lead to improved business process, better business practices and improved competitveness.			I	I					R
2. Prepare students for key decision-making roles in organizations and heightened thinking and analysis through specialized modules.			R	R	R	R			R
3. Stimulate students to successfully apply key information systems and management theories and concepts to real-world scenarios through the delivery of modules that span both IS and general management domains.		I	I	I	I	I			R
4. Equip students with core elements of the discipline through taught modules that are central topics in IS study during the core phase of the course.	I	I	I	I	I	I		M	

Table 1 shows an excerpt of a curriculum map from a graduate programme within the University. The section of the map shows four of the programme objectives on the left and the courses, listed using course codes on the right. The courses are mapped to the programme objectives using a key of introductory (I), reinforcing (R), or mastery (M). Courses are mapped to the objectives based on whether they provide an introductory, reinforcing or mastery concept.

Kotter's 8-Step Change Process

According to Kotter (1996), following the order of the steps in the change process in the sequence is essential, as skipping a step can be detrimental to the change process (p. 23). The eight–step change process has three factors: see, feel, and change. Although the Curriculum Specialist and the Faculty Curriculum Chairpersons saw the need for the change, the strength of the guiding coalition was not effective enough to garner total buy-in from the academic staff who are the primary stakeholders. The third step, developing a strategic vision, focused on the curriculum unit's long-term goal of having each new and

amended program use the curriculum map to reduce and eventually remove content overlaps and facilitate learning from the bachelor to master's to doctoral programmes. According to Kotter and Cohen (2002), the vision should include guiding principles, but it also has to keep up with the environment's pace to avoid falling behind (p. 4).

Communicating the vision should be effective. Communicating the vision through strong, simple channels facilitates understanding for more stakeholders' buy-in (Kotter & Cohen, 2002, p. 4). The communication of the vision in this case may have lacked the vibrancy needed to encourage the change process. Working through the fifth stage required the removal of obstacles that may hinder those champions of change (Kotter & Cohen, 2002, p. 104). The programme development process carries several approval tiers that are embedded in policy. Hence removal of some barriers to effect change is not a linear process, thus hindering speed in the change process.

Kotter and Cohen (2002) emphasized creating short–term wins because they foster enthusiasm and keep the momentum for the change (p. 5) as the sixth step. One of the wins celebrated came after the pilot when the first team understood the assignment and was able to populate the map, with guidance and were able to see the benefits of completing the map. In the seventh step, all the pieces must be in place to complete the change process at this stage (Kotter & Cohen, 2002, p. 147). Thus, creating structure and granting power to aid the process is vital (Kotter & Cohen, 2002, p. 147). This step emphasizes the linear process that is involved in the change process. However, not all change processes follow a linear process, thus the rigidity of this process may have adverse effects on the success of the venture. Kotter and Cohen (2002) purported that successful cultural change happens over time, and efforts to change the values prior to new ways of doing things is a grave error (p. 176). Making the change stick is critical to successful implementation. To date, four faculties have used the curriculum map in their new and revised programme submissions to the Curriculum Unit. The other faculties have expressed interest in receiving training to use the map in their revision process.

The interviews conducted with academic staff members regarding implementing the use of the curriculum map provided helpful information for improvement. Several inferences have been drawn from the data among them that academic staff are frequently overwhelmed by the constant information they receive through the University's communication systems.

The curriculum map formed part of the policy on Programme development. The curriculum map was introduced at a university curriculum committee

meeting. However, the information relating to its introduction was distributed to only some academic staff who would be the primary users of the curriculum map. While some academic staff were willing to get involved in the changes during the academic period, it became an overwhelming burden based on tasks with similar or exact timelines as this new addition to the policy. The perception was that the curriculum map was an additional task added to their demanding schedule. Despite the intimidating nature of the curriculum map, the staff thought the curriculum map was a valuable tool for new courses of study to ensure that the defined learning outcomes have the potential for achievement.

The opposition that academic staff members had to implement the curriculum map represented resistance to the change process. Some participants thought the communication strategy for introducing the curriculum map should have been more robust. However, others thought that the communication and sensitization were adequate. If persons were not involved in the curriculum development process within their faculty, they were unaware of the curriculum map. Therefore, the curriculum specialist has considered whether the sensitization process should be more strategic and target individuals appointed to positions of responsibility, such as program director, head of school, vice dean, dean, and faculty curriculum chairperson.

The curriculum map as a supporting element to the programme development policy now forms part of the quality assurance framework of the institution. Thus, all courses of study should follow a curriculum map. One participant noted that the curriculum map would ensure that the programme's learning outcomes were met. However, it will be challenging if the academic staff cannot complete the map. The participants found the curriculum map an excellent addition to the Programme Development policy. However, more training workshops and further feedback from the academic staff are needed to ensure participants are comfortable using the curriculum map.

Kotter's (1996) eight-step change process may be divided into the three stages of see, feel, and change. Before a change can really take place, stakeholders must recognize its necessity, and the change agent must establish the conditions necessary to enable it to occur. Although it has been emphasized that the Kotter's change process is linear and that phases must be completed in order, internal difficulties might prevent the process from proceeding according to plan. Following the processes in a sequential manner did not provide the opportunity to revisit earlier steps and improve any weak areas to ensure a successful end. The researcher acknowledged that the guiding coalition had not themselves received adequate training or a clear enough goal to garner

the support of other academic staff. Additionally, the communication of the vision may not have been expressly clear to the guiding coalition which also hindered the process moving forward successfully. Thus, in the interviews, the participants recommended that more sensitization and training are required.

Conclusion

Change efforts are sometimes resisted within organisations. Leaders have to find creative ways to implement necessary changes. The eight-step change model developed by Kotter is one way to instigate change. The eight steps in the model included: creating a sense of urgency, creating a guiding team, creating a strategic vision, communicating the vision and strategies, empowering individuals for action, creating short-term wins, consolidating improvements, and institutionalising the changes. The methods suggested by the change process appeared to be effective, and people appreciated the strategies used to implement the change, although more workshops are needed to make the change effective. Communication of the change was also a significant factor in the change process. While the challenges appear to be many, the vision for the institution to improve its systems was recognised.

Author's Note

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Identifying my Teaching and Learning Preferences in the Online Environment

A Reflection

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Abstract

The school of thought exists that teachers teach in accordance with their own learning preferences. The VARK (visual, aural, read/write & kinaesthetic) Questionnaire is a self-report that serves to identify or suggests an individual's most preferred learning/teaching style/s which can result in modification of teaching and learning behaviour for best outcomes. Therefore, the objective of this reflection is to introduce the VARK Questionnaires to my peers that they might find helpful for reflecting on teaching and learning in the online learning environment (OLE). The questionnaires that accompanied each other were accessed online at Vark-learn.com. The author was identified as a 'multimodal' learner with a 'mild kinaesthetic' teaching preference style. Multimodal learners learn through a combination of formats incorporated under any of the four learning styles. A mild kinaesthetic teaching style supports practical activities, case studies and real-life applications. There are some limitations to learning online for the multimodal learner; kinaesthetically, they might not be adequately challenged or positively impacted visually. Generally, in the online learning environment, interferences from the adjacent environment can obstruct learning and learner engagement. In the case of the teaching style, kinaesthetic teaching, in general, would require knowledge of and appropriate educational tools for curriculum delivery. Completing the VARK Questionnaires can provide insight into personal teaching and learning preferences in the OLE as well as add literature for future comparative studies.

Keywords: Teaching and Learning, Online Environment, VARK Questionnaire, Reflection, Teaching Style and Behaviour

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Introduction

In March 2020 when the COVID-19 pandemic reached Jamaica, teaching and learning rapidly moved to the online learning environment. However, the priority was not teaching and learning styles; uppermost in the minds of we educators was completing the curriculum to the best of our abilities and that was teaching the way we knew how to teach as we grappled with managing and delivering with the available educational technologies, inappropriate and inadequate personal devices and connectivity issues. There have been reports in our local media about difficulties faced by teachers and learners in engaging in online learning (Gilchrist 2021; Thomas 2020). There were learners in the local space who expressed feelings of disengagement in some classes because their styles of learning were not considered. There were staff-room discussions as well where some teachers expressed that they did not feel engaged with the learners. To engage with learners in any learning environment, teaching and learning styles must be aligned (Aldajah et al. (2014) while Peyman et al. (2014) insisted that the selection of teaching style is important to be appropriated to the learning style. Therefore, the objective of this reflection is to introduce the VARK Questionnaire to my peers which they might find helpful as a teaching reflective tool.

It was not long ago that I was introduced to the VARK (visual, aural, read/write & kinaesthetic) Questionnaire. The purpose of the questionnaire is to identify an individual's dominant learning style/s or to suggest the learning style/s most suitable to an individual. It was initially developed by Neil Flemming of Lincoln University, New Zealand in 1987 and co-authored with Charles C. Bonwell of Southeast Missouri State University (VARK Learn Limited, 2022). Regrettably, Flemming was deceased June 16, 2022, but he has left a legacy. The questionnaire is a 32-item self-reported scale (long version) which is also adapted for online learning as it seeks to meet the needs of the current education system. In all my years of learning and later teaching, it never occurred to me to assess my learning preference. I assumed that I was a visual and kinaesthetic learner. I did not try to identify my teaching preference as I taught according to the demands of the courses I delivered. However, the need for self-evaluation

in teaching and learning style preferences in the online learning environment, curiosity to know if my learning style is reflective of my teaching style, and my introduction to the VARK Questionnaire which would be useful in this regard provoked me into completing the VARK Questionnaires for learning and teaching styles.

Results from the VARK Questionnaire

Table 1 below displays the result of the VARK Learning and Teaching Styles Questionnaires that were completed at two different points in time. The learning style questionnaire was completed while doing an online course and I used the opportunity to assess who I am as a learner. The teaching style questionnaire was done around the time of writing this article and so provided me with meat for my reflection.

Table 1: The VARK Teaching & Learning Styles Preference Result Table

VARK Items	Learning Score	Teaching Score
Visual	7	5
Aural	12	6
Read/Write	12	6
Kinesthetic	11	10
Preference Styles	**Multimodal**	**Mild Kinaesthetic**

(A detailed profile was not accessed)

Learning Styles

I am identified by the VARK learning style questionnaire as having a "multimodal" learning style preference. Multimodal indicates that an individual learns through a combination of formats. Usually, illustrations, diagrams, arts, practical exercises, debates, discussions, laboratories and field experiences/discovery learning, case studies, reading and writing among other forms would be incorporated under any of the four learning styles. The result above runs contrary to Ridwan et al. (2019) who posited that learners' preference styles are "all modal"; a component of multimodal. However, individual learner preferences may be bi-, tri-, or quad-modal (all modal). In a study conducted on students in dental education, Shah et al. (2013) concluded that students have multimodal preferences with a leaning towards kinaesthesia.

In order of highest preference, my result indicated that aural and read/writing learning styles are my most dominant preferences, followed closely by kinaesthetic learning and lastly, trailed by visual learning. I do believe the result is for the most part correct, although, I used to think that there was no difference between my kinaesthetic and visual learning preferences.

I believe that being a multimodal learner potentiates me to function well in the online environment as a learner and most likely as a teacher if I am to follow Yamagishi (1990) who suggested that teachers teach based on their learning styles. Furthermore, there is evidence that multimodality in learning is an active student-centred approach which is currently translated in the online learning environment as the use of multimodal technologies to deliver teaching and learning activities (Papageorgiou & Lameras, 2017).

Teaching Style

The result of the VARK Teaching style inventory indicated that my preference is "mild kinaesthetic". This means that I would employ practical exercises, demonstrations, case studies and real-life applications in delivering the curriculum. I am barely surprised at this result as most of the courses I deliver involve practical or clinicals. Individual category result portrayed a stalemate between aural and read/write teaching styles trailed by visual preference. Significantly, visual preference was again observed to be the lowest value on the VARK scales of teaching and learning with no difference between aural and read/write modalities. Kinaesthetic modality was again observed as dominant. Interestingly, Ridwan et al. (2019) concluded from their study that most teachers prefer the kinaesthetic teaching style. The result table above indicates a relationship between teaching and learning style preferences. Yamagishi (1990) who relied heavily on the works of forerunners like Butler (1984) and Gregorc (1977) affirmed that teaching style is directly related to personal learning style while researchers like Aldajah et al. (2021) and Peyman et al. (2014) reinforced that teaching and learning styles must be compatible. On the other hand, Abrecht, (2003) suggested that as teachers, one's thinking about learning mainly dominates one's way of teaching. Inconsistent with the preceding views is Oleson and Hora (2013) who proffered that prior experiences and knowledge shape teaching styles and aphorised that faculty teach the way they were taught because they received little formal training before entering the classroom, a maxim which could be applicable in my case. A criticism of personal learning

preference style and its influence on teaching style is that it limits teachers' visions and understanding of the different types of learners (Yamagushi, 1990).

The Evaluation: Multimodal Learning and Mild Kinaesthetic Teaching Behaviour

Completing the VARK questionnaires has provided me the opportunity for intro- and retrospection. On introspection, in the capacity of a learner, my aural learning style allows me to multi-task that may lead to distraction. Over time, I relied on listening and if there were something to read, I would read and make notes/jottings as this reinforced my learning. In an online session, I would be doing more than one thing. Listening helps me with recall as I will remember the tone of the facilitator/presenter and I have a mental picture of how the information was presented (visual learning style). At times, I would revert to reading the live transcript or captions in order to supplement any information that was missed. I find that to be fully engaged, I have to be engrossed in an activity. This prohibits multi-tasking, in which I engage a lot when I am not facilitating. In the past, I have found myself in webinars reading the live transcripts of the presentations instead of watching the power-point presentations. I would only revert to the power-point presentation screens occasionally if reference were made to specific items or data. Performing this assessment has allowed me to have a better understanding of the behaviour of my students in the online learning environment.

I currently embrace the use of various educational technologies (web conferencing tools and add-ins) to deliver my lessons. These educational media assist in engaging the different learning styles so students will get a fair chance at being successful. I make use of chats, discussion boards, wikis, case studies, group work, oral presentations, power-points, video recordings and YouTube presentations, whiteboard, question and answers, reading assignments and note taking, essays, reflective journaling and practical activities. The lesson objectives determine the media used and the format taken. Salient points in asynchronous sessions might be clarified in synchronous sessions which permit oral responses and practical reinforcements. However, note taking is becoming an issue. In recent classes, learners are showing a preference for screenshots and screen recording as they are now more inclined than ever not to write. Hence, there are times when a session would be dedicated to using the Chat tool and collaborative annotation on the whiteboard or class discussion taking place in a forum/channel. The purpose of these sessions are two-fold as they help

learners to familiarize themselves with multiple uses of the online educational tools and allows me to assess learners' knowledge level.

Retrospectively, I reviewed my teaching style to see how much my lessons were delivered in accordance with my learning preferences. I focused on my personal learning preferences as I sought to see things as the learner. I did find that I included chat and online discussions to a large extent. I also required learners to work collaboratively as well as independently as they engaged in group presentations which allowed use of their creativity. I incorporated activities some which could be done at home and asked them to submit videos of these activities for peer, self, and instructor assessment. I designed forms for students to complete their assignments; for example, I have a reflective journal form and an essay form. These forms are given to students to respond to essay questions and do reflections. I developed rubrics and competency forms to aid the teaching and learning process. Pre-recorded lessons were used to a lesser extent; question and answers also played a big part. I found that my lesson delivery is consistent with my learning preferences as I tried to engage my learners as much as possible. This, as I realize that my aural learners can be distracted. Hence, I subscribe in part to the views of Abrecht (2003) who suggested that we tend to teach the way we think about learning and agree with Yamagishi (1990) that there is a direct relationship between one's personal learning style and one's teaching style as one teaches according to one's personal learning style. Coincidentally, my teaching preference is highly kinaesthetic thus aligning with the conclusion made by Ridwan et al. (2019).

Preference Styles Challenges

There are some challenges that may occur with the preferred learning and teaching styles. The multimodal learner can be disadvantaged in the online learning environment. That is, a highly kinaesthetic learner might not be challenged enough online. A presenter may not be emphatic or confident to make the sort of impression that can impact the visual learner in a positive way. One of the ways for me to recall lessons is the tone of the voice associated with the presenter. On the other hand, synchronous oral presentations or online discussions might not be the best learning format for certain lessons considering the interferences which can obstruct learning and learner engagement.

Teachers with mild kinaesthetic preferences would most likely focus on their dominant learning preference or according to the gradient measure of preferences. Potentially, this would impact the level of success of the learners who

are high on the other learning preference styles. Ridwan, et al. (2019) indicated that this would be a mismatch with learners' styles of learning. Moreover, the teacher with the kinaesthetic preference could be challenged with delivering the curriculum online if not adequately trained for that environment. Such an individual would need to be prepared with the appropriate education tools. There are some pre-emptive strategies suggested by Flemming on the VARK Learn Limited website which can be employed.

Suggested Strategies

The strategies below can be used for teaching the multimodal learner. It should be recognized by this, that the multimodal learner is thoroughly engaged with all learning styles. The teacher with the kinaesthetic preference would also be able to apply some of the following:

a. Visual strategies: Different art formats, space, graphs, charts, diagrams, illustrations, maps, interesting layouts and plans. Symbolisms, varying fonts, colours and spaces are creatively used for emphasis.
b. Aural strategies: Listening, discussing, talking, questioning, recalling, humour. The focus is the spoken word and hearing.
c. Read/write strategies: Lists, notes, handouts, print, and texts using electronic and print media. Emphasis is placed on the printed word.
d. Kinaesthetic: Practical exercises, experiences, examples, case studies, trial and error, role play, creations.

Strategies for Online Delivery

In online lesson delivery, the following strategies reflective of the various learning styles can be incorporated. For the visual learner, they can be asked to illustrate or draw, annotate the whiteboard in shared screen if the platform allows, text highlighted for emphases, and do presentation with graphics, graphic interchange format (gifs) and animations, jpegs, tables and other figures.

To cater to the aural learner, debates and discussion boards, chats, tutorials, lecture, narratives/stories, question and answer, oral quizzes and tests can be used to educate and inform the aural learner.

Reading/writing strategies used in the online environment are: Essay writing, spelling, quizzes, chapter reading and reading links, note taking and assignments inclusive of research papers.

For the kinaesthetic learner, problem-solving exercises, case studies, role

play, scenario building, engaging in an activity and capturing it on video or capturing activity online in class (video recording), group work activities wherein the breakout room is valuable, reflective journaling and polling can all be accommodated. For clinical and laboratory based courses educational tools of trade (for example those used in telehealth), haptic simulators and virtual laboratories are invaluable.

Conclusion

It should be noted that this is my personal experience and a multimodal learner or a teacher with mild kinaesthetic teaching preference might be different in their behaviour. Upon introducing the VARK Questionnaire in this reflection, I am challenging colleagues to conduct a self-assessment and share their reflections. This would increase comparative literature in the field of teaching and learning preferences in the online environment and hopefully stimulate further research.

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Carnival in Jamaica 2022

Is the Current Model Viable?

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Abstract

In March 2022, it was announced that Carnival in Jamaica would return after being postponed twice since the COVID-19 pandemic. The announcement was a relief to stakeholders and participants who were eager to return to the road. However, the return can best be described as lukewarm due to the short notice and resulting lack of interest. Although the festival lacked its usual number of overseas participants, there was nevertheless a return of the local patrons, who had not been the target market since the development of the brand Carnival in Jamaica. This paper reports the results of a study that used an ethnographic approach, which included observations, interviews, and analysis of social media posts to examine the rebound of the festival in 2022.

Keywords: Carnival, Jamaica, Carnival in Jamaica, Fete, Mas, Trinidad-style, Road March

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Introduction

Internationally, in November 2019, the three prominent carnival bands in Jamaica launched their masquerade costume offerings for the staging of Carnival in Jamaica in 2020. First out of the gate was veteran band Bacchanal Jamaica on November 9, 2019, with their presentation, Lost Kingdoms. Within the same month, Xaymaca International debuted 15 sections under the theme Playlist, depicting lyrics from various pop songs over the years. In addition, Xodus

launched Enchanted, the Live Your Fantasy, with sections like Khaleesi- The Mother of Dragons and Redd-Her Red Cape will Covet you. The costume launch enticed locals and visitors and garnered the backing of corporate sponsors and the Tourism Linkages Network of the Ministry of Tourism. The atmosphere of excitement and anticipation that marked the activities of November 2019 indicated that Carnival in Jamaica 2020 was going to be one of its biggest stagings to that date.

Unfortunately, on March 13, 2020, the following declaration was made by the Ministry of Tourism: "With an increase in coronavirus (COVID-19) cases in Jamaica, the Ministry of Tourism has announced that the road parade for Jamaica Carnival 2020 has been postponed until October 25" (Jamaica Information Service, 2020, para. 1). The declaration was a significant blow to all carnival stakeholders. Carnival in Jamaica and the overall festival tourism and entertainment industries took a significant financial hit during the COVID-19 pandemic. However, in March 2022, the Ministry announced that Carnival in Jamaica would be held in July of that year.

Before the formation of Carnival in Jamaica in 2017, the festival had a local focus, whether on the University of the West Indies (UWI) campus, uptown Kingston, or the corporate areas. However, the new festival model under the Ministry of Tourism was visitor-centered and profit-driven, making the carnival even more exclusionary. This exclusionary nature has always characterized the Caribbean carnival in different ways as the festival grapples with finding a place in post-emancipation and post-colonial societies. First, in Jamaica, outside of the UWI campus, the festival appealed to those of the middle and upper classes as they sought out a cultural practice that set them apart from the lower-class black population. Then, by 2017, the festival aspired to attract visitors from the Caribbean diaspora in North America and other Caribbean countries, which gave it new socio-economic and cultural functions.

The paper argues that the current model for the festival in Jamaica is not viable in a global crisis where travel and leisure have not been priorities. Through this lens, it assesses Carnival in Jamaica's rebound in 2022 using observations, views from participants and stakeholders, as well as a content analysis of social media posts.

The Development of Carnival Brands in Jamaica

Carnival was introduced to Jamaica through students from Trinidad and Tobago and other Eastern Caribbean countries on The UWI campus in Mona from 1955.

Beyond the boundaries of the Mona campus, in 1976, the Orange Carnival was initiated by a small group of elite Jamaicans who had attended the carnival in Trinidad (Brown, 2005). Jamaican musician Byron Lee was at the forefront of the activities, eventually leading to Jamaica Carnival's formation in 1990. At this time, carnival included fetes calypso and steelband shows, large costume portrayals, and a street parade or road march.

By 2000, two main organizing forces of carnival co-existed in Jamaica- Byron Lee's Jamaica Carnival, which attempted to include participants from all socio-economic classes- and the groups that formed Bacchanal Jamaica that offered a more elite encounter that replicated the party experience in Trinidad. Both entities were self-financing and depended on corporate sponsorship with little or no support from the government. Failing health eventually forced Byron Lee to opt out of the carnival in the mid-2000s. The entrance of Xaymaca and Xodus expanded the carnival with their costumed bands and events. Their aesthetic appealed to younger well-off Jamaicans and visitors from the diaspora and the Caribbean. Interestingly, these bands were aligned to mas conglomerates Tribe and Yuma from Trinidad and Tobago, further boosting their appeal to the overseas carnival market.

By 2017, the carnival was no longer monopolized by Bacchanal Jamaica and its affiliates but grew to include new promoters and bands as well as support from the government, specifically the Entertainment branch of the Ministry of Culture, along with the Ministry of Tourism, the Tourism Enhancement Fund, the Jamaica Tourist Board, and the Tourism Linkages Network. Under the Linkages Network, the umbrella brand Carnival in Jamaica was created. Their mandate for the carnival was to make it a part of the country's cultural tourism offerings while creating business opportunities for various sectors: "This is an annual undertaking, which aims to transform the carnival experience locally. It is a key initiative of the Tourism Linkages Network with support from the Jamaica Tourist Board and key stakeholders" (Ministry of Tourism, 2020).

The new promoters, both local and international, added new fetes to the carnival season outside of Bacchanal Jamaica and its affiliates. Whereas Bacchanal always had corporate backing as many of their managers were linked to businesses, as is, director Michael Ammar Jr., who is well-known in the local corporate sector. Similarly, Bacchanal Jamaica's affiliate, Frenchmen, is led by Ian Wong, chair of Coldfield Manufacturing Ltd, one of Bacchanal's main sponsors ("Frenchmen teams with", 2017). Outside of Bacchanal Jamaica, some of the new promoters include those associated with I Love Soca- Andrew Bellamy, Ian Bourne, Ricki Walsh, and Denver Holt. Andrew

Bellamy was chief executive officer of the Xaymaca mas band as well as the councilor for the Mona Division in St Andrew, a government position. Because they are familiar with the party scene in Jamaica and known for their Dream Weekend event, Scott Dunn and Kamal Bankay of Dream Entertainment were well-positioned to put on carnival events under their Xodus brand. Bankay is also head of the Ministry of Tourism's Sports and Entertainment Network and chair of the Carnival Stakeholders Committee. The event organizers therefore grew to include those with not only business links but political connections. The entrance of new players and the support from the Ministry of Tourism and businesses ensured Jamaica had enough events to offer a whole carnival week (Easter weekend to the second Sunday of Easter), but at the same time, extended the carnival outside the limits of uptown Kingston to visitors that helped to maintain its exclusionary nature.

It should be mentioned that smaller entities such as Downtown Carnival, Ghetto Carnival, Ocho Rios Carnival, Inner City Carnival, and St. Thomas Carnival also put on carnival activities away from Kingston's corporate center. However, this paper will focus on the more significant commercial carnival event and the brands that form Carnival in Jamaica.

The Trini-Style Carnival Model

Carnival in Jamaica has depended on the Trinidad-style model to make the festival appealing as a tourism and entertainment product, particularly in Kingston. The Trinidad model refers to a replication of the economically successful fetes and masquerades from the twin island republic. Using this model, the Carnival in Jamaica brand is characterized by fetes and pretty mas that only represent the Trinidad Carnival's commercial aspects.

Historically, two parallel carnival festivities emerged in Trinidad- one celebrated by the former planter class characterized by European Catholic rituals and another celebrated by the Black population, with a strong African influence. For them, the carnival was a space to celebrate their traditions that were banned or denigrated by European colonizers. The oppositional elements of the carnival can be traced to the celebration of the kambule/canboulay, which later invaded carnival spaces in the post-emancipation period (Riggio, 1998, p. 12).

The history and development of the modern carnival in Trinidad have assimilated the tensions between the resistive and celebratory aspects of the kambule/canboulay and the commercial elements of a modern capitalist society that result in a complicated carnival culture. For instance, conflicts between

the growth of the commercial pretty mas and the all-inclusive fetes as opposed to the declining cultural heritage of the festival are prevalent in the national discourse. These tensions are not new and have been around since the Canboulay riots in 1881 and the nationalization of the festival during the independence period when it was decided that the state would be responsible for the carnival.

The fetes and the masquerade are, therefore, the most profitable and appealing to visitors from abroad (Burke, 2013). They also serve as the basis for the almost 100 carnivals across the world modeled on the Trinidad-style festival. According to Nurse (2018), it has become the most "globalized festival" in the world. Jamaica then is one of the sites for the globalized carnival started by the students at the UWI campus, then expanded by those who went to Trinidad's carnival, and now by those who bring events directly.

Carnival in Jamaica has been curated into a commercial product marketed primarily to well-off middle and upper-class Jamaicans (locally referred to as uptown) and visitors from the diaspora. As an imported cultural product with primarily commercial motives, Carnival in Jamaica operates without historical ties to celebrating emancipation as it does in many other Caribbean countries. Without this heritage, it operates as a safety valve with a focus on the party aspect of the festival. As a result, Jamaica is a significant stop on the Caribbean carnival calendar. The timing works for Jamaica as there is no competing carnival during the Easter season. Furthermore, the low cost of fetes, costumes, and accommodation, in comparison to those at other major carnival destinations like Trinidad and Barbados, where popular fetes can start at US$100 or costumes at US$600, make Carnival in Jamaica even more attractive, where fetes can start at US$40 and costumes at US$380. Furthermore, the cost-effective nature of the experience is especially attractive to carnival chasers who see Jamaica as more "bang for their buck".

Carnival chasers travel to various carnivals in the Caribbean, North America, and Europe. They fall mainly between the 25–35 age group and may be from other Caribbean countries. However, they primarily reside in North America or the United Kingdom and have links to the Caribbean through heritage or other means. For those residing in the diaspora, the overseas carnival, like the one in Jamaica, is a follow-up to the festival in Trinidad.

Carnival chasers are entirely absorbed into the festival and attend as many events as possible to maximize their chase. Thus, another significant benefit of attracting the carnival chaser is that they spend in US dollars or another foreign currency, which is a bonus to the economics of the festival. For example, the

Jamaica Tourism Board figures indicated that visitors spent about US$236 per day for an average of 5 days in 2018 (Ministry of Tourism, 2018).

In addition, carnival chasers primarily document their chase using social media, which brings about FOMO (fear of missing out) among their followers. Sigala (2019) wrote that FOMO "drives consumer behavior, brand preferences decision, making, lifestyle and consumption patterns, because people follow the social norms and suggestions of groups they belong to…" (2019, p. 250). In this regard, chasers' social media content may drive travel behaviors among their followers to consume specific experiences in certain places, like the Trinidad-style carnival. The curated experience ultimately ensures likes from their social media audiences, and in turn, FOMO influences followers to attend carnival events. As such, carnival bands have included social media influencers in their marketing strategy to attract visitors.

Carnival for Jamaicans

Because carnival is not indigenous to Jamaica, it is easier to market as an exclusive party product, which makes the celebration more appealing to an elite consumer. One Jamaican carnival entrepreneur expressed on Twitter in 2019: "Please don't talk to me about party prices or costume prices. Don't go or don't jump. We are not forcing you" (King, 2019). The statement from the self-proclaimed Kween of Karnival reinforces that Carnival in Jamaica remains an elite activity enjoyed by a small group of Jamaicans and those in the diaspora who can afford it. Consequently, race and class issues that tend to define the cultural context of Caribbean societies are brought to the fore. Edmondson (1999) posited that the carnival does not represent a dominant Black Jamaica but a more ethnically diverse population. This cultural complexity is framed by Jamaica's history of slavery and colonization, which resulted in socio-ethnic discord that influence cultural practices. This discord, the high cost of participation, and its non-indigenous nature ensure the carnival is an event for uptown locals and visitors.

The norms developed about the carnival tend to suit Jamaica's middle-class values. For instance, the soca/dancehall binary is created to make carnival more exclusionary. In this binary, dancehall culture is stereotyped as violent, highly sexual, and misogynistic, unlike soca's perceived feel-good and inclusive traits. The binary helps to sell the carnival to Jamaicans who subscribe to respectable middle-class values. These values are associated with being wealthy, light-skinned/white, monogamous, attractive, educated, and well-behaved,

which are not typical characteristics of the dancehall and its participants. The division, especially as it relates to women, is captured in an assertion by Cooper:

The freedom of the middle-class to parade its nakedness in the streets is a symbolic acting out of its usual position of social superiority, literally at centre-stage. Indeed, the increasing cost of participation in Jamaica carnival reduces working-class aspirants to the role of mere spectators who find themselves on the periphery of a new decentering drama of social dominance. (1993, p. 189)

Cooper contended that privilege is afforded particularly to middle-class female participants in the carnival, whereas women in dancehall are chastised for doing the same. Although she wrote about these socio-economic and ethnic divisions in the 1990s, those who sustain middle-class values and do not want to identify with dancehall's cultural baggage have always been given a respectability pass during carnival. The release, celebration, and perceived social unity are packaged and sold successfully to middle-class Jamaicans and, by extension, chasers and visitors seeking an escape or safety valve.

Carnival in Jamaica 2022: The Return

Carnival events have all the significant facets that facilitate the spread of the novel coronavirus- large gatherings, close physical contact, and travel. And as a result, Carnival in Jamaica was postponed in 2020 and 2021. Likewise, the physical aspects of all Caribbean carnivals in the region, North America, and the United Kingdom were canceled in 2020 and early 2021. By March 2022, however, with the relaxation of COVID-19 measures in Jamaica and worldwide, it was announced that Carnival in Jamaica would be back from July 1–10, 2022, with the road march set to take place on July 10, 2022. The rebound was necessary, as reiterated in a statement by Kamal Bankay in his capacity as chair of the Carnival Stakeholders Committee:

> We are beyond happy to be able to announce, plan and execute another amazing carnival season for all the CIJ revellers we have missed since 2019. Having the event sector closed was devastating to us all, but we believe there is no better way to officially start summer than with a carnival. Additionally, Carnival in Jamaica is the biggest entertainment and tourism earner for our country, with an economic impact of over four billion Jamaican dollars annually. (Dowrich-Phillips, 2022, para. 4).

Although less than a typical carnival season, the lead-up to the new carnival date saw fetes held in June and July; these were smaller events mostly by local promoters. And after almost two years of restrictions that stymied the enter-

tainment industry, participants welcomed the 2022 fete season. A promoter confirmed that fetes, especially those held during the carnival week, were primarily sold to local patrons as the tourist market was significantly absent (personal communication, July 21, 2022). The promoter added that it was more challenging to market fetes to locals as visitors usually spend more liberally on fetes. Even so, he felt that having a carnival in July increased the popularity of many events among local patrons. He concluded that although there were fewer fetes and work needed to be done to overcome the challenges the pandemic brought to the entertainment industry, the fetes did well.

Another aspect of the fete rebound in 2022 was the noticeable absence of franchise fetes. These are fetes rooted in Trinidad and are then hosted in other carnivals using the same brand and model. A franchise usually involves operating a business under another company's brand and is practical because a market already exists. The franchise of carnival events entails sites importing the Trinidad-style model and brands that mainly target tourists. Franchise fetes are beneficial as they bring an existing tourist market to an overseas carnival. As a result, they typically exclude locals.

The short planning time frame, limited consumer spending, and the absence of tourists resulted in fewer fetes than in previous years. Nevertheless, to the fete promoter's satisfaction, "the locals brought their own vibes to the fete space" (personal communication, July 21, 2022). The local character of the fetes further saw more local fete brands at the fore and local Disc Jockeys (DJs) at the music helm. Also, the absence of franchise fetes gave the local fetes a thrust. This appreciation was reflected in a social media post by a blogger and carnival chaser: "Jamaica carnival is very locally centered this year and I loveee it" (Sandramanjie, 2022). She followed up with:

> No carnival should try to remake what is happening in another country's carnival, so I really appreciate the huge dose of Jamaican culture in its carnival this year. There was no reliance/dependence on foreign promoters. It was #CarnivalInJamaica by Jamaicans FOR Jamaicans. (Sandramanjie, 2022)

The fete rebound focused on the local patron and local fete brands, which may see Carnival in Jamaica moving away from its dependence on franchise fetes.

Although the fetes got support from the local market, the road march was visibly smaller. The absence of tourists played a significant role in the downsizing of the road march. It reached the point when Downtown Carnival and Xaymaca announced they would not participate in the 2022 staging. Xaymaca made the following statement:

> . . . In an effort not to disrupt the original schedules of our sister carnival within the region; which we also know our carnival chasers are already booked for, Xaymaca International will not have our flagship or associated events within the period and we will not be participating in the Road March on July 10. (Xaymaca International, 2022).

The declaration from Xaymaca proved that their preferred masqueraders were mostly visitors or carnival chasers. Consequently, the competition from other established summer carnivals, namely Vincy Mas (St. Vincent and the Grenadines), St. Lucia Carnival, as well as carnivals in Grenada and Barbados, Toronto, New York, and Notting Hill made it difficult for the band to pull off the road march that had been anticipated at their launch in November 2019.

While some patrons were understanding, the comments for Xaymaca's post on the band's Instagram page revealed that others who had registered after the launch in 2019 and early 2020 were eager for word on their refund. A frustrated masquerader commented on Xaymaca's post: "So the ppl like me who paid the money back in 2020, is that money still good for the costumes next year cus that mention was NOT in ur statement n i need to know" (Sassykhadz, 2022). The no-refund policy set by Carnival in Jamaica in September 2020 was put into effect when the festival was again postponed (Xodus Carnival, 2020).

Even though the other two bands, Bacchanal Jamaica and Xodus had fewer masqueraders than previous years, the revelry continued. Xodus estimated they amassed about 3000 masqueraders (Kamal Bankay, personal communication, July 28, 2022), and Bacchanal Jamaica said they had about 1000 revelers (Lyew, 2022).

On its 20th anniversary in 2022, Bacchanal Jamaica stuck to its mandate to offering Jamaicans a "most enjoyable carnival" (Bacchanal Jamaica, 2022). This experience, however, focused on their local masqueraders. One masquerader from the band noted: "I didn't see as many foreigners, but I always believed that Bacchanal was the local's band. And the other two were for the foreigners, especially with how they priced the costumes" (personal communication, July 13, 2022). Another masquerader in Xodus observed a similar situation of fewer foreign masqueraders. Interestingly, the veteran masquerader said this resulted in the late build-up of revelry, as locals tend to lack the party vibe that foreigners bring (personal communication, July 27, 2022).

Soca and Dancehall in Carnival

Soca drives the Caribbean carnival street parade, which is necessary for the revelry, release, and excitement that it portrays. In this respect, the masquerader in Bacchanal praised the dominance of soca played by the DJs. In an interview on the development of Jamaica's Carnival, Robert Ammar Jr., Bacchanal Jamaica's director, declared, "Bacchanal will always be a soca band we are a soca band and I say it unapologetically (Williams, 2019). Not surprisingly, research conducted in 2018 found that 52% of patrons wanted to hear only soca at fetes while 33% preferred a mix of dancehall and soca. In line with these findings, according to the Xodus masquerader, the band kept their commitment to a soca/dancehall fusion on the road in 2022 (personal communication, July 27, 2022). As such, Xodus' obligation to visitors was reflected in their choice of dancehall and soca during the parade.

Although there was a dominance of soca in Bacchanal Jamaica and a fusion in Xodus, the dancehall selections appeased middle-class expectations to stay within the fun mood set by soca. In this sense, another masquerader in Xodus identified Ding Dong's Bounce and Stir Fry, along with Laa Lee and Gold Up's Bird as dancehall songs that stood out on the road (personal communication, July 28, 2022). A DJ previously rationalized to the researcher the limited number of dancehall songs at Carnival in Jamaica:

> Nothing is wrong with mixing up the dancehall with it (soca) once we stay along the same theme of being happy, reveling, and enjoying ourselves. We don't encourage overly aggressive songs. One or two because they are popular. Outside of that, we keep the mood happy. (Personal communication, April 17, 2017).

The happy songs are dancing songs. Walker noted that the dancing songs of dancehall "creates harmony . . . allows creativity . . . and the projection of the pure joy of movement . . ." (2002, p. 62). Likewise, soca creates this kind of joy and release with its feel-good themes backed by groovy and energetic beats.

A dancehall versus soca narrative is prevalent in the Jamaican festival. In this binary, soca is characterized as feel-good music as against dancehall which is characterised as a violent and sexually explicit genre. The fact that. both genres reflect Afro-Creole traditions that simultaneously celebrate and resist is ignored in order to sustain the binary. However, even if limited, the inclusion of dancehall in the road march operates as a modification of the festival by the local carnival destination (Barratt & Cooke, in press). For instance, although

there is a push for soca-only carnival events, dancehall has a significant presence in events such as UWI Carnival and Xaymaca's Beach Cool Down Lyme, which closes the carnival season. This adaptation is not new, as Byron Lee introduced a reggae aesthetic (Brown, 2005) in the 1990s, which made carnival appealing to a larger group of Jamaicans. Likewise, carnivals in diasporic cities with large Caribbean populations like Toronto, Notting Hill, New York, and Miami include dancehall music as these festivals attract not only those with ties to Trinidad and Tobago but anyone with a Caribbean heritage.

Since the late 1990s and 2000s, soca has included more dancehall sounds and linguistic imitations. For example, songs by Bunji Garlin and Machel Montano have a definite dancehall connection. There have also been collaborations with soca and dancehall artistes such as Shaggy, Beenie Man, Vybz Kartel, Konshens, Shenseea, and others, and inclusion of dancehall artistes on soca riddims like Charly Black on Kurt Riley's "Jambe-an Riddim" (2016). Another instance of collaboration is with Jamaican producers such as Nine Mind Entertainment and Lenkey Records for the "Upendo Riddim" in 2018 that featured Trinbagonians Voice, Machel Montano, Turner, and M1. Jamaican artistes performing soca songs is not new since Byron Lee And The Dragonaires' "Tiny Winey" (1984) and Fab Five's "Ringroad Jam" (1985). More recently, Linky First's "Rock and Come in" (2017) and Shenseea's "Play di Soca" (2018) showed Jamaican artistes' easy transition to soca. That being the case, incorporating dancehall in the festival is not a legit source of division, but it is one created to attach carnival to those who can spend to keep out the popular cultural practices among lower-class Black Jamaicans.

Carnival in Jamaica's Return to di Road

The new date for the festival and the short notice affected participation in the masquerade. However, the absence of carnival chasers and tourists had a more visible impact on the road march, which was lukewarm and did not entice the usual excitement among participants and observers. Patrons who had registered for costumes in 2019 were finally able to collect. However, many overseas visitors were disappointed as they could not use their costume packages or receive a refund. Consequently, the no-refund policy left a bitter taste among those who could not attend. This sentiment was captured in a blog post from a carnival chaser based in the United States:

> . . . The drama with Jamaica Carnival 2022 has left a bitter taste in my mouth.

> What's the most disturbing about this whole ordeal is that Xodus has demonstrated they are willing to chess-piece their patrons into eating the risk of their business. While I won't be attending this year, I feel so slighted by this whole situation that I wonder if I'll ever consider going to Jamaica Carnival (American Wines Matter, 2022, para. 12)

The bands, therefore, will have to engage in critical damage control to regain attention from chasers and other visitors from the diaspora for them to return to the road march. Similarly, the same will need to be done to get locals back on the road to achieve what Byron Lee did with Jamaica Carnival. The focus on making the carnival a local festival will ultimately give it a more inclusive Jamaica Carnival feel than Carnival in Jamaica, which is more curated and out of reach.

Applying Kerrigan's (2016) metaphor of the gated community, *Carnival in Jamaica* is a cultural import that houses uptown Jamaicans and those in the diaspora who are enticed by middle-class aspirations. This intentional separation is especially evident in the road march and fetes where ropes and the all-inclusive label are used as a gate to keep others out. Furthermore, although the dancehall/soca binary has been modified to allow for happy dancehall or dancing songs, it continues to assign carnival cultural and social privilege.

In other spaces like the Caribbean diaspora, carnival empowers the marginalized by giving their culture and practices visibility. It is also a tradition that confronts a brutal history of slavery and colonization. On the other hand, Carnival in Jamaica has very little evidence of what Hall (1992) called the underside of everyday practices and traditions in popular culture as the festival has been recontextualized as an elite, high, and foreign culture that excludes Jamaicans. It has been curated into profitable parties and a pretty mas road march or what Nurse (1999) branded as a Trini party accentuated by multi-racial harmony, colorful pageantry, fun soca lyrics, and skimpy costumes. Yet, Hall's declaration must be addressed in the Jamaican context as it is helpful in understanding the positioning of reggae, dancehall, and other Jamaican cultural practices that can be included in the re-imagining of carnival in Jamaica.

The essay argued that the *Carnival in Jamaica* brand under the Ministry of Tourism has transformed the festival to suit tourists from the diaspora while marginalizing locals and local culture. And when the locals are in fact included, the events target only those who can spend or elite Jamaicans. Cudny (2013) captured this phenomenon aptly: "Sometimes certain groups of the town population (poor, ill-reputed) are displaced in order to "purify" the festival space from poor people, who do not fit the positive image of the tourist destination,

created for tourists". The festival, then, has been sanitized to make way for profits. A part of this sanitization includes promoting the narrative that dancehall does not have a place in the carnival put on in Jamaica.

The return to di road in 2022 demonstrated that the tourist-centered carnival model is unsustainable in Jamaica post-pandemic. The model needs to add value to local communities and cultural practices such as dancehall. The 2022 staging generated little incentive for locals to participate as they could not afford it or identify with its meanings. Moving forward, therefore stakeholders and carnival entrepreneurs must revisit and re-imagine a carnival that balances enjoyment, inclusion, and profit.

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Banana or Cho Cho

Food and Sexual Normativity in Jamaican Popular Music

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Abstract

This paper contends that while heterosexual normativity and hegemonic masculinity, dual features of Jamaica's patriarch construct, emerge powerfully in the lyrics of Jamaica's popular music – Dancehall – they have been the subject of serious challenge by the increasingly powerful voices of female singers in the space. Through a potpourri of food metaphors, masculinist norms are both grounded and destabilised. This research spotlights several dancehall lyrics on sex/power relations [such as, but not limited to, fellatio and cunnilingus] vis-à-vis food, spanning roughly 20 years of the music with a view to determine changes in masculinist norms. For balance, the perspectives of male, as well as female singers, and in two instances a male and a female singer are considered. This paper examines the socio-cultural context, decidedly heterosexual, that is responsible for a man being a man, and draws upon the theoretical lens of Linden Lewis and Rafael Ramírez in articulating the expectation of the hegemon, the macho or the masculinist. Figuring importantly, too, are gendered perspectives of female dancehall theorists, such as Carolyn Cooper, Donna Hope, Sonjah Stanley Niiah, and Patricia Saunders. Employing the metaphor of food, an essential to man, not only reveals how deep-seated heterosexual normativity and hegemonic masculinity are, both in the music of the Jamaican people and their psyche, but the great strides of female singers who challenge these masculinist constructs, which are also mythically contrived, as these so-called male foods are not libido-enhancing.

Keywords: Dancehall Music, Food, Hegemonic Masculinity, Heterosexual Normativity, Male Artiste, Female Artiste

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Introduction

Food and sex rank front and centre in human survival and negotiation. Many a cultural expression, instantiated, for example, in holy books, is replete with serious prescriptions and proscriptions on both, as part of a larger identity and separationist narrative of a people. Little wonder, these two elements: food and sex, critical to the perpetuation of humanity and its defining folkloric elements, are bound up with each other in continuing literary expressions and art forms. Jamaican popular music – Dancehall – one such art form, has importantly sought to privilege and authorise heterosexual normativity through food as metaphor. Employing food – a daily staple in the lives of humans, to either validate the heterosexual consensus or allegorise heterosexual expressions, is a trope, compelling as it is humorous in form. Heterosexual normativity – the ideology that ordinary people belong to rigid and complementary natural gender taxonomies (man and woman) – seeks to legitimize heterosexuality. Such sexual orientation invariably situates males as predators while objectifying women. In this male-monopolized cultural space arise several sexual dos and don'ts. Dancehall figures as a fertile ground in which sexual politics unfold. And while the dancehall space is traditionally a male- and masculine-heavy space, several challenges have emerged primarily from an increasing and threatening pool of female artistes seeking equal rights, gaining agency, and ultimately calling for dancehall reading through changing lens.

This paper probes the Jamaican context to ascertain the role of food *vis-à-vis* sex and power relations in dancehall music, and how the trope, still prepared and served mainly by male chefs, is now undergoing surprising female culinary approaches to exude a flavour menacing to male cooks. Firstly, a theoretical conspectus and cultural grounding in a general Caribbean context will provide the framework in which heterosexual normativity thrives and how such a construct contributes to gendered norms and expectations. Key terms are defined in this section. The research taps into food tropes in dancehall music over a period of twenty years, to ascertain any cultural changes and implications for the music. Selecting lyrics that feature male and female sexual perspectives reveals the tension created by both sides of the gender pancake in reinforcing

norms yet destabilising them. While this critique on sexuality in dancehall lyrics, via food, is both literary and ideological, the research really reflects social happenings: "Many contemporary debates around race, gender, and sexuality have been played out in the theatre of popular culture" (Chin 127).

Drawing on male theorists does pay homage to the male-dominated dancehall hot pot on issues of gender and sexuality, but the growing presence of female artistes and the potpourri of challenges they bring, warrant a generous serving of female theorists, namely, Carolyn Cooper, Donna Hope, Stanley-Niaah and Pat Saunders in grounding how sex acts are leveraged through food metaphors. Figuring importantly, too, are local foods touted to make a man a man, and how dancehall music, which reflects the ideology of the people, represents and reinforces these, proverbially, male dietary needs. This paper will further spotlight lyrics of some male artistes, instrumental in grounding hegemonic masculinity in dancehall, while exploring challenges to male dominance by contemporary female artistes.

Cultural Context and Theoretical Frame

Gender specialist, Linden Lewis, traces how Antillean males, licensed by patriarchy,[1] erect a virility-valorising masculinity in opposition to femininity. He defines masculinity within gender relations as both a set of praxes and of ideologies that represent society's interpellation of males as men. Biologically, males recognise their physical difference to females, and seek other men to approve masculine performance. Such endorsement occurs through repetitive engagement in gender norms as cultural expressions. Female approval also figures prominently in affirming manhood: "Few acts are more threatening to men than a public interrogation or ridicule of their masculinity by a woman" (Lewis 95).

Masculinity manifests itself through the powerful, sexual, autonomous male. He decides "where he wants to be, what he wants to do, how he wants to dress . . ." (97). Accordingly, to be male defines physical and inner strength, and independence. Above all, in his ethnological research, Lewis situates the exercise of power and the issue of control at the heart of masculinity. Theo-

1 Patriarchy is a social system with father or eldest male as household head, having authority over women and children. Patriarchy also defines a male-dominated economic, cultural, and political system. In this "man's world," men make the rules, and rule in all fora outside the home. Under this rulership, women should bear children, keep the house, and assist the man.

rist, Rafael Ramírez, agrees with Lewis that men view power as entitlement: "The desire for power is the specific and constituent element of masculinity and the intrinsic essence of the project of becoming male" (237). Male power is strengthened by an androcentric, sex-gender system of binary opposites – male-female, man-woman, masculine-feminine, and heterosexual-homosexual. Upholding these binaries is critical to normalising heterosexuality. The conventional dominant system of power, patriarchy, concedes privileges to masculinity and heterosexuality through homoerotic subordination and the devaluation of everything feminine. Caribbean males generally emerge as powerful, exceedingly promiscuous men known to shun parental duties and having a female-battering propensity.

Male preoccupation with power easily morphs into hegemonic masculinity. Hegemonic masculinity defines an orientation that is heterosexual and decidedly homophobic. This particular orientation valorises sexual conquest, and ridicules men who define their sexuality in different terms. The figure of the macho expresses the archetype of hegemonic masculinity in Spanish-speaking Caribbean islands (Ramírez 254). The macho's heterosexual position rejects male effeminacy. Attributes of strength, courage, and self-assertion all emerge as ideals, "but the predominant characteristic of the macho is power, sexual power, and how he conveys this to women" (254). Ramírez' quotation further solidifies why attributing effeminacy to the macho, or labelling him a queer, undermines him. Masculinist ideology forces males to possess, command, and constantly reproduce attributes of masculinity. For instance, the *macho completo* has male-specific biological traits, the demeanour, symbols, and skills of male-centrism. He wants to know that others consider him a heterosexual, a lover of women. Differently, he can act irrationally like an animal: "To be a man also signifies a continuous demonstration and ratification of a masculinity that is always threatened by the other, because social encounters between males are articulated with power, competition, and potential conflict" (Ramírez 240). The superstud or macho figures as the well-endowed, hypersexualised male. This figure often appears in the Jamaican context and is perpetuated in cultural artefacts of carved images of males with highly disproportionate penises.

Masculinity and Food in Jamaican Culture

Many Jamaican men hold that food is critical in defining masculinity and reinforcing masculinist norms. Since sexual performance critically defines masculinity, there is a heavy emphasis on foods in the male Jamaican diet

purported to increase sexual drive and stamina. Steam fish and okra, peanut punch, irish moss, strong back,[2] cashew banana, ground provisions [like irish potato], manish water,[3] Magnum tonic wine and horse tonic, among others, figure as libido-enhancing foods. However, according to sexologist, Dr. Sidney McGill, "there is no supporting evidence that natural aphrodisiacs such as food or drink actually increase sexual desire" (Quoted in *The Gleaner*). Notwithstanding, such belief pervades the Jamaican culture and is served in the kitchens of Dancehall when artistes like Makka Diamond asks if "the steam fish inna yuh back done already;" Fabby Dolly chants: "Man no drink bag juice pon base, strickly peanut punch fi wine out ma girl waist"; Terro 3000 says "di gyal dem waan da stamina man, mix da guiness and da peanut fi da stamina plan"; and Terror Fabulous remarks his "mix up punch: the milk and the stout and da sinkle bible [aloe vera plant]," and asks "who di gyal dem a cry fa, no di man wid di mix up punch an di stamina." If you are what you eat, then constructing masculinity's sexual prowess from foods without sexual powers presents masculinity as a mythical paradigm.

Male anecdotal responses reflect the depth of the psychological imprint, revealing the extent to which hegemonic masculinity will go to reassert its manhood, even as laughable as it may appear. One of masculinity's central features is that "Men must avoid doing anything that *appears* feminine *in all areas of their lives*, including career, interests, emotional vulnerability, and sexuality [italics mine] (Thompson, quoted in *The Gleaner*)." A comrade of mine who eats the chicken breast, abhors the thigh, located close to the chicken's sex organ and rear; neither does he eat cucumber, for it gives the *appearance* of a dildo and used as such. Some Jamaican men, if they eat a banana, prefer breaking rather than biting it for fear the act evokes biting the phallus, a clear masculinist prohibition. Others exclude cho-cho which evokes the vulva, nor suck the seed of a fruit like guinep, since, firstly, 'seed' is another term for the scrotal sac locally and sucking it seemingly opposes the masculinist agenda. Clearly, masculinists may take real foods to metaphorical extremes to define their reality.

2 Strong back may refer to any concoction in Jamaica that is said to enhance sexual performance. It also refers to an arid medicinal plant with a bitter taste and which features as a natural aphrodisiac.

3 Jamaican soup made with goat head and belly.

Masculinity and Dancehall

Dancehall is the chosen medium of this paper on challenges to hegemonic masculinity because "since the early 1980s, dancehall music and culture has remained the most pervasive and persistent manifestation of Jamaican popular culture" (Hope xiii).[4]

Cooper defended Buju Banton's 1992 'Boom Bye Bye', shooting down the literal gun which, she maintains, should be substituted by 'a symbolic penis' to celebrate a heterosexual man's sexual prowess. Hope remarks that the 90s saw dancehall culture infiltrated with violent symbols, with 'the cold steel of the knife' replaced by the 'warm lead of the gun' (p. 117). With Cooper's work importantly spotlighting metaphor in defining masculinity's revolver, this paper revolves, not only around the male sex organ or the banana but also the female sex organ, the cho-cho, through food as metaphor. Hegemonic masculinity and its brainchildren: homophobia and female objectification easily manifest themselves in dancehall culture. From a tender age, the culture teaches boys to be tough and avoid effeminate behaviour. Gopal and Julien cite the country's former Prime Minister, Michael Manley, who says youths need machismo to survive in the inner-cities, the main breeding ground for dancehall artistes. Hope notes that "an important characteristic of dancehall's dominant male creators is the fact that a significant majority of these men hail from the inner-cities of Kingston, St. Andrew and St. Catherine" (xvi). These dominant male creators were once these voiceless youths now with a voice through music and what Hope calls the videolight syndrome (xv). Understandably, this learned machismo plays out in dancehall. As Saunders notes: "With a dire shortage of 'socially acceptable' yardsticks of manhood, namely the ability to work and provide for one's family and self, many young men resorted to gunplay, literally, verbally, and sexually" (104). Gunplay and violence then become naturalised in male dancehall identity: "The symbiotic relationship between dancehall music and culture, and the social and economic conditions that exist in the inner cities that give dancehall its organic life and creativity play an important role in creating and projecting crime and violence as an important characteristic of a dancehallized identity" (Hope 55). This violence easily informs male lyrical

4 Hope further says: "An examination of dancehall culture, and its representation of Jamaican masculinities is extremely valuable in the quest for a fuller understanding of the gendered structures of power and the play and interplay of hegemonic definitions of masculinity that operate in contemporary Jamaica" (xvi).

sexual expressions. With youths "hav[ing] a fragile sense of their economic prospects, some of them compensate with a hyper-masculinity. Dancehall lyrics urge males to identify their manhood through sexual conquest and domination, which is often reflected in their extreme paranoia about male homosexuality" (Chunnu in "Battyboy must die!"). In Shabba Ranks' song, Dem Bow', "the Jamaican 'rudeboy/ghetto yute' must avoid performing the emasculating rituals of oral sex (with women), which gives away his (masculine) power" (Pinnock 55). Not only is sex with men wrong, there is a right and a wrong type of sex with women, a notion challenged by a growing number of female artistes, even as male artistes endeavour to make their sexual dominance felt.

The Male Farmer and the Female Garden

Dancehall songs are replete with food metaphors that reinforce hegemonic masculinity, which seeks ratification in males as active agents of power. Bounty Killer chants in his song, "Gyal fi get Wuk":

> Gyal fi get wuk any means anyhow
> Some way the gyal dem garden fi get plough
> I have di carrot, devour dem pap chow
> Sink di kin inna dem cho cho now
> Mi mad lakka twenty cow.

Bounty Killer emphasizes male control over a female. The lyrics demonstrate sexual objectification, having sex with women, by any means, and in any position, he chooses. The firm carrot, the male genitalia, he sinks into the cho-cho and pak choi, the female genitalia. The male farmer is "mad lakka twenty cow"—this raging animal, for sheer strength, is the pride and joy of hegemonic masculinity. As Ramírez reminds us, while attributes of strength, courage, and self-assertion all emerge as ideals, "the predominant characteristic of the macho is power, sexual power, and how he conveys this to women (254).

Max Element's "Pound a Carrot" reinforces that the conveyance of sexual power to females must be by a lethal pound of carrot, and a male lacking such lacks much. Such representation perpetuates the myth of the hyper-sexualised black man, the superstud.

> Gyal come fi di, come fi di poun a carrot
> Some boy just full a bag a chat
> Don't falla dem, dem a just Papparat

When dealing with a virgin, Bounty Killer is "mad" when it comes to sex:

> Virgin Island me no pet
> Tell a gyal seh bet
> She mussie[probably] tink seh me have short a bret . . .
> Mi put mi big fat plantain inna dem basket
> Mi mad when it com to sex

Here, the macho believes that sex with a woman should be rough and painful with his big fat plantain in her basket.

Serving the Meal in a Balanced Way

While songs like Bounty Killer's privilege female sexual objectification, something negative, females are challenging that notion, saying they positively want their gardens ploughed and with a big plough, with even male artistes acknowledging the demand of and therapy to women.[5]

Fabbi Dolly, in his song, "Peanut Punch," sings:

> When the girls dem want di sweet juice from the long cane
> Tranquilise dem body and sturbilise dem brain

This long cane and sweet juice are therapeutic for women. He avers that women want them for their calming effect,[6] even while he is proclaimed "best wukka[worker] man".

Goofy, in his song, "Fudgie", highlights mutual satisfaction with the sweetness he brings.

> Here comes fudgie
> Gyal from all bout seh dem love di nutty buddy
> Here come the fudge man with a box of satisfaction…
> And inna da boiling sun, any which part him tun
> Di woman dem a run him dung
> Dem waan di icecream fi mek dem body shake
> Icicle pan stick fi mek dem rail and kick
> Most a dem she dem waan di choco bar
> Cuz dem waan fi see twinkling star

5 Sizzla's song, "Pump up har pum pum," is presented as a female desire, as the line says: "She waan you pump up har pum pum, she want you "'ram it up, rhum."

6 In fact, Sizzla's song, just referenced above, says "di woman want you fi pump up har pum pum."

The fudge, nutty buddy, icicle, and choco-bar are all ice-cream-based delectables Jamaicans know. The nutty buddy evokes the male genitalia, also known as "buddy" locally. This man's best friend is the sweet friend of women and provides them a box of satisfaction, as they "run him dung [run after him]" despite "the boiling sun."

In the video which accompanies her song, "Banana", Jada Kingdom parades in a ripe-banana-coloured vehicle and phone of same colour. In the video, she rejects the small banana served for a sizeable one. She is happy and only then embraces the man, a stately figure.

Mi wan my fruit, that banana
Time fi get loose, give me wha mi waah nuh
Mi waah my fruit, that banana
Nah stop screw, want do wah mi wanna

Kingdom wants a nightly dose of the fruit and prescribes how she wants it:

Love when yuh circumcise enuh
Peel it off, ah so mi like it yea
Wan fi ride it off nightly yea
Slide it right up inside me yea

Macka Diamond, a female artiste, employs the cow foot, a delicacy from one of the largest land animals in Jamaica to demonstrate her size preference:

Maas John mi a beg yuh sell me two pound a you cowfoot
Because mi roun a Mista D a fi him cow foot too small
To how mi vex, mi man fear how mi look . . .
A no di one inna di pot weh a cook
Mi no want no chicken foot
Mi no want no goat foot, mi waan mi cow foot
Dis yah cowfoot yah hot an long till it bend

The female artiste refuses Mr. D's small cow foot and gets angry when she can't get the right size. The cow foot is the most elaborate motif employed, and sexual preferences through female lens. The kick sedates her into sleep, and awakes mesmerised by the indispensable cow foot:

Di cow foot weh kick me til me weak
Mi fine bed an drop asleep
Mi wake up, wonda how di cow foot dweet
Di cow foot nearly stop mi heart beat
Das why me can't live without mi cow foot

Not only are female artistes claiming a space for how they want to be served their banana and cow foot, they are putting forward their cho cho as valuable, equal and complementary to the male foods.

Female chefs on the rise in Dancehall Kitchens

While the male phallus has ruled the dancehall space, female artistes and their increasing presence have elevated the female sex organ, calling for a levelling of the playing field. Pamputtae's "It good" says of the vagina:

> It good it good it good it good good good
> So him a seh wen him a wine pon da hood . . .
> Jus like dat a so mi keep it tight
> Likkle an teenie a dat man like

The emphasis on how good the vagina is, is seen in line one's repetition. She lists the qualities accounting for its goodness, being small and tight and what men like. Notice, while men are valorised for a big penis, Pamputtae proffers the tight vagina to be valorised in its own rights.

> Shaneil Muir's "Phat Phat" adds another layer:
> Dis yah pussy full a luck inna it . . .
> True me have di
> Ighty-tighty
> Buff Almighty . . .
> Me have di
> Phat Phat
> Me Tight Phat Phat

These words clearly exude pride with her "tight phat phat, tight phat phat," that she has elevated to divine status, calling it "buff almighty", which now equals the kingly representation of the phallus on the other side of the pancake. Elsewhere, she compares it to the Porsche, unstoppable.

Spice's "A so mi like it" notes:

> Bum pon di buddy head
> And mi wi buss it like a bubble
> Skin out mi pum pum
> Pon di buddy mi a wine an a bum bum bum

While male lyrics may tend towards sexual violence, mirroring male-monopolised vernacular of "stabbing," "nailing," and "slamming" Chevannes

notes in his study about becoming a man, expressions like "buss it" in this song, "bruk it off",[7] "cut up you cocky like cutliss"[8] by females are increasingly rivalling the dominant male vocabulary.[9] Spice is the active agent here, 'wining on the buddy head', and celebrates by "skinning out her pum pum," much in solidarity with the lyrics of one of dancehall female elder artistes, Lady Saw. Cooper argues how "dancehall culture provides feminist empowerment . . . and female artiste Lady Saw's explicit sexuality emerges from or is an extension of West African tradition of female empowerment, contained in sexuality rites" (Quoted in Hope xiv). Following in a parallel direction, Stanley-Niaah notes how Dancehall through its dancing performance, such as the slave ship dance or limbo of 1664 re-emerges in 1994 as a dancehall move, a body celebrating performance (103). Both lyrics and performance therefore combine for a larger identity politics that pay homage to the motherland.

The treatment of another type of sexual intimacy, oral sex, provides much insight into the changes Dancehall has undergone and the less than firm grip hegemonic masculinity has in this space.

The Oral Food Challenge

Dancehall music has undergone radical revisioning in its treatment of oral sex, known as bowing. "Dancehall was about not 'bowing'. Nobody wanted you to 'bow'. A man didn't want to accept oral sex or give it. It was just a huge no-no in dancehall, and it was taboo because Jamaicans had not yet got to that stage with sexual practices where they were willing to think about the mouth being connected to the sexual organ" (Hope in "Licking Down Barriers," *The Jamaica Observer*). Shabba Ranks expresses this posture in "Dem Bow" and invites death upon the 'bowcat':

7 See Macka Diamond's "Tabanka."

8 See Ishawna's "Equal Rights," dealt with later in the paper.

9 See Spice and Kartel's "Romping Shop" for a greater levelling of the sexual playing field, with the force of Kartel's responses equalled and, arguably, in some cases, surpassed by Spice's retorts. For example, Kartel's "Hey, cocky nuh play, mi wi bruk yuh back" is met by Spice's "Mi wi quint it up two time and pop yuh cock." Kartel's "mi wi mek you run out a mi house inna half a frock" is overtaken by Spice's "A gyal eva ride pon it and giv you heart attack?" Both come to recognise the power each brings to the sexual table as Spice's confession: "Kill me wid di cocky", is followed by Kartel's: "Kill me wid the tightness." In the performance of the song, the line "I can't stop fucking you" is sung by the two and not Kartel alone, jettisoning the notion of the main verb as solely a male function.

"Raga daga dap[gunshot] inna bow cat head top . . .
Man under table mi say dat him bow
Gyal a clean rifle mi say dat she bow . . .
A man a eat fur, dat mean say him bow."

The fur is sometimes a shortened form of fur burger [the vagina]. The strict masculinist dietary prohibition is quite clear. Cobra in "Not Dis Face" adds his venom, saying

From no gyal cya call you furniture face,
Not dis mout not dis face . . .
From you know you conscience nah carry no weight
Not dis mout, not dis face.

The issue is a seriously moral one for him, knowing his conscience frees him of the oral act. Spragga Benz' hit song 'Cyaa Get no Gyal' says of oral sex: "What a nastiness, like we betta change di national dish to Jackie and Saltfish". In her commentary on this song, Saunders, in *Buyers Beware,* reads Spragga's song as suggesting that women are a culinary treat for some men in Jamaica who are unable to handle the wuk[copulation] due to premature ejaculation and sexual dysfunction.Masculinity's insistence on oral sex as food poisoning is relaxed with the passage of time. Dancehall culture has grown to normalise fellatio. Beenie Man's "Wickedest Slam" says:

"Men, if you never get you pedal and wheel
And if you never have your banana peel
Man if you want fi know how good loving feel
Yuh better try a girl weh live a Maxfield".

Men should access girls from Maxfield, a metonymy for ghetto areas, and who are adept at "peeling the man's banana" or doing fellatio. In the late 1990s, Baby Cham sang: "A which gal a jump and a say she naa suck/Right ya now a that run the cut. . . . yeah!" This song along with Vybz Kartel's celebration of "freaky gyal dem" and the latest and probably most elaborate being Brysco's 'Code': "Backroad gyal suck it wid di ensure [a food drink]" signal a paradigm shift in the male diet. This oral shift runs parallel to a larger identity shift Hope identifies in expressions of dancehall masculinity towards a "feminized aesthetic", one which includes "regular visits even by the most hardened ghetto youth to cosmetologist for facials . . . and regular visits to salons for hair care" (125). Though Hope has identified this "softened variant of dancehall masculinity", males maintain their seemingly hardened upright posture in their lyrics

while only women figure as going under the table. Saunders in *Buyers Beware* reads many dancehall songs as attributing oral sex influences to foreigners, saying that "go farin" is "also to travel a metaphorical distance away from what is sexually accepted at home in Jamaica, the implication being that 'sexual deviance' is the result of foreign influence." Dancehall now finds itself in a precarious position in which it is trying to hold on to its "values" yet holding on to the benefits of "farin" to the space, a case of wanting to have its cake and eating it. Something, apparently, "got to give".

Through the lyrics of Lloyd Lovindeer and Lady G, a discussion ensues where the female artiste carefully tests the waters to see if the tables can be turned from fellatio to authorising cunnilingus. In this song, "Yuh eat?", food and sex are so inseparably linked in local culture that the Jamaican question "you eat" means: Do you engage in cunnilingus?

> Lovindeer: Weh yah seh, Lady G, Yu ready fi mi?
> Lady G: How you mean if me ready? You betta mek sure seh you ready, Mr Lovindeer
> . . . a talk bout how much you waan di wuk . . .
> Mi fit an mi ready fi run di marantan wid a adventorus energetic man
> So baby before wi start di action you betta answer di question
> Lovindeer: Whats dat?
> Lady G: You eat?
> Lovindeer: You cook?
> Lady G: How you fi answer question wid question?
> Lovindeer: Mi jus waan mek sure mi no answer you rong.

Her question to him "you eat?" speaks for women who welcome cunnilingus, a no no for dancehall male artistic expressions, which refuse to stoop below cultural expectations of a man. The cautious Lovindeer 'literalises' his response by asking: "You cook? As if, how dare you ask me, a man, if I engage in oral sex, signalling a refusal to bow.

Contemporary female dancehall artistes, however, have now boldly included the fur burger on the dancehall menu and invite male patrons to eat. This is revolutionary in its challenge of the dominant patriarchal serving in asking, in public language shocking to masculinists, to have their cho-cho eaten, licked, and sucked. Cecile's "Do it to me" outlines:

> Bwoy stop lie, truth yuh fi speak
> Bwoy nah fi hide cau mi know yuh a freak
> Gwaan use yuh tongue cau mi love when yuh dweet
> Weh mi a lie fah? love di man dem weh eat

Clearly, this is an affront to hegemonic masculinity, in dubbing the masculinist a freak, a term only males, like Kartel, apply to women. This herbivore-turned-carnivore label would not go unpunished: "That song killed CeCile's career. She can say what she want to say but they blacklisted her on sound systems; the (selectors) refused to play her music, she was not booked for shows because the people who were running the industry were men and they felt that she had breached a law, a sexual law," (Hope in *The Jamaican Observer*). But other female artistes saw hope in Cecile's challenge to the system. Ishawna, by way of example, calls for "Equal Rights" in a dancehall space of unequal gendered power relations as she maintains what is food for the goose should be food for the gander, and has asked that two important drinks, one local [bag juice] and the other international [pepsi] be added to the mix, in effect, saying that hard foods are complemented with soft drinks:

> Bumper to your forehead
> Show me wha' your tongue can do
> If you nuh have it inna waist, you better have it inna face
> Bright enough fi a look gyal fi shine you
> And you nuh waan taste?
> Treat me like a bottle of Pepsi
> Your back nuh have no use and your face look cute
> Deal with me like a bag juice
> Mi say, equal rights and justice
> Nuff ignorant people a go cuss this
> Mi pussy tight cut up you cocky like cutliss
> But if you waan head, my youth, you haffi suck this
> Mi love it wen di man dem move up
> A nuff man have dem good tongue a save up…
> Mi no fraid a nuh baddy
> Who no like me dem fi bite me

The 'bumper to the forehead' is a rough blow to the public image of the male. Here, Ishawna declares oral sex should be mutual but hits hard at males in suggesting "if you nuh have it inna waist, you better have it inna face," that is, if you can't dweet [have sex], then you should eat. Any opposition or backlash by masculinists, who should enjoy her like one does a bottle of pepsi or bag juice, is dealt with when she renders them 'ignorant.' She stands behind this daringly bold stance expressing, in the penultimate line, fear for no one and declares with a paronomasia: as a matter of fact, if you don't like me, come and bite me.

Then from Ishawna's bag juice and Pepsi is Shenseaa's song "Lick" with her ice-cream, icicle and lollipop-riddled video.

Lov big dick but dat no enough
Mi waan mi pum pum[vagina] suck suck suck…
Am a queen
So boy go dung pon you knees…
Mi waan siddung pon you head, pon you mine
You fi dine dis break, lunch and dinner time
Lick lick lick

The tables are incontrovertibly turned. The men are now the subjects in Shenseea's queenly narrative who must bow and go on their knees to eat. She wants total manipulation of their heads as shown in her hyperbolic stance of wanting to sit also on their minds, and normalise the act, making it a breakfast, lunch and dinnertime snack, a novelty for her subjects. The verb 'suck suck' also reminds Jamaicans of the noun by the same name, a type of bag juice drunk or eaten from bag to mouth, primarily by sucking. While the male sexual organ is the *sine qua non* of hegemonic masculinity in the display of prowess, Shenseea's "Lick" elevates the vagina and is saying in the first two lines, if there is no licking, something is lacking. Pat Saunders, in "Is Not Everything Good to Eat Good to Talk", contextualises this bolder stance by women: "With the advent of increased economic avenues for women to secure some measure of economic stability for themselves, women have become more independent and, according to many songs, more demanding sexually" (103). But Ishawna adds to Saunders' intervention by stating that it's "modern times, it's okay", in essence calling for razing barriers that characterise the Postmodern era, leaving hegemonic masculinity in the shadows of the distant past, ancient, suggesting its reducing relevance now. Saying "she love wen the man dem move up" is further telling these males to get with the times. As Stanley-Niaah puts it, noting a similar shift in perceptions to "nastiness": "Today, tolerance levels have changed and some of the song lyrics are aired without any censorship as a sign of changes in the conservative broadcast standards" (10). Where such changes relate to female liberation, Saunders is suggesting that the patriarchal status quo, with men as sole breadwinners and women, keepers of the home, is dated. The rising presence of female artistes is itself threatening to Dancehall masculinity as "women's bodies are the site for articulating wealth, national prosperity, and lyrical and sexual prowess. Second, women are the bearers of the nation, both figuratively and literally . . . [and] women make up a large portion of dancehall audiences, and their presence makes both the state and the church most uncomfortable socially and economically" (Saunders 105).

The watershed moment for Dancehall would be for male artistes to declare

they engage in and enjoy cunnilingus. Though embattled, hegemonic masculinity is currently holding strong with this last strand. Actor, Bad Boy Trevor, who was videoed engaging in the mouth act in the early 2000s believes this grip will go, as he told the *Jamaican Observer:* "People are singing about stuff they like. I am happy that there are so many openly freaky people in Jamaica. Male deejays are singing about threesomes, getting head and so on. Dem time deh when so much artiste a bun out dis and dat, we never as educated as we are now." This shift Hope attributes to rising world influence on Jamaica: "Jamaica does not live in an isolated world and things have been evolving around the globe; for better or for worst, for good or for evil and the artistes have to evolve with it" (*The Observer*). For refusing, in song, to move with international trends in authorising cunnilingus, many have identified this posture of male artistes as hypocritical, presenting what this paper calls "masquerading masculinity" in which the public image of the male runs counter to his private practice; as Cecile says: "Boy you fi stop lie." In essence, "man up and admit to eating." Stanley-Niaah puts it best, saying "dancehall identity is contradictory, competitive, as it is simultaneously sacred' (115).

Conclusion

Patriarchy and its masculinity strands have provided the fire and much of the ingredients in the serving of Jamaican popular music, Dancehall, nationally and internationally. Much as humans are peculiar with food and resist having anything tamper with what they eat, heterosexual normativity and its cater-cousin, hegemonic masculinity, will naturally fight to defend their status and maintain the dominance needed for survival. But this fight is an increasingly difficult one for patriarchy to maintain in Dancehall and in this battle, hegemonic masculinity is becoming more and more embattled and losing the battle on certain fronts.

Primarily through the trope of food with its strong mythical hold in defining and maintaining hegemonic masculinity, this paper has shown how this patriarchal thread has supported its foundations on make-believe, the fabricated and the non-existent. With food at the core of any culture and feeding any belief, it is no simple feat when hegemonic masculinity, through the lyrics of dancehall, aligns its sexual prowess to food having no scientifically proven libido-enhancing properties. In this respect, hegemonic masculinity's claim to fame in its fabulous position in Jamaican culture, is exactly that fabulous, fabled and accordingly, loses credibility. When males within the local culture

take masculinity to extremes, insofar as food is concerned, and refusing to eat certain foods for fear of being associated with the female sex organ, this posture, many may view as ridiculous, in effect, a mythical masculinity, the phallus in the 'phallusy'.

While the lyrics continue to feature female objectification, some may view it as a step in the right direction that male voices are now having a balanced discussion, recognising the mutually important role both males and females share in sexual intercourse. Since the dancehall space is a male-created one, sexual concessions by males importantly undermine hegemonic masculinity in the space. What is more, changing economic conditions have caused more women to penetrate the once male-monopolised space, causing a reconfiguration and hence destabilisation of the space. These female artistes, by their very and even more so growing presence, present a threat to the status quo of masculine dominance. With greater economic power, women become increasingly independent with stronger voices, and their robust additions to the lyrical menu are a reflection of greater empowerment to these women in the larger society.

With greater empowerment, female artistes are demanding equal rights through their lyrics. While the male phallus has been the weapon at the disposal of male sexual domination, women are increasingly valorizing their sex organ, and in one instance elevating it to the level of the almighty, asking that senior respect be given it, even debunking the notion of a male-monopolised vernacular, by tapping into similar terms and projecting them back on men. While the presentation of rough sex with big and long bananas and carrots by males figure as female sexual objectification, many female artistes are challenging that notion, asking that it be viewed through female lens, maintaining that therapy and deep satisfaction are to be derived by females whose cho-cho enjoy taking in and digesting any cow foot, carrot or banana. In other words, some female artistes in negotiating sexual intercourse between males and females present the exchange both as complementary and complimentary to both.

Possibly the greatest or most elaborate demand for equal rights is the radical treatment of oral sex by female artistes. It is in this regard that patriarchy has suffered one of the most lethal blows. The literary history of dancehall music has revealed strong taboos on the sex act in the early days, both for men and women. Then in a twist that shows the Jamaican culture is not immune to westernization, men started to legitimise oral sex, namely, fellatio, in song. Male artistes, to date, refuse to give legitimacy to cunnilingus in the music, which is where women, the other players in the bedroom are telling their truth as they know it. The most daring intervention came from Cecile, whose career died

so that others like Ishawna's and Shenseea's could live. Cecile's martyrdom has shown that hegemonic masculinity is still a force to reckon with and the extent to which it will go when threatened with perceptions of emasculation. While male artistes have presented themselves as kings, their female counterparts have men now bowing to them, rendering them subjects and catapulting them in the very positions they represented women. Given, though, how palatable fellatio has become in the music, from a point of total prohibition, many feel that Dancehall is on a trajectory to have male artistes confessing to eating the furry burger. But as long as this does not happen, patriarchy will continue to foster a masquerading masculinity, a form of Janus-facedness that reveals the hypocrisy among male artistes. If female artistes in song, along with ordinary men and women in the culture all agree that cunnilingus is a common meal in the bedroom and one enjoyed by men, then male artistes are presented with a serious challenge, sticking out as a sore thumb. A similar duplicity is found in the treatment of male homosexuals, where artistes, to assert their dominance, chastise homosexuals when some of these artistes are engaging in the act behind closed doors. In these cases masculinity appears to be in crisis and lacks a stable identity, much as masculinity for most men in the inner-city is born out of lack of poor male figures and a surrounding that valorises young boys having sex with girls and women even with these males not reaching the age of consent.

This dynamic space has crossed or transgressed many boundaries and within the digitized, technological era of the global village, it is left to be seen how much more the space will evolve.

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Using the Design Science Approach to Develop and Analyse the Effectiveness of Text Mining Techniques to Detect Malicious Activities in Chatlogs on Social Media

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Abstract

In today's digital era, use of the internet and social media is growing rapidly and equal to this growth are cyber-security breaches. The continuous growth in the use of the internet, the ease of access to online communities like social media, have provided new ways of committing old crimes and also creates novel ways of committing crimes. Finding a response to this problem has proven to be a challenge. Recently, machine learning techniques have become more prevalent in investigative fields and have been applied in investigating potential malicious activities over the internet. The advent of big data and the unstructured nature of this data have resulted in heightened interest in natural language processing. This study investigated how machine learning may be employed in the social media domain to identify malicious activities. A Python dataset was used to evaluate three text mining classification algorithms: Support Vector Machine (SVM), Naive Bayes, and Decision Tree. These algorithms were compared in relation to their accuracy, precision, F-measure, and recall statistical criteria. Based on the findings, SVM was the most efficient technique.

Keywords: Cybercrime, Cyber-security, Text Mining, Social Media, Twitter, Support Vector Machine (SVM), Naïve Bayes and Decision Tree.

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Introduction

In today's information age, social media is the medium of choice for social interactions and basic communication. Social media is a highly interactive platform, users can create, co-create, modify, discuss and share content (Alami & Eleqqali, 2015). Connection to the internet and the use of social media is growing at a faster rate in developing countries than in developed countries. However, developing countries have weaker safeguards and this makes them more vulnerable to cyber-crime than developed countries (Gereke 2011, 2009, Salifu, 2008). With a wide range of social media applications/social network platforms such as Facebook, Twitter, WhatsApp and WeChat, communication has never been easier (Ngejane, Mabuza-Hocquet, Eloff, & Lefophane, 2018). Many people have taken advantage of the convenience that social media presents, and equally cyber criminals have capitalized on the open nature of these networks. Researchers points out that the ease at which data/information can be accessed on social media it has become the platform of choice for malicious people who have moved to cyberspace to discover their next victim (Alami & Eleqqali, 2015). Research indicates that developing countries are connecting to the internet at a much faster rate than developed countries and their weak safe guards makes them they are more vulnerable and they are affected more by cyber-crime than developed countries (Gercke, 2011, 2009, Salifu, 2008).

Anomaly detection techniques can detect most known attacks against a network (Omar, Ngadi, & Jebur, 2013). Despite the drawbacks such as the system complexity, high false alarms and the difficulty of detecting which event triggers those alarms, anomaly detection is able to detect unknown attacks (Omar, Ngadi, & Jebur, 2013). Techniques such as automatic anomaly detection requires less human intervention which is a practical approach to achieve the next generation of intrusion detection systems (Omar, Ngadi, & Jebur, 2013). The increased use of the internet and the ease of access to online communities there is a need to identify ways to identify activities of malicious users, anomaly detection techniques can assist in this regard (Özel, Akdemir, Saraç, & Aksu, 2008).

The aim of the study is to analyze chat logs which includes replies, retweets, comments, likes, and posts by using three (3) different classification text mining algorithms to determine which is most efficient in accurately detecting potential criminal activities in chat logs. The proposed approach compares Naïve Bayes, Support Vector Machine and Decision Tree.

Purpose of the Study

The purpose of this study is to analyze the most efficient text mining algorithm that can be applied to assist in detection of malicious activities in social media (Twitter) chat logs.

Significance of Study

This study has both theoretical and practical significance. Theoretically, there is a paucity of study in relation to cybercrime and its effects on developing countries. The lack of resources both human and capital in the developing regions makes them more vulnerable to cyber-attack (Gercke 2011, 2009, Salifu 2008). This study will add to the body of knowledge that currently exists regarding the use of text mining techniques to detect suspicious activities in cyberspace (chat logs) that are embedded within social media platforms. Practically the findings of this study will provide a framework that if implemented could assist with the identification of potential cybercriminals with a high degree of accuracy and efficiency along with several recommendations for future development. This study can be very beneficial to law enforcement agencies and policy makers in developing countries. Despite the implementation of the Cybercrime Act 2015, crimes in Jamaica's cyber-attacks continue to grow.

Research Question

To what extent can machine learning techniques (Decision Tree, Naïve Bayes, and Support Vector Machine) assist in identifying potential criminal activities based on social media posts?

Literature Review

Introduction

This section looks at literature relevant to this study, including techniques that are used and the ones proposed for use in this study and the benefits and drawback of these methods.

Growth in the use of Social Media

According to Statista[11] a survey was conducted that revealed for 2018 social media users were projected at 2.62 billion with a potential increase in 2019 at 2.77 billion. Social media sites can be describing community-based websites, online discussions forums, chatrooms, and other social spaces online (Gupta, Singh, Kumari & Kunwar, 2017), a few well known social media sites are Facebook, Instagram, Twitter and LinkedIn. The essential part of obtaining an account by most users is to share ideas, photos, videos, comments, and to inform others about online or real-world activities. Adults also use social networking sites to connect/reconnect with family and friends (Subrahmanyam, Reich, Waechter & Espinoza, 2008). Social platforms also facilitate connection with new people based on a mutual connection or established criteria.

Ease of Committing Crime on Social Media

The Internet is a global system of interconnected computer networks that has revolutionized almost every aspect of human lives. The rapid development of the Internet has allowed entire industries to move their operations online. The Internet has enabled the development of social media (Alanezi, 2016). Social media has no doubt become an indispensable tool in human usage. With its borderless nature, social media allows people to share content worldwide. However, many people have used this feature to commit online crimes (Alanezi, 2016). Online crimes pose danger to society just as crimes committed in real life (Alanezi, 2016). Online crime is sophisticated by nature and as such, it allows online perpetrators to coordinate their actions and even merge into organized crime groups (Alanezi, 2016). With social media, concealing communication and identification have been made easy. The number of online crimes continues to rise and is estimated to exceed billons of US dollars internationally (Alanezi, 2016). Therefore, despite social media proving its usefulness and effectiveness, it is also a medium for perpetrators to victimize users and as such, it is important to develop an effective framework that will help to detect malicious users and their activities in cyberspace.

1 Statistahttps://twitter.com/StatistaCharts?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor

Anomaly Detection Techniques

Anomalies done through social networks can imply irregular and most often illegal behaviours. Detection of these anomalies, have made it easier to identify malicious individuals, including spammers, sexual predators, and online fraudsters. There are three main machine learning techniques for anomaly detection; (1) Supervised, (2) Semi-supervised and (2) Unsupervised (Akoglu, Tong & Koutra (2015); (Omar, Ngadi, & Jebur, 2013).

Anomaly is not only limited to be detected using either a supervised or unsupervised technique. Community detection can also be utilized since people tend to build relationships based on their similarity and common interests. This behaviour stands true in online social networks (Yang, Y., Y.C. Guo, & Y.N. Ma, 2010). In this form of detection, the authors examined users' super-egonets, to give sufficient information to find any similarities and common interests between their friends by examining their connections. The pattern of communities between friends of friends also can set rules that help us to spot anomalous users (Yang, Y., Y.C. Guo, & Y.N. Ma, 2010). It is critical that methods of anomaly detection in social networks are developed to coincide with developments in usage of social networks (Nayak, Hassanzadeh, Reza, Richi, &Stebila, Douglas, 2012).

Machine Learning Using Classification Algorithms

According to Ghahramani (2004), Machine learning (ML) is a wide interdisciplinary field which builds upon concepts from computer science, statistics, cognitive science and many other disciplines of mathematics and science. Machine learning entails several applications, but data mining is the most significant. Machine learning can be classified in two broad categories such as supervised and unsupervised machine learning (Soofi' & Awan, 2017).

The classification problem is classifying an object into a particular group, "The classification algorithm is used to discover a model for the class in terms of the remaining attributes. The objective is to use the training data set to build a model of the class label based on the other attributes such that the model can be used to classify new data not from the training data set" (Ghosh, Roy & Bandyopadhyay, 2012).

Classification models:

The models that will be used are as followed:

1. Naïve Bayes classifier

2. Support Vector Machine
3. Decision Tree

Classification Using Naïve Bayes

Naïve Bayes is a simple and easy technique for classification (Ardhapure, Patil, Udani & Jeta, 2016) based on the Bayes theorem of conditional probability and strong independence assumptions. The purpose of the Naïve Bayes classifier, it calculates posterior and prior probabilities to find the class. "This classifier emphasizes the measure of probability that whether document A belongs to class B or not. It is based on an independent feature model. It assumes that occurrence or non-occurrence of a particular attribute is unrelated to the occurrence or nonoccurrence of a particular attribute" (Sheshasaayee & Thailambal, 2017).

Bayes Theorem:

$P(A \mid B) = P(B \mid A)\, P(A).\, P(B)$

Where:

P(A|B): the conditional probability that event A occurred. Posterior probability
P(A) and P(B): probability of A and B without regard for each other.
P(B|A): conditional probability that event B occurs, given A has occurred.

Classification Using Support Vector Machines

Text Classification has become one of the key techniques for organizing online information such as document databases, filter spam from people's email or learn users' news reading preferences (Joachims, 2002). According to Vapnik (1995), Support Vector Machines are based on the Structural Risk Minimization principle form computational learning theory. SVMs are very universal learners. In its basic form, SVMs learn linear threshold function and by simply adding the appropriate kernel function, it can be used to learn polynomial classifiers, radial basic function networks and three-layer sigmoid neural sets (Joachims, 1998). There are 3 properties of text namely, (1) High dimensional input space, (2) Few irrelevant features and (3) Document vectors are sparse and SVMs has acknowledged them (Kivinen & Warmuth, 1995). SVMs measure the complexity of the hypotheses based on the margin with which the data, not the number features (Joachims, 1998). This makes it possible to generalize even if there are many features available and the data is separable with the wide margin using functions from the hypothesis space.

Classification Using Decision Tree

According to Patel, Prajapatiand Lakhtaria (2012), the decision tree is a flow chart like tree structure, where each internal node denotes a test on an attribute, each branch denotes an outcome of test, and each leaf node holds a class label. The topmost node in a tree is the root node. Decision tree learning uses a decision tree as a predictive model which maps observations about an item to conclusions about the item's target value. "Decision tree learning uses a decision tree model to anticipate and maps out the observation of an item and draws a conclusion about the target value "(Sharma & Kumar, 2013).

Related Text Mining Frameworks

Presented below are three different types of text mining used for classifying chat logs data, which are similar to the work presented in this research. The first, fromÖzel, Akdemir, Saraç, and Aksu (2008), employed the following text classification methods: Support Vector Machines (SVM), decision tree (C4.5), Naïve Bayes Multinomial (NBM), and k Nearest Neighbors (kNN) to achieve accuracy in detecting cyberbully in the dataset gathered from Twitter (Özel, Akdemir, Saraç, & Aksu, 2008). The second, from Khangura, Dhaliwal, & Sehgal, (2017), used Support Vector Machine and Genetic algorithm to analyze chat logs. Finally, Alami & Eleqqali (2015) proposed the calculation of a similarity distance to distinguish suspicious posts for detecting suspicious profiles.

Özel, Akdemir, Saraç, & Aksu (2008) used Support Vector Machines (SVM), decision tree (C4.5), Naïve Bayes Multinomial (NBM), and k Nearest Neighbors (kNN) to detect posts with cyberbullying content by gathering dataset from Instagram and Twitter messages. The Naïve Bayes Multinomial (NBM) was the most successful classifier in terms of both accuracy and running time. All classification accuracy improved when feature selection is applied except the C4.5. The research was the first to use the Turkish text messages as dataset to detect cyberbullying (Özel, Akdemir, Saraç, & Aksu, 2008). However, two shortcomings that were evident from the research are that the dataset could have been larger and several other preprocessing steps could have been applied.

Khangura, Dhaliwal, & Sehgal (2017) used Support Vector Machine (SVM) and Genetic Algorithm (GA) for optimization to identify suspicious activities in chat logs. In their proposed framework a supervised machine learning classifier – Support Vector Machine – is used to classify the different suspicious activities based on the keywords. The concept of genetic algorithm is used to

get the optimal result as well as the identification of the user profiles associated with the suspicious activity. The proposed approach shows that the SVM classifier gave an accuracy of only 65.4% while the SVM and GA gave an accuracy of 74.3%. Therefore, the results obtained from genetic algorithm showed more accuracy than the results procured by SVM classifier.

Proposed Text Mining Framework

The proposed approach incorporates Naïve Bayes Multinomial (NBM), Support Vector Machine and Decision Tree. The purpose of this approach is to determine which classification algorithm would be most efficient regarding accuracy and execution time to discover whether there is a potential cyber threat.

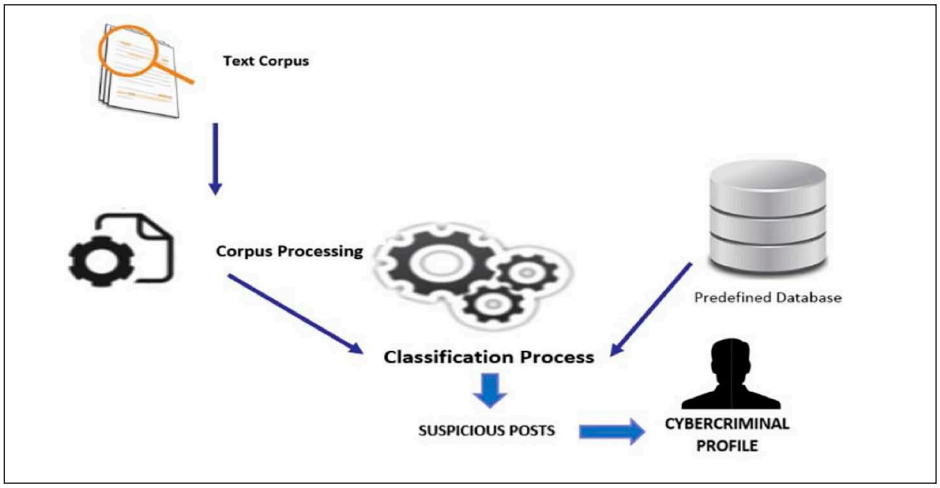

Figure 1: The proposed approach (Alami & Eleqqali, 2015)

Methodology

Design science is a qualitative methodology, and it is central to what information system practitioners and researchers do. Design science is a technology-oriented paradigm that has its foundation in the sciences and engineering. Generally design science focuses on: build and evaluate (Von Alan et. al. 2004, Nugrahanto & Morrison, 2008). Where build looks at the development of an artefact to meet specific requirements and evaluate is concerned with how well they achieve the intended purpose and contribute to knowledge. Design science brings together technology-based artifacts that can be classified as instantiations, constructs,

methods or models (Golding & Donaldson, 2009, Pries-Heje, Baskerville & Venable, 2008). Design science aims to simplify a problem and build artifacts that are referred to as human-machine with the intent of "supporting operations, management, analysis, and decision-making activities" in organizations (Hevner & Chatterjee, 2010). Hevner & Chatterjee (2010) points out that the goal of information systems (IT) researchers is to provide innovative IT solutions that solve problems and demonstrate how these artifacts work. An evaluation of them should outline the potential benefits and risks that are associated with them. Construction of these artifacts should answer the important question in computer science "What can be (efficiently) automated?"

Table 1: Outline of the Design Science Guidelines

Guideline	Activity
Design as an Artifact	The designed artifact must be effectively represented, enabling implementation and application in an appropriate environment.
Problem Relevance	The objective of design science research is to develop technology-based solutions to important and relevant business problems.
Design Evaluation	The quality and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods. Good designs embody a style that is aesthetically pleasing to both the designer and the user.
Research Rigor	Design science research requires the application of rigorous methods in both the construction and evaluation of the design artifact. Often empirical methods are required to evaluate the artifact as part of a complete human-machine system.
Design as a Search Process	The search for an optimal design is often intractable for realistic information systems problems. Heuristic search strategies produce feasible, good designs that can be implemented in the business environment. Decomposition of complex problems is an effective heuristic in the search for effective designs.
Research Contribution	Effective design science research must provide clear contributions in the areas of the design artifact, design construction knowledge, and/or design evaluation knowledge.

The design science approach was used to develop the TWEEPIMENT artifact for sentiment analysis on twitter. In this study, the similarities and differences in the results of using three (3) classification algorithms Decision Tree, Naïve Bayes, and Support Vector Machine for text mining were investigated, and the results to determine the most efficient and effective technique.

The application of the design science methodology that was used in the study is outlined below:

Design as an Artifact

- An artifact was developed for the Text Mining Framework

Problem Relevance

- The importance and relevance of the problem was established in chapter 1 of this study.

Design Evaluation

- The artifact was developed and presented, and an evaluation of the artifact done.

Research Contribution

- The definition and an illustration of an artifact presented.

Research Rigor

- Utilization of established techniques and justification of "solution" presented.

Design as a search Process

- Literature on concerns regarding malicious behavior on social media, text mining techniques, machine learning techniques and other literature relevant to the study informed the development of the artifact.

Population

- The target population of this research is social media users with public accounts.

Sample

Purposeful sampling was used in this study. Purposeful sampling is ideal when the participants selected by the researcher is based on the some established need (Coyne 1997, Marshall 1996). Purposeful sampling is ideal where "information-rich cases" are selected by the researcher for a detailed study and this leads to a deeper understanding of the matter being investigated (Coyne 1997, Suri 2011). Frequent Users of the app or website were purposefully selected and could assist in giving us a deeper understanding of the phenomenon under investigation. Tweets were selected with meaningful messages in which some include suspicious words or trigger words which are preset in our database.

Data Collection Instruments

The data collection method used was Python version 3.6. In order for, Python to retrieve the data, a Twitter API was setup and granted read and write level access to Twitter's feed. However, for the tweets to be retrieved several Python libraries were used, these consist of *Tweepy* to connect to Twitter Streaming API and downloading the data, json for parsing the data, *pandas* for data manipulation, *matplotlib* for creating charts, and re for regular expressions.

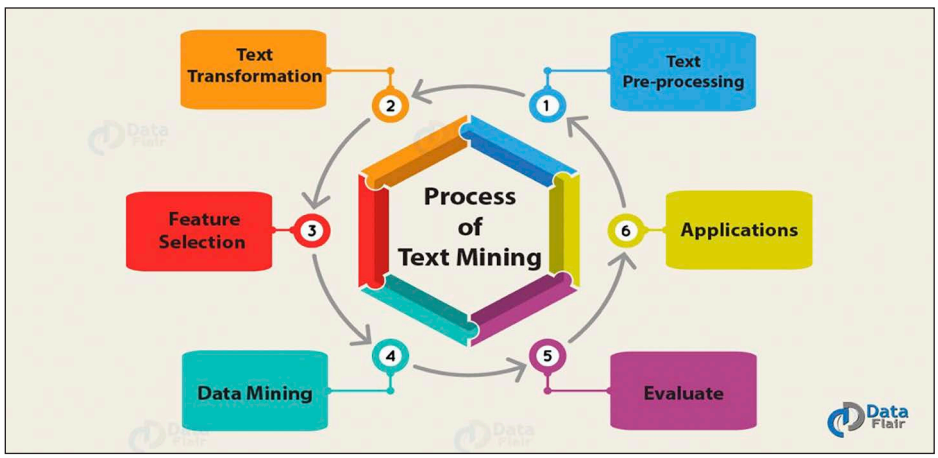

Figure 2: Text Mining Process

Figure 2 displays the life cycle of the tweets and the processes that are employed to determine if they contain malicious statement

Analysis of Data

Overview

The dataset used consists of 17,410 rows with 8 columns; tweets were then normalized by removing stop words such as: 'it', 'has', 'was' to increase performance when processing. Normalization of the twitter status creates a list of the essential words used in the status that we further analyzed to create a sentimental score, this was obtained through a feature we imported from a source called Vader sentiments, using a sentiment intensive analyzer. A polarity score for each sentence was given that gave a description of whether the sentence was either negative, positive or neutral which was added to the data table for each row, a compound score that was higher than zero meant that the tweet analyzed was

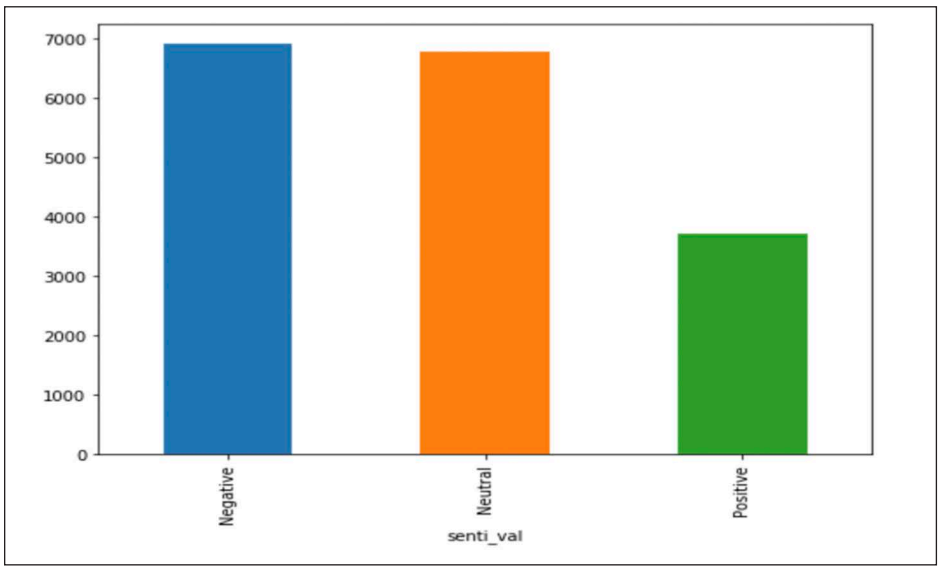

Figure 3: Number of tweets classified as negative, neutral and positive within the dataset

positive, a score lesser than zero meant it was negative and neutral was given a score that was equal to zero. Data was then transformed in order to be better interpreted by the machine learning algorithms we split the data into a 60/40 train test split which means that 60% of the data would be randomly chosen to train the model and 40% would be used to evaluate it at this point the data is ready to be analyzed by the various classification algorithm.

The graph above shows that there were approximately 6,900 tweets classified as negative, 6800 tweets as neutral and approximately 4,000 as positive.

Performance Parameters for Evaluation

Experimental evaluation of a classifier usually measures its effectiveness, which is the correctness of the classification algorithm. In text mining and machine learning, the results of evaluation are done using performance metrics like accuracy, precision, recall, F-measure, support among others. The classification models were evaluated using the following parameters: accuracy, precision, recall, F1-score, support value and confusion matrix.

1. *Accuracy:* This shows the percentage of correctly classified instances in each classification model.
   classification accuracy = correct predictions / total predictions
2. *Precision:* Measures the exactness of the relevant data retrieved. High pre-

cision means the model returns more relevant data than irrelevant data.

3. *Recall:* Measures the percentage of all relevant data that was returned by the classifier. A high recall means the model returns most of the relevant data.
4. *F1-score:* The F_1 score is the harmonic average of the precision and recall, where an F_1 score reaches its best value at 1 (perfect precision and recall) and worst at 0.
5. *Support:* Is an indication of how frequently the items appear in the data.
6. *Confusion matrix:* Shows the number per class of correctly classified and mislabeled instances.

Attributes Used to Explain Results

1. *True Positive:* Label which was predicted Positive (in our scenario Suspicious posts) and is actually positive (i.e., belong to Positive 'Suspicious' Class).
2. *True Negative*:Label which was predicted Negative (in our scenario Normal) and is actually negative (i.e., belong to Negative 'Normal' Class).
3. *False Positive*: Label, which was predicted as Positive, but is actually Negative, or in simple words the posts wrongly predicted as suspicious by our Model but is actually not.
4. *False Negatives*:Labels which were predicted as Negative but is actually Positive (Suspicious posts as Normal posts).
5. *True Neutral:* Fair Neutral posts found in the testing data and defined as the number of sentences that are correctly predicted by the classification model as Neutral.
6. *False Neutral*: Unfair Neutral posts found in the testing data and defined as the number of sentences that are incorrectly predicted by the classification model as Neutral.

Confusion Matrix

Table 2: Representation of a confusion matrix

	Predicted Positive	Predicted Negative
Actual Positive	TP	FN
Actual Negative	FP	TN

Accuracy= (TP+TN)/(TP+TN+FP+FN)

Precision=TP/(TP+FP)

Recall= TP/(TP+FN)

F1= (2 * Precision * Recall) / (Precision + Recall)

Table 3: Showing the true positive within the table represented in the confusion matrix

		Predicted Class		
Actual class		**Class 1**	**Class 2**	**Class 3**
	Class 1	True positives		
	Class 2		True positives	
	Class 3			True positives

Support Vector Machine (SVM) Confusion Matrix

Figure 4 displays the confusion matrix of the support vector algorithm which states from the dataset the algorithm predicted 1,859 of the tweets that were positive, 2,101 which were neutral and 649 that were negative. Which were all predicted correctly.

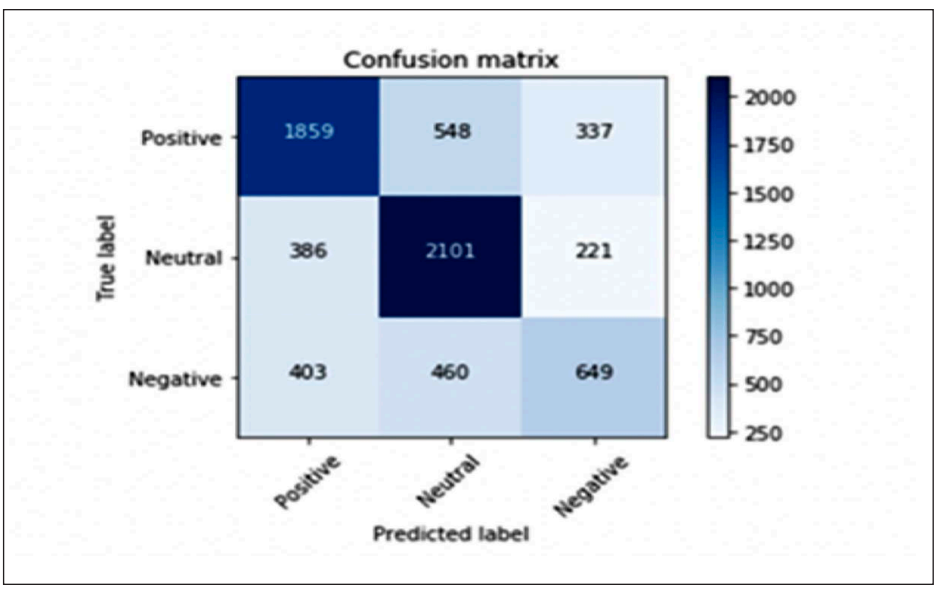

Figure 4: SVM Confusion Matrix

Naïve Bayes Algorithm Confusion Matrix

Figure 5 shows the confusion matrix of Naïve Bayes algorithm and in its prediction the classifier predicted true the positive tweets at 551, neutral 1,392 and negative tweets 1,988.

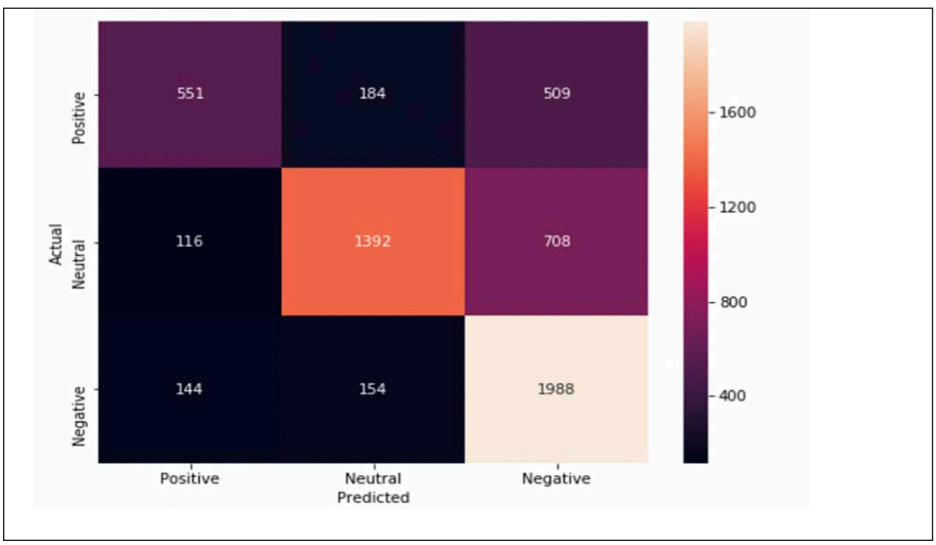

Figure 5: Depicts the classification matrix for Naïve Bayes

Decision Tree Algorithm Confusion Matrix

The decision tree overall accuracy on the test set was 65.7% (Accurate predictions/All or True Positives/All). An insight we can get from the matrix is that the model produced more accurate results in the neutral label than the positive. However, accuracy for negative true label was low which indicated few correct predictions.

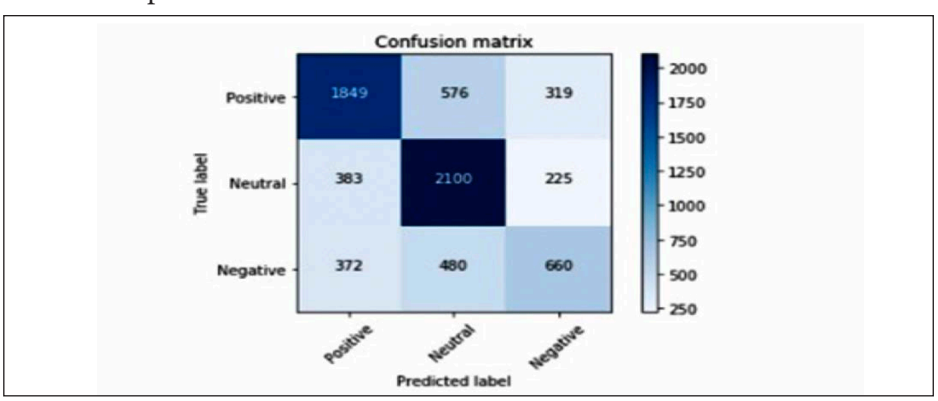

Figure 6: Depicts the confusion matrix for decision tree

Classification Reports

The following were calculated: level of accuracy, precision, recall, f1-score and support within this report for each algorithm. The data are depicted as 0- Negative, 1-Neutral and 2-Positive.

```
80.05456634118323
```

Figure 7: Accuracy score for SVM

	precision	recall	f1-score	support
0	0.80	0.84	0.82	2613
1	0.90	0.78	0.84	3140
2	0.62	0.78	0.69	1211
micro average	0.80	0.80	0.80	6964
macro average	0.77	0.80	0.78	6964
weighted average	0.81	0.80	0.80	6964

Figure 8: SVM Classification report

The Support Vector Machine (SVM) algorithm, gave an accuracy reading of 80.05% in detecting offensive and crime related tweets. The scale represents the category in which the trigger words fall based on the presets, and how sensitive the trigger words are based on the scale.

Figure 8 and 9 shows that using the Naïve Bayes algorithm, the accuracy was 67.59339%. The weighted average precision was 0.74, the weighted average recall was 0.68, the weighted average f1-score was 0.69 and the support value was 5746.

```
model, name
MultinoimialNB        67,593339
Name: accuracy, dtype: float64
```

Figure 9: Naïve Bayes Accuracy

	precision	recall	f1-score	support
0	0.44	0.68	0.54	811
1	0.63	0.80	0.71	1730
2	0.87	0.62	0.72	3205
micro average	0.68	0.68	0.68	5746
macro average	0.65	0.70	0.66	5746
weighted average	0.74	0.68	0.69	5746

Figure 10: Showing Naïve Bayes classification report

	precision	recall	f1-score	support
0	0.70	0.68	0.69	2744
1	0.67	0.77	0.71	2708
2	0.54	0.43	0.47	1512
micro average	0.66	0.66	0.66	6964
macro average	0.63	0.62	0.63	6964
weighted average	0.65	0.66	0.65	6964

Figure 11: Decision Tree Classification Report

Figure 11 above represents the classification report of the decision tree. From the confusion matrix, it determined the precision, recall, fi-score and support of the positive (0), neutral (1) and negative (2), which was then used to calculate the weighted average of each to determine its accuracy. Precision has a weighted average of 0.65, recall has a weighted average of 0.66, f1-score have a weighted average of 0.65 and support weighted average of 6964.

Comparison of Algorithms

In Table 3 the results of the comparisons of the Accuracy, Precision and Recall-ability for all three algorithms as displayed in Figure 7–11. The results outlined that the Support Vector Machine has the highest accuracy rate, while

Table 3: Comparing SVM, Naïve Bayes and Decision Tree

	Accuracy	Precision	Recall	F1-Score	Support
SVM	80.05%	0.81	0.8	0.8	6964
Naïve Bayes	67.59%	0.74	0.68	0.69	5746
Decision Tree	65.70%	0.65	0.66	0.65	6964

the Decision Tree has the lowest accuracy rate. Comparing the values in F1-Score according to the recall criterion, the Naïve Bayes has a recall score of 0.68, Decision Tree 0.66 and Support Vector Machine 0.80.

The algorithms that yielded the best results for the precision criterion are Naive Bayes and Support Vector Machine. In summary, the Support Vector Machine is the best algorithm, referring to the column accuracy, F1-Score, and recall statistical criterions. Considering the value of precision, it is clear that the Support Vector Machine has the closest precision value with the best result.

The graph shown in figure 12 displays Accuracy of evaluation parameters for SVM, Naive Bayes, Decision Tree algorithms, as applied on the Twitter dataset. The SVM algorithm's classification accuracy outperformed the other algorithms.

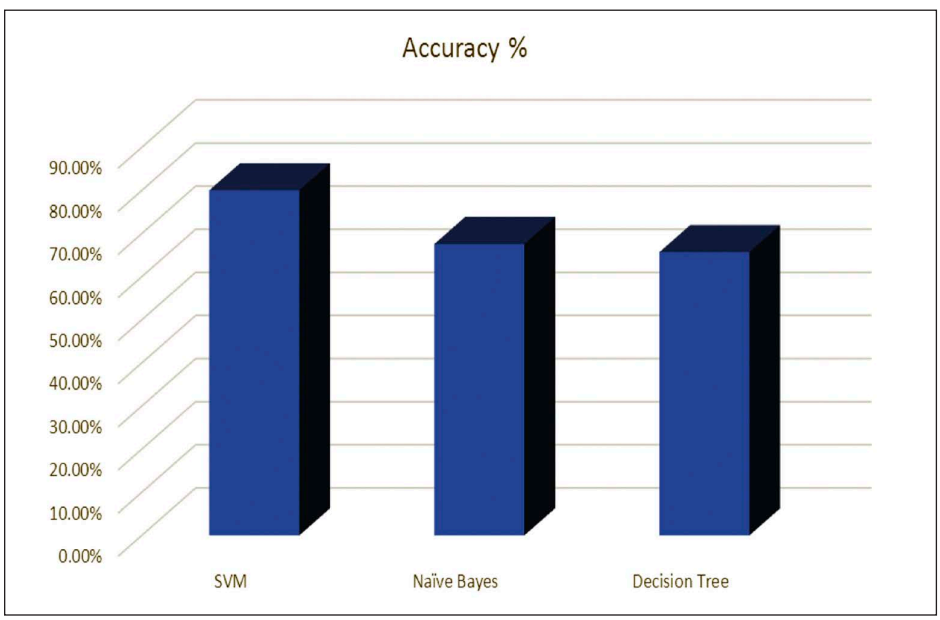

Figure 12: Visualization of a comparison of accuracy score for all three algorithms

Preliminary Evaluation using Informed Arguments

(Maes & Poels, 2007) presented an assessment framework based on Seddon's re-specified Information Systems Success model (Seddon, 1997) which acknowledges quality as an antecedent to system success. This model identified four interconnected categories as necessary to assess the quality of an artifact. Table 4 presents the results of the use of an Informed Argument approach to conduct a preliminary evaluation of our proposed Information Security Conceptual Data Model based on the Maes & Poels (2007) framework.

Table 4: Outline of the Informed Argument Approach

Category	Activity
Perceived Semantic Quality	The "TWEEPIMENT" artifact created in this study used classification algorithms to detect suspicious strings in social media posts. The study used established text mining techniques to demonstrate that machine learning techniques can be used on large data sets and produce relatively accurate results. This is valuable in the social media domain because it is proven that data mining techniques can be applied across various domains regardless of the crudeness of the data that exist in these domains. It was used in the identification of suspicious criminal activities, therefore, should contain the 'information that users think it should contain'.
Perceived Usefulness	Given that the artifact is based on knowledge/information expressed in established classification algorithms frameworks& previously proposed techniques which have been linked in a manner that allows for querying the corresponding data flows, then use of the proposed classification techniques should result in improved performance by stakeholder in using the proposed artifact for the identification of suspicious activities.
User Satisfaction	Given that stakeholders may be at different levels of knowledge and competence with regards to using various classification techniques, then stakeholders should be satisfied to have access to relevant information that would be contained in the sentiment analysis classification technique "*TWEEPIMENT*" which is based on the artifact.
Perceived Ease of Use	The stakeholders would not be interacting directly with the classification algorithms but rather through a graphical user interface that is provided by the "*TWEEPIMENT*" artifact.

Figure 13: Evaluation of the segment analysis

Figure 13 displays the results of the evaluation of the segment analysis technique using support vector analysis used in this study. Initial investigation reveals that the classification techniques used were effective and efficient in identifying the negative strings transmitting in the selected social media platform.

Conclusion and Recommendations

This study corroborates with studies done by Özel, Akdemir, Saraç, & Aksu, (2008); Khangura, Dhaliwal, & Sehgal, (2017); Khangura, Dhaliwal, & Sehgal (2017); Alami & Eleqqali (2015), however, none of these study tested and compared the results of all three techniques. In this study the performances of the algorithms were compared according to their accuracy, F-measure, precision, recall criteria and support value and the Support Vector Machine (SVM) classification algorithm was found to be the most efficient and effective technique.

This study has both theoretical and practical significance contributes to existing literature by suggesting classification algorithms that can be used in detecting suspicious posts social networking sites and can be used by law enforcement agencies in their data mining efforts to identify suspicious criminal activities in cyberspace. In future work, the dataset can be expanded to include other social media network platforms (e.g., Facebook and WhatsApp) or extended to other domains that have large data sets.

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Appendix A

Prototype Exhibit

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ARLENE McKENZIE-CAWLEY, MSc. in Power Electronics and Drives, University of Birmingham, England. Lecturer, Industrial Work Experience Coordinator, UTech, Jamaica.

Research interests: Ocean waves power, generation technology, piezoelectric, project-based teaching and productivity improvement.

ALDITH LOWE, Ph.D. Candidate, Organizational Leadership, Indiana Wesleyan University, USA. Curriculum Specialist, UTech, Jamaica.

Research interests: Accreditation, leadership in higher education

VALRIE J. McKENZIE, Ph.D. Candidate, Doctor of Philosophy in Educational Leadership & Management, UTech, Jamaica. Lecturer, UTech, Jamaica.

Research interests: Educational leadership, online learning, oral health

KAI BARRATT, Ph.D. in Communication Studies, The University of the West Indies, Mona. Lecturer, UTech, Jamaica.

Research interests: Exploring social media platforms as a space for carnival representations.

WARRICK LATTIBEAUDAIRE, Ph.D., in French Literature, The University of the West Indies, Mona. Associate Professor, Lecturer and Public Orator, UTech, Jamaica.

Research interests: Languages, Gender studies, Postcolonial studies and Dancehall music.

NADINE A. BARRETT-MAITLAND, Ph.D., in Computer Science, The University of the West Indies, Mona. Senior Lecturer, UTech, Jamaica.

Research interests: Issues related to artificial intelligence, information security, and application of information technology.

PROFESSOR LAWRENCE WILLIAMS, PhD., in Insect Toxicology at UWI, Mona. Adjunct Professor, College of Health Sciences, UTech, Jamaica.

Research Interest: Biological activity of natural products

Garth Dawkins, Master of Philosophy (MPhil) IN Biochemistry. Senior Lecturer, Head of Division (Biology), Faculty of Science and Sports, UTech, Jamaica.

Research Interests: Food, medical and environmental microbiology.

JAHMARI HARRIS, Final year student, Bachelor of Pharmacy Programme, UTech, Jamaica.

Research Interests: Pharmacy, Pharmaceutical related research.

KAMAICA PINNOCK, Final year student, Bachelor of Pharmacy Programme, UTech, Jamaica.

Research Interests: Pharmacy, Pharmaceutical related research.

KELLY-RAY JACKSON, Final year student, Bachelor of Pharmacy Programme, UTech, Jamaica.

Research Interests: Pharmacy, Pharmaceutical related research.

KERENE ROSE, Final year student, Bachelor of Pharmacy Programme, UTech, Jamaica.

Research Interests: Pharmacy, Pharmaceutical related research.

SHERICA WILSON-FRECKLETON, Final year student, Bachelor of Pharmacy Programme, UTech, Jamaica.

Research Interests: Pharmacy, Pharmaceutical related research.

Journal of Arts Science and Technology

Submission Guidelines

About the Journal of Arts Science and Technology

The *Journal of Arts Science and Technology (JAST)* is the flagship, international, multidisciplinary, peer-reviewed journal of the University of Technology, Jamaica. Its publication is in keeping with one of the objects of the University of Technology Act, to "preserve, advance, and disseminate knowledge through teaching, scholarship and research . . . and to make available the results of such … to promote wisdom and understanding."

Aims and Scope

JAST aims to promote and enhance research and technology in diverse fields of knowledge, including: engineering, computing, business management, finance, marketing, health, sports, pharmacy, arts, hospitality, architecture, urban planning, education, liberal studies, and law.

Responsible Office

The School of Graduate Studies, Research & Entrepreneurship [SGSRE] is responsible for the academic publications of the University of Technology, Jamaica. The School is directly in charge of the publication of *JAST*.

Frequency of Publication

JAST is published twice per year.

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The Editorial Board of the *Journal of Arts Science and Technology (JAST)* considers the submission of a manuscript to be representation by authors that it is not copyrighted by another party, not currently under consideration for publication elsewhere, and was not previously published.

The *JAST* considers the following types of articles for publication:

- **Research Article** (A written account of original research results; should not exceed 6,000 words, excluding references and appendices).
- **Concept Paper** (Should outline a proposed idea, project, or research study by providing a clear and concise overview of the concept, including its rationale, objectives, methodology, and potential outcomes; 1000–3000 words).
- **Commentary** (Should be written in a coherent manner and provide insight, analysis, or criticism of a topic to encourage readers to think critically about the issue; 1000–1500 words).
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- **Scholarly Personal Reflection** (A combination of personal experiences and academic analysis to explore a particular topic; it is a reflective essay that goes beyond a simple personal narrative by incorporating critical thinking and academic research; 1000–1500 words).

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Font, line-spacing, alignment: Calibri, double-spaced lines in MS Word, 12-point font, margins 2.5 cm, and left align.

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- Title page (The front page of the Research Article should include: the title, name, affiliation, postal address, and email for each author.
- Abstract (Shall not exceed 250 words and must state the research problem and its significance, the methodology used, key results and main conclusions); five relevant keywords should be placed immediately below the abstract.
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- Literature Review (Include a review of the pertinent literature to 'situate' the problem within the gaps in the literature it seeks to address)
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- Conclusion (State conclusions clearly based on the results; summarize the evidence for each conclusion)
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