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Editorial / vii

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Illuminating the Andragogical Dimensions of the Legacy of  
Marcus Mosiah Garvey, Jamaica's First National Hero / 1

---

Large-Scale Integration of Bioinformatics is Necessary for Strengthening  
HIV Prevention Efforts in Jamaica / 12

---

Numerical Analysis of Multi-Bed Activated Carbon/Methanol Adsorption  
Refrigeration System With Allowance For Dynamic Pressure Variations / 21

---

Antinociceptive and Anti-inflammatory Effects of the Hydroalcoholic Extract  
and Cinnamic Acid obtained from *Lychnophora Pinaster* / 35

---

The Teaching of English as a Second Language: Recommendations for  
Policy Makers at the Tertiary Level / 46

---

Effect of Cooperative Learning on the Performance and Attitude of  
Chemical Engineering Students in Mathematical Modelling at the  
University of Technology, Jamaica / 65

---

Fostering an Innovation Mindset amongst Jamaican Youth / 82

---

*Continues on inside front cover*

Vision in Response: Disaster Risk Reduction / 97

---

An Analysis of Customer Service Offered to Graduate Students at the  
University of Technology, Jamaica / 116

---

The Relationship between Traumatic Life Events and Depressive  
Symptoms among a Sample of Jamaican University Students / 132

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# Contents

---

## Editorial / vii

Illuminating the Andragogical Dimensions of the Legacy of  
Marcus Mosiah Garvey, Jamaica's First National Hero / 1

*Paul W. Ivey*

Large-Scale Integration of Bioinformatics is Necessary for Strengthening  
HIV Prevention Efforts in Jamaica / 12

*Aneisha Collins-Fairclough*

Numerical Analysis of Multi-Bed Activated Carbon/Methanol  
Adsorption Refrigeration System With Allowance For Dynamic  
Pressure Variations / 21

*Kirkland Rowe, Paul A. Campbell*

Antinociceptive and Anti-inflammatory Effects of the Hydroalcoholic Extract  
and Cinnamic Acid obtained from *Lychnophora pinaster* / 35

*A.O. Azevedo, I.D.G. Duarte, M.S.A. Castro, A. Klein, A.C. Perez*

The Teaching of English as a Second Language: Recommendations for  
Policy Makers at the Tertiary Level / 46

*Clover Jones McKenzie*

Effect of Cooperative Learning on the Performance and Attitude of  
Chemical Engineering Students in Mathematical Modelling at the  
University of Technology, Jamaica / 65

*Paula O. Henry, Jan-Cherie Campbell Fraser, G. Junior Virgo*

Fostering an Innovation Mindset amongst Jamaican Youth / 82  
*Lisa Facey-Shaw*

Vision in Response: Disaster Risk Reduction / 97  
*Jacquiann T. Lawton*

An Analysis of Customer Service Offered to Graduate Students at the  
University of Technology, Jamaica / 116  
*Carol Newman-Rose*

The Relationship between Traumatic Life Events and Depressive  
Symptoms among a Sample of Jamaican University Students / 132  
*Patrice Reid, Joni McKoy and Dean Beckles*

Notes on Contributors / 155

*The Journal of Arts Science and Technology:*  
Submission Guidelines / 158

# Editorial

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*The Journal of Arts Science & Technology (JAST)* now appears in the EBSCOhost Caribbean Search database.

This 2014 issue of the journal, volume 7, offers the usual mix of peer-reviewed papers across the disciplines in the publisher institution, the University of Technology, Jamaica.

In this issue 10 papers are carried, leading with a creative new look at a little explored angle of the work of Jamaican National Hero, pan-Africanist, philosopher, and man of action, Marcus Garvey. Illustrative narrative examples are used in the paper to show that, in implementing his vision of self-empowerment, Garvey's strategies and methods were rooted in the andragogical model of learning, which is the art of helping adults learn. Garvey's andragogy, it is concluded, represents a template that may be adopted or adapted by an individual, a community or a nation aiming for transformation and empowerment.

Following the Garvey paper, an empirical case is made for the large-scale integration of genotypic bioinformatics for strengthening HIV prevention efforts in Jamaica.

Noting the large energy demands for air-conditioning and other refrigeration requirements, the third paper reports a novel system for the improvement of refrigeration systems to be more energy efficient.

From engineering to biomedical science, the fourth paper by Brazilian researchers reports on the positive antinociceptive, or analgesic, and anti-inflammatory properties of extracts from the plant *Lychnophora pinaster*, commonly known as arnica in its native environment and widely used in folk medicine for these properties

The next paper tackles the perennial problem of how best to teach English language to improve student performance in the bilingual environment of

Jamaica with an oral creole language and Standard English as the official language. The English paper argues for teaching English as a second language (ESL) and “suggests that the ESL approach must be guided by a carefully devised plan of action rooted in the findings of applied linguistics, and endorsed by policy-makers at the highest level.”

The paper, “Effect of Cooperative Learning on the Performance and Attitude of Chemical Engineering Students in Mathematical Modelling at the University of Technology, Jamaica”, found that “higher academic performance was achieved with the use of cooperative learning”, with 80% of the participants in the study embracing working in groups cooperatively.

“Fostering an Innovation Mindset amongst Jamaican Youth”, “is intended to stimulate discussion amongst educators, employers and the private and public sector on the need to foster an innovation mindset amongst . . . youth so that we can bolster the future competitiveness, productivity and economic growth of Jamaica.” The paper argues that “though significant focus is placed on education at the tertiary and post-secondary levels . . . given that a significant number of Jamaican students do not access tertiary education, a systematic development of its innovation systems through innovation and entrepreneurship education is important at the earlier education levels.”

Coming out of the Built Environment, the paper on disaster risk reduction reports on collaborative work done by the Caribbean School of Architecture and the Jamaican Office of Disaster Preparedness and Emergency Management on shelter solutions for disaster emergency management. The paper shows how “spatial thinking can induce strategies connecting structural and non-structural mitigation efforts.”

Following is a paper on customer service and customer satisfaction in the experience of graduate students in a university seeking to expand its graduate programmes and its graduate student population.

This issue of *JAST* closes with a study of “The Relationship between Traumatic Life Events and Depressive Symptoms among a Sample of Jamaican University Students.” The results of the study indicated that 99% of the students reported experiencing at least one traumatic event in their lifetime and students who reported a higher number of traumatic events reported significantly more symptoms of depression.

# Illuminating the Andragogical Dimensions of the Legacy of Marcus Mosiah Garvey, Jamaica's First National Hero

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## Abstract

*Marcus Mosiah Garvey, Jamaica's first national hero, has earned international acclaim as a world-class philosopher and symbol of self-empowerment for formerly enslaved persons of African descent and Africans everywhere in the Diaspora. However, a little-known or recognized facet of the colossal intellectual legacy Garvey bequeathed to the world is that, in implementing his vision, he expertly deployed andragogical strategies. In this paper, historical analysis and evaluation are used to situate Garvey's legacy within an andragogical framework and illuminate it from a similar perspective. But, to facilitate a better understanding of what stirred Garvey into action, this paper starts by briefly recounting aspects of chattel slavery and the realities of early post-emancipation Jamaica. Illustrative narrative examples are used herein to show that, in implementing his vision of self-empowerment, Garvey's strategies and methods are rooted in the andragogical model of learning, which refers to the art of helping adults learn. This paper also posits Garvey's direct involvement in politics as the zenith of his effective andragogy, aimed at ensuring the sustainability of his efforts. It is concluded that 'Garvey's Andragogy' represents a template that may be adopted or adapted by an individual, a community or a nation aiming for transformation and empowerment.*

**Keywords:** Andragogy, agents of change, adult educators, enslaved Africans, Marcus Mosiah Garvey, self-empowerment

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## National Hero and World-class Philosopher

Marcus Mosiah Garvey, Jamaica's first national hero, was born on August 17, 1887, 53 years after the abolition of chattel slavery in Jamaica. He has earned international acclaim as a world-class philosopher and symbol of self-empowerment for formerly enslaved persons of African descent, as well as Africans everywhere in the Diaspora. In 2003, Ian Adams, honorary fellow of the University of Durham, and his co-author R. W. Dyson, director of the Centre for the History of Political Thought, jointly published *50 Major Political Thinkers*. This publication listed Garvey among giant thinkers and well-known philosophers over a 2,000-year period, beginning with Plato, Aristotle, and including others such as St. Thomas Aquinas, Nicholas Machiavelli, and Karl Marx. But, what is not widely-known or recognized are the andragogical dimensions of the colossal intellectual legacy Garvey bequeathed to the world.

## Chattel Slavery's Aftermath in Post-Emancipation Jamaica

To better understand the contextual background against which Garvey emerged and was stirred into action, a brief recounting of aspects of the institution of chattel slavery and its aftermath in early post-emancipation Jamaican society is necessary. This author thinks this 'point of departure' effectively reveals the depth of Garvey's genius showing as it does his intuitive recognition that tourniquets needed to be applied to the abused psyche of his people, to arrest the hemorrhaging of their self-esteem inflicted by the indignities of slavery and its aftermath.

According to Sherlock and Bennett (1998), from 1500 to 1800 AD, 10-11 million Africans were dragged from their homeland and brought to the western hemisphere to serve for life a strange owner of another race. Having survived the horrific voyage across the Atlantic Ocean, even greater indignities awaited the enslaved Africans. They were then to spend the next 300 years as chattel and subjected to unspeakable cruelty and dehumanization, open exploitation in a society characterized by physical and psychological terror. After severe hardships, open rebellion on the sugarcane plantations by the enslaved Africans fuelled by an insuppressible desire to be masters of their own destiny, and the

agitation of “people of conscience,” the British parliament passed the Act of Emancipation of 1833.

In a perverse act that has provided grist for the persons persistently agitating for reparations for the enslavement of Africans, owners of enslaved Africans in Jamaica were compensated to the tune of £6,616,927 for the inconvenience and loss they were expected to endure when they no longer had access to free labour that had supported their affluent living. On the other hand, the freed former enslaved Africans, were not compensated (Sherlock & Bennett, 1998). In addition, post-emancipation Jamaica was characterized by a socio-political order that saw the planter class conspiring to retain power over the freed African-Jamaicans at all cost. The latter had no input in the decision-making process as they were bereft of political power and representation or the economic means to make a decent livelihood.

The pervasive, pernicious, and unbearable injustice that marked early post-emancipation Jamaica precipitated the Paul Bogle led Morant Bay Protest in October 1865. As Nelson Mandela (1994) unapologetically averred, “to overthrow oppression has been sanctioned by humanity and is the highest aspiration of every free man” (p. 162). The Morant Bay Protest therefore heralded the determined struggle of the people against continued oppression, indignities, suffering, and dehumanization. It was within this socio-economic milieu that Marcus Mosiah Garvey emerged and subsequently developed into, not only a world-class philosopher and international African liberator, but also an adult educator and agent of change.

At the time of Garvey’s birth in post-emancipation Jamaica, people of African descent the world over were colonized, disenfranchised, and subjugated. They had the heavy baggage of the tragic legacy of chattel slavery on their shoulders as well as deeply embedded into their collective psyche. It must be remembered that African speech, religion, mannerisms, and other cultural norms were systematically denigrated as savagery and subhuman, so as to imbue black people with a sense of collective worthlessness and inferiority (Sherlock & Bennett, 1998).

The ideology of racism used to legitimize African slavery was extended to the physical, genetic, and biological traits of black people. The very colour of the African skin was deemed to be the first and lasting indicator of inferiority,

together with the form of the mouth, nose, and hair texture. This need to extend the ideology of racism from cultural to physical traits was to guarantee that persons of African descent, however successful they were in internalizing white culture, would be forever trapped in their status as just mere slaves permanently imprisoned in their black skin (Girvan, 1988). So, even after slavery was abolished, Blacks suffered from a persistent hangover from the despicable orgy of cruelty and denigration that was chattel slavery.

To get an insight into the level of cruelty routinely perpetrated upon the enslaved Africans in Jamaica, one simply has to read the diaries of Thomas Thistlewood, an owner of enslaved Africans. Thistlewood came to Jamaica in 1750 where he lived until his death in 1786. He owned the Breadnut Island Pen property in Westmoreland where he made a record of his daily activities, including the severe punishments he often administered to the humans he owned (Hall, 1999). Furthermore, Sherlock and Bennett (1998) noted that “wherever the European colonizers went they pressed ahead with great cruelty in their relentless search for labour. How was it that they were so insensitive to human suffering and killed other human beings so easily?” (p. 60).

Coming on the scene as he did in a post-emancipation Jamaica steeped in injustice and denigration of “Blackness,” Garvey was stirred into action. Indeed, as a young boy Garvey himself was exposed to racial prejudice: he used to play with the white daughter of the Methodist minister in the town of his birth, but this was discontinued by the child’s mother simply because Garvey was black (Sherlock & Bennett, 1998). Garvey’s early exposure to books from his father’s and godfather’s collections helped to arouse his curiosity and stimulated his interest in social issues. And he developed into an effective communicator of ideas largely through his own determined efforts.

Further particularizing Garvey’s keen intellect, Sherlock and Bennett (1998) noted that:

His richly stored mind linked the particular with the universal, the past with the present, the local or national with the global. To read even a few of his statements and reflections is to encounter a mind that illuminates the Jamaican historical experience; in his analysis of colonial society in the 1920s, for example, he demonstrates his methods of basing conclusions on observations and analysis (p. 293).

## Garvey's Vision and Economic & Education Agenda

Garvey had a vision of mental (psychological) and economic emancipation for Africans (=black people) by Africans. On the economic front, he advocated for lands to assist farmers and peasants and the building of roads and ports to transport their produce. He also advocated for a national shipping line, which would be used by farmers to transport their products to the different available markets of the world. Garvey also called for the establishment of trade commissioners and marketing and advertising agencies in the principal countries to facilitate marketing of Jamaican products. And, to incubate local industries, Garvey advocated for the establishment of a Central Industrial Bank (Lewis, 1988; Sherlock & Bennett, 1998). Here we see that Garvey's vision included globalization! Garvey was convinced that Black self-reliance was an absolute necessity for the people of African descent to assert themselves and take their rightful place in the world as a proud race.

Complementary to his economic agenda, Garvey also had an education agenda. He had an intense respect for books, education and scholarship. Sherlock and Bennett (1998) noted that "he was an avid reader and developed a passion for learning. He always carried a pocket dictionary from which he learnt three or four words each day, and as a result built up a phenomenal vocabulary" (p. 296). Always placing an emphasis on education, Garvey advocated for the setting up of a university in Jamaica for persons desirous of pursuing courses in the sciences and arts. He wanted African-Jamaicans, and indeed Africans everywhere, to deepen and expand their knowledge of themselves, their glorious past, and their boundless potential as a society and race.

Garvey left Jamaica for Britain in 1935. In Britain, he was influenced and inspired by the Egyptian, Druse Mohammed Ali, in whose magazines, *Africa Times* and *Orient Review*, the appalling conditions under which Africans were living and ruled by colonial power were revealed. This exposure served to further motivate Garvey. It was during his time in Britain that Garvey developed and crystallized his idea of one great international organization of black people, educated, financially independent, having pride in their race; black people who would take their place as equals on the world stage (Lewis, 1987). According to Hill (1987), Garvey committed himself to implementation of the vision he articulated.

## Andragogy and Garvey's Deployment of Andragogical Methods

It is this author's view that it was in implementing his vision that Garvey the adult educator and his grasp and expert deployment of andragogical methods become obvious. Cookson (1998) defined the term adult education "as a comprehensive 'umbrella' term which includes all forms of training and education for adults" (p. 4). Knowles (1998) alluded to two separate and dichotomous models of learning. They are pedagogy (from the Greek *paid*, meaning 'child,' and *agogus*, meaning 'leader'), which refers to the teaching of children, and andragogy (from the Greek *aner*, meaning 'adult'), referring to the art of helping adults learn. As models of learning, pedagogy and andragogy are predicated on a suite of different assumptions about children and adults as learners. Flowing from these different set of assumptions, different methods of teaching children and helping adults learn have been developed.

Some examples of adult education scenarios enumerated by Cookson (1998, p.6) include: a worker studying alone to improve job performance; rural peasants participating in a literacy campaign; a school teacher enrolling adults in evening classes for their secondary school diploma; a social worker helping a group of abused women learning more effective coping strategies; and a lay religious leader teaching mothers how to guide their children's moral development.

Clearly, Garvey's project of identity-building and conscious-raising to awaken and arouse the consciousness of African-Jamaicans and Africans everywhere in the Diaspora (circa "400,000,000" of them) to respond to his entreaty of "Up, Up Ye Mighty Race, You Can Accomplish What You Will" (Jacques-Garvey, 1969, p.18) is of a similar species to the examples of the adult education projects cited by Cookson (1998).

In implementing his vision, Garvey launched an adult education project in which he realized that appropriate methods were needed. And, further reflecting the breath of his genius, he intuitively selected appropriate *andragogical methods*. The significant efforts of Garvey to raise the consciousness of his people were very important as a counterfoil to the colonial ideology that consistently debased Africa as well as people and things African. In the process of the formation of Jamaica as a nation, the negation of Africa and blackness has been constant. And so has the resistance [to this negation] by black people (Lewis, 1988). One

sees here, when the contextual realities are accounted for, how daunting Garvey's challenge was to raise the consciousness of his people. But, he had the fortitude, the cojones, the audacity, and courage to initiate his crusade as well as to pursue it with great perseverance. Garvey's tenacity is best understood when one considers that the "empire always strikes back," and struck it did. According to Sherlock and Bennett (1998), Garvey was:

A man who through his life lived his message; and did so through triumph and disaster, in the face of derision and oppression, of imprisonment and of rejection. Those in the centers of white power and influence in Jamaica, in the United States and Europe saw Garvey as a formidable threat and used all means in their power, the law included, to obstruct and vilify him; they projected the image of a black racist subversive, a rabble-rouser, a confidence man, and trickster (p. 293).

However, the elegance of Garvey's genius becomes even more obvious when one sees that he intuitively recognized that his starting point had to be the application of a tourniquet to the abused psyche of his people to arrest the hemorrhaging of their self-esteem that was inflicted by the indignities of chattel slavery and its aftermath. Sherlock and Bennett (1998) noted that "Garvey was one of the few of his time who understood how seriously the inner world of the African had been damaged, and in some instances destroyed, by the experience of enslavement combined with alienation" (p. 294).

So, being fully cognizant of the colonial ideology that denigrated blackness as inferior and whiteness as superior, Garvey started his crusade first by attempting to raise the consciousness of his people about themselves as a race by focusing on racial pride and self-esteem in an attempt to break their mental chains of self-contempt, self-doubt, and cynicism. Garvey thus clearly demonstrated his understanding as an adult educator that *consciousness-raising* is a precursor to significant learning. Still further evidence of Garvey's genius as an adult educator is seen in his use of consciousness-raising not as the culmination of his project, but as the initial scaffolding upon which to build a more sustained programme of learning and action.

*Oratorical persuasion* was another one of tools in Garvey's andragogical toolkit. He was an avid reader as a young boy and, as mentioned earlier, always carried a pocket dictionary from which he built a good vocabulary. Perhaps he

had sensed his calling as he later utilized his awesome vocabulary as a public speaker and orator. When Garvey moved from St. Ann to Kingston he began to improve his oratorical skills by visiting churches and watching the ministers in full flight. He also rehearsed reading aloud, participated in and organized elocution competitions, and seized every opportunity to appear on public platforms.

Having honed his oratorical skills, Garvey then arranged numerous public meetings and gatherings wherever he went and used these skills to mesmerize and touch the heart and spirit of his audiences (Sherlock & Bennett, 1998). Clearly, a large part of Garvey's emotional power, and success, was linked to his oratorical prowess. Consider, for example, being part of the 25,000 strong crowd hearing Garvey in full flight, proclaiming at Madison Square Gardens, New York in 1920, at the first Universal Negro Improvement Association (UNIA) Convention that:

We are the descendants of a suffering people; we are the descendants of a people determined to sufferer no longer . . . we shall raise the banner of democracy in Africa or 400 million of us will report to God why . . . we pledge our blood to the battlefield of Africa where we will fight for true liberty, democracy and the brotherhood of man. It will be a terrible day when the blacks draw the sword to fight for their liberty; I call upon the 400,000,000 blacks to give the blood you have shed for the white man to make Africa a republic for the Negro (Sherlock & Bennett, 1998, p. 304).

This is powerful oratory imbued with *passion* from a courageous adult educator. One sees here that passion for one's calling is a highly desirable attribute for success, and Garvey clearly had passion.

Retrospectively naming and connecting some of Garvey's methods to adult education theory, it is realized that Garvey also used a form of *experiential learning*, which is the process of making meaning from direct experiences (McCarthy & McCarthy 2006). Garvey believed that blacks (= African-Jamaicans and Africans everywhere) would learn self-reliance by creating their own economic institutions. And in translating this vision into action, he established the Universal Negro Improvement Association (UNIA).

The UNIA was, therefore, a vehicle that would own and operate successful businesses. Most noteworthy was the *Black Star Line*, a steam ship company to

run between America, Africa, the West Indies, Canada, South and Central America, carrying freight and passengers. There were other businesses as well such as cooperative grocery stores, restaurants, steam laundries, tailoring and dressmaking shops and a publishing house (Curtin, Hamilton, and Patterson, 1987). Garvey's aim was that Blacks would, through the operation of these businesses, experientially learn self-reliance. This was in effect vision finding method!

Yet another dimension of Garvey's genius as an Adult Educator is manifested in his recognition of the fact that, inasmuch as learning sites could be created from social spaces, many of the sites were episodic and transient, therefore *permanent incubators* and *containers of learning* were required. In this regard, Garvey established an Adult Education Centre at Edelweiss Park at 67 Slipse Road in Kingston as:

A centre for spiritual upliftment, self-improvement, political indoctrination, and purposeful recreation. Political and religious instruction formed part of the weekly programme, and was intended to 'combat ignorance and narrow-mindedness among the masses. Thousands thronged to hear Garvey speak on Sunday nights and young and old journeyed from far off rural places, just to get a glimpse of the man who carried the message of inspiration and anti-colonial solidarity (Sherlock & Bennett 1998, page 311).

Further demonstrating his vast repertoire of adult education methods, Garvey also used *pageantry* and *role-playing* in his incessant andragogy. Picnics, parties, promenades and concerts were frequently held at Edelweiss Park. With respect to pageantry, Sherlock and Bennett (1998) write that:

On the night of August 22, 1929 (the closing night of the Sixth International Convention of the UNIA) there was a re-enactment of the court life of Ancient Africa before some 10,000 persons at Edelweiss Park. The high dignitaries of the UNIA, accompanied by their bejeweled ladies, appeared resplendent in their rich robes of state, while the officers of the African Legion fairly dazzled the black multitude with their dapper uniforms, shiny Sam Brown belts, and gleaming swords. . . . As the President General of the UNIA and Provisional President of Africa passed between lines of erect legionnaires holding aloft drawn swords, the vast assemblage gave a mighty roar of greeting. Accompanied by his wife and the High Potentate of the Association, Garvey made his way to a lavishly decorated stage

where he informed his audience that they were but celebrating what had gone before in the noble court of Ethiopia, the grandeur of past ages (p.311).

The zenith of Garvey's andragogy, from this author's perspective, is manifested in his direct involvement in politics when he formed the People's Political Party in 1929. Garvey's involvement in politics represented, this author thinks, his total evolution. As a political representative, Garvey was now manifesting what Freire (1970) later realized: that education is politics and that the fundamental effort of education is to help with the liberation of people. One sees that, being an adult educator, Garvey sought to connect learning to transformative action on the part of Blacks. And he realized, genius that he was, that it is only by taking matters into their own hands that Blacks would liberate themselves starting with consciousness-raising regarding self-knowledge, racial pride and self-esteem, and culminating in self-reliance that would be buttressed and secured through *political action*.

## Conclusion

It is concluded that, from a retrospective perspective, the methods Garvey employed – consciousness-raising, experiential learning, pageantry, passion, political action, oratorical persuasion, role-play and drama – in the implementation of his vision of self-empowerment for formerly enslaved persons of African descent and Africans everywhere in the Diaspora may be located within the andragogical model of learning. Also, 'Garvey's Andragogy' – this hitherto little-known or recognized dimension of his legacy – represents a template that may be adopted or adapted by an individual, a community or a nation aiming for transformation and empowerment.

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# Large-Scale Integration of Bioinformatics is Necessary for Strengthening HIV Prevention Efforts in Jamaica

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## Abstract

*The Human Immunodeficiency Virus (HIV) is a debilitating virus that infects 35 million people worldwide. To date Jamaica's HIV response has heavily utilized behavioral, clinical and social observations in creative ways to inform and guide prevention and treatment efforts. With the emergence of new threats to successful HIV management in the island, treatment and prevention would benefit from increased insights from HIV genetic sequences. To validate this assessment, a meta-analysis was conducted on studies that have reported bioinformatics analyses of HIV genetic sequences from Jamaica. This meta-analysis revealed that nucleotide sequence is available for no more than 1% of the approximately 32,000 persons living with HIV in Jamaica. This situation exists despite the generation of crucial insights from the few HIV genetic studies conducted in the island; further it emerged that only 52% of nucleotide sequence data is shared by scientists who report HIV nucleotide sequences in Jamaica, even after publication of their study. Together, the data suggest that increasing utilization of HIV sequencing and bioinformatics will be highly beneficial to supporting HIV prevention and treatment in Jamaica, as well as protecting prior successes gained in Jamaica's HIV response.*

**Keywords:** Bioinformatics, Genotyping, Human Immunodeficiency Virus

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## Introduction

All organisms contain genetic material which holds the information for determining their characteristics and abilities. The genetic material is deoxyribonucleic acid (DNA) in most organisms but some viruses use ribonucleic acid (RNA) instead. Whilst the DNA stores and transfers the genetic information, RNA facilitates its decoding to generate proteins, which carry out a myriad of physiological, metabolic and structural roles in our bodies. In bioinformatics, computers are used to organize, store and analyze the DNA, RNA and proteins, along with accessory information on them, so as to generate insights into the features and functions of organisms[1]. The birth of bioinformatics can be traced back to 1965 when Margaret Dayhoff published her computerized collection of protein sequences in her work entitled: *Atlas of Protein Sequence and Structure*<sup>2</sup>. Subsequent to the production of the Atlas, Dayhoff reported the use of computers to conduct evolutionary analyses on proteins [3]. The discovery of techniques to determine protein sequences, the determination of the structure of DNA and the elucidation of the genetic code are among the defining advancements in knowledge that facilitated the genesis of bioinformatics [2]. The growth of Bioinformatics was fostered through the development of techniques to obtain the nucleotide sequence of DNA and today continued expansion of the discipline ensues, as DNA sequencing technologies improve in speed and become more cost effective.

The Human Immunodeficiency Virus (HIV) infects approximately 35 million people worldwide, with the Caribbean having the second highest prevalence of the disease [4]. HIV is primarily transmitted through unprotected sexual intercourse. Heterosexual transmission accounts for the majority of new infections, however HIV prevalence among men who have sex with men (MSM) is disproportionately higher than HIV prevalence among the general population, globally [5].

The field of Bioinformatics has been essential in acquiring an understanding HIV and is an integral part of the global response, as it enables the execution of HIV genotyping, to reveal characteristics of HIV in different parts of the world. In the early days of the epidemic, bioinformatics facilitated the identification of HIV as the causative agent of Acquired Immune Deficiency Syn-

drome, AIDS [6, 7], unveiled the diversity of HIV [8] and the global distribution of the different subtypes [9]. These discoveries were pivotal for identifying segments of the virus that are suitable for vaccine development [8], tracing the origin and dissemination of the virus [10], as well as promoting HIV prevention [11]. Bioinformatics is also integrated in HIV treatment, which incorporates databases and computer algorithms for *in silico* prediction of drug resistant HIV strains [12, 13].

Jamaica has seen a decrease in overall HIV prevalence among the general population from a peak of 1.96% among pregnant women in 1996 to 0.91% among pregnant women in 2012 [14]. Despite the progress made in reducing HIV infections in Jamaica, HIV prevalence among Jamaican MSM is 33 times higher than HIV prevalence among the general population [14]. Increased access to antiretroviral (ARV) drugs has been a vital element of Jamaica's successful response to HIV, yet there is no routine surveillance in place to monitor the extent to which circulating HIV strains evolve to break the protection offered by ARV drugs.

This paper describes a meta-analysis of studies that incorporate bioinformatics to investigate the HIV strains in Jamaica. This meta-analysis will enable an assessment of how well bioinformatics has been utilized in acquiring an understanding of Jamaica's HIV epidemic, as well as highlight future roles that it could have in strengthening Jamaica's HIV response.

## Methods

The PubMed literature database and the Los Alamos HIV sequence database were used to identify studies that describe genetic features of HIV in Jamaica. PubMed is an authoritative citation database for biomedical and life science literature from journals and online books [15]. The Los Alamos HIV Sequence database is a comprehensive repository of HIV sequences from across the Globe and it is updated regularly to include new HIV sequences that are deposited to NCBI GenBank. On May 14, 2014, a search of the PubMed database was done using the search phrase "Jamaica HIV" and a search of the Los Alamos HIV Sequence database was conducted with the following search parameters: Virus=

HIV-1, Subtype=Any Subtype, Sampling Country= JM (Jamaica), Genomic Region=Any, PubMed ID=list in the output. A Basic Local Alignment Search Tool (BLASTn) search of GenBank was conducted using all sequences returned from the Los Alamos Database search, to identify and eliminate redundant sequences. Results from the PubMed and Los Alamos HIV database searches were cross-matched for consistency, reconciled and compiled into a list of publications that were reviewed to determine whether they investigated the genetic sequence of HIV strains in Jamaica, as well as to identify their aims, findings and techniques used.

## Results

### LIMITED UTILIZATION OF BIOINFORMATICS IN JAMAICA'S HIV RESPONSE

The PubMed search using the phrase “Jamaica HIV” returned 325 literature citations. Perusal of the abstracts and full texts for these publications revealed that only 5 generated nucleotide sequences and performed bioinformatics analyses on HIV strains in Jamaica (Table 1). The search of the Los Alamos Database returned 195 sequences which were provided by 4 published manuscripts and 3 direct database deposits which are not currently associated with any journal article. Three of the four publications identified by the Los Alamos Database were also identified by PubMed (Table 1). Sequences with GenBank accession numbers JN135105-JN135134 (n=30) are identical to the reverse transcriptase segments of 30 larger polymerase sequences published by Hamilton et al. 2012 and were eliminated as redundant sequences. In Jamaica, approximately 32,000 persons are infected with HIV [14].

A total of 319 unique Jamaican sequences (Table 1) represent only 1.0% of the total HIV strains circulating in the country; illustrating the severe paucity of knowledge on the HIV strains in the Jamaican epidemic. This must be improved if Jamaica is to benefit from transferring promising advancements in treatment and prevention to priority areas in Jamaica's epidemic. The persistently high HIV prevalence among Jamaican MSM (>30%) despite interven-

**Table1.** Studies that Generate Nucleotide Sequence and Perform Bioinformatics Analyses on the HIV Strains in Jamaica

Publications Generating Sequences from HIV Strains in Jamaica		Publication Features				
PubMed Search	Los Alamos Search	Patient Risk	HIV Segments Sequenced (number)	Sequences in the Los Alamos Database (number)	Study Aim & Bioinformatics Analyses Performed	
Barrow, et al. 2013 [16]	N/A	Mostly Heterosexual	Pol (100)	No	In <i>Silico</i> Drug Resistance Analysis	
Hamilton, et al, 2012 [17]	Hamilton, et al, 2012 [17]	Mostly Heterosexual	Pol (102)	Yes (102)	In <i>Silico</i> Drug Resistance Analysis	
Roye, et al., 2011, [18]	Roye, et al., 2011, [18]	Mostly Heterosexual	Full Length (7)	Yes (7)	In <i>Silico</i> Drug Resistance Analysis	
					Genetic Signatures of HIV in Jamaica	
					Phylogeny for origin of HIV in Jamaica	
Heslop, et al., 2009 [19]	Heslop, et al., 2009 [19]	N/A	Gag (26) Env (28)	No	Phylogeny for origin of HIV in Jamaica	
Nadai, et al., 2009 [20]	Nadai, et al., 2009 [20]	N/A	Pol (3)	Yes (3)	Phylogeny for origin of HIV in Jamaica	
N/A	Schneidewind, et al., 2009 [21]	Mother to Child	Gag (11)	Yes (11)	Genetic Signatures for Virus Transmission Fitness	
N/A	Ramkisoorn, et al Unpublished	N/A	Pol (41)	Yes (41)	In <i>Silico</i> Drug Resistance Analysis	
N/A	Gao et al., Unpublished	N/A	Env (1)	Yes (1)	N/A	
Number of Unique Jamaican Sequences	319	165				

NA= not applicable/available

tions, is one area in which HIV sequencing and bioinformatics could be particularly useful. Currently there is no comprehensive analysis of the genetic strains circulating among MSM and this data could provide insights on HIV movement both within the MSM subgroup as well as between the subgroup and the general population. Genetic information on HIV strains would also facilitate the implementation novel approaches such as pre-exposure prophylaxis (PrEP), which uses antiretroviral drugs to prevent transmission [22] .

### BIOINFORMATICS STUDIES HAVE DEMONSTRATED STRONG POTENTIAL FOR STRENGTHENING JAMAICA'S HIV RESPONSE

The five published studies that conducted nucleotide sequence analyses of Jamaican HIV strains illustrate a diversity of ways in which bioinformatics can be applied in the HIV response. The studies used bioinformatics in detecting drug resistance [16-18], determining virus origin through phylogeny [18, 19] and investigating how the genetics of the human host drives genetic changes in HIV and impact disease progression in Jamaicans [21].

The most urgent need for HIV sequencing and bioinformatics analyses in Jamaica's response, at present, may be the routine surveillance of drug resistance mutations. HIV can undergo genetic mutations in the presence of antiretroviral therapy; this is known as acquired drug resistance and usually occurs when antiretroviral therapy is sub-optimal. HIV drug resistance results in individuals remaining viremic, reducing expected improvement in patient health and presenting the opportunity for drug resistant HIV strains to be transmitted to sexual partners. The transmission of drug resistant HIV strains compromises the ability to control HIV in the population and it has been reported in Jamaica [16, 17]. These studies are highly significant as they identified a current threat to Jamaica's HIV response and validate the need to implement routine drug resistance testing to protect the benefits that have been gained to date.

### Need to Promote Sequence Data Sharing

Only 52% (165/319) of Jamaican HIV sequences are deposited in a sequence database for public access. Sequence data sharing facilitates global monitoring

of HIV dissemination and evolution, as well as reduces the occurrence of missing links in future studies. In this era of genomics when nucleotide sequence data is main stream most journals typically require sequences to be deposited in a public database as a condition for manuscript publication. Local scientists generating HIV sequence data should appreciate that once they have published a manuscript describing sequences, such sequences should be released to the community of scientists to be incorporated in future studies. Data sharing in this way is beneficial to the goal of eliminating HIV, as evidenced by global usage of the Los Alamos HIV database and the Stanford drug resistance database [13].

## Conclusion

This meta-analysis of HIV genetic studies in Jamaica has illustrated that there is significant underutilization of HIV sequencing and bioinformatics analyses in Jamaica's HIV response. Increasing HIV sequencing and bioinformatics analyses as part of Jamaica's comprehensive HIV response is likely to provide insights that can:

- 1) break the staggeringly high HIV prevalence among MSM and
- 2) routinely monitor the evolution of drug resistance in HIV strains in the island to guide selection of the most effective regimen for antiretroviral therapy.

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# Numerical Analysis of Multi-Bed Activated Carbon/Methanol Adsorption Refrigeration System With Allowance For Dynamic Pressure Variations

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## Abstract

*The performance of a multi-bed (4 beds) adsorption refrigeration system having an activated charcoal-methanol pair was investigated using a numerical model. The model appropriately accounts for heat transfer, mass transfer, and thermodynamic behaviours, and distinguishes itself from similar studies in that it allows for pressure variation during desorption and adsorption stages. During operation, methanol desorbs and adsorbs simultaneously in two separate adsorber beds, while two other beds are heated and cooled in preparation for desorption and adsorption, respectively. A control strategy was investigated whereby bed switching is automated as a response to changes in bed pressures and water flow rates. The results were analysed to determine the effects of key operational parameters including water flow rate, heat source temperature and evaporator temperature on the performance indicators of coefficient of performance (COP) and specific cooling power (SCP). The system achieved a COP of 0.33 and SCP of 327 W.kg<sup>-1</sup> with a heat source temperature of 90°C.*

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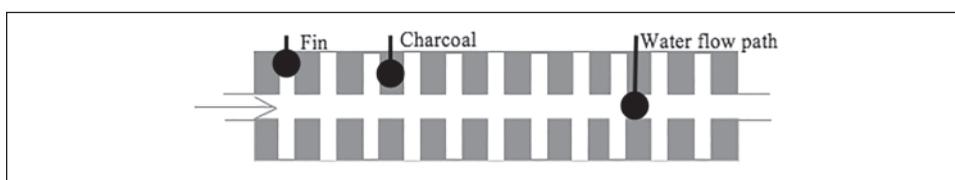
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## Introduction

Energy consumption in buildings has increased in recent years with the development of global economies. Because much of this energy is committed to air-conditioning and other refrigeration requirements (Wang et al., 2009), several novel refrigeration technologies, such as adsorption refrigeration, are being researched as viable alternatives to conventional refrigeration technologies. In this technology, waste or low-grade heat such as heat from solar thermal systems is used as the energy input for a modified vapour compression cycle (Claude et al., 2008; Wang et al., 2011). Additionally, there are environmental concerns regarding the application of conventional vapour compression air conditioning systems and the pollution they generate due to the use of CFC or HCFC refrigerants (Ge et al., 2009). This has led to increased interest in adsorption refrigeration systems that use refrigerants that are benign to the environment and comply with the Montreal protocol on ozone layer depletion and the Kyoto protocol on global warming (El Fadar et al., 2009). It is commonly appreciated that utilizing these energy resources is one possible way to reduce fossil fuel consumption and greenhouse gas emission in buildings. However, more research is necessary to improve system performance and reduce the cost and size of adsorption refrigeration systems.

## Design

The performance of an adsorption system depends highly on the characteristics of the adsorbent bed. One method for improving performance is by increasing the heat exchange area with the use of fins (Wang, 2001; Wang et al., 2011). The use of lightweight finned tubes heat exchangers is a design adopted from the work of Restuccia et al. (2004). Such a design is shown schematically in Figure 1.



**Figure 1:** Adsorber bed heat exchanger

In this study, one adsorber bed is modelled as four lightweight copper finned tubes in parallel, each packed with granular activated charcoal between the fins (Figure 1). The heat transfer fluid, used to cool or heat the bed, flows through the inner channel of the finned tube. As shown in Figure 2, the four beds are linked to create a multi-bed adsorption system, able to provide continuous cooling since one bed is always executing one of the four key stages of the ideal Clapeyron thermodynamic adsorption cycle, i.e. either heating, desorbing, cooling or adsorbing. This staging of processes also exploits heat recovery strategies thereby improving system COP through improved second law efficiencies. This is achieved by directing a fraction of the hot water leaving the desorbing bed to heat the heating bed. Similarly, an equivalent fraction of cold water leaving the adsorbing bed cools the cooling bed. In this manner, the temperature difference between a bed and its heat transfer fluid is reduced thereby minimizing thermodynamic irreversibilities. Diversion of some of the heat transfer fluid in this manner is also an essential element in controlling bed pressures and, by extension, the switching frequency of the adsorption refrigeration system.

For higher flow fractions, the temperature, and by association, the pressure of the heating bed increases more rapidly. The heating bed pressure eventually

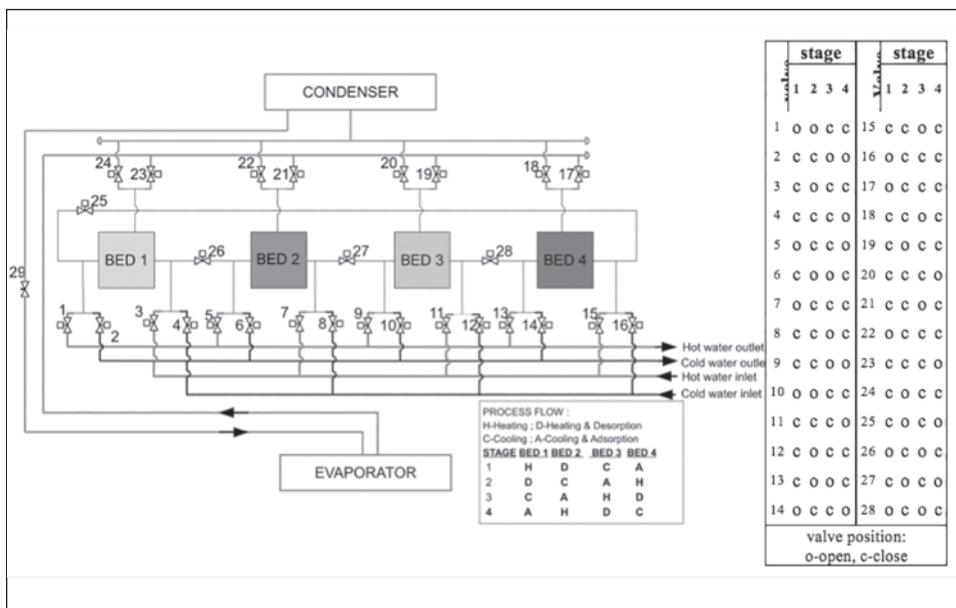


Figure 2: Adsorption system flow process

becomes equal to the desorbing bed pressure, and this occurrence becomes the criteria establishing the moment when bed switching is to occur, when all beds switch to the next stage in the adsorption cycle sequence. The primary implication of this strategy is that the switch condition is not independently enforced by the operator at predetermined times. Rather, the switch time becomes a dynamic parameter, automatically adjusted by the system itself as other system inputs such as heat source temperature and cooling load changes. This design characteristic is one of the most novel aspects of the model. It provides the benefit of ensuring that continuous cooling is achieved, even under highly variable conditions, without any interruption in the overall operation of the refrigeration system.

## Simulation Model

The numerical model simulating the behaviour of the adsorption system was coded and executed in the Matlab® programming language and acknowledges several fundamental physical laws and empirical models. Solving the model required the input of refrigerant property data using instantaneous system conditions. This was made possible by generating functions using least-squares fits to tabulated data. Such functions were able to approximate property values with less than 3% error.

## CONSERVATION OF ENERGY

The beds are assumed to be insulated, making heat transfer between the bed and the surroundings negligible. As a result, the sensible energy extracted from the hot water that flows through and heats the desorbing bed provides sensible energy that raises the temperature of the bed components as well as energy needed to effect desorption.

$$\dot{m}_{hw} c_{p,w} (T_{hw,in} - T_{hw,mid}) = (m_{char} c_{char} + m_t c_t + m_f c_f + x_d m_{char} c_{p,ml}) \frac{dT}{dt} - h_d m_{char} \frac{dx_d}{dt}$$

Zhang & Wang (2002) relates the heat of desorption,, and the heat of vaporization by

$$h_d = \frac{T_d}{T_{sat @ P_d}} h_{fg @ P_d}$$

The heating bed is modelled similarly to desorbing bed, except that in eq. 1, the desorption term is eliminated, causing the expression to become

$$\begin{aligned} F_{r,h} \dot{m}_{hw} c_w (T_{hw,mid} - T_{hw,out}) \\ = (m_{char} c_{char} + m_{fin} c_{fin} + m_{tub} c_{tub} + x_h m_{char} c_{p,ml}) \frac{dT_h}{dt} \end{aligned}$$

where the flow rate of water through heating bed is . Energy conservation in the adsorbing bed is slightly more complex than that for the desorbing bed (eq. 1) since cold vapour from the evaporator also contributes to the cooling of the adsorbing bed. The heat removed from the adsorbing bed during adsorption can be expressed as

$$\begin{aligned} \dot{m}_{cw} c_w (T_{cw,in} - T_{cw,mid}) = (m_{char} c_{char} + m_f c_f + M_t c_t + x_a m_{char} c_{p,ml}) \frac{dT_a}{dt} \\ - (h_a m_{char} - m_{char} c_{p,mg} (T_a - T_{evp})) \frac{dx_a}{dt} \end{aligned}$$

The energy balance on the cooling bed is identical to that of the heating bed.

$$\begin{aligned} F_{r,c} \dot{m}_{cw} c_w (T_{cw,mid} - T_{cw,out}) \\ = (m_{char} c_{char} + m_{fin} c_{fin} + m_{tub} c_{tub} + x_c m_{char} c_{p,ml}) \frac{dT_c}{dt} \end{aligned}$$

For both eq. 3 and eq. 5, the temperatures of the hot and cold water supplied to the adsorption system are known. However, the temperature of the water exiting the beds is dependent on the characteristics of heat exchange process and can be determined from eq. 6 (Incropera & DeWitt, 2002).

$$T_{bed,out} = T_{bed} - (T_{bed} - T_{bed,in}) \exp\left(\frac{-UA}{\dot{m} c_{p,w}}\right)$$

where  $U$  is the average overall heat transfer coefficient. For this application, would include contributions due to convection at the inner tube surface, conduction through the tube wall, conduction from the tube surface to the activated charcoal and fins, as well as from the fins to the activated charcoal.

### DUBININ-ASTAKHOV EQUATION

For the equilibrium of adsorption in micro-porous materials such as the activated carbon methanol pair, Dubinin and Astakhov proposed the following equation (Leite & Daguenet, 2000), usually referred to as the D-A equation.

$$x = x_o \exp \left[ -D \left( T \ln \left( \frac{P_{sat@T}}{P} \right) \right)^n \right]$$

When applying the D-A expression to the numerical model, only the characteristic constants  $D$ ,  $n$  and  $x_o$  are held constant. The properties for the activated charcoal used in the model was based on the work of Jing & Exell (1993) where the characteristic constants  $D = 88.982 \times 10^{-5}$ ,  $n = 1.12$  and  $x_o = 0.7725 \text{ kg.kg}^{-1}$ . At the same time, in order for the model to more closely reflect reality,  $T$ ,  $P$ ,  $P_{sat}$  were allowed to vary with time in all four stages of the cycle, while  $x$  was allowed to vary during the heating and cooling stages.

### CONSERVATION OF MASS

The complete mass balance for methanol in the condenser can be expressed as

$$\frac{dm_{con}}{dt} = -m_{char} \frac{dx_d}{dt} - \dot{m}_{valve}$$

This accounts for the vapour refrigerant entering the condenser from the desorbing bed, and liquid refrigerant exiting the condenser through the expansion device or valve. Similarly, for the evaporator, refrigerant enters from the condenser through the expansion device and exits as a refrigerant vapour entering the adsorbing bed. Therefore,

$$\frac{dm_{evp}}{dt} = -m_{char} \frac{dx_a}{dt} + \dot{m}_{valve}$$

In addition to these expressions, the refrigerant vapour in both the condenser and evaporator was assumed to behave as an ideal gas. Therefore, to allow for pressure changes in the condenser and evaporator during the desorbing and adsorbing processes, a transient form of the ideal gas equation was developed. The model also couples pressure changes to the rate at which gas molecules are added to or removed from the gas phase in the adsorber beds, the evaporator and the condenser.

## PERFORMANCE INDICATORS COP AND SCP

COP and SCP are the two main performance indicators for the adsorption system. The COP is the ratio of heat removed by a refrigeration system per unit heat supplied, which is given as

$$COP = \frac{Q_{evp}}{Q_{heat\ supplied}}$$

Heat is supplied to both the desorbing and heating bed simultaneously from the heat reservoir. Therefore, heat supplied to the adsorption bed is given as,

$$Q_{heatsupplied} = F_{r,h} \dot{m}_{hw} C_w (T_{hw,mid} - T_{hw,out}) + \dot{m}_{hw} C_w (T_{hw,in} - T_{hw,mid})$$

For a continuous adsorption system, the SCP can be given as,

$$SCP = \frac{Q_{evp}}{\text{Total charcoal mass in system (4 } m_{char})}$$

## Results of Simulation

A base case scenario was created for this study and deviations from this case analysed to determine the influence of key variables on system performance. This analysis is not necessarily an optimization strategy, as Critoph (2001) notes

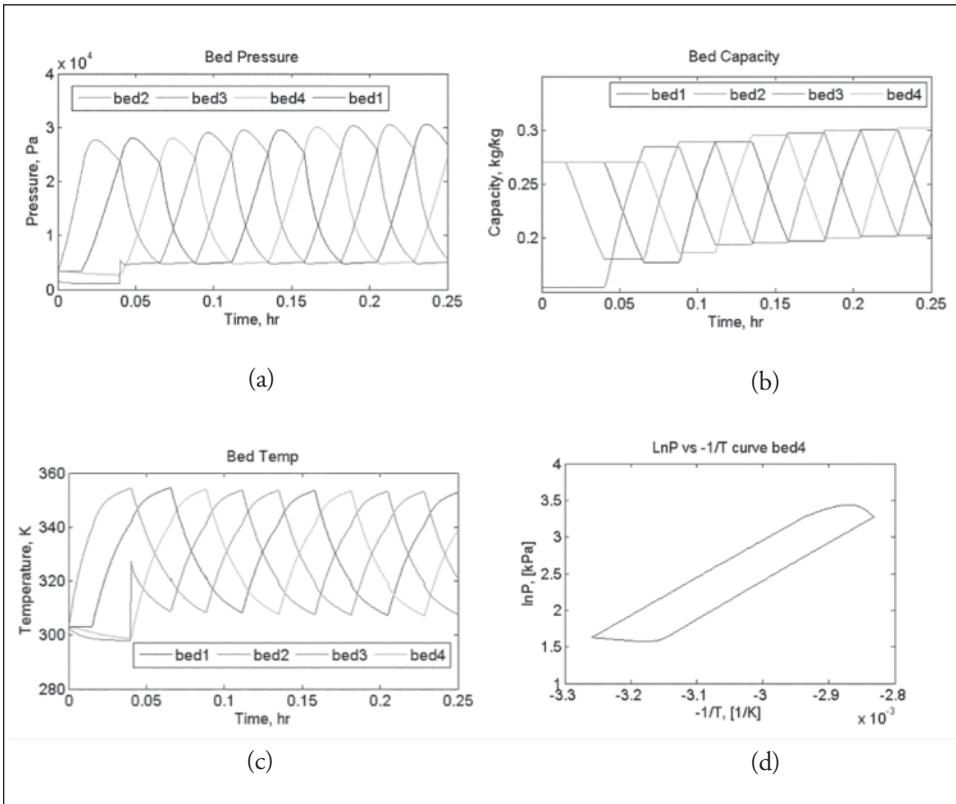
**Table 1:** Design and Operating Parameters for Base Case

Parameter	Value	Performance Indicators	Value
Condensing temperature	30 °C	COP	0.33
Evaporating temperature	5 °C	SCP	327 W.kg <sup>-1</sup>
Fin height	3 mm	Mean Evaporator Temperature	3 °C
Fin spacing	7 mm	Mean Condenser Temperature	36 °C
Tube length	0.5 m		
Tube outer diameter	0.016 m		
Hot/Cold water flow	5.05E-03 kg.s <sup>-1</sup>		
Hot/Cold water temp	90 °C /25 °C		
Hot/Cold water flow fraction	0.5		

that there are many design parameters and many different functions that may be considered. Therefore, the concept of a single optimum design is not necessarily useful. The key design parameters, operating conditions and the main performance indicators for the base case are presented in Table 1.

Figures 3(a-c) shows variation of pressure, temperature and adsorbed methanol in all four adsorption beds from start-up to steady state regular cyclic behaviour using the conditions described in the base case scenario. These graphs show the impact of the bed switching protocol. When the heating bed pressure increases to the value of the desorbing bed pressure, each bed moves to the next stage in its cycle. The variation in bed pressure can be observed in Figure 3(a).

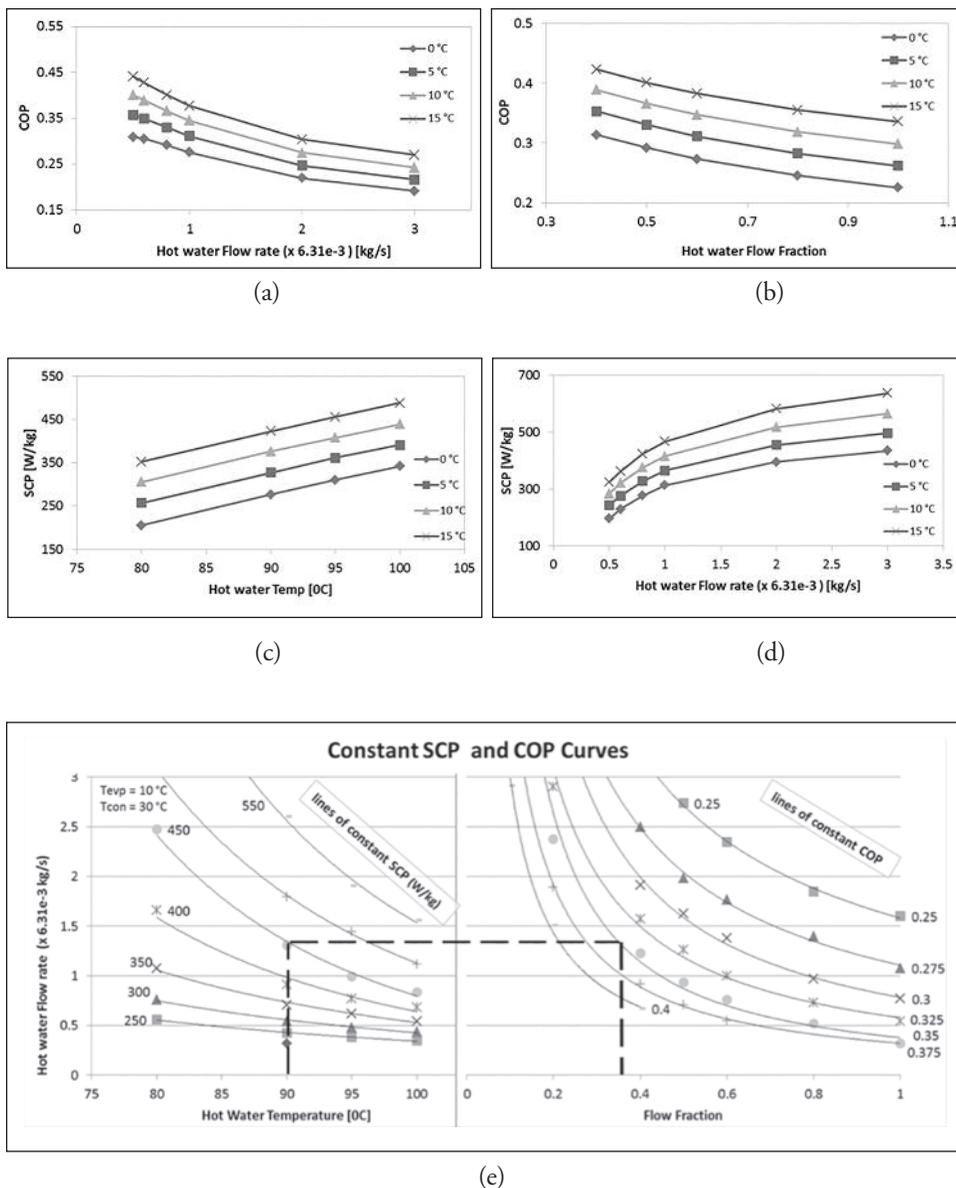
The thermodynamic cycle of pressure versus temperature was obtained for the base case analysis as shown in Figure 3(d). This figure resembles the ideal Clapeyron thermodynamic cycle except for the pressure variation during the desorption process represented by a curve instead of a straight horizontal line. This is expected since pressure variation was allowed during the desorption process.



**Figure 3:** (a) adsorber bed pressure vs time from start-up; (b) adsorber bed capacity vs time from start-up; (c) adsorber bed temperature vs time from start-up; (d)  $\ln P$  vs  $-1/T$  thermodynamic cycle

## Key parameters and their effect on performance

The influence of operational parameters such as evaporating temperature, and heating and cooling water flow rates and temperatures on the main performance indicators of COP and SCP are analysed here. General physical design features of the adsorber bed were not the focus of the investigation. During this analysis, the evaporator's surrounding temperature was varied between 0 °C and 15 °C; conditions which typify application requirements such as food storage and air conditioning.



**Figure 4:** (a) effect of hot water flow rate and evaporating temperature on COP; (b) effect of flow fraction and evaporating temperature on COP; (c) effect of hot water temperature and evaporating temperature on SCP (d) effect of hot water flow rate and evaporating temperature on SCP; (e) selection of adsorption system performance

Figures 4(a–b) shows that at higher evaporator temperatures and at lower flow rates and flow fraction, better refrigeration COPs can be achieved. However, several combinations of water flow rate and evaporator temperature can be used to achieve the same COP. This suggests that lower water flow rates are more suitable if increasing COP is of primary concern. Also, the numerical model reveals that heat source temperature has negligible effect on the COP for the range of operating conditions investigated. The relative insensitivity of the COP to hot water temperature is in keeping with general thermodynamic principles which maintain that the variables which primarily impact on COP are the temperature of the refrigerated space and the temperature of the ambient (heat sink). Generally, for all thermodynamic cycles, heat transfer between large temperature differences always results in increased irreversibilities, which is associated with lower COPs. Furthermore, the absolute temperature change in the heat source is too small to significantly impact the COP.

With reference to Figures 4(c–d), it was observed that an increase in evaporator temperature and hot water temperature and flow rate resulted in increased SCP. For any evaporator temperature, the highest SCP was achieved with the largest heat source temperature of 100 °C and highest flow rate. Also, similar values of SCP could be achieved for different combinations of evaporator temperature and hot water temperature and flow rate. However, at lower flow rates, the significance of evaporator temperature on SCP diminishes. The model showed that changes in flow fraction had relatively no effect on the SCP for a given evaporator temperature. When Figure 4(d) is compared to Figure 4(a), it can be concluded that achieving more cooling power often means sacrificing system efficiencies. The decision whether or not to aim for higher SCP versus higher COP will therefore primarily depend on the consistency of the heat source and/or the capacity of the heat storage.

The cumulative effect of flow rates and heat source temperature on performance can be demonstrated on a single chart to provide a selection tool based on required system performance. Figure 4(e) was developed to allow for the selection and determination of the adsorption system performance based on SCP, COP, hot water temperature, flow rates and flow fraction. By using this figure, and knowledge of one's desired or limiting parameter, all other parameters can be determined for hot water in the 80–100 °C temperature range.

## Conclusion and future work

The novel strategy of using water flow fractions to control adsorption bed cycling has been demonstrated. Using a fraction of the hot water flow leaving the desorbing bed to heat the heating bed can result in an automated control strategy for bed switching. Bed switching is critical to ensure continuous cooling is achieved without any noticeable interruption in performance of the refrigeration system. The main output of interest for adsorption systems is the SCP and COP. The highest SCP and COP are achieved at higher evaporator temperatures. Therefore, the adsorption system is most suited for application requiring relatively high evaporator temperatures such as air conditioning applications. This analysis has not focused on optimizing the design of the adsorption system. Additional research would need to be carried out to optimise the heat exchanger design and improve heat recovery strategies to improve the performance of the adsorption system. Consequently, the development of a prototype using optimised adsorber bed heat exchanger dimensions would be the next logical effort in this research agenda. Such a prototype would not only be used to conduct optimization studies, but would also be used to validate the numerical model, all of which would lead to a better understanding of adsorption refrigeration systems.

NOMENCLATURE

$A$	Area [ $\text{m}^2$ ]	Subscripts	
$c_p$	specific Heat Capacity [ $\text{J.kg}^{-1}.\text{K}^{-1}$ ]	$a$	adsorbing bed/ adsorption
$D$	constant of D-A equation	$cw$	cold water
$F_{r,c}$	Heat sink fluid fraction flowing to cooling bed	$con$	condenser
$F_{r,h}$	Heat source fluid fraction flowing to heating bed	$c$	cooling bed
$h_a$	heat of adsorption [ $\text{J.kg}^{-1}$ ]	$char$	charcoal/carbon
$h_d$	heat of desorption [ $\text{J.kg}^{-1}$ ]	$d$	desorbing bed/ desorption
$h_{fg}$	latent heat of vaporization [ $\text{J.kg}^{-1}$ ]	$evp$	evaporator
$k$	Thermal conductivity [ $\text{W.m}^{-1}.\text{K}^{-1}$ ]	$f$	fin(s)
$m$	mass [kg]	$h$	heating bed
$\dot{m}$	mass flow rate [ $\text{kg.s}^{-1}$ ]	$hw$	hot water
$n$	constant of D-A equation	$in$	inlet/entering
$P$	pressure [Pa]	$mg$	methanol gas/vapour
$Q$	Heat rate [W]	$ml$	methanol liquid
$R$	gas constant [ $\text{J.kg}^{-1}.\text{K}^{-1}$ ]	$out$	outlet/exiting
$T$	temperature [K]	$sat$	saturation
$t$	time [s]	$t$	tube
$U$	overall heat transfer coefficient [ $\text{W/m}^2.\text{K}$ ]	$w$	water
$V$	volume [ $\text{m}^3$ ]		
$x$	mass of refrigerant adsorbed [ $\text{kg.kg}^{-1}$ ]		
$x_0$	maximum adsorption capacity [ $\text{kg.kg}^{-1}$ ]		

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# Antinociceptive and Anti-inflammatory Effects of the Hydroalcoholic Extract and Cinnamic Acid obtained from *Lychnophora Pinaster*

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## Abstract

*The objective of this study was to evaluate the antinociceptive and anti-inflammatory effects of *Lychnophora pinaster* (Asteraceae) and cinnamic acid in male Swiss mice (20–30 g). Antinociceptive activity was measured using formalin-induced nociception and tail-flick nociceptive reflex. Anti-inflammatory activity was evaluated by carrageenan-induced paw edema, carrageenan induced peritonitis and measurement of nitrite concentration. The results showed that the extract caused inhibition ( $p < 0.05$ ) in the formalin test (inflammatory, second phase) but did not modify neurogenic pain in the formalin test, tail-flick reflex latency or rota-rod motor performance test. *L. pinaster* extract also inhibited ( $p < 0.05$ ) carrageenan-induced paw edema and peritonitis. From this active extract, a compound (cinnamic acid) was obtained and tested with similar results to the hydroalcoholic extract. The nitroergic pathway seems to account for this antinociception. The  $IC_{50}$  of the hydroalcoholic extract and cinnamic acid were 427 and 0.73 mg/kg (p.o.) respectively. The present study suggests the presence of antinociceptive and anti-inflammatory activities for both the extract and the cinnamic acid.*

**Keywords:** *Lychnophora pinaster*, Antinociceptive, Anti-inflammatory, Cinnamic acid

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## Introduction

There are several species within the genus *Lychnophora* (Asteraceae) used in folk medicine and in this study, we chose *Lychnophora pinaster* Mart (LP). It is known as false arnica or arnica mineira because its smell is similar to that of *Arnica montana*. The latter is native to Europe and has already had its medical effectiveness proven.

LP was shown to be active against *Trypanosoma cruzi*, the etiological agent of Chaga's disease (1), and a preliminary screening showed antinociceptive effects (2).

LP belongs to a genus restricted to the Brazilian cerrado and has been widely used in Brazil for the treatment of inflammatory diseases; however, because it is frequently mistaken with *Arnica montana*, anecdotal data comprise much of the popular information available about this plant. Folk medicinal use of native species should be encouraged in developing countries as long as it is supported by scientific studies. That is why we decided to evaluate the anti-inflammatory and antinociceptive effects of the hydroalcoholic extract and a compound derived from this extract: cinnamic acid

## Methods

### PLANT MATERIAL

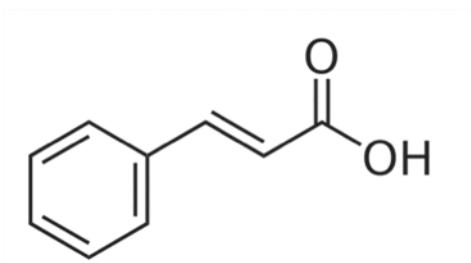
The aerial parts of *Lychnophora pinaster* were collected in Minas Gerais, Brazil. The species was identified by Professor J. A. Lombardi, from the Institute of Biological Sciences, UFMG, Brazil, where a voucher specimen is deposited (BHCB No 60265).

### EXTRACTION, FRACTIONATION, ISOLATION AND IDENTIFICATION OF COMPOUNDS

The air-dried powdered plant material was extracted at room temperature by percolation with ethanol:water (65:35 v/v). Solvent was removed in a rotatory evaporator, at maximum temperature of 50°C, affording a dark green residue.

The crude hydroalcoholic extract was further fractionated as described by us in a previous paper (3). Four compounds were isolated and identified (cinnamic acid, caffeic acid, pinobanksin and chlorogenic acid) by comparison with previously reported spectroscopic data and authentic samples (3).

We focused on compound identified as cinnamic acid (see Figure 1) as it was obtained in good yield for biological testing. The purity of the substance was confirmed by high-pressure liquid chromatography (HPLC) analysis.



**Figure 1.** Structure of Cinnamic Acid

## EXPERIMENTAL ANIMALS AND DRUGS

Male Swiss mice weighing 20–30 g obtained from Universidade Federal de Minas Gerais (UFMG), Brazil were used in the experiments. They were housed in standard cages at room temperature and provided with food and water ad libitum and 12-hour light-dark cycle.

The study was conducted in concordance with the IASP Guidelines on the use of laboratory animals (4) and approved by the Ethics Committee on Animal Experimentation of the Federal University of Minas Gerais. All drugs and reagents were from Sigma (USA).

## EXPERIMENTAL PROTOCOL

The hydroalcoholic extract (0.1–2 g/kg) was given p.o. (gavage). The  $IC_{50}$  value was determined by linear regression from individual experiments (formalin test). For cinnamic acid the dose found was 0.73 mg/kg and for the hydroalcoholic extract 427 mg/kg.

## FORMALIN-INDUCED NOCICEPTION

The method used was similar to that described previously (5) adapted for mice (6). Formalin solution (2% in PBS; 30  $\mu$ l/paw) was injected into the hind paw plantar surface (intra plantar injection). The time spent licking or biting the affected paw was rated during two time intervals: 0–5 min (first phase or neurogenic pain) and 15–30 min (second phase or inflammatory pain). Oral treatment (p.o.) with sodium diclofenac (10 mg/kg; positive control), morphine sulphate (5 mg/kg; positive control), vehicle (water, 10 ml/kg; V), LP hydroalcoholic extract (100 – 2000 mg/kg) or cinnamic acid (0.3–30 mg/kg) were given 60 min prior to formalin injection. When measuring only the second phase animals received: L-NAME, L -arginine, D-arginine (10 mg/kg; p.o. 30 min prior to formalin injection), naloxone (5 mg/kg, p.o., 30 min when prior to morphine), hydroalcoholic extract or cinnamic acid as above 1 h prior to formalin. n= 6 for each group.

## TAIL-FLICK NOCICEPTIVE REFLEX

Animals were placed on the tail-flick apparatus (Ugo Basile, Italy) with their tails smoothed into a groove that contained a photocell. A light source was activated and the light remained focused on the tail until the rat moved its tail (a spinal reflex), thus switching the light off. The intensity of the light was adjusted to obtain a baseline tail-flick latency of 2–4 s and a cut-off-time of 9 s was chosen to prevent tissue damage (7). The tail-flick reflex latency was measured every 30 min, from 1 h before (basal values) up to 2 h after oral treatment with vehicle (water, 10 ml/kg), morphine sulphate (5 mg/kg; positive control), hydroalcoholic extract (1 and 3 x  $IC_{50}$ ), or cinnamic acid (1 and 3 x  $IC_{50}$ ). n= 6 for each group.

## CARRAGEENAN-INDUCED PAW EDEMA TEST

Mouse paw edema was induced by i.pl. injection of carrageenan (Sigma, USA, 1,5% in saline, 30  $\mu$ l/paw) in the right paw of animals treated by oral administration of vehicle (water, 10 ml/kg, V), sodium diclofenac (10 mg/kg; positive

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control, D), hydroalcoholic extract (427 mg/kg and 1281 mg/kg) or cinnamic acid (0.73 and 2.19 mg/kg) respectively 1 and 3 x IC<sub>50</sub>. The contralateral paw received the same volume of saline and was used as a control. Paw volume was measured hourly on a plethysmometer (Ugo Basile, Italy; (8)), starting 1 h before (basal values) and up to 6 h following carrageenan injection. Edema was calculated as the difference (μl) between injected and control paw. The area under the curve (AUC) time versus variation (Δ) of paw volume was calculated for each animal. n= 6 for each group.

Carrageenan induced peritonitis and measurement of nitrite concentration

Animals received an i.p. injection of carrageenan (Sigma, USA, 1.0% in saline, 250 μl/cavity) 60 min after oral treatment of hydroalcoholic extract (3 x IC<sub>50</sub> = 1281 mg/kg), vehicle (water 10 ml/kg), dexamethasone (2 mg/kg; positive control). Under anesthesia (ketamine 100 mg/kg and xylazine 15 mg/kg, i.p.), lavage fluid was collected after 6 h and neutrophils counted in Neubauer chamber (May-Grunwald-Giemsa stained) under optical microscopy.

A sample of this lavage fluid (100 l) was assayed for nitrite concentration. Total nitrite (the metabolic end product of nitric oxide; NO) in exudates was measured by an enzymatic method using the Griess reaction (9). n= 6 for each group.

#### MOTOR PERFORMANCE TEST (ROTA-ROD)

Motor performance was measured (10) as time spent walking on a rotating rod (16 rpm) during 2-min trials (Rota-rod, Ugo Basile, Italy). Mice were submitted to three training sessions 24 h before testing and those scoring <90 s were rejected. Motor performance was evaluated immediately before (basal), 30, 60 and 120 min after oral treatment with vehicle (water 10 ml/kg), xylazine (2 mg/kg; positive control), hydroalcoholic extract (1 and 3 x IC<sub>50</sub>), or cinnamic acid (1 and 3 x IC<sub>50</sub>). n= 6 for each group.

#### STATISTICAL ANALYSIS

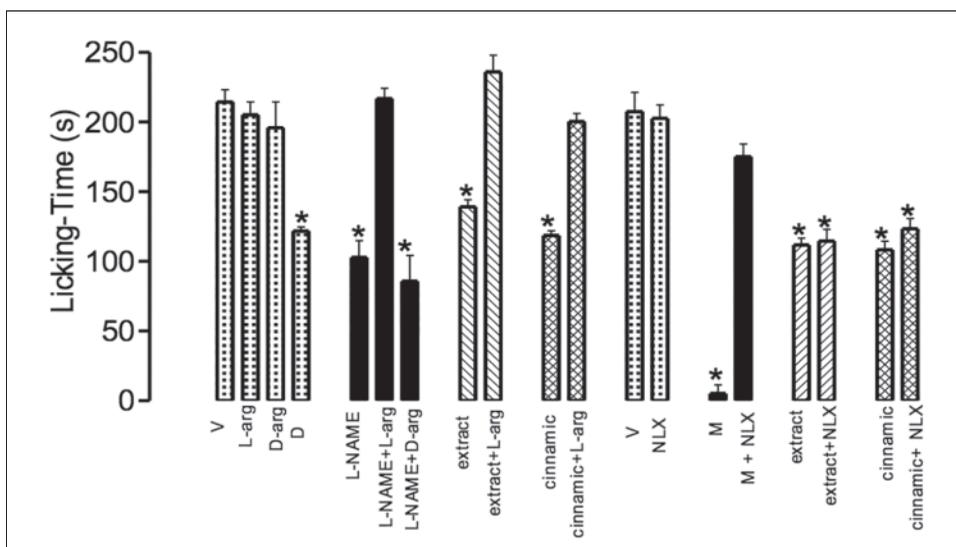
The results were expressed as mean ± S.E.M of the evaluated parameter. IC<sub>50</sub> values (the dose of extract or compound reducing the nociceptive response by

50% relative to the control value) were determined by linear regression from individual experiments using linear regression Graph-Pad software (GraphPad software, San Diego, CA, USA). The statistical significance of differences between groups was detected by one-way analysis of variance followed by Dunnett's test. The minimum level of significance considered was  $p < 0.05$ .

## Results

### FORMALIN-INDUCED NOCICEPTION

Oral administration of the hydroalcoholic extract (100–2000 mg/kg) or cinnamic acid (0.3–9 mg/kg) exhibited a significant dose-dependent reduction only in the second phase of the formalin-induced nociception test. Naloxone did not reverse the antinociceptive effect of hydroalcoholic extract ( $3 \times IC_{50}$ ) nor cinnamic acid ( $3 \times IC_{50}$ ). On the contrary this antinociceptive effect was reversed by pre-administration of L-arginine as shown in Figure 2.



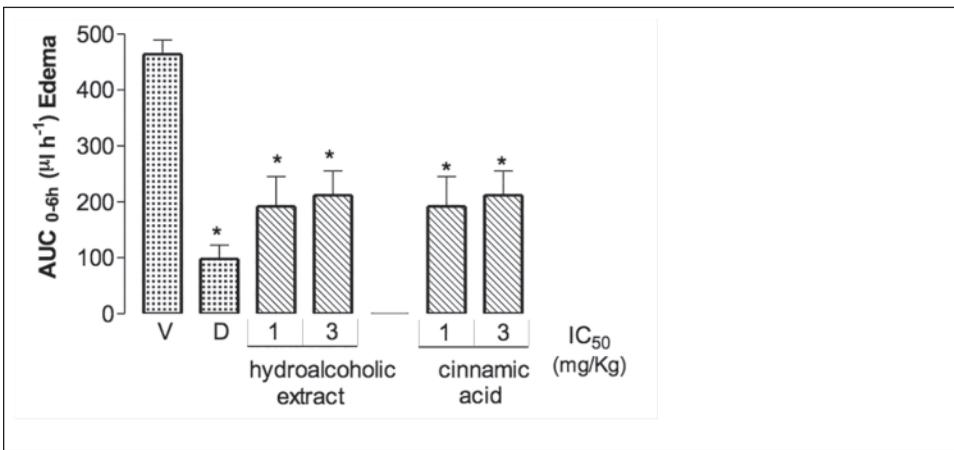
**Figure 2.** Second phase of formalin-induced mice nociception test

### TAIL-FLICK NOCICEPTIVE REFLEX

Hydroalcoholic extract (1 and 3 x IC<sub>50</sub>) and cinnamic acid (1 and 3 x IC<sub>50</sub>) did not change tail-flick reflex latency (data not shown).

### CARRAGEENAN-INDUCED PAW EDEMA TEST

Hydroalcoholic extract and cinnamic acid (1 and 3 x IC<sub>50</sub>) reduced ( $p < 0.05$ ) inflammatory paw edema induced by carrageenan as shown in Figure 3.



**Figure 3.** Inflammatory paw edema induced by i.pl. injection of carrageenan (30 µl/paw)

### CARRAGEENAN INDUCED PERITONITIS AND MEASUREMENT OF NITRITE CONCENTRATION

Hydroalcoholic extract reduced neutrophils infiltration (hydroalcoholic extract:  $9.39 \pm 1.16 \times 10^3$  cells/cavity; control:  $17.50 \pm 4.16 \times 10^3$  cells/cavity; dexamethasone:  $8.11 \pm 3.16 \times 10^3$  cells/cavity) and nitrite concentration in peritoneum fluid (hydroalcoholic extract:  $13.70 \pm 1.30$  µM; control:  $36.20 \pm 3.16$  µM; dexamethasone:  $14.43 \pm 4.16$  µM).

## MOTOR PERFORMANCE TEST (ROTA-ROD)

Hydroalcoholic extract (1 and 3 x IC<sub>50</sub>) and cinnamic acid (1 and 3 x IC<sub>50</sub>) did not change motor performance (data not shown).

## Conclusion

Pre-treatment with hydroalcoholic extract (100–2000 mg/kg) or cinnamic acid (0.3–9 mg/kg) inhibited only the second phase of the formalin-induced nociception test. Figure 1 shows hydroalcoholic extract (3 x IC<sub>50</sub>) and cinnamic acid (3 X IC<sub>50</sub>) second phase inhibition. This test is divided into two parts, the first phase (acute pain) appears immediately following the injection of formalin, lasting only a few minutes and is believed to be the result of primary afferent nociceptor activity. The second phase (tonic pain) is observed 15 minutes after the formalin injection and lasts at least 60 minutes. This second phase is mediated by various substances and results from nociceptive spinal neuron hyperactivity and is inhibited by non-steroidal anti-inflammatory drugs (NSAIDs) (11) like diclofenac (used in our experiments as a positive control). A peripheral inflammatory process is involved in the second phase. Morphine inhibits both phases.

As shown in Figure 1, naloxone, an opioid antagonist did not reverse the antinociceptive effect of the hydroalcoholic extract (3 x IC<sub>50</sub>) or cinnamic acid (3 x IC<sub>50</sub>). However this antinociceptive effect was reversed by pre-administration of L-arginine. These results indicate participation of the nitrenergic but not opioidergic pathway in the antinociceptive effect.

An analgesic effect of an n-butanol fraction of *Lychnophora ericoides* was reported in a neurogenic model of nociception (writhing test) in mice (12). This represents a model of peripheral nociception and is also used for analgesic screening involving direct stimulation of chemical receptors in the peritoneum. In the formalin test the first phase is explained by direct stimulation of nociceptors and reflects centrally-mediated pain validated by the tail-flick test that is also more sensitive for assessing centrally acting analgesics. Along with having no effect in the first phase of the formalin test, neither hydroalcoholic extract

nor cinnamic acid had any effect in the tail-flick reflex test suggesting a peripheral effect for both compounds.

Carrageenan-induced local inflammation (paw edema) is commonly used to evaluate non-steroidal anti-inflammatory drugs because it has been linked to neutrophil infiltration and production of reactive oxygen species free radical like NO (13). The hydroalcoholic extract and cinnamic acid (1 and 3 x IC<sub>50</sub>) reduced inflammatory paw edema induced by carrageenan. Diclofenac again was used as a positive control.

Interestingly we observed that the hydroalcoholic extract reduced neutrophils infiltration by 46.34% and reduced nitrite concentration in peritoneum fluid by 62.15%. The presence of nitrite in exudates is a good indicator of NO synthesis. Because a reduction of NO production could lead to a reduction in the cellular infiltration induced by carrageenan (13) we can validate the participation of the nitergic pathway in this effect. This pathway may have contrasting effects, antinociception or nociception, depending on the dose or site of administration, possibly due to different subtypes of primary nociceptive neurons. In fact, Vivancos and cols. (14) demonstrated that intraplantar injection of NO donors and dibutyryl cGMP caused antinociception and an intradermal administration caused the opposite effect (hypernociception).

A cross over between nitric oxide synthase (NOS) and cyclo-oxygenase (COX) pathways has been suggested by many studies. Prostaglandin generation in the site of inflammation seems to be at least in part under the control of NO, and NO may have a dual effect, either by negatively or positively modulating prostaglandin generation (13).

Recently, Guzzo et al. (2) showed, with different methodologies (acid acetic writhing test), antinociceptive and anti-inflammatory activity with LP. Their preliminary results showed that this effect was not dose-dependent, and was only observed with a low dose.

Both the hydroalcoholic extract and the cinnamic acid effects are unlikely to be due to sedation or motor abnormality, because motor performance in rotarod test was not impaired.

Because inflammation mobilizes several agents, we cannot rule out the participation of several other substances in the inflammatory process (15) during the second phase of pain induced by formalin, however up to this point our

studies give unequivocal support to the use of LP for its anti-inflammatory and antinociceptive effects through a nitrergic pathway and that cinnamic acid may contribute to this effect.

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## Appendix

### Figure Legends

**Figure 2.** Second phase of formalin-induced mice nociception test. Animals received by gavage (p.o): water (V, 10ml/kg), sodium diclofenac (D, 10 mg/kg), morphine sulphate (M, 5 mg/kg), *Lychnophora pinaster* hydroalcoholic extract (extract, 3 x IC<sub>50</sub> = 1281 mg/kg) or cinnamic acid (cinnamic, 3 x IC<sub>50</sub> = 2.19 mg/kg) 1h prior formalin injection (2%, 30 µl/paw, i.p.l.) or L-arginine (L-arg), D-arginine (D-arg), L-NAME (10 mg/kg) or naloxone (NLX, 5 mg/kg) 30 min prior to formalin injection. Licking time was measured for 15 min after formalin administration up to 30 min. n=6, \*p<0.05 compared to the control (V) group by one-way analysis of variance followed by Dunnett's test.

**Figure 3.** Inflammatory paw edema induced by i.pl. injection of carrageenan (30 µl/paw). Animals received by gavage (p.o): water (V, 10 ml/kg), sodium diclofenac (D, 10 mg/kg), *Lychnophora pinaster* hydroalcoholic extract (1 and 3 x IC<sub>50</sub>) or cinnamic acid (1 and 3 x IC<sub>50</sub>) 1h prior carrageenan. Paw volume was measured hourly starting 1 h before (basal values) and up to 6 h following carrageenan injection. Edema was calculated as the difference (µl) between injected and control paw. The area under the curve (AUC) time versus paw volume was calculated for each animal. n=6, \*p<0.05 compared to the control (V) group by one-way analysis of variance followed by Dunnett's test.

# The Teaching of English as a Second Language

## Recommendations for Policy Makers at the Tertiary Level

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### Abstract

*The protracted discussion surrounding the teaching of English in Jamaica rages on while students continue to face numerous problems. Various persons have voiced opinions as to how the situation may be fixed. One prominent and valid suggestion is the adoption of the English as a second language (ESL) approach to the teaching of English. However, there is evidence that some Jamaicans have inadequate knowledge of what this approach entails. While some see it as merely having implications for English Language educators, this paper argues that ESL also makes demands on policy makers, budget holders and content specialists. Based on conclusions drawn from the findings of research in the field of second language teaching and learning, the paper suggests that the ESL approach must be guided by a carefully devised plan of action rooted in the findings of applied linguistics, and endorsed by policy-makers at the highest level. Tertiary institutions, especially universities, with their mandate to assist in and perhaps lead national development, should set the pace, by creating and implementing language education policies influenced by the findings of relevant research. The paper makes recommendations as to the nature of this policy.*

**Key words:** English as a second language; English Language teaching policy; Jamaican language context; Tertiary language teaching

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## Background

While there are still some Jamaicans who believe that all the citizens of this country speak only English, with some using *proper* English and others employing forms of broken English, there is currently widespread agreement that Jamaica can be considered a bilingual state (Devonish & Carpenter, 2007; Ministry of Education, Youth & Culture, 2001). The two dominant varieties, Jamaican Creole (JC) and what is referred to as Standard Jamaican English (SJE), play contrasting roles. With Creole formally functioning as the language of social discourse and English serving as the official language to be used in formal contexts, students are expected to become proficient in SJE.

However, educators also concur on the fact that the English Language output of some secondary school graduates, even those with a pass in an external English Language examination, displays various types of deficiencies (Blagrove-Smith, 2004; Dunn-Smith, 2010; Evans, 2001, Virtue, 2013). There is even some congruence regarding the solution to the problem: teach English as a second language. Where the discrepancy seems to lie is in how this feat should be accomplished.

## The Current Buzz

Perhaps because everyone went to school, everybody appears to be qualified to state how teaching should be carried out. The teaching of English, specifically, appears to be benefitting from proposals originating from persons in every field of endeavour. The latest proclamation, perhaps due to the *newly found* recognition that Jamaica has two dominant language varieties, is that English should be taught as a second language. This pronouncement is made with such fervour that listeners would believe that this is surely some great new discovery.

Yet, many teachers of English who benefitted from the language education programmes at institutions such as Shortwood Teachers' College and the University of the West Indies know that, from at least the late 1970s, this philosophy guided aspects of the teacher training language education programmes. In addition, the ESL approach was the suggested strategy identified in the Draft

Language Education Policy (DLEP) devised in 2001 by the Ministry of Education, Youth and Culture. However, this policy was never officially implemented. This inaction is perplexing given the difficulties some students face.

While the DLEP remains in its draft state, the declaration that teachers are not employing the proper teaching techniques (Coard & Dyche, 2013, p. 79), as well as the call for ESL strategies to be employed by language educators continue. These suggest that the problem merely lies in teaching strategies. A proposed review of the current Draft Language Education Policy (DLEP) announced in 2012 by Dr. Hill, the national literacy coordinator, also implies that teaching methodology is the main factor. Dr. Hill was reported as saying that “the (new) draft policy will stipulate a system-wide approach to the teaching of English” and that “this would have implications for how student teachers are trained in the teachers’ colleges and universities” (Dennis, 2012, para. 3).

### The Need for a Clear Language Education Policy

While educators are major players in devising and implementing curricula and are expected to have personal philosophies that guide their teaching, there must be some broader framework under which teaching occurs. Thus, policy-makers and middle-level administrators must also be included (Wang, 2010, p. 126). Language planning issues go much further than the classroom, and educators have neither the power nor resources to deal with the larger factors.

Jules (2010), in calling for modifications in how education is approached in the Caribbean, advocates for the development of a philosophy of education, which would guide efforts to improve the output of these systems. This suggestion makes sense, since teaching is a very complex task. As with all complicated undertakings, there is a requirement for the application of relevant and carefully evaluated theories and principles, which would aid in the provision of a rationale for and guidance in the use of particular strategies (Silva & Matsuda, 2010, pp. 6–7).

The task of improving language proficiency is said to be particularly complicated, according to Kennedy (2011), as it involves a set of intertwining variables. These factors include social, psychological, political, historical and

linguistic issues. Therefore, seeking to fix one factor, (teaching methods), cannot solve the problem of poor performance in the use of SJE. In articulating strategies for the development of education in the Organization of Eastern Caribbean States (OECS), Miller, Jules and Thomas (2000, p. 14) include among their recommendations, a call for the development of a “comprehensive language policy,” which would address the use of appropriate strategies in the teaching of English as a second language.

For the policy to be seen as effective, it must have certain characteristics. According to Carroll (2013) and Robertson (2010), it should be a plan of action that

- articulates a certain philosophy governing the approaches to be employed,
- has clear objectives, and
- identifies the procedures for accomplishing the set goals.

This means that the plan, as stated by Liddicoat and Baldauf (2008, p. 56), has to be “systemic, rational, [and] theory-based.” Thus, some degree of cooperation between policy makers and specialists within the field of second language teaching and learning is needed.

The 2001 Draft Language Education Policy (DLEP), though not perfect in its declarations, acknowledges the role of the government, Ministry of Education, parents, the community, teacher training institutions and the learners in the teaching/learning process (Ministry of Education, Youth & Culture, 2001, pp. 29-31). The policy creators, which involved a number of language educators, appear to have gotten that aspect right; but as lamented by Maxwell (2008, “Official Language,” para. 2), “the scholarship and good intentions of that transformational exercise appear to have come to nought.”

Could the problem be that theorists devised the DLEP, and the bureaucrats did not share the ideas presented? According to the Jamaica Language Unit (2010, p. 2), “policy makers do not listen to them [linguists] on matters of language which require the expertise of linguists, especially in the area of language education.” Also, the issue of bilingual education, at least at the primary level, has not been fully explored despite the work of the Jamaica Language Unit housed at the University of the West Indies, Mona. Jamaica does not appear to be alone in this predicament, however, as Kennedy (2011), writing in a publi-

cation by the British Council, laments that unlike the response given to medical professionals, for example, little attention is paid to applied linguists. He explains that this may occur because results within fields such as medicine are more concrete.

While the current emphasis on early childhood education and literacy development shows that some research findings are being applied to solving problems within the education system, a more comprehensive and systematic plan of action needs to be devised and implemented. It will be interesting to see the alterations that will be made in the new draft policy, and what attention will be placed on meeting the conditions, apart from teacher training.

## Planning for English as a Second Language at the Tertiary Level

Given the mandate of tertiary institutions, especially universities, this alleged rift between policy makers and theorists should not exist at this level. These institutions should have knowledge generation and application as part of their core functions. It is the universities that should lead the way in showing how theory should be applied to solving problems. They should, as part of their mission to produce the ideal graduate, use available information on issues related to the Jamaican language-learning context and the teaching of English as a second language to develop and implement effective language policies. These policies would provide a systematic means of guiding language development at their institutions, and exemplify what should obtain in the wider education system. The following recommendations could be of assistance in accomplishing these tasks.

### **Recommendation One:** Develop a Theory-based Background for ESL Policy Development

Within the university context, decisions should be made in a systematic manner, using a problem-solving approach that involves

- identifying the issue,

- locating adequate valid information,
- evaluating and synthesize the information,
- drawing logical conclusions, and then
- as far as possible, making decisions free of personal bias.

Students are taught this procedure in critical thinking classes; it would therefore be very peculiar, if university policy makers do not follow this approach. In understanding the issue surrounding ESL in Jamaica, policy makers would need to be aware of the factors discussed in the following sections.

### What is an ESL Context?

Since English is seen as a second language for most Jamaicans, it is understandable that practitioners would benefit from an examination and application of the principles of second language acquisition (SLA) in seeking to assist learners. Based on the tenets of SLA, a second language context consists of learners who already speak a native language and are attempting to learn another variety (Cook, 2008). In addition, the target language in this situation is usually being used within the learners' surroundings (Gass & Selinker, 2008, p. 7). This description aptly fits the status of Standard Jamaican English (SJE).

The second language situation contrasts with the foreign language context in which the target language may not be used within the learners' environment, or is restricted to specific situations. For example, in Jamaica, Spanish is a foreign language since it is not widely used in this country. Only workers in specialized fields, such as the tourism industry or companies catering to international clients, may normally encounter this language on a daily basis. Learners of Spanish may be seeking to acquire this variety in order to work in another country or in specialized industry. Standard Jamaican English (SJE), on the other hand, is required for all formal contexts including education, business and the legal system. Thus, while some applicable foreign language teaching activities may be useful, English language teaching in Jamaica cannot adopt a broad foreign language approach, as being suggested by some individuals.

## Requirements for Learning English as a Second Language

### REQUIREMENT ONE: USEFUL INPUT AND OUTPUT

Although there are contrasting theories as to exactly how a second language (L2) is acquired or learnt, there is agreement on some of the basic components that have to be in place. One of the most important is the need for adequate, useful input (Bahrani & Soltani, 2012; Ellis & Collins, 2009). This input should expose the learner to the lexicon, phonology, syntax, morphology and social rules of the language. Useful input is attained both by eye through reading, and by ear via listening to the language being used in meaningful contexts, or by engaging in conversation using the language. In conjunction with the previously mentioned methods, knowledge of the structure of the language may also be obtained through direct instruction, that is, the conscious teaching and learning of the information.

Of importance also is the concept of output (Swain, 1985). Language learning is said to involve a number of cognitive processes (Juan & Flor, 2006; Goldstein, 2008). These processes allow learners to use the input or knowledge gained, explicitly or implicitly, to produce structures of their own. Through experimenting with their own creations, learners can build their competence based on feedback received. Thus opportunities have to be available for meaningful language production by the learner.

### REQUIREMENT TWO: ADEQUATE TIME FOR SKILL ACQUISITION

Unfortunately, the second language learning process is not a short or smooth one. This is due to the fact that language is a complex “cognitive ability” (Galotti, 2004, p. 307). Mental processing of input has some very strict requirements. Successful processing, for example, requires learners to be at the point where they are ready and willing to process the relevant input. Evidence of this may be seen in the attempt to constantly correct a wrongly used structure or word in children’s speech. Despite the parent or teacher’s efforts, they will continue using the inappropriate form until the correct version just seems to appear.

In relation to writing, especially at the tertiary level, the complexity is said

to be even deeper. According to Ferris (2008), “it takes years to acquire competence in a second language approaching that of native speakers;” but, “when the standard of ‘competence’ is academic literacy tasks required in higher education, the timeline is even longer” (p. 92). Hence, the attempt to have students producing high standard written output in a single course is futile since it is impossible to reduce “the SLA process into a fifteen-week course” (Ferris, 2008, p. 94).

The belief that writing is more complicated than speaking has been supported by biological evidence. Sousa (2001), for example, purports that “mental centres responsible for speech and writing are located in the same area of the brain;” however, though connected, they are distinct in their functions (p. 118). Sousa offers as evidence of this, the fact that while speech can develop naturally, writing requires explicit instruction, even in the first language. According to Sousa, the brain sees speech as a “survival skill,” while writing is described as a “complex, labour intensive operation” containing “coordination, memory, visual processing, language and higher-order thinking skills” (pp. 118–120). Sousa’s views are supported by Harrison (2009, p. 59), who asserts that “composing written text is arguably the most cognitively taxing of language production tasks requiring the integration of multiple processing demands across lower order . . . and higher order skills.” The fact that poor performance in writing at the tertiary level is an international problem (Doolan and Miller, 2012; Marcus and Majerol, 2010) may substantiate the view that writing is very complex.

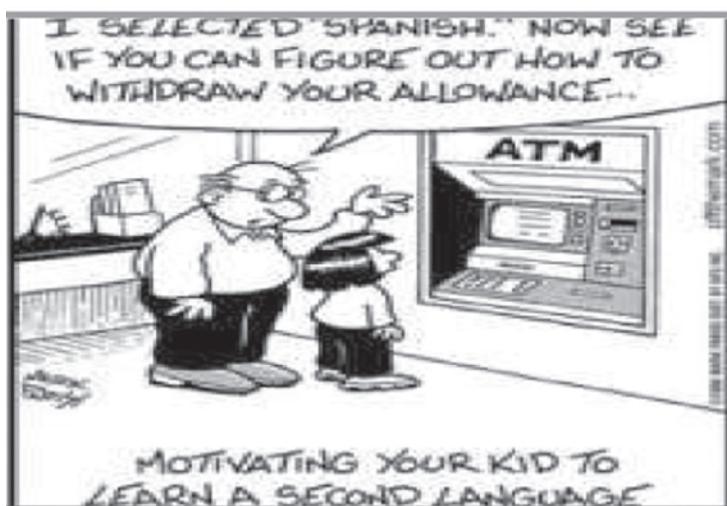
The formal writing process can become even more complicated when one is learning to write in a second language (L2). Corduner (2007) uses the results from studies of the writing output of American university students to show that “L2 (sic) writers have far more to contend with than simple errors in convention, punctuation, and spelling,” as there are difficulties related to “both performance and competence errors” (p. 28). The research showed that despite their high degree of expertise in their first language (L1), the students had difficulties with organization and cohesion (Corduner, 2007, p. 13). It is said that this additional burden may be linked to the fact that the L2 learners are trying to develop literacy skills in a language in which they may have limited speaking and comprehension skills (Coleman & Goldenberg, 2010, p. 108).

Another potential problem that could face L2 students seeking to develop

their writing skills is the lack of literacy in the L1. As reported by Leki, Cumming, and Silva, (2008, p. 103), research findings have shown that “literacy development in one language had a positive effect on development in the other.” This is said to be so, as literate second language learners would have developed skills in the first language that could assist them in acquiring proficiency in the target variety. Learners with knowledge of the development of effective paragraph creation within their L1, for instance, would then only be concerned with the vocabulary, sentence structure and social norms within the context of the L2. In contrast, the learners who are illiterate, as far as their L1 is concerned, will have to consider those factors in addition to the requirements for effective paragraphing.

### REQUIREMENT THREE: HIGH DEGREE OF MOTIVATION

Even with the required input and opportunities for output, effective language development may not occur if attention is not paid to psychological factors (Coard & Dyche, 2013). Consistent with the principles of cognitive theory, learning in general requires students to participate in the act of information gathering (Hyslop-Margison & Strobel, 2008; Ultanir, 2012). This action necessitates an adequate level of motivation that will inspire the learners to will-



Source: Noriega Fernandez (2012)

ingly perform the relevant tasks. Second language (L2) learning, given its complexities, demands a high degree of willingness to process input (Gardner and Lambert, 1972; Schumann, 1986). This willingness is often linked to the students' beliefs, attitude and experiences (Mercer, 2011).

## Application to the Jamaican ESL Context

The brief description of the requirements for effective learning of a second language shows that the Jamaican ESL learners are faced with a number of challenges. In relation to the first requirement, useful input, there is some amount of deficiency. The provision of the required knowledge may be restricted by a number of factors including

- the close resemblance between Jamaican Creole (JC) and English,
- the inability of most students to differentiate between the two varieties,
- the tendency to be infrequent readers, and
- restricted exposure to appropriately structured English utterances in the wider community.

Concerning output, the Jamaican student will also face challenges. If Standard Jamaican English (SJE) is not normally widely utilized on a daily basis, opportunities for practice will be inadequate. In addition, since literacy is only officially offered in English, students who are dominant Creole speakers will not receive the benefits of using knowledge and skills related to the L1 to assist in gaining literacy in another variety.

The uniqueness of the Jamaican Creole context holds further difficulties for the ESL learner. While JC and SJE have different grammatical systems, they share a vast amount of their vocabulary. This can serve to confuse the learners and lead them to think that they are using English when they are not. Devonish and Carpenter (2007) identifies this problem as one of the deterrents to gaining proficiency in the use of English. An added issue is the dominance of Jamaican Creole (JC). While the use of JC is not a negative thing, when learners see that they are coping with their communication needs, they may not put much effort into the learning of the target language. The dominance of the Jamaican culture

can also serve to concretize the view that a high level of performance in English is not important.

Additionally, the difficulties with input and output may partner with other historical and social issues to impact the degree of motivation to acquire proficiency in English. Although slavery has long passed, some remnants of its effect still remain. The way JC, a language with its association with slaves and the under-classed, is viewed, appears to be one factor. There are still individuals who see JC as the language of unintelligence. Also, JC's close resemblance to English may confirm that it is a *broken* version of English. When this is coupled with the fact that it remains an oral language, which makes it unsuitable to be included in the quest for literacy, the Creole-speaking learner may harbour feelings of inadequacy.

This feeling may worsen when the negative views of the language is passed on to the speaker. According to reports given by Devonish (2011) and Jones McKenzie and Orogun (2012), Creole speakers have been ridiculed and dealt with in a manner that may lead to shame. Graff (2011, p. 135) describes shame as a feeling of "attack on one's personal identity" which may cause one to want to flee from experiences associated with this response. In order to defend themselves, learners may not want to put much effort into the learning of English, as it may be seen as a difficult subject that they will never master (Coard & Dyche, 2013; Evans, 2001).

Furthermore, parental practices may negatively impact learners' level of motivation. According to Lipps et al. (2012, p.1), "extensive research has suggested that the strategies which parents use to guide and discipline their children can affect their academic, social and emotional development." In the area of language enrichment, there is the danger that authoritarian strategies supporting rigid control and limited verbal interaction can restrict the development of ingenuity and reasoning skills (Ricketts & Anderson, 2008, p. 63). An examination of the practices of some Jamaican parents will show that they instill obedience without questioning authority (Graff, 2011, p. 141). The children are not encouraged to ask questions in order to develop their critical thinking skills. This behaviour, along with the way in which the children are scolded and punished may lead to "low self-esteem" (Ricketts & Anderson, 2008, p. 63). This factor can severely impede successful learning (Du, 2012, p. 509).

## **Recommendation Two:** Assess What Currently Occurs at the Institution in Relation to the Requirements for ESL

### RECOGNITION OF STUDENTS' LEVEL OF PROFICIENCY

After a careful analysis of the requirements and their applicability to the Jamaican second language learner, policy makers at the tertiary level must then turn their attention to what pertains at their institutions. The problems described in the previous section, coupled with the issues related to teacher performance and the availability of resources, may account for the fact that a significant number of secondary school graduates do not achieve the expected degree of proficiency in the use of English. Policy makers at the tertiary level should be aware of the English Language status of the students they admit into their institutions and make adequate provisions for improvements in line with the goals described in their mission statements. While I do not wish to be guilty of drawing conclusions without the benefit of adequate research, experiences with at least three local tertiary institutions suggest that this is not what usually obtains.

For at least two institutions, recognition of the fact that secondary school graduates may not be sufficiently proficient in the use of English is seen in the administration of an English Language Proficiency Test (ELPT). At one institution, the students who fail to achieve a passing grade are asked to complete a 13-week module of two hour and fifty minutes per week, in classes of up to 25 students to one facilitator. These classes take place in regular classrooms that sometimes are more conducive to lectures. In addition, no special types of resources are usually available. This unavailability of adequate resources permeates the entire education system. Thus no matter how much training a teacher has, it may be impossible to fully utilize knowledge and skills given the limitations (Jones McKenzie, 2005).

### PROVISIONS MADE FOR THE IMPROVEMENT OF ENGLISH LANGUAGE SKILLS

At some Jamaica universities, the students are required to complete two to four English Language related one-semester courses/modules across their years of

study. Due to the fact that language skills take time to develop, this is inadequate given the problems some students have with language. Seeing that even the students who fail the ELPT are allowed to complete their specialist courses/modules, some students may be completing four or five others, while struggling through the writing course. This could be contributing to the phenomenon of some students sitting the university writing courses at least four times before managing to pass them.

In addition, these language courses are usually counted as general education subjects that may not be highly regarded by the students. After all, they went to university to learn computing, business administration or some other subject matter (Jones McKenzie, 2013). To further complicate matters, some students manage to successfully complete their specialist courses while trailing first year language courses (Coard & Dyce, 2013; Virtue, 2013). This can bar them from graduating within the expected time frame. As stated by Coard and Dyche (2013, p. 79), poor performance in English does not necessarily mean under-performance in other subject areas; however, non-mastery of formal writing skills can impede the learners' professional opportunities.

Another means of acknowledging the fact that students may need assistance with writing in English is the provision of writing centres. This type of resource, if properly equipped, could greatly assist struggling writers. However, it seems to be undervalued within the Jamaican context. At one institution, the centre is a small room with outdated computers, very little useful software, one resource person, and a director who also teaches. Thus, only few of the students who need help will receive it. The writing centre at another institution was closed. Tyson (2013) in lamenting the situation involving the weak efforts to help students in the development of efficient language skills states that

one sad testament to how off track we are in this matter is reflected in the state of what used to be a useful and dynamic Writing Centre . . . . I thought this was a well-needed service since complaints were often heard about the insufficient competence of university students in writing Standard Jamaican English. Yet this centre was closed because of lack of financial funding. ("Assist with English," para. 2).

As institutions that should lead problem-solving initiatives, it is very odd that instead of finding ways to deal with a difficulty, the approach is to shut down or downscale the work of a potentially useful entity.

### **Recommendation Three: Develop a Institution-wide Approach**

Even with the scarcity of financial resources, efforts have to be made to create the type of environment in which successful learning can occur. The research shows that proficiency in the use of formal language skills cannot be developed over short periods of time, especially where students lack mastery of foundation skills. Yet, a very small percentage of the students' time at university is focused on the formal development of these skills. Therefore, Like Coard and Dyche (2013, p. 79), I wish to recommend that more time be allotted for the teaching of academic writing skills.

However, even more importantly, I support the adoption of an institution-wide approach to the development of English Language skills, as advocated by Bryan (2014). The ESL context presents various challenges for the Jamaican English Language learner in regards to time for skill development, motivation, the acquisition of useful input and the provision of opportunities for practice. Reinforcing language skills across the university will provide more opportunities for learning, show the usefulness of the skills within the content area and serve to motivate students. A policy that promotes the following approaches may therefore prove useful.

- Each course/module should incorporate the goal of achieving proficiency in the use of the official language. Thus, all lecturers should include language objectives within their content areas. This should not be a problem, since every professional field includes some amount of reading and writing, for instance.
- To reinforce the need for language skill development in the content areas, there has to be a policy that requires all courses/modules to incorporate the assessment of applicable language skills.
- To assist with the above suggestions, there has to be a system of partnership between content specialists and language educators.
- Creative means of funding the writing centres must be found. Since the students who use them belong to the entire university, they could be treated as one would a library. All faculties would share the responsibility for funding them. The centres could also seek to generate income.

## **Recommendation Four:** Ensure that the Policy is Strictly Implemented

As Bryan (2014) explains, a system-wide approach to language learning must occur within the framework of a language policy that defines clear goals and objectives. These carefully designed goals will be useless, however, without concrete strategies for their achievement. Therefore, the plan must identify needed resources and methods for their strategic deployment, as well as means of enforcing the policy and assessing its achievement.

The plan should not just remain on paper, or on a computer database, waiting for funding. Limited financial resources should not be a deterrent if universities view fluency in the use of English as a crucial part of being a university graduate. Additionally, if universities aim to encourage students to become creative and innovative, they should seek to display these qualities.

## Conclusion

The prolonged discussion on how English Language should be taught in Jamaica needs to come to an end. If for over a decade, the ESL approach has been seen as the potential solution, what is now needed are means of effectively employing these strategies. Universities, which are serious about breaking the cycle of producing students who may be skilled in the content area, but are deficient in interpreting written information, thinking logically and communicating ideas using SJE (Dunn-Smith, 2010), will lead this endeavour. This can best be done through the adoption of an institution-wide approach that is guided by effective theory-based policies.

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# Effect of Cooperative Learning on the Performance and Attitude of Chemical Engineering Students in Mathematical Modelling at the University of Technology, Jamaica

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## Abstract

*This study investigated the effect of cooperative learning as a strategy for modifying students' performance in the mathematical modelling module at UTech, Jamaica. The sample comprised 34, year 3, chemical engineering students at UTech, Jamaica. The students were divided into two groups, Groups A and B, where the former was subjected to the traditional learning approach and the latter, to cooperative learning. A pretest-posttest research design was adopted for this study with the posttest being the single instrument used to assess the effect of the treatments for both teaching/learning strategies. The results from the posttest revealed a higher mean score of 77.67% for the treatment group (Group B) compared to 63.59% for the control group (Group A). A Student's *t* test for independent samples at  $\alpha = 0.05$  indicated a significant difference in performance between the two groups. An analysis of covariance was performed and confirmed the *t* test results ( $t(32) = -2.25, p < 0.05$ ) indicating that higher academic performance was achieved with the use of cooperative learning. Students' attitude towards cooperative learning was also assessed through the use of a*

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*questionnaire, which consisted of both closed-ended and open-ended items. Although 80% of the participants embraced working in groups cooperatively, some students preferred the traditional method of disseminating knowledge and as such limited their participation in cooperative learning activities. Based on the findings, it is recommended that cooperative learning strategies be incorporated in other modules in the chemical engineering programme at the university.*

**Keywords:** Cooperative Learning, Traditional Instruction, Performance

## Introduction

The Chemical Engineering programme offered at the University of Technology, Jamaica is viewed by students as the most challenging programme in the School of Engineering. Although the intake of students is normally small (20–30 students per academic year) less than 90% of a cohort graduate each year (Chemical Engineering Department's Students' Academic Award Listing). Students who do not meet the requirements for the award of a degree, in most cases have failures in 1st and 2nd year modules. Lecturers' evaluations of students across all year groups reveal a lack of critically thinking, the inability to apply knowledge and, in some cases, lack of interest as being major areas of concern. Consistent with the aim of educational curriculum of engineering schools trying to remain current with the demands of their respective industrial sectors, engineering graduates are expected to be quick and flexible learners, current in their knowledge as well as innovative.

With the constant increase in the amount of engineering information that is included in the four year curriculum at UTech, Jamaica, there is a challenge to complete the individual modules and simultaneously produce engineering graduates of a high quality. While majority of the lecturers in the department has earned a diploma in education and has been trained in several teaching and learning strategies, there is little evidence of the use of innovative teaching strategies; hence, the traditional method of disseminating knowledge remains the dominant mode of delivery. Having 13 weeks in which to complete a module syllabus, the time factor is perhaps the main reason for the continued use of traditional instruction. Unfortunately, the drive to complete the modules within

the time frame could lead to superficial delivery of class material which will affect the students' ability to apply the information effectively. This view is shared by Lee and Yeap (2005) who suggested that in many cases lecturers fail to effectively transfer knowledge to their students. Lee and Yeap (2005) also recommend that engineering educators consider moving away from the traditional method of delivery for engineering education and embrace more active learning strategies.

In passive learning classrooms, students are not active in the learning process as they play the role of spectators while the teacher presents the information through lectures. On the contrary, with active learning students do much more than simply listening and watching as they are actively engaged in "discussing, questioning, arguing, brainstorming, or reflecting". Active learning strategies have, in recent years, received increased attention. One very effective active learning strategy commonly employed is cooperative learning. Cooperative learning involves students working together towards a common goal. This strategy has been used at various levels of education and in several subject areas both as a teaching method and a learning tool. Felder (1994) has conducted several research studies on instructional strategies including cooperative learning with chemical engineering students and has reported higher academic performances.

Cooperative learning should not be confused with simple group work. Rather, it is a structured form of group work where students pursue common goals while being assessed individually. In addition, the groups in cooperative learning are small and consist of students with mixed ability. Research studies have established that working cooperatively is a powerful way for students to learn. However, for cooperative learning to accomplish improved learning it must be effective. Dahley (1994) highlighted five essential elements that lead to effective cooperative learning. These are: positive interdependence; face-to-face interaction; individual accountability; social skills and group processing. Positive interdependence is where each member of the group depends on each other to accomplish the group's goal. While face-to-face interaction promotes a support structure where group members support and encourage each other. With individual accountability, each member is accountable for his or her own task. This prevents members from 'freeloading' off other members. Social skills is a critical aspect of cooperative learning as students with different levels of

communication skills and social issues must work together to foster a strong cooperation among group members. Finally, group processing allows both students and teacher to assess the functioning of the group, as a whole, in terms of achieving the group's goal. Once these elements are incorporated within every cooperative learning activity then the activity has a high probability for succeeding.

Majority of the studies done on cooperative learning reported significant improvement in academic achievement. Slavin (1987) reported that of 38 studies done on comparing cooperative methods to traditional instruction, 87% found significantly greater achievement in assessment done in classes taught cooperatively. The other 13% found no significant differences in the scores obtained. To support these findings Mourtos (1997) also reported a success rate of between 80% and 90% for problems solved cooperatively as opposed to 50% when solved individually. The improved performance noted in these studies may be linked to increased student understanding and application as reported by Faryadi (2007) who stated that students who participate in cooperative learning also improve their critical thinking and intellectual skills. Although viewed as an effective teaching/learning tool, Ravenscroft (1997) pointed out possible trouble areas in the use of cooperative learning. One problem is students' dissatisfaction in sharing of grades especially if they feel that a group member is 'free riding' or that the responsibilities of group members are not equally aligned. Another setback involves the better students who may feel that their academic progress is being hampered by group work with others who are slow learners. He suggested that these problems can be remedied if the lecturer makes frequent assessment of the group's activities to maintain a high level of cohesiveness between the members.

Although cooperative learning is seen as an academic performance improvement strategy in most cases, Nilson (2003) recommends that cooperative learning should not replace lecture and other methods, completely. It should, however, be used to supplement the teaching and learning process, giving students a break from lectures. This will create a balance which will see the completion of the units within the semester while facilitating a more active role for students in the learning process. Even though cooperative learning is not a new teaching or learning strategy, there is little evidence of its use in the Jamaican

education system either due to unpublished research findings or lack of research in this area. One local study identified is that of McLeish (2009) who assessed a cohort of Knox Community College students' attitude towards the technique and found that students were apprehensive and some students indicated their preference for independent study even with improvement in their class participation and academic performance. McLeish (2009) also opined that cooperative learning was underutilized and that lecturers at the institution were not aware of the different cooperative learning activities.

The goals of this study were to investigate the effect of cooperative learning on students' performance and students' attitude towards cooperative learning. By conducting this study, additional evidence of the application of this teaching/learning strategy in a Jamaican tertiary institution is provided with the hope that more local educators will employ active learning strategies in their classrooms.

## Method

This research employed both quantitative and qualitative approaches. A pretest – posttest control group design was selected for this study on the basis that this approach controls internal threats related to the selection of the participants. The pretest – posttest analysis provided quantitative data while the questionnaire yielded both quantitative and qualitative information

Purposive sampling technique was used to select the third year students in the Chemical Engineering programme. The number of students enrolled in this year group was 34, which represented 31% of the total chemical engineering student population. Simple random sampling was used to place the research participants in two groups; A and B respectively. Group A was the control group while Group B, the experimental group. The selected module was Mathematical Modelling, which is highly numerical and calls for critical thinking and application of knowledge. The sample group would have met the prerequisite requirement of Engineering Mathematics III, which covers First and Second Order Differential Equations and Integration.

The cooperative learning subgroups in Group B were formed using random

selection with each group limited to 3-4 members for all cooperative learning activities.

The pre-test and post-test were typical paper and pencil test types. The pre-test consisted of 10 multiple choice items which assessed the research participants' prior knowledge of Numerical Methods (the selected topic) to determine if equality exists between the two groups before treatment was administered. The post-test was designed to measure students' understanding and application of Numerical Methods to mathematical problems in Chemical Engineering. The test included two restricted response items on Numerical Methods. The research participants who were exposed to cooperative learning activities were required to complete a 20-item questionnaire. The questionnaire consisted of both closed-ended and open-ended items; and contained three sections, namely A, B, and C. Section A consisted of seven items which assessed participants' learning preference. Section B contained eleven (11) statements which captured information on participants' view on the value of the cooperative learning strategies. In this section, participants were required to state their response based on a Likert type scale ranging from five (5) strongly agree to one (1) strongly disagree. Section C consisted of two (2) open-ended items which allowed the participants the freedom to provide more detail on their perceptions of cooperative learning. The questionnaire items on learning preference and attitude were adopted and modified by the research team.

To remove the threat to reliability, the pre-test and post-test used were non-equivalent tests assessing different learning outcomes. Only the scores obtained from the post-test was used to evaluate the effect of the treatments. The scores from the pre-test served only as an indicator of the equality level of the two groups prior to treatment. To minimize the threats to validity, the following steps were taken:

1. Random assignment was used to place participants in the control, experimental and cooperative learning groups.
2. The experiment was carried in a normal classroom environment in the research participants' regular class schedule.
3. The post-test items were representative of the material covered in the sub-units.

4. The researcher's facilitation of the participants was confined to the learning environment in each classroom setting for the duration of the study.

Each group of participants met once weekly for a two (2) hour lecture/tutorial session. Prior to administering the treatment, a pre-test was given on Numerical Methods. Two topics from this unit were selected as the topics to be covered in the treatment period during separate tutorial sessions. These were First Order Ordinary Differential Equations and the Euler Method. Group A participants were taught using traditional instruction while Group B participants were taught using cooperative learning strategies. The treatment lasted for three weeks.

For Group A the researcher delivered the lessons in a didactic mode prior to solving problems and highlighted applications of the major concepts of the topic. After receiving the lectures, the research participants were given 30 minutes to work individually on practice questions. Occasionally, a participant was selected to present his or her worked solution on the whiteboard. A copy of the solution key for the practice items was made available to the participants for their review at the end of the class session.

For Group B, the researcher outlined the format of the cooperative learning activity for each session. The cooperative learning activities used were Structured Groups, Think-Pair-Share and Team-Pair-Solo. The participants were randomly assigned in groups of four for all activities and further randomized in groups of two. For the structured groups, a group leader, time keeper and group recorder were identified and the researcher explained the responsibility of each group member. The participants were encouraged to discuss the assigned tasks within the groups until their collective effort produced a solution. The participants were given 20 minutes for group deliberations, 30 minutes to complete the solution to the problems and 10 minutes to present the solution to the rest of the class. The researcher visited the groups periodically to facilitate the participants' understanding of the tasks to be completed. The participants were exposed to mini-lectures on the subtopics for approximately 15 minutes before each active learning exercise began.

In Think-Pair-Share, groups of four participants were randomly assigned numbers one to four. Each group member was provided with a common prob-

lem sheet and given 10 minutes to think about the problem. At the end of the 10 minutes period the researcher paired even and odd numbered students within each group. The pairs were allowed 10 minutes to share their thoughts after which the group of four was reformed and allowed 30 minutes to share and solve the problem collectively. A member of each group was randomly selected to do a 10 minutes presentation of the group's solution. A similar procedure to that of Think-Pair-Share was followed for Team-Pair-Solo activity but in the reverse order.

A pre-test on Numerical Methods was administered to both treatment groups prior to the commencement of the study. After three weeks of instruction, a post-test on the subtopics covered was administered to the two treatment groups. During the administration procedures, the researcher explained the purpose of the pre-test and post-test and instructed the participants to answer the items individually. Each participant was provided with a question and answer sheet. After the allotted time, the answer sheets were collected and safely secured. The raw scores from both tests were analyzed.

A 20-item questionnaire was administered to Group B participants at the end of the post-test. The participants were given 15 minutes to complete the questionnaire. In addition, participants were observed in both treatment groups.

Both sets of scores from the pretest and posttest were analyzed using inferential statistics. An independent t-test was done to compare the scores for the cooperative learning group and the traditional instruction group. Qualitative data gathered from the questionnaire are represented in tables and graphs and the findings discussed.

Approval to conduct the study was obtained from the University of Technology Ethics Committee; and prior to the commencement of the study, the research participants completed and signed an informed consent form.

## Results and Discussion

### STUDENTS' PERFORMANCE ASSESSMENT

The pretest scores were used to determine similarities between the treatment groups while the posttest scores were used as the criterion variable to analyze

the treatment effects. Hence, the difference between the pretest and posttest scores was not meaningful in this study. A *t* test with a significance level of 0.05 ( $\alpha = 0.05$ ) was used to analyze the pretest and posttest scores for the two treatment groups. The mean, standard deviations and *t* test results for the pretest scores are presented in Table 1.

**Table 1.** Comparison of Pre-test Scores

Group	Number of students	Mean (%)	Standard Deviation (SD)	<i>t</i>	<i>P</i>
A	18	44.7	17.72	-1.37	
B	16	52.78	17.08		0.090

As shown in Table 1, the mean for the pretest scores for Group B was slightly higher than that of Group A, however, the difference between the means was insignificant at the 0.05 alpha level,  $t(32) = -1.37$ ,  $p > 0.05$ . It was, therefore, concluded that the treatment groups were similar in their previous knowledge of the material of the selected topics. However, the posttest showed a marked difference in the mean scores obtained. The *t* test analysis revealed that a significant difference existed between the two groups. Table 2 shows the means, standard deviations and *t* test results for the posttest.

As indicated in Table 2, the mean score for Group B was 77.67% and 63.59% for Group A. The *t*-test done on the posttest data showed significant difference between the two groups,  $t(32) = -2.25$ ,  $p < 0.05$ . An analysis of covariance showed that the effect of the treatment was significant,  $F(1, 32) = 5.085$ ,

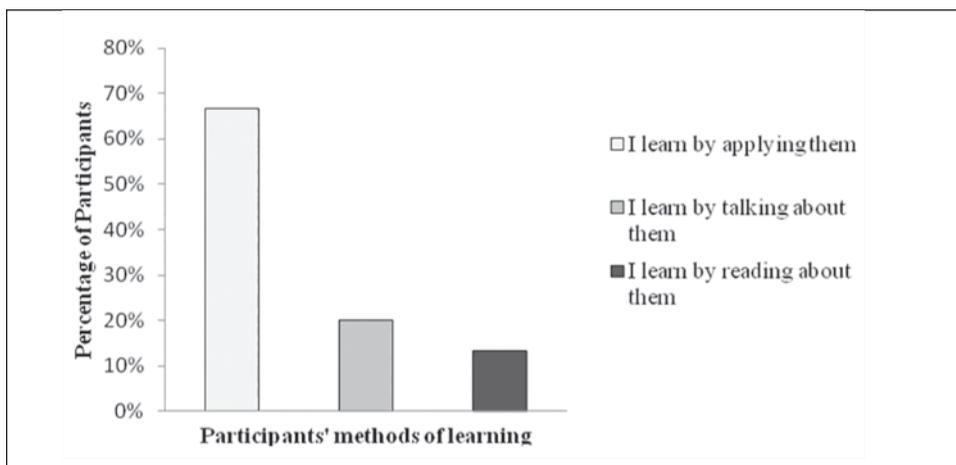
**Table 2.** Comparison of Pre-test Scores by Instructional Method

Group	Number of students	Mean (%)	Standard Deviation (SD)	<i>t</i>	<i>P</i>
A	18	63.59	17.54	-2.25	
B	16	77.67	19.29		0.016

$p = 0.0014$ . This result indicated that the participants who studied using cooperative learning attained a higher level of performance than students who studied using traditional instruction. One possible reason for the increase in students' scores in the experimental group could be due to the students' involvement in discussion amongst group members on the subject matter given. Here, the students were actively engaged in explaining their views and steps to solve problems; and at the same time receiving feedback on their views as well as other members' opinion on the subject. This exchange of data between group members enabled the students to cement concepts, address misconceptions about a topic and reinforce problem solving steps. The use of cooperative learning strategies provided an atmosphere where the students involved felt comfortable and this promoted an interest to learn. For those involved in traditional instruction they were provided with fewer opportunities to do any of these activities. Another possible explanation for the improved performance of the experimental group, Group B is the dedication they exhibited when solving problems. When the students in the cooperative groups met upon a challenging problem they kept at it until a solution was found. By doing so they were able to further understand the problem solving steps needed to create a solution. Cooperative learning seems to allow the students to be actively involved in the learning process and this aided their cognitive processing of the class material presented. However, the students in the traditional instruction group did not display this level of dedication to problem solving. Some students gave up when they could not grasp the understanding of a challenging mathematical problem. Another observation of the two groups revealed that the students in the cooperative groups were not afraid to ask questions and state their opinions as opposed to the students in the control group who asked few questions even when they were prompted to do so. In the cooperative learning activities, students in the cooperative learning group were provided with an atmosphere of active learning in which they could work together cooperatively which led to better performance in the post-test than those in the traditional instruction group. This observation is supported by Felder & Brent (1994) who stated that cooperatively taught students tend to exhibit higher academic achievement. The use of cooperative learning strategies provided an atmosphere where the students involved felt comfortable and this promoted an interest to learn.

## Student Learning Style Preference

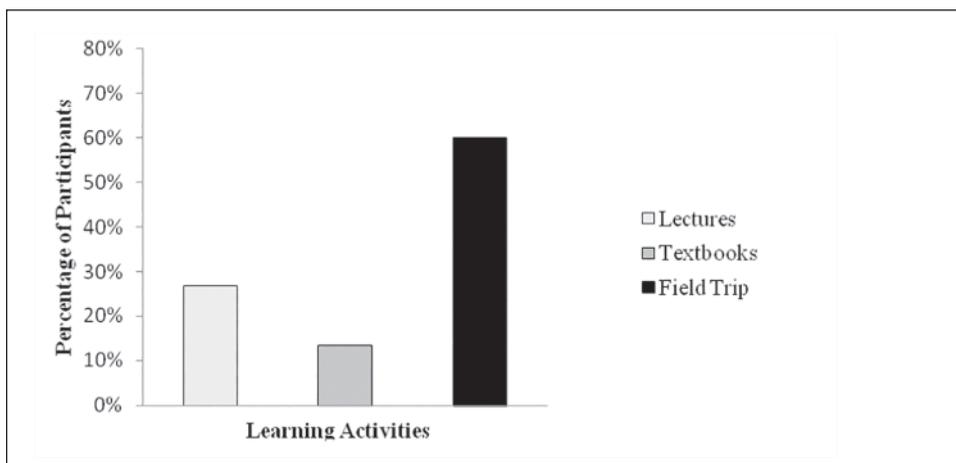
Participants in Group B were asked to complete a questionnaire aimed at providing information on their learning style; their views on the value of cooperative learning; and for them to freely state their perceptions of cooperative learning as a learning strategy. A total of 16 questionnaires were distributed; 15 were completed and returned. Figure 1 shows the results to item one on the questionnaire, “How best do you learn ideas and theories?” The results show that 66.7% of the participants learn ideas and theories when they apply them; 20% preferred talking about them; while the remaining 13.3% preferred reading about them.



**Figure 1.** Participants' Methods of Learning Ideas and Theories

Figure 2 highlights the students' preference for learning activities. This shows that 60% of the participants prefer going on field trips better aided their understanding of a subject matter, 26.7% preferred lectures; while 13.3% indicated that textbooks were better at aiding their understanding of a subject.

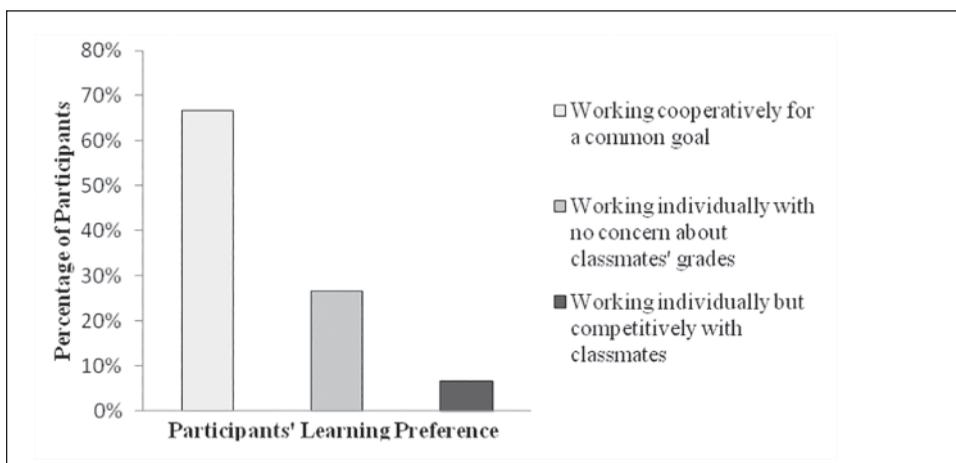
In response to their preference in working on projects and assignments, 66.7% of the participants preferred to work cooperatively for a common goal when working on projects and assignments; 26.7% preferred working individually with no concern about classmates' grades; and only 6.6% preferred to



**Figure 2.** Students' Preference for Learning Activities

work individually but competitively with classmates. This result is displayed in Figure 3 below.

A review of the responses indicates that the participants generally displayed a positive attitude towards the use of cooperative learning strategies. This is supported by participants' preference to learning style as majority of the participant preferred to be actively engaged in learning. The use of cooperative learning strategies allowed for majority of the students to be in a learning envi-



**Figure 3.** Students' Preference to Working on Projects and Assignments

ronment that catered for their learning styles. The students were engaged in discussions; they were applying what they learnt on the subtopics and most importantly they were arriving at answers with little or no help from the teacher. Dahley (1994) supports the view that students in their cooperative groups learn to rely more on their peers and become less dependent on the teacher for help. This dependency shared amongst group members is termed positive interdependence. This is one of the five elements of cooperative learning in which team members are obliged to rely on each other to achieve a desired goal. Each member is said to have a significant role to play by contributing to the overall learning of the group because he/she was not overlooked in the learning experience. The students knew each member was responsible for not only his learning but also that of the other group members. Therefore, the assigned task was not completed until all group members understood the underlying principles. The fact that all these activities were happening in the class and the students were leaving at the end of the class session with a better understanding of the topic may have resulted in their relatively high appreciation of the cooperative learning strategies.

### Students Attitude towards Cooperative Learning (CL)

Attitude towards cooperative learning was determined through the responses to a set of eleven statements on the questionnaire concerning preferences to group work and outcomes of working cooperatively with each other. The findings are presented in Table 3 using a Likert scale.

Only item 10 relating to work attitude, registered responses in the “Strongly Disagree” category returning a value of just 6.7%. Furthermore, the highest value registered for the “Disagree” category was 53.3% in response to item 2 which sought to assess the participants’ preference for working in groups as opposed to working independently. The response to item 2 indicated that more than half the experimental group preferred working in groups. Excluding item 2, more than 60% of the responses were positive towards the use of cooperative learning in the classroom, with a combined total of 80% of the participants expressing that they achieved more when they work within a group.

**Table 3:** Students' Views on the Value of Cooperative Learning

Items	SA	A	U	D	SD
1.My CL group members are committed to the success of the group.	6.7%	53.3%	–	33.3%	–
2.I prefer not to work in groups on class projects and assignments.	6.7%	13.3%	13.3%	53.3%	–
3.I feel responsible for the success of each individual in my CL group.	20%	40%	20%	20%	–
4.I feel responsible to my CL group.	26.7%	53.3%	20%	–	–
5.My CL group is structured so that multiple points of view were represented.	33.3%	60%	6.7%	–	–
6.The purpose of each CL activity was clear.	33.3%	60%	6.7%	–	–
7.My CL group had sufficient time to complete the activities.	40%	20%	13.3%	26.7%	–
8.The CL approach forced me to take on more responsibility for learning.	26.7%	40%	6.7%	26.7%	–
9.The cooperative learning experiences in my class enhanced my learning.	26.7%	40%	6.7%	26.7%	–
10.CL improves my attitude towards work	6.7%	53.3%	13.3%	13.3%	6.7%
11.I achieved more in a group than on my own	20%	60%	13.3%	6.7%	–

**Key:** SA – Strongly agree, A – Agree, U – Undecided, D – Disagree, SD – Strongly disagree

From Table 3 above, the low percentage of participants who disagreed with, or who were undecided about the statements on cooperative learning may be explained by the students' familiarity with the lecture method and their characteristic learning style. The participants were used to receiving explanations on topics from lecturers; hence their dependence on lecturers. Cooperative learning presented a new approach where students had to be responsible for their own learning. Observations of student-to-student interactions in a few groups revealed that some group members played a dominant role in the dis-

discussion while others listened without contributing to the discussion. Informal interviews with the participants regarding this observation revealed that the participants who did not contribute to the discussions felt that they were not given the opportunity to express their views, they were not prepared for class, or they preferred to work independently on the solution. Students who did not participate in discussion felt left out and as a result this may have contributed to their refusal to embrace the strategy of cooperative learning.

The two open-ended items on the questionnaire required participants to compare cooperative learning to individualistic learning and to state whether they would recommend the use of the strategy in other chemical engineering modules. Analysis of the responses received revealed that all respondents viewed cooperative learning as the better strategy to be used in problem-solving. The respondents stated that the strategy allowed for faster problem-solving and better understanding of a topic. Three participants, while in support of cooperative learning, indicated that they found the learning strategy to be time consuming. Two participants stated that they were not given sufficient time to use the strategy and could not make an accurate comparison between the two strategies. Eighty percent of the participants consented to the use of cooperative learning in other modules. The remaining 20% stated that the strategy did not allow for individual thinking and its use would require extensions of class sessions. One respondent opined that traditional instruction works perfectly and should not be changed.

## Conclusion

The goals of this study were to compare the academic performance of students exposed to cooperative learning with those taught using traditional methods and assess students' attitude toward the active learning strategy. The pretest – posttest research design was successfully employed for a treatment period of three weeks. Based on the posttest results, the experimental group scored, on average, 14.08 percentage points higher than the control group. This mean score difference between the groups proved to be statistically significant as confirmed by an independent t test ( $t(32) = -2.25, p < 0.05$ ). These findings

support the literature discussed that cooperative learning does promote higher academic performance.

The results of the questionnaire administered to the treatment group showed that majority of the participants displayed a positive attitude towards the use of cooperative learning activities as they felt more responsible for their own learning. Although 80% of the participants indicated that they achieve more using cooperative learning, some students preferred the traditional method of disseminating knowledge and therefore limited their participation in cooperative learning activities.

In light of findings of this study, it is recommended that cooperative learning activities be included in the teaching and learning environment of the Chemical Engineering students at UTech. Further studies on heterogeneous and homogeneous groups in cooperative learning sessions as well as social interactions between members of cooperative groups should be investigated.

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# Fostering an Innovation Mindset amongst Jamaican Youth

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## Abstract

*International statistics show that Jamaica's level of innovation is very low. Various factors facilitate the process of innovation and there is a view that a high degree of education is required for effective competition today's globalised economy. This paper focuses on the educational system as a skills building platform for fostering innovation in the Jamaican society. It adopts the view that improving Jamaica's competitiveness can be answered in great part by addressing the level of innovativeness amongst its youth. Whereas various studies exist on providing innovation education students at the tertiary level, very few seem to address foundational skills at the early education levels which can lay the platform for the innovation skills that can lead to the development of new technologies, products and processes. This paper makes the contribution that given that a significant number of Jamaican youth do not access tertiary education, innovation and entrepreneurship education should be established within the educational system at far earlier levels to develop the creativity, problem solving, curiosity and other skills that will provide a good foundation for building the effective human capital necessary for an innovative, competitive economy. The paper is intended to stimulate discussion amongst educators, employers and the private and public sector on the need to foster an innovation mindset amongst our youth so that we can bolster the future competitiveness, productivity and economic growth of Jamaica.*

**Keywords:** Innovation Mindset, Innovation Education, Entrepreneurship Education, Jamaica, ICT.

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## Introduction

A SWOT analysis of Jamaica's information and communications technology (ICT) sector, outlined in the Vision 2030 Jamaica ICT Sub-Sector Plan, reveals a low level of ICT innovation in the public and private sectors, and at the tertiary level (ICT Task Force, 2009). The Global Innovation Index<sup>1</sup> ranking for Jamaica was 92 of 125 countries in the year 2011, 91 of 141 countries in 2012 and 82 of 142 countries in 2013. Though various initiatives have been implemented to foster innovation within Jamaica, it appears that the measures undertaken have not significantly transformed the mindset of the Jamaican society as evident in the low rankings on innovation. The World Bank's Innovation Policy Guide for Developing Countries suggests that governments should facilitate the innovative process by "supporting innovators through appropriate incentives and mechanisms, removing obstacles to innovative initiatives, establishing responsive research structures, and forming a creative and receptive population through appropriate educational systems" (World Bank, 2010). With the notion from this Innovation Policy Guide that "a good educational and training system is fundamental to building a population receptive to innovation", it is this author's view that based on the current economic situation in Jamaica, the cry to improve the competitiveness of the country can be answered in great part by addressing the level of innovativeness amongst our citizens, and in particular our youth. Whereas various studies exist on providing innovation education or otherwise fostering innovation amongst university students (Bozic & Dunlap, 2013; Duval-Couetil & Dyrenfurth, 2012), very few appear to address the foundational skills expected of students *prior* to the tertiary level to provide them with a mindset that is ready and capable of applying their knowledge at that level to new product and process development and the management of the innovation process. The overarching question surrounding this paper therefore is: How can we foster an innovative mindset amongst our Jamaican youth?

The structure of the paper is as follows: first there will be a discussion on facilitating innovation, then the link between innovation and education will be examined. Thereafter, the paper will focus attention on developing an innovation mindset amongst Jamaican youth. Given the technological age in which

we live, a brief discussion ensues on ICT-enabled innovation, followed by the conclusion and recommendations.

## Facilitating Innovation

Innovation is seen as technologies or practices being newly diffused to a given society (World Bank, 2010) or more comprehensively as “finding new or better ways to do things, creating new products or services, applying new technologies to solve existing problems, or using existing products and technologies to meet new needs” (Science, Technology and Innovation Task Force, 2009). These definitions show that innovation is sometimes viewed as a product or as a process. Importantly however should be the recognition that innovation can be incremental or radical and should not always be seen as a “new-to-the-world” implementation, but as “the dissemination of something new in a given context” (World Bank, 2010). This, the World Bank Innovation Policy Guide suggests, provides developing countries with an opportunity to tap into the knowledge and technologies already available within far more economically advanced countries and to apply these within their domestic context.

Lederman, Messina, Pienknagura & Rigolini (2014) show clearly how the capacity to innovate, introduce new products and explore new markets arise as a result of the special talents of successful entrepreneurs who are able to transform ideas into profitable enterprises, yet the authors bemoan the low levels of innovation by the many entrepreneurs existing in the Latin America and Caribbean region. A variety of factors are discussed by the authors to explain the innovation gap, such as the need for a more competitive business environment, financial underdevelopment and the low density of engineers needed to provide effective human capital within the region.

The World Bank (2010) report provides a comprehensive set of guidelines and policy suggestions for facilitating innovation through a supportive framework of structures involving business and finance services, improvement of the regulatory framework for innovation, an adequate and responsive research base and a broad set of skills fostered through educational interventions which will necessitate reforms of the traditional methods of schooling. The need for com-

petencies such as creativity, problem-solving, logic and technology skills, as suggested in World Bank (2010) cannot be underscored enough if Jamaica wants to be able to compete effectively on a global scale. Matthews (2013) believes that tertiary education has a big role to play in providing the high level skills and research needed to develop new technologies and improve growth and productivity, while Kelly (2008) acknowledges that innovation is not confined to tertiary degree-holders but that a high degree of education is necessary to compete in a global knowledge economy.

Some of the key challenges affecting science, technology and innovation in Jamaica have been identified as our low capacity for enquiry based learning and scientific inquiry, inadequate human, technical and financial capacity to apply research and development (R&D) and an inadequate enabling environment for innovation (Science, Technology and Innovation Task Force, 2009). Some of the strengths outlined in this report by the Task Force are a strong relationship with technologically advanced countries, standards development experience, and an enabling legislative environment, however the challenges show that we have much to accomplish if we are to foster the kind of innovative infrastructure such as that compared to Singapore, a small island state with which Jamaica is often compared (Kelly, 2008).

In terms of ICT, growing recognition of the importance of technical and vocational education and training (TVET) and incentives for research and innovation in ICT, such as the National Innovation Awards for Science and Technology, have placed Jamaica in a positive light. Weaknesses in the country however, such as a considerable gap between ICT education and the skills capacity required to expand ICT, the lack of a structured national ICT R&D programme which addresses needs of national priority and yields high impact output, and lack of a strong culture of promoting or rewarding innovation and research (ICT Task Force, 2009), hinder innovation.

All is not lost however in Jamaica's capacity to facilitate innovation. Recent initiatives such as the ELearning Jamaica Project<sup>2</sup>, Tablets in Schools Project<sup>3</sup>, the E-Dashboard of National Indicators which outlines the progress of the implementation of Vision 2030 Jamaica<sup>4</sup> and the announcement for the establishment of a Microsoft Innovation Center<sup>5</sup> are all measures that can provide a good foundation for the fostering and monitoring of innovation in Jamaica.

The Vision 2030 Plan proposes to establish a dynamic and responsive National Innovation System that will help to “build the critical mass” to quickly leap us forward into applying science, technology and innovation. It also urges a move towards an innovation-driven stage of development while the ICT Sub-Sector Plan and Science, Technology and Innovation Sector Plan outline various strategic goals for advancing the ICT sector and fostering economic growth, productivity and global competitiveness through science, technology and innovation.

The mobile innovation sector is also growing, particularly with the commitment of the infoDev/World Bank to strengthen the mobile innovation ecosystem in Jamaica and the Caribbean. The low technological barriers to entry, high mobile adoption rate, competitive telecommunications market, prevalence of smartphones and growth in mobile broadband has led infoDev to design and implement regional and local activities targeted at mobile app innovators and both aspiring and existing entrepreneurs (InfoDev Mobile, 2012). This augurs well for the fostering of ICT innovation amongst the youth, especially as the project seeks to address youth unemployment and inclusive growth.

## The Innovation-Education Link

The link between education and innovation is captured by Kelly (2008) as this: “countries with high levels of education enjoy higher levels of innovation and economic growth than countries with lower levels of education”. Innovation education is important for start-up businesses (Ohngren, 2012) but it is the educational system within a country that this paper seeks to highlight as an avenue of fostering an innovation mindset amongst our youth.

According to the Ministry of Education's student statistics for the 2012/2013 academic year, of approximately 685,202 students enrolled in the formal public education system, only approximately 42,466 were registered at the various colleges and universities (Ministry of Education, 2013), equating to roughly 6% of the student population. With approximately 231,845 students enrolled at the secondary level, it appears that the students enrolled at the tertiary level (42,466) represent only about 18% in comparison to those enrolled at the

secondary level. If higher education is expected to play the role of providing the kinds of skills needed to enhance competitiveness and drive innovation in the economy, then what is the role expected of the remaining 72% of students who do not or cannot access tertiary education and will have fewer years of schooling? What kinds of jobs will they be able to attain and what kinds of skills will they possess to enable them to function within the Jamaican society? Are they not also required to at least possess innovative skills that will contribute to effective human capital, even if not at the managerial or executive levels?

Wagner (2012) asserts that many young Americans “have most often become innovators in spite of their schooling, not because of it” and that U.S. high schools and colleges are failing to prepare students to become innovators. For those schools succeeding at educating young people to be innovators, the author identifies five differences about them: (1) the value placed on collaboration rather than individual achievement; (2) a multidisciplinary approach to learning versus specialization; (3) a recognition that trial and error, and failure, is integral to problem-solving, versus avoiding risks; (4) students being creators, and not merely consumers in the process of acquiring knowledge; and (5) a focus on intrinsic, rather than extrinsic motivation.

Innovation education is therefore necessary in the quest to prepare innovative students. While innovation education is usually taught at the post-secondary or tertiary level, Jónsdóttir, Page, Thorsteinsson & Nicolescu (2008) describe the development of an innovation education subject, named Innovation and Practical Use of Knowledge, which emerged in Icelandic compulsory schools and which was subsequently formalized in their National Curriculum for Compulsory Schools in the 1990s, albeit with some challenges for dissemination and acceptance. Tan & Gopinathan (2000) state that calls for schools to foster creativity and innovation in Singapore were heeded with the implementation of three initiatives: the Thinking Schools, Learning Nation vision in 1997 which focused on developing students’ critical and creative thinking skills; the Masterplan for Information Technology in Education, also in 1997, which attempted to incorporate the teaching and learning of information technology in all schools; and changes in the university admission criteria to consider broader participation in various projects and extra-curricular activities, amongst other things, intended to stimulate curiosity, creativity and other qualities. Ng

& Tan (2006) explain how Singapore realized that an economic policy alone was insufficient for transforming its economy – innovation and enterprise was necessary in schools, a change in mindset was needed and the change among the youth in Singapore had to start early – thus giving birth to the ‘Innovation and Enterprise’ Initiative in 2004.

Justification for the inclusion of innovation education into the national curriculum for Jamaican schools may seem to be a challenge but as Jónsdóttir, Page, Thorsteinsson & Nicolescu (2008) show, timetabling it as a subject or integrating it within other subjects are options that could be pursued. Even outside of the national curriculum, finding ways to allow students to participate in projects which bring out their curiosity and creativity is important for developing innovation skills. A few ad hoc national competitions alone will not allow for such skills to be developed and sustained – what is needed is a consistent culture in which these skills can evolve. A radical shift in tradition, authentic forms of assessment, focused professional development and other transparent models of success are some of the measures that schools can take to develop a culture of innovation (Wagner, 2012).

Preparing young people to be innovative would be a most arduous task if educators themselves do not play a significant role in the process. For example, Wagner (2012) explains how one public school teacher in her after-school club requires her students to develop research projects which require a multidisciplinary approach, allows them to create something useful, and gives them ownership of what they are learning and a motivation to persist despite failures. Being an innovative teacher requires undertaking a supportive, flexible, constructivist approach to the teaching-learning process that may require a fundamental shift in thought, school culture and professional philosophy (Jónsdóttir, Page, Thorsteinsson & Nicolescu, 2008). The role and characteristics of the “innovative teacher” should not be overlooked in our quest to achieve the outcome of the institutionalization of science, technology and innovation education throughout the Jamaican education system (Science, Technology and Innovation Task Force, 2009).

#### Fostering an Innovative Mindset

Kuczmariski (1996) describes an innovation mindset within an organization as “... a pervasive spirit that stimulates individuals, as well as teams, to endorse

holistically a belief in creating newness across all dimensions of the company”. This definition can be applied to persons in a society, and in particular, at all educational levels within the society. There is recognition that science, technology and innovation education should be institutionalized throughout the Jamaican education system (Science, Technology and Innovation Task Force, 2009) but a great majority of the strategies and specific actions outlined in the Science, Technology and Innovation (STI) Sub-Sector Plan remains at the tertiary institutional level. The scientific and technological culture needed to foster an innovative mindset must be promulgated amongst the ordinary Jamaican in homes, communities and schools so that we can become creators and not just consumers of technology (Kelly, 2008).

In the same way that athletics, particularly track and field, has become a significant part of our Jamaican culture, so much so that there are various championship meets at the primary/preparatory level, secondary and tertiary levels, innovation needs to be promoted within the society, and especially amongst our future generation – the youth. The institutionalization of sport at all education levels has yielded the nation remarkable success decades after putting in place the necessary infrastructure for the continued growth and development of the sport and the preservation of its legacy. Our enviable and rich sporting history has been no mean feat and in recent times we have seen the staging of sport conferences to promote development in, and to address issues challenging the sport. This author proposes the view that in the same way that the nation has coalesced around sports, Jamaica needs to be united around a similar vision for innovation so that we can develop an innovation culture amongst our Jamaican youth to develop the kind of generational mindset crucial to the transformation and sustainability of our economy.

To understand the relationship between innovation and entrepreneurship, we can take the viewpoint of Drucker (1985) who contends that innovation is a tool used by entrepreneurs to exploit change as an opportunity. Entrepreneurs therefore continuously exploit opportunities and innovate to come up with new products and services to satisfy customer needs, thus education in this area usually consists of both innovation education and entrepreneurship education. The European Commission (2012) asserts that building a local and regional entrepreneurship education ecosystem where schools at each level are involved in

entrepreneurship education and wider linkages established through partnerships can help to promote and develop entrepreneurship. In a similar vein, innovation education and entrepreneurship education can be systematically infused within the Jamaican education system at the varying levels.

Though one view is that these forms of education can be assessed as a part of the mainstream curriculum within the various levels of educational establishments (European Commission, 2012), it is this author's view that Jamaica can begin the process through a concentration on the informal curriculum – that is through more frequently established competitions, projects, extra-curricular/after-school clubs, library programs and other similar initiatives – particularly at the earlier levels, with more formal courses and mechanisms, such as closer ties with industry, established at the secondary, post-secondary levels and tertiary levels. In other words, we should develop the innovation and entrepreneurial mindset from the primary education level; at the secondary level, hone the creativity, problem-solving and other skills needed for innovation so as to add to the pool of human capital that can participate in the knowledge economy and use the tertiary level to develop the highly specialized knowledge and skills, research capacities and managerial capabilities necessary for developing and leveraging new and existing technologies that will provide transformative growth.

While there is a proposed strategy to “improve the connections between educational institutions and industry to enhance mutual interaction, stimulate creativity and innovation” (Science, Technology and Innovation Task Force, 2009), the stimulation should start at the earlier educational levels to build the mindset of students. The proposed structural changes to Jamaica's Grade Six Achievement Test (GSAT) to include more critical thinking, rather than memorizing<sup>6</sup> can therefore, on the face of it, be construed as a positive step, notwithstanding the challenges and concerns of parents but such a discussion goes beyond the scope of this paper. Besides critical thinking, building the creativity, scientific inquiry and other skills needed to lay the platform for an innovation mindset should also form the basis for structural changes to the curriculum at the early education levels so that by the time students access higher education, they would have naturally developed the high level skills needed for the growth and productivity of the nation.

To actualize the expectation of high level skills, the foundation needs to be laid long before the post-secondary level where most major initiatives appear to be undertaken to develop the innovative capacities of our young people. Whereas students at the early childhood, primary or even secondary level would not naturally possess the innovation skills required to introduce new business models and develop new markets to capitalize on technologies or applications exploited to create innovative products and services, it is the cultivation of innovation and entrepreneurial mindset that, developed at the early level, can serve as a strong foundation for future management of innovative processes and positive transformation of our developing economy. One can only imagine the kind of output that could be provided by students entering tertiary institutions who are already steeped in an innovation and entrepreneurship education, and possessing the curiosity, creativity, scientific, problem-solving and innovation skills that can be applied to real-world industry or societal problems or to creating new, patent-capable technologies.

As Kuczmarski (1996) explains, achieving an innovation mindset is not easy – it requires motivated and effectively managed groups of people, innovation leadership, recognition that failure is a part of innovation and that some efforts will not be successful, and a consistent innovation message. In the same way that Kuczmarski outlines that senior management is expected to create an innovation mindset and culture if the organization is to be successful at innovation, then policy-makers, principals and heads of educational institutions would need to lead the charge, be committed to innovation and provide a supportive environment if they wish to create schools driven by innovation and students with an innovation mindset.

Ng & Tan (2006) outline various challenges to this, however, key of which appears to be asking schools to innovate within a government-controlled, examination-driven environment where there may be no perceived link between innovation and academic results. Attracting and retaining qualified teachers, the constraints of the budgetary environment, convincing the society of the value of STI as the driver for socio-economic well-being, the tendency for resources to be assigned to more pressing needs, low applied research and development activity and insufficient public-private sector partnerships (Science, Technology and Innovation Task Force, 2009) are some of the challenges facing

the nation's capacity to innovate but with a serious recognition of the need for a culture of innovation and a 'where there's a will, there's a way' commitment to this momentous task, it is possible to address the challenges and allow for the positive effects of such a transformation to yield an improved, competitive and productive economy and a nation of innovative thinkers.

## ICT-Enabled Innovation

Much of the foregoing discussion applies to innovation across all disciplines but globalization, the knowledge economy, continuous advancements in technology and the applicability of ICT across all industry sectors warrant a brief exploration of ICT-enabled innovation. Spiezia (2011) suggests that ICTs do not increase a firm's capability to be inventive or to develop new products and processes but rather that ICTs function as an enabler of innovation. The author acknowledges however that ICTs are indeed a source of innovation due to their ability to provide substantial efficiency and productivity gains. With youth gravitation towards technology, the ability of ICT, though not a panacea, to foster growth and competitiveness, transform the economy and promote development, supports the position for ICT innovation to be explored by developing countries such as Jamaica. Jamaica's poor ranking in the international State of Broadband Report 2013, 95th in fixed broadband penetration and 123rd in mobile broadband, out of a total of 194 countries (Broadband Commission for Digital Development, 2013) is cause for serious concern.

Recently, calls have been made by the Jamaican Minister of Science, Technology, Energy and Mining for the island's telecommunications operators to reduce the price of broadband Internet service<sup>7</sup> but more needs to be done to improve Jamaica's rankings. The 2013 Broadband Report explains that broadband accelerates innovation as it facilitates greater dispersal of knowledge, new ways to collaborate and create value, and thus can drive change across four major pillars of innovation – people, ideas, finance and markets. It is crucial that Jamaica recognises that the population of networked youth or digital natives, that is, young people born in the digital age (aged 15–24) and who are growing up using ICTs, have the potential to drive the information society, stimulate innovation and harness the benefits of ICTs (ITU, 2013).

Technological innovation is often considered to be the result of technology entrepreneurship and increasingly requires a high level of skills, knowledge and experience (Naudé, Szirmai & Goedhuys, 2011). The role of education in motivating young people towards technology-based entrepreneurship needs to be emphasized even as Jamaica's ICT Sub-Sector Plan pushes for the strengthening and development of the country's ICT sector. Based on a study of the early environment and schooling experiences of existing high-technology entrepreneurs, one recommended strategy is to "blend entrepreneurship education, technology content-specific education, and high-technology venture experience at both the high school and college levels" (Kourilsky & Walstad, 2002). Again, this points to the fostering of a mindset through the early education levels so as to prepare the youth to take advantage of future opportunities in this area. The infoDev Caribbean Mobile Innovation Project represents a good start – similar initiatives should be created to expand the possibilities for preparing a generation of innovative learners who can employ novel, unconventional but effective approaches to solving Jamaica's pressing societal problems and business needs.

## Conclusion and Recommendations

Innovation is important for the competitive advantage, economic growth and development of a nation. Various ways exist for governments to facilitate the process of innovation but this paper has concentrated on the attention that needs to be paid to the education system so as to foster innovation amongst Jamaican youth. Though significant focus is placed on education at the tertiary and post-secondary levels, the contribution that this paper makes is that given that a significant number of Jamaican students do not access tertiary education, a systematic development of its innovation systems through innovation and entrepreneurship education is important at the earlier education levels. This will help to develop foundational skills to build the effective human capital necessary for an innovative, competitive environment.

Strong innovation leadership, unity around a vision for innovation similar to the coalescence around sport, beginning the process of innovation and entrepreneurship education at early educational levels through the informal curricu-

lum, a focus on ICT-enabled innovation, and bringing together innovation related activities under a single umbrella initiative are measures recommended for changing the current mindset towards innovation. This will allow even the very young to latch onto the vision for an innovative Jamaica. It is opportune time to stimulate discussion amongst educators, practitioners, government and the private sector on achieving Jamaica's innovation vision. Fostering an innovation mindset amongst Jamaican youth will not be easy but it is a task that needs to be urgently undertaken.

## Notes

1. <http://www.globalinnovationindex.org>
2. [http://www.mmt.gov.jm/PDF%20Files/E-Learning%20Project/The\\_e-Learning\\_project\\_Information\\_Sheet.pdf](http://www.mmt.gov.jm/PDF%20Files/E-Learning%20Project/The_e-Learning_project_Information_Sheet.pdf)
3. <http://jis.gov.jm/contracts-signed-tablets-schools-pilot/>
4. [http://devinfohive.info/dashboard/Jamaica\\_vision2030/index.php](http://devinfohive.info/dashboard/Jamaica_vision2030/index.php)
5. <http://www.micjamaica.com/>
6. <http://jis.gov.jm/changes-gsat-2015/>
7. <http://www.jamaicaobserver.com/latestnews/Paulwell-calls-for-reduction-in-broadband-Internet-rates>

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# Vision in Response

## Disaster Risk Reduction

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### Abstract

*The Caribbean School of Architecture, University of Technology, Jamaica (UTECH.) in collaboration with the governmental agency the Office of Disaster Preparedness and Emergency Management Jamaica has researched over a two year cycle, shelter solutions for Disaster Emergency Management. The results address constraints and demands of disaster management in Jamaica as well as present how spatial thinking can induce strategies connecting structural and non-structural mitigation efforts.*

**Key Words:** Caribbean; architecture; hazard-risk; emergency; shelter; settlement; policy.

### Introduction

The Disaster Preparedness and Emergency Act outlined a path towards a national hazard-risk reduction policy in 1993. Subsequently, A National Hazard Mitigation Policy and National Response Matrix was prepared by the Office of Disaster Preparedness and Emergency Management (ODPEM), the national agency charged within the Act with the responsibility of mitigation and recovery in Disaster management. Non-Structural Mitigation has been the core strategy for Disaster Preparedness in Jamaica as mechanisms for implementing and enforcing such procedures already exist. Structural mitigation on the other hand

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promotes economic challenges and requires more comprehensive knowledge of high risk areas.

Between 2010–2012, Design Studio 7 at the Caribbean School of Architecture (CSA) embarked on investigations to evaluate and propose solutions for emergency responses to human shelter in the context of the Caribbean using Jamaica as the example. The study focused on the more challenging aspect of Structural mitigation.

In generating the project scope and contexts for learning CSA entered into discussions with ODPEM, The Housing Agency of Jamaica, The National Housing Trust (NHT), Jamaica and attained professional input of Civil, Mechanical, Electrical and Coastal Engineers as well as insight from Construction Industry Contractors. The United Nations High Commissioner for Refugees (UNHCR), *Handbook for Emergencies* was utilized as a reference guide. Although the handbook is suited for Refugees resulting from civil unrest, the guide informed the Studio as a planning manual for displaced persons, so as to consider standards for density and short to mid-term settlement, service needs, settlement occupancy levels and humanitarian concerns associated with trauma of displaced persons. In addition the *Sphere Handbook* complimented that resource tool.

A review of the existing local literature shows little or no documentation of research on this topic. This paper is designed to begin to fill the gap in existing literature. In addition, this paper presents the architecture Studio findings as solutions for the problems unearthed during the investigative process. It identifies loopholes in emergency responses discerned from the learning contexts and by utilizing the emergency cycle as a vehicle for envisioning architectural and spatial planning strategies, it promotes avenues for disaster risk-reduction.

## Method

A qualitative approach based on grounded theory (Groat and Wang 2002) was applied through various tactics of the design process to investigate avenues for the structural mitigation of natural disasters in Jamaica. This approach allowed researchers to build theory through the emergence of lines of data and its analy-

sis. The architectural design process is inherently iterative. It is distinguished by generating spatial coding in the form of images, drawings and models, evaluating these and descriptively building cohesion as three dimensional solutions. This strategy allows for an inclusive and open-ended procedure by which many points of view and concepts can be framed.

There was an average of 41 students and 4 lecturers conducting this research over the two-year cycle. The study focused on sites in the Parishes of St. Catherine and Clarendon, Jamaica. The learning context sample consisted of housing projects appointed through governmental agencies. Importance was given to collecting data on varied responses to emergency housing following Hurricane Ivan (2004 – category 5). The projects differed with respect to scale of the resettlement or proposed settlement and geological features of the sites. These factors impacted on site suitability assessment as well as the type of mechanical and electrical services infrastructure proposed and /or implemented. The projects were similar in that they were contractor-led initiatives.

Tactics applied in this study included interviews of residents within the learning contexts, site visits and field notes which were correlated with remote sensing data as well as presentations of professional consultants. Literature review included manuals on international standards for planning emergency settlement and shelter as well as case studies of local, regional and international architectural responses to shelter.

Multiple data source analysis allowed the researchers to develop user needs profiles and restate the research question as a design program. The program postulates a spatial theory which permits elaboration and conjecture of formal, structural and constructional systems. It is important to note that the evaluation of solutions were conducted through a jury process; the critique sessions of an architectural studio. The panel of lecturers and visiting professionals deliberated through comparative analysis thus extending the natural setting of a qualitative approach to the studio domain.

## The Emergency Cycle

In the disaster response sheltering of people there are at least three phases. The Relief phase of emergency shelter, the Recovery phase of transitional shelter

and the Re-settlement or Reconstruction phase. These phases overlap, expand, contract. Dependent on the type and global location of a disaster the temporal component of each phase attenuates.

Aspects of property ownership, proof and one's ability to return home after a disaster as well as land use allocation, funding and strategic implementation by varying agencies of disaster management all mediate the limits of these phases. A handbook created by the World Bank on *Reconstructing after Natural Disasters* (2010) lists six different settlement options for displaced populations. The Options include Host Families, Urban-self settlement, Rural-self settlement, Collective Centers, Self-settled camps and Planned camps. In the Self-settlement options displaced persons occupy available public or private property or land. Self-settled camps are independently occupied areas without services and infrastructure where as Host families shelter persons in households where the land or property is owned by them.

#### RELIEF: COLLECTIVE CENTERS

The instances of emergency response cited in the Studio presentations made by ODPEM include two rural cases of Collective Centers. Examples of retrofitting Industrial structures for 24–72 hour emergency shelter needs from hurricane displacement in the Portland Banana boxing plant adaptive reuse and the Chigwell, Hanover events were discussed.

The Chigwell events were documented. They included the Flood (1979) which displaced the entire community, Hurricane Gilbert (1988), where roofs were lost as well as animals and crops for sustenance, (rebuilding roofs was a community effort) and Hurricane Ivan (2004), where crops were lost and the road network submerged due to flooding. Due to the recurrence of floods, it was noted that homes sited in vulnerable locations made returning to resettle improbable.

Emergency shelter structures in Chigwell are limited, for example one church and a basic school. The challenges associated with collective emergency shelters include the need to be able to retrofit existing structures with water closet services, e.g. showers, changing areas and toilets to suit a high population demand, providing privacy, cleanliness and protection for vulnerable citizens. Trailer

toilets and Trailer bathrooms have proved for ODPEM to be a costly turnover as the cost of trucking water and sourcing potable water in the aftermath of a natural disaster is challenging. Hospitals demand water and are typically where the national available supply is sent.

Solutions should consider water harvesting, filtration and re-use as well as the potential of dry composting toilets. Non-withstanding, the portability of services may be a viable option in instances where Collective Centers are over-subscribed. A major goal of managing Collective Centers, at any stage of an emergency cycle, is security. That is, the protection of occupants by limiting access of external entities so as to reduce potential abuses between a collection of strangers being sheltered. This has an impact not only in the service areas but in creating privacy during sleep and the consideration of places that store minimal belongings.

Collective emergency shelters, as in the example of Chigwell, that are institutional buildings central to the communities everyday living patterns are effective emergency centers if residents are able to return and occupy their properties or mobilize as a community to fix damaged property. In Jamaica, the demand on state resources limits the time frame of this initial Relief period to 72 hours and a maximum length of stay during the Recovery phase of up to 6 months. Such constraints present avenues in design thinking for temporal adaptive reuse. The Studio proposed that when settlements are planned at the regional level they should be integrated with multi-use facilities. Such facilities would enable the Relief and Recovery process as well as inhibit random occupancy of urban and rural self-settlement.

## RE-SETTLEMENT AND RECONSTRUCTION: LAND USE

**Portland Cottage.** Portland Cottage in Clarendon, Jamaica is a community whose livelihood is predominantly fishing. Settlement is on salt plains, 3 meters below sea level facing the grand bay of West Harbour. The Rio Minho's course is north to south through the center of Clarendon collecting thirteen tributaries. She runs west of Portland Cottage. In 1986, her banks overflowed. Portland Cottage is prone to flooding with a high tide, storm surges or activity by the Rio Minho. The settlement displacement risk is multi-tiered. The community

developed as a housing need for employees of the Money Musk Sugar Estate, the largest employer in the region in the early 1960's, this dates the community's occupancy history. Four years prior to Hurricane Ivan the population grew approximately 39% (Jackson, 2006). During that period, habitat and other social investment instruments such as a library and a computer lab were supported by Food for the Poor.

The path of Hurricane Ivan was critical for this community. There were sixteen human casualties, eight of which resided in Portland Cottage. It has been speculated that the absence of the mangrove forest, its clearance for a non-sustainable salt extraction development initiative of the 1980's, amplified the storm surges' reach; a man-made hazard. In addition, Rio Minho's banks overflowed and compounded the impact of water's tumultuous reign. Land use allocation for housing resulting from Hurricane Ivan was a no-build zone of low lying areas surrounding West Harbour. Re-settlement was spearheaded by the Office of National Reconstruction who identified feasible sites.

Jackson (2006) describes that the process was negotiated with Portland Cottage residents as there were two sites elected before the agreed decision. The first was a plot on the eastern part of the community however the distance from the initial site was too far and would affect the quality of life. The second plot was prone to flooding and would have encroached on a watershed zone. In addition, displaced persons from an adjacent community would also be housed there. The third and agreed site was a reasonable distance from the dock where fisher people launched their boats, close to the original settlement yet elevated 5 to 55 meters above sea level. It was privately owned land which the government of Jamaica procured on the basis that the costs associated infrastructural works of the other two site options out-weighed the private property purchase.

Harmony Hall, the relocation site, forms part of Portland Bight, one of the largest protected areas since 1999. The area was designated a Wetland of International Importance under the Ramsar Convention (Spence, 2006). Agriculture and forestry use mitigates fragmentation of the land in conserved areas. The National Environment and Planning Agency (NEPA, 2004) investigative report noted the following concerns, "the volume of persons being relocated, as well as the type of activities which will be practiced by individuals within the conservation zone...The larger number of persons being relocated, the greater

demand on existing resources and by extension the possibility of uncontrollable sprawl into unwarranted areas". The concern as evidenced in the community's habitat growth prior to 2004 was warranted.

Harmony Hall was approved by Cabinet under the emergency provision in the Housing Act of Jamaica. It was planned initially to resettle 250 homeless persons (Rose, 2004). The land-use questions that remain are, should protected areas (e.g. Portland Bight) be subdivided into small parcels of land (1/4 acre) for private ownership? How do you regulate habitat expansion and density once such a precedent is set? What long term physical planning methods are employed to conserve the ecology of protected areas and forest reserves, fisheries and wildlife sanctuaries, without which there would be little livelihood for such communities?

**Learning contexts.** While the geological features between, Storm surges and Floods differ significantly, the hazards associated with coastal zone settlement is a common denominator. Watershed and agricultural land-use for settlement also affect hazard-risks.

Within the portfolio of The Housing Agency of Jamaica, Bourkefield, St. Catherine consists of approximately 36.7 hectares (90 acres) and had been partially established as a Relief Housing Project in 2004. It is adjacent to Blackwood Gardens. In Freetown, Clarendon, 174 hectares (432 acres) within the portfolio of The National Housing Trust is slated for a dormitory city Housing Scheme named Longville Phase III. Both sites offered different in situ opportunities to review emergency housing needs in the consideration of site selection and approaches to site amenities. The schemes provided opportunities to probe distinctions between camp and a commune as implied by settlement scale and configuration.

**Bourkefield.** The existing Bourkefield site presented several challenges. Situated within a coastal zone, both ponds and flooding are evident in the Geographic Information System data generated by student groups and information gleaned from the Studio's consulting Coastal Engineer. "[During heavy rainfall the area floods]" stated an area resident. Squatting and informal settlement in adjacent land plots were evident and agriculture appeared to a livelihood. Social integration with residents of the adjacent Blackwood Gardens appeared not to have been considered. Due to logistical planning matters

regarding the mechanical and electrical systems of the Relief houses, the units were never occupied. Hurricane Dean (2007) devastated the properties, followed by vandalism. The structures remain abandoned and occupied by goats. The project appears to have been a Contractor led initiative with support from Venezuela. Whether this support was design based or financially related, the Studio could not assess as research data concerning the development aspects was not forthcoming.

From these site investigations and observations the Studio probed design strategies for flood prone areas as well as site strategies that could reduce the environmental impact of flooding and enhance the capacity of water. Planning strategies for zoning use were based on topographical levels. Rain water harvesting for landscaping and other non-potable recyclable purposes, soil retention, storm and surface water drainage and constructional considerations all informed the conception of built form by integrating the landscape and ecology. (Figure 1)

The Studio brainstormed what the programmatic needs of a settlement might be, so as to consider communal spaces which could bridge existing communities and displaced residents by softening thresholds through shared public user needs

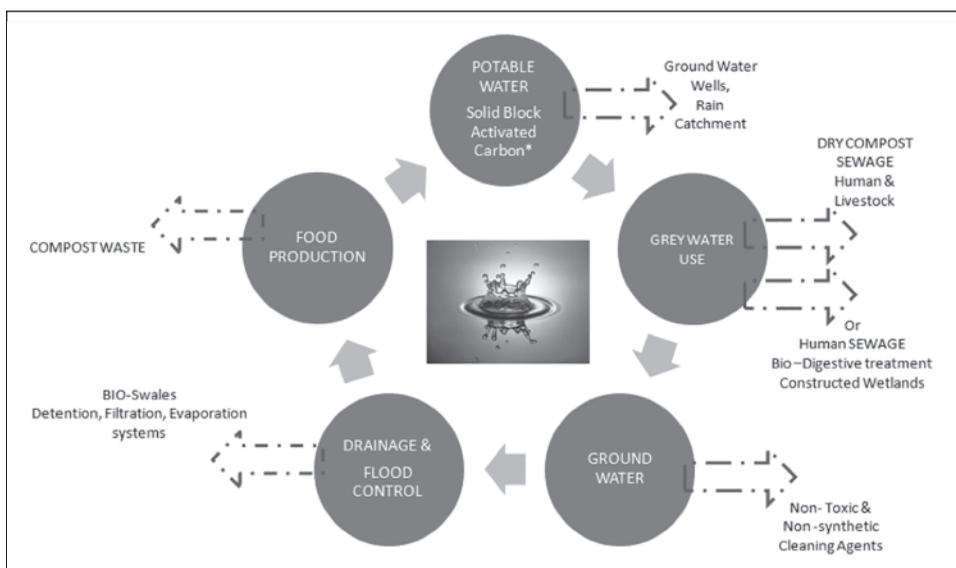


Figure. 1 Water resources, CSA – Design Studio 7

and activities. Sport related areas, corner shops, educational spaces, health facilities, non-denominational chapels and multi-purpose community halls were deemed culturally relevant social spaces.

These findings along with a review of the UNHCR and the Sphere guidelines resulted in the following design program for settlement constraints:

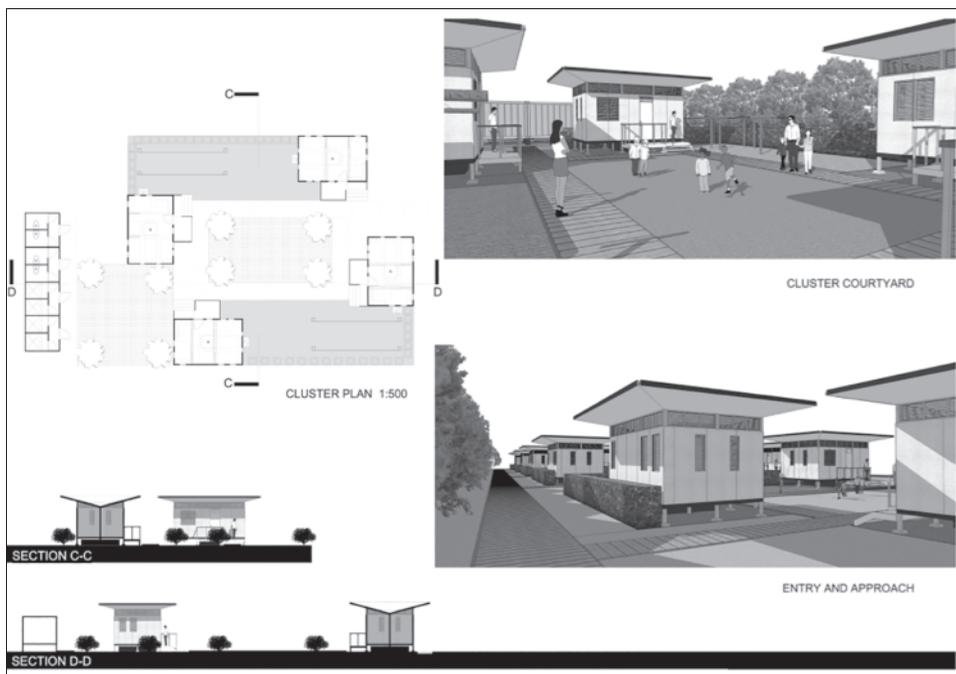
- Site area: 2.0 acres / 8093 m<sup>2</sup>; Settlement footprint set at 47%;
- Population modules: a) the family of 5 persons, b) a community of 16–20 or 100 persons allowing 45m<sup>2</sup> per person or 1800 m<sup>2</sup>;
- Administrative functions, communal activity, recreation and housing aspects of co-operative living: 2020 m<sup>2</sup>;
- UNHCR guidelines on Sanitation, Water Supply, Fire prevention, Access for both Pedestrian and Vehicular (emergency);
- Environmental impact reduction strategies, e.g. envisioning natural resource dependent livelihoods, the mechanics of soil retention and drainage.

The more successful architectural solutions developed as clustered patterns with central green space for collective protection and the well being of individuals, families, the elderly and the young. (Figure 2)

Verandahs are unique cultural spaces for Caribbean living, thus they were envisioned as part of the footprint for cluster units. Dining was perceived as a communal activity, under roof or sky. Sanitation services for each cluster was centralized for efficiency in water and waste management as well as the piping of the mechanical system and costs associated with supply and distribution. Visibility of the station by all occupants within the cluster was a security planning priority.

In discussion with the Studio's consulting Mechanical Engineer, it was highlighted that the potential for untreated sewage discharge to enter into water bodies increases health hazards during an emergency. Options for improving shut off and diversion systems to segregate combined overflows in addition to the consideration of small-scaled sewage/ sanitation solutions were identified. A drying yard and potential garden plots in between units provided spaces where families could share activities in less formal social settings.

**Longville.** Inversely, the Clarendon, Longville site, established as an extensive housing subdivision, questioned the existence of support and service spaces



**Figure. 2.** Cluster configuration (CSA-Young)

that would become available for residents during a natural disaster event. Phase III of the Longville development carries a population capacity of 228 serviced lots, 173 one-bedroom units, 300 two-bedroom units and 140 Studio Units (NHT, 2012). The developers promote the design as a complete community with space allocated for schools, shopping, churches and recreational facilities. The site is bounded by Highway 2000 but far from a transportation hub or access route. The closest Hospital is seven miles away in May Pen and there are a few institutional structures to support emergency relief, which may act as temporary shelters. The Studio identified seven schools in May Pen, and three major schools in Old Harbour. Cost effective, efficient and easily maintained public transportation that is not largely dependent on privately owned vehicles did not appear to be fully conceived in the planning layout. Transportation access of a relief site to facilities such as hospitals, other emergency centers, water supply agents or fire stations is deemed critical under the UNHCR guidelines.

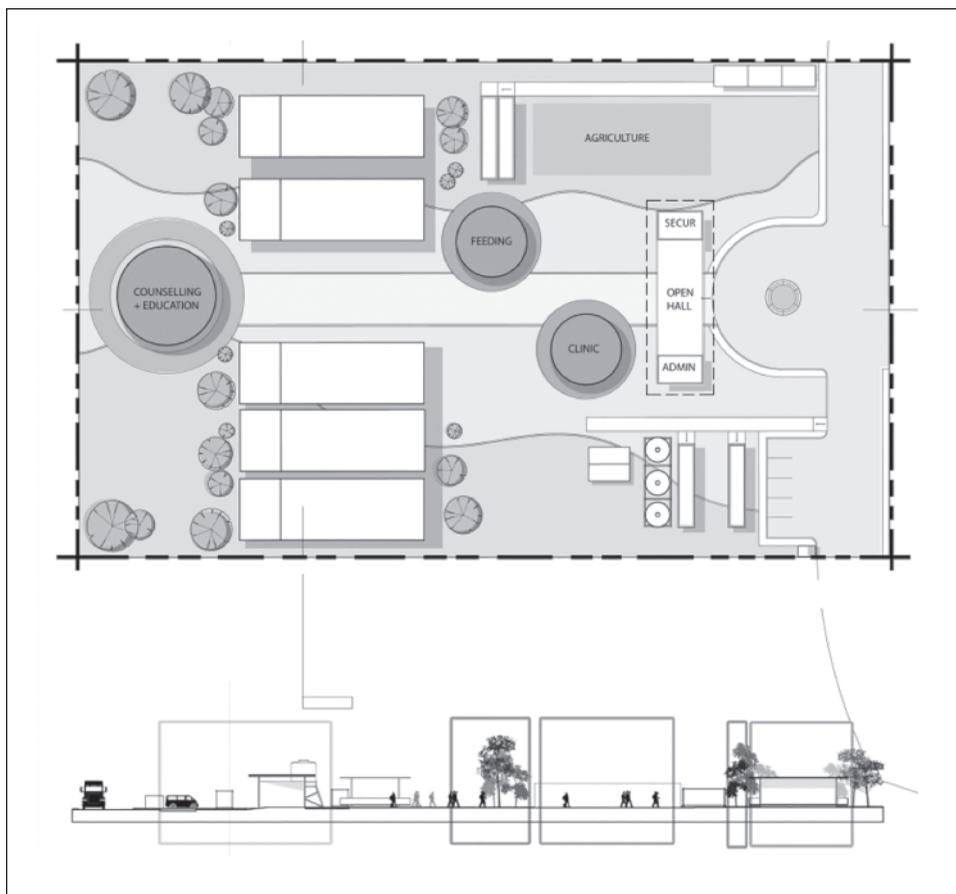
The implications of these needs on design program in-terms of access for emergency vehicles, food goods, supplies and constructional materials delivery, reinforced a design factor of reduced distances in transportation routes. In addition, road networks that include pathways for less fuel dependent vehicles, integrating pedestrian use with public transit routes would offer varied modes of access.

To retrofit the Longville planning approach with current sustainable design thinking which prioritizes pedestrian movement and mixed use, (for example 5 minute walking routes to public amenities) would allow opportunities for infusing access with community spaces. This would be a valuable exercise for structural mitigation and for the consideration of settlements as communes or neighborhoods as opposed to camps. Other questions which arose included what off-grid energy and water supply resources are integrated in the tracks of homogeneous housing? How will storm water be treated, is aquifer recharge considered? Are the institutional structures strategically positioned in relation to topography so they may act as Collective emergency centers.

For the purpose of the Studio objectives at hand, design strategies for the operational functions and support spaces of the Relief (24–72hrs) phase of an Emergency Cycle were considered. The design program called for the planning of an Operational Zone within 0.5 acre / 202.4 m<sup>2</sup> or less to service up to 100 persons. Provide amenities for the planning and functional needs of an emergency Relief phase i.e. Community Center or Multi-purpose Hall, Health Clinic, Chapel, Counseling rms., Feeding Centre, Day Care Centre, Laundry Area and Agricultural Areas. (Figure 3)

#### RECOVERY: TRANSITION SHELTER AND TEMPORARY HOUSING

Transitional Shelter and temporary housing offer recovery solutions for displaced persons between the Relief and Re-settlement phases. Such housing can provide ways for families to restore the autonomy of daily life and the privacy of living together. Whether self-built, community led or prefabricated by governments and non-governmental agencies, transitional shelters can be readily available to meet the needs of people in a reduced amount of time so long as its occurrence is strategically planned. Transitional structures can provide aid in



**Figure. 3.** Operational Zone (CSA-Angus)

Self-settlement options for displaced persons while temporary housing options engage existing undamaged domains such as residing with Host families or occupying rented apartments.

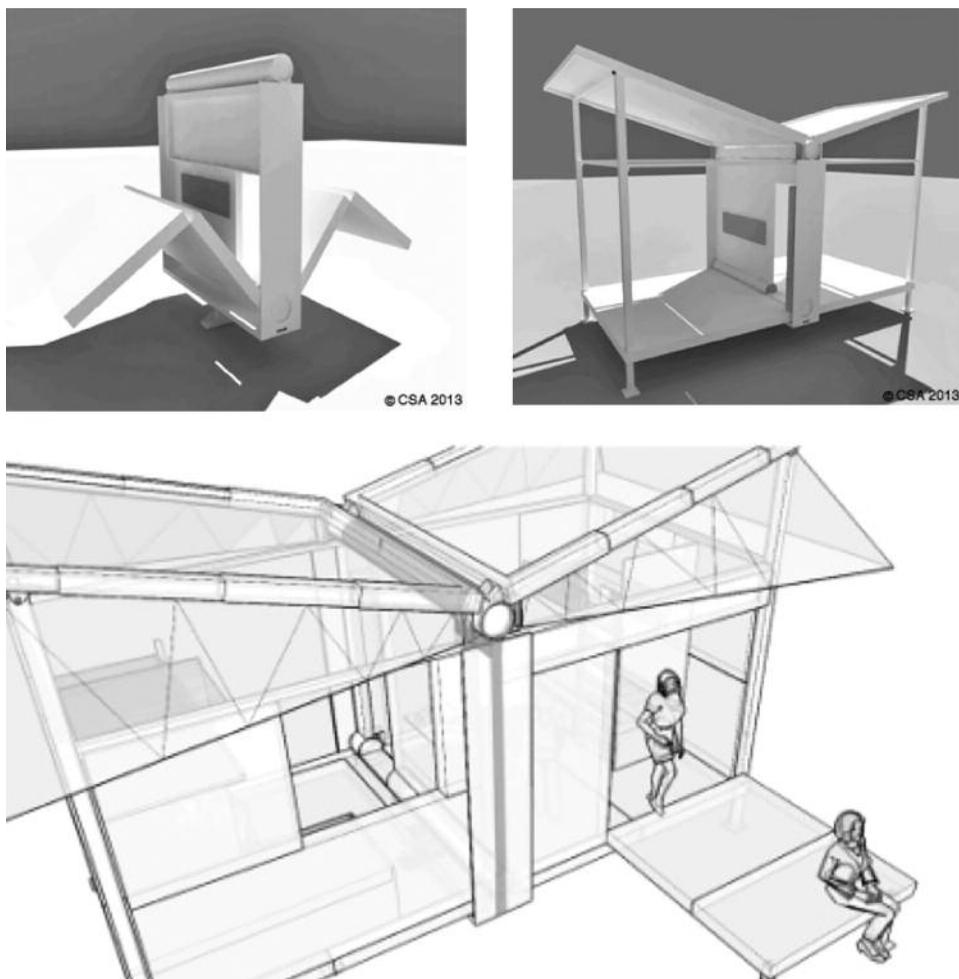
While the costs for implementing a Transitional Shelter program may be lower than operating a Planned camp, provisions for water, sanitation and electricity are essential components to be factored. The potential of transitional structures to become permanent is problematic if land rights policies or strategies for landless persons are deficient or the construction cost including infrastructure impacts on the funding available for reconstruction. This problematic becomes a design opportunity in rethinking the operability, mobile and reuse

or recycle potential of transitional structures. Design Studio 7 at CSA considered local precedents such as the traditional 1960's approach of State managed Self Built and expanded housing solutions (Cox, 1985) connected to sites and services subdivision schemes in the 1970's. The design potential investigated by the class was Moving Day, Jamaica 1871 (JIS press, 1985), a portable option which may be applied to several phases of the emergency cycle. If events recur within a given hurricane season, they could be readily disassembled and emergency relief centers re-occupied. Their immediacy could allow time for introducing new services infrastructure or retrofitting old systems with renewable technologies in instances where persons would reoccupy their land. Given the history of the expandable house in Jamaica, the structures could also function as core starter units. The Studio developed the following design program from the UNHCR, the Sphere standards and case studies reviewed.

Create a Transitional Structure for a population module of a family of 5 persons, housed between 3.5 m<sup>2</sup> and 4.5 m<sup>2</sup> per / person of covered living area. It was acknowledged that all sorts of family composites exist. Extensive, maternally led families or single persons constitute potential family composites. The adaptation of configurations should account for family variances. Design options for water management in terms of catchment, use and re-use as well as renewable energy resources is to be integrated. The construction method, material and connection of the unit's components are to be design for efficiency in erection and dismantling. Adaptable footings for varied soil conditions are desirable. Appropriate building envelope and material specification for the tropical climatic zone is required.

The Transitional Shelter structure is to be occupied for a maximum of 6 months and stored in shipping containers by the Office of Disaster Preparedness and Emergency Management, in between use.

The solutions varied from traditional approaches of architectural form, materials and constructional assemblies to innovations of that tradition while generating a light weight quick assembly architectural product. Variations on ways of utilizing a portal frame and infill panels were evident in most cases. A consistent typological concern in maximizing livable space was evidenced in volumes which folded out and walls which were outfitted with components to provide attachable and interchangeable furniture and fittings for water collection.



**Figure 4.** Portable Transitional Shelter (CSA-Johnson)

Footings and mounting details were also detailed to be adjustable for varied site conditions. During the second year of investigations the design parameters included an additional concern of compactness and efficiency in assembly. The challenge in designing for the maximum amount of units to be stored within standard 40 ft length shipping containers introduced a reuse –recycle component to the Emergency cycle. Constructional material assignment included aluminum for its lightweight, durable and corrosive resistant properties (Figure 4). In all instances the Transitional Shelter and its environment was to provide

human comfort for living in the Tropics, protection from the elements, a space to live and store belongings, privacy and emotional security for displaced persons.

## Disaster Risk-Reduction Avenues

The ability to re-settle or return to normalcy after a disaster depends largely on the condition of health and safety aspects of the environment, the right to return to a place of abode and the availability of services e.g. water, food and shelter. The Design Studio's research identified that in Jamaica, for each phase of an emergency cycle there are structural risk reduction loopholes associated with an ability to return. Recovery is a large loophole for emergency management as evidenced in Portland Cottage where individuals returned to an unsafe place for a period of two years while awaiting relocation as in flood prone communities like Chigwell. These loopholes interpreted as architectural and spatial planning strategies include:

Ensuring multi-use and institutional structures can accommodate the population of their communities when functioning as Collective emergency centers. Ensure by retrofitting or with new construction; Developing up-to par renovation in sustainable design thinking of current housing scheme models and include Operational zones for emergency management; Designating urban and rural settlement zones in each Parish for transitional housing during the disaster phases; Investing in Transitional Shelters and mobile mechanical and renewable energy resources, consider these as first aid kits for use, re-use and recycling.

Risk-hazards associated with natural disasters compound when induced by uncalculated man-made interventions in the natural environment as evidenced in Portland Cottage. Although, natural disasters can provide opportunities to improve decision making, reconstruction methods are deficient and costly if geological and ecological components of the natural environment, its processes and dynamics, are not valued through current strategic spatial planning and in the site selection analysis of built developments. In the selection of sites appropriate for the Relief, Recovery or Reconstruction phases of an emergency cycle, a site assessment of the geological, physical, social conditions of the locale are

significant components in ascertaining economic feasibility. It is probable that the Re-settlement houses at Bourkefield may be refurbished and services integrated however the stigma held by the community of the structures is one of ablutation.

Including an Environmental Impact Assessment process in the selections of sites, as well as insurances bonds tied to developers for infrastructural and housing development of vulnerable sites should be considered. Assuring that disaster related housing, re-settlement and reconstruction adheres to planning and building approvals are part of a regulatory mechanism aimed at reducing redundancy.

Connecting structural and non-structural hazard-risk reduction may hinge on developing legislation towards a National Comprehensive Disaster Management Policy as its performance depends on the policy's ability to integrate, streamline and air mark overlapping deficiencies of various institutional sectors for example, the Acts related to Heritage, Resource Conservation, Forestry, the Coastal zone, Town and Country Planning, Urban Development, Housing, Planning, Waste management and The proposed Building Act (2011).

The Town and Country Planning Act in retaining regulations for urban and rural areas should include the coastal area and reference hazard vulnerable zones, seismic and otherwise. Delineation in the mapping of hazard-risk zones could be included in Development Orders. Areas of high vulnerability if correlated with resource conservation, forestry, water ways and watershed land, can delimit no-build areas. A Development Order for the entire coastline of Jamaica is justifiably imminent. The re-zoning of the coast of Jamaica, high hazard-risk areas and conservation areas to regulate the development of human habitation, commercial and industrial activity is a structural disaster risk management priority.

The proposed Building Act ought to recognize existing Acts of registered building professionals and require all architectural drawings submitted for a building permit to be sealed by a Registered Architect. Re-viewing and upgrading Building Codes with knowledge accrued by registered building professionals saves lives, reduces liability and assures the quality of a sustained, resilient built environment. Risk Assessment and Hazard Mapping ought to be connected with physical development planning through the Planning Act and a national spatial plan. The incorporation of hazard mitigating and hazard-risk zoning in

physical development planning is a component of making long term risk reduction decisions.

From the Studio investigations it was also apparent that the Emergency Cycle is not always sequential. The phases hinge on the type of event and the level of preparedness. The tiers of dialogue between national, local and community level governance need to be effective during disasters is necessarily fluent during times preparedness i.e. on a continuous basis. This includes documentation and public access to emergency Responses for reflective case studies on best practice. The Disaster Preparedness and Emergency Management Act's focus on hazard-risk reduction in disaster management planning speaks to non-structural preventative measures. Limiting risks by increasing the capacity of communities' ought to include measures for safe keeping documents pertaining to ownership and also pre-empt disputes for land or settlement rights that may not rest entirely on deeds, titles and courts. A culture of preparedness formulated through stakeholder input can also increase participation in the creation of viable emergency shelter and housing solutions.

## Conclusion

The interconnectivity of our natural environment and human habitat is most evident when we provide shelter during natural or human made disasters. This paper outlines an array of problems and solutions related to disaster risk reduction within the context of Jamaica.

The design process revealed structural risk reduction loopholes associated with the phases of emergency management response. These loopholes illustrated disconnects between sustainable regional planning and current practices in designating human settlement. Such disconnects are evidenced by the case studies of Portland Cottage and Longville, Clarendon and Bourkefield, St. Catherine.

The Studio investigations presented how design thinking can be utilized as a valuable tool for societal learning. The focus on process –oriented research maintained a space for participation in the envisioning of potential risks, reframing these as problems with the insight of professionals /practitioners and developing design criteria on the premise of grounded theory.

The Studio results promote contextually relevant, spatial responses that address the practical need to locally provide emergency shelter through a variety of structural strategies. The results connect ecological and geographical concerns with strategic programming. The solutions visualize a mobile and flexible architecture utilizing component systems that inform new ways of living with Nature.

To better understand Comprehensive Disaster Management within the wider national context, legislative and planning imperatives that affect the regulatory mechanism of the built environment are also discussed in this paper.

## Acknowledgements

Over the two years of investigation, Part-time Lecturer, Mr. Robert Fuller coordinated for Design Studio 7, the site data and logistical visits through The National Housing Trust, The Housing Agency of Jamaica and The Ministry of Transport, Works and Housing.

Mr. Ronald Jackson and Ms. Michelle Edwards of ODPEM on several occasions delivered talks and presentations to the Studio and were instrumental in the review of the Transitional Shelter proposals.

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# An Analysis of Customer Service Offered to Graduate Students at the University of Technology, Jamaica

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## Abstract

*The research was done to gain graduate students' perceptions of the services offered in three Colleges/Faculty at the University of Technology, Jamaica (UTech). Qualitative methods were utilized in the process of data collection and analysis. Twenty students participated in the study – 18 in focus group discussions and two in in-depth interviews. Analysis was undertaken using the NVivo (10) qualitative software.*

*Most students were satisfied with the customer service being offered to them. They however felt that the university lacked some of the resources needed to properly execute some of the programmes. Recommendations were made for improvements mainly in the area of physical space, and dissemination of information. All except one student endorsed the establishment of a graduate students' lounge to facilitate networking.*

**Keywords:** graduate student, customer service, perception

## Introduction

The University used for this study was established in 1958 as the Jamaica Institute of Technology. In 1959, the Institute became the College of Arts, Science and Technology. The institution was formally accorded University status on

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September 1, 1995 as the University of Technology, Jamaica, and became fully chartered on June 29, 1999.

The increased competition from both local and international universities forced UTech's management to expand its offerings both at the undergraduate and graduate levels which is believed would increase revenues. Management felt that one way to do this was by identifying weaknesses in the quality of customer service offered, and developing and implementing strategies for improvement. The University then embarked upon a drive to improve the services by establishing a Customer Service Advocate Unit with responsibility for working with the different Colleges, Faculties and Units to improve the quality of service offerings (University of Technology, Jamaica Terms of Reference: Customer Service Advocate Unit 2010).

The purpose of the study was to determine the level of graduate students perceptions of customer service provided to them by the University of Technology, Jamaica (UTech) staff.

The study was guided by the following research questions:

1. How do graduate students perceive the customer service extended to them?
2. What type of customer service do graduate students expect?
3. How can the services offered be improved?
4. How is feedback from graduate students handled?

## Significance of the Study

This analysis of the customer service offered to graduate students is important to the University of Technology, Jamaica, the only national university. The expectation is that quality service will be offered to all stakeholders and in particular the students who are the primary consumers of the majority of services offered. This study therefore, provided an assessment of the degree of satisfaction derived from the quality of customer service enjoyed by students pursuing graduate programmes. An assessment of the University's customer service yielded comments made by students during the focus group discussions and the in-depth interviews, which provided a better understanding of how students

feel about the services being extended to them. The information collected can be used to develop a baseline and benchmark for continued improvement by UTech's support offices and graduate education facilitators. Other institutions proposing the offering of graduate programmes can use the findings of this study to assist with the development of good customer service. Additionally, the study will add to the existing body of knowledge on graduate student's perception of the services provided by academic institutions. It could be developed as a case study for use in customer service training in an academic institution.

## Methodology

A phenomenology research design was used for the study. Moran (2000) defined phenomenology as an attempt to capture experience in process as lived, through descriptive analysis. It studies how things appear to consciousness or are given in experience, and not how they are in themselves, even if it is known that the given contains more than or is different from what is presented.

The study site used was two Colleges and one Faculty at the University of Technology, Jamaica. Purposeful sampling was used in the selection of participants. These include the College of Business and Management (COBM), the College of Health Sciences (COHS), and the Faculty of Education and Liberal Studies (FELS). These Colleges/Faculty were used because they offer graduate programmes.

A sample size of 34 was selected using purposeful sampling from a total population of 235 graduate students in the COBM, COHS and FELS. However, 20 graduate students expressed interest, and the letter of participation and informed consent circulated to these students.

The participants who were chosen were able to provide the feedback needed to answer the research questions. Participants were required to be registered graduate students, be pursuing graduate studies in the College of Business and Management, College of Health Science, and Faculty of Education and Liberal Studies, and be willing to participate. Students who did not submit a signed informed consent form, and who requested to discontinue participation were excluded from the study.

The techniques that were used in the data collection process were focus group discussions, and in-depth interviews both of which were semi-structured. According to Thomas, MacMillan, McColl, Hale, and Bond (1995), a focus group is a technique involving the use of in-depth group interviews in which participants are selected because they are a purposive, although not necessarily representative sample of a specific population, this group 'focused' on a given topic. Open-ended questions were used in the discussions to capture the emotions of the participants, and provided additional information for the researcher.

The second data collection technique that was utilized in this research was in-depth interviews which were also semi-structured. According to Darlington and Scott (2002), in-depth interviewing is the most commonly used data collection approach in qualitative research. They posited that the in-depth interview takes seriously the notion that people are experts at their own experience and so best able to report how they experienced a particular event or phenomenon. In-depth interviews allowed for a more private setting with participants, where open-ended questions were asked, and participants were allowed to express their feelings openly. One focus group discussion consisting of six participants was conducted in each College/Faculty; however, one in-depth interview each was carried out in the COBM and FELS.

In order to prevent bias two semi-structured interview schedules/scripts consisting of open-ended questions were developed. The semi-structured focus group script was designed to include the title of the research study. An introduction was also outlined and included the purpose of the study, welcome, ground rules for participation and the choosing of a pseudonym to use during the discussion. These questions helped with probing in order to get additional information or clarify a point made. The conclusion for the focus group script and the in-depth interview script were similar and given a timing of ten and five minutes respectively. The purpose of the conclusion was to signal the official end of the discussion, to allow participants to hear a summary of the information they gave, to give them a final chance to make additional input, and to thank them for their time and participation.

Lincoln and Guba (1985) in Alexander (2004) opined that this term trustworthiness is used to represent several constructs including: (a) credibility/truthfulness, (b) transferability, (c) dependability, and (d) confirmability. The

phenomenology research design was used, which contributed towards truth. The use of this design was significant because it required that graduate students gave their own experiences and perceptions, which was transcribed and this further contributed to the truth. Summaries of the information for each interview were done with the participants to ensure that what was recorded was what the participants meant. Participants were also given an opportunity to call and make changes to any information they had given. This process is called “member checking”.

Purposeful sampling was used to address the issue of transferability in this study, in that each participant was strategically chosen because they were able to provide the data needed to answer the research questions. To deal with dependability in this study, the researcher utilized a peer debriefer who is a Master’s student at another university, currently doing her thesis to provide feedback on phases of the study, more specifically the data collection process, analysis and the results in order to determine whether or not she would have reached the same conclusions had she undertaken the research. She was also asked to provide feedback on the clarity and consistency of the research process.

## Results

A majority of the study participants were female ( $n = 13, 65\%$ ) while there were seven male participants ( $35.0\%$ ) with ages ranging from 21–50 years. Similar proportions of respondents were enrolled in graduate programmes across the three selected colleges/faculty (approximately a third in each college/faculty). The results are organized based on the four research questions.

### Customer Service Experiences

Overall, there was favourable feedback on graduate students’ experiences. Positive customer service experiences were characterized by good interactions with lecturers, units and departments. Satisfaction was also evident among most students with regards to the relevance of modules, handling and timing of feedback

to resolve issues and accessibility of information about programs of study. The need for improvements in some aspects of customer service was particularly in the area of upgrading and establishing facilities for graduate students and improving the timing and quality of information dissemination and communication.

Luo and Lee (2011) in the literature review defined perceived service value as the consumer's overall assessment of the utility of a product based on perceptions of what is received and what is given. In examining how graduate students perceive the customer service extended, participants were asked to identify some of the services offered by their college/faculty. These were identified as mentorship, research supervision, academic advisement, wireless internet, health insurance, a reading room, and the recording of classes which are then posted online. Notwithstanding these responses, there were other graduate students who were not aware of any service and others that did not feel that there were any services provided by their college/faculty.

Students in their feedback were comfortable with the lectures and tutorials being offered. They spoke to the effectiveness of the lectures and tutorials which they say are interactive and stimulating. Mention was made of the passion with which lecturers lectured and tutored using technology to enhance delivery. Although most of the students had similar sentiments, there were a few who felt the lectures and tutorials were not enough to cover modules with large content. Some felt tutorials needed to have a more practical approach. One such module is Environment Health. The COHS could examine the modules to see how they could increase the practical experience for students.

In looking at the relevance of the modules, a majority of the students felt that the modules they did were relevant to the programme of study. It was felt that the module "Descriptive and Inferential Statistics" was quite advanced, and a basic statistics module should first be introduced to students. Other students felt there could be a more 'practical approach' to some of the modules, while one student in COBM felt that the specializations should have modules that reflect a strong concentration in the area. The need for opportunities for teambuilding was also highlighted. The perspectives of the students especially as it relates to teambuilding and relevance of modules are in keeping with views by Kilgore (2003) on what the graduate experience should encompass. Kilgore

is of the view that among other things, students should be given the opportunity to work together.

Graduate students felt that information was sent in a timely manner; however, sometimes information is inaccessible online, thus depriving them of critical information such as financial records. In Muyeed's (2012) study, banking customers identified prompt and accurate information as a critical need and an expectation when conducting business. The students' claims therefore are justifiable, as communication is critical to the life of any business, but the way in which it is done is even more essential.

Students expressed that the classrooms and campus safety were in the best condition followed by library resources and parking. The ratings for study space and computer laboratories were poor in terms of their condition. Students from COBM gave the highest ratings for the condition of classrooms, parking and campus safety, but gave the lowest score for computer laboratories. One reason for the high rating of parking could be because these students have their classes on the weekend when the facility is not being utilized by the total student population. The reason for reporting poorly on the condition of the computer laboratory could be because the teaching facilities are located off the main campus where there are limited laboratory facilities.

FELS with its programmes located on the main campus gave the highest points to the computer laboratories and the library resources. Campus safety also received excellent ratings in terms of its condition. The COHS gave the lowest ratings for the overall condition of the facilities except for campus safety which received the highest ratings.

Students were asked to rate the availability of the facilities mentioned above. The overall ratings by the colleges and faculty were low. The availability score of the facilities were seen as poor. Although poor, the highest score was given for library resources (FELS) and parking (COBM). This indicates a lack of resources for graduate students to utilize. The conditions and availability of the facilities is a vital part of the customer service offerings at not just UTech, but in other studies done to examine the customer service given, students were also asked to indicate how they felt about the facilities afforded to them. One could argue that it is the programmes offered that matters in the provision of customer service, however, universities have to bear in mind that some of these facilities

are resources which aid in the delivery of the programmes. As such, the currency of these facilities to the successful delivery of programmes should not be undermined.

### Types of Customer Service Students Expect

Students from COHS pursuing an MPhil programme outlined that the service met their expectations, considering that the programme was new. Mention was made of the service not being good but improving, and the customer service being basic to other universities. Students pursuing a new programme in the COHS felt that the services during the first two years exceeded their expectations however the services deteriorated thereafter. From this information, it is clear that customers expect the same quality service throughout the time they do business with an organization. This fact was corroborated in Muyeed's (2012) study where customers gave a negative review of a bank because of a service they enjoyed which the bank was no longer providing. Overall, the students emphasized the need for more resources and internships.

### Suggestions on how to Improve Customer Service

Dragoon (2004) emphasized that one way of improving the service offered to customers is to first discover what their needs are. This question was critical because the best persons to inform management on the changes to be made to improve the system are the end users. With regards to the dissemination of information, some students felt satisfied with the way in which information was circulated. There were others, however, who felt it could be improved. Some ideas they gave for improvement were to communicate changes quickly, use bulletins on the website, update brochures regularly, and send financial information on time. The request for timely communication as a means to improve service was reinforced by Funston (1992), who underscored that communication is critical, and impacts customer expectation and eventually customer satisfaction.

A majority of the students felt that there needed to be full online registration with a flow chart that provides guidance, as some students were not sure where the registration process ended. Majority of the students interviewed were satisfied with the arrangements for the payment of fees, with the payment plans available. A few asked that facilities to pay fees on a Saturday be made available, as well as the facilities for online payment. Convenient banking hours was on the top of the list of expectations for bank customers in the study done by Muyeed (2012).

Although a majority of the graduate students felt the modules were relevant to their programme, they made some recommendations for improving their delivery. Some students in the COBM and COHS preferred online delivery as long as the module was not quantitative in nature. Students in COBM asked that a one day break be given between the delivery of modules, while students from COHS were not satisfied that they had to pass the coursework and exam in order to pass the course, as well as improvement was needed regarding the research component of the programmes. Students in FELS suggested the distribution of course outlines be done at the first class of each module.

The students in the COBM suggested that refreshments be provided on Sundays, and that the Accounts Department be opened later in the evenings to facilitate fee payment. This facility however, may not be needed if they are able to make payment online. All three colleges/faculty interviewed felt that the classroom facilities were not available to them. Timely opening of classrooms prior to the start of class was requested. The upgrading of library resources to facilitate students was requested. COHS requested installation of more safety showers in case of accidents/spills, as well as for increased parking space. The graduate students in FELS requested wireless access, installation of water coolers, and additional study and parking space.

Students from all three colleges/faculty felt that the university should have an academic writing workshop from which all students could benefit. The COBM recommended workshops on proposal writing, project management, career planning, and professional dress code. Resume writing and public speaking workshops were recommended by both the COBM and COHS. FELS recommended a workshop in personal development/self-marketing.

Majority of the students in the colleges/faculty said no improvement was needed in the treatment given by faculty. Three students in the FELS and one from COBM however lamented the need for advisors to be assigned to students or for lecturers to make themselves available outside of classes. Alston, Allan, Bell, Brown, Dowling, Hamilton and Williams (2005) and Gordon (2000) agreed that critical to a successful learning environment is the supervision arrangement. Gordon (2000) also suggested that one of the main factors in student withdrawal is dissatisfaction with their supervision arrangements, and believed that an important aspect of improving customer service to graduate students involves ensuring that they are satisfied with the level of supervision provided to them.

Students from the COBM and FELS asked that there be an increase in security presence after 9 p.m. One student from the FELS felt improvement was needed in terms of the amount of time it takes to pay the fine when a security parking ticket has been misplaced. Other studies done indicated that students were as equally concerned about security as other services.

Kilgore (2003) indicated that students should be given the opportunity to work together, and to network with other graduate students in other fields. This validates the graduate students' perspectives on the establishment of a lounge. All except one student welcomed the idea saying it would aid in networking, build camaraderie, and increase the sharing of new ideas. The sentiments about the establishment of this lounge ranged from the need to "work and play" to the increase in ranking the university would gain. Students from COHS felt the lounge could serve as an area in which they could relax while conducting labs throughout the night. They indicated that the lounge could include items such as coffee and snack dispensers, internet access, twenty-four hour access, computers, printing and photocopying facilities, lounge chairs, white board, security, reading material, air conditioning, rest rooms, television, a quiet area, and a water cooler. The graduate students' perception of how the prestige of the university would be improved if a lounge is established corroborates with Keith's (2005) study that stipulates that creating a customer service college culture has far ranging benefits. He further pointed out that a great image of an institution that cares about its student customers attracts student prospects and contributes to a positive experience, from the first contact

through to graduation and beyond. One limitation of this study was that the customer service extended to graduates and alumni was not evaluated.

Amidst complaints of lack of resources, a majority of the students conveyed that they would recommend other persons to pursue graduate studies at UTech. They gave reasons such as the flexibility in class delivery, flexible payment plans, location of the university, being on par with competitors, and excellent programme offerings. Although there were a few students who would not recommend UTech to other persons to pursue graduate studies, and one student who would recommend the institution with minor adjustments, an MPhil student revealed that he would not recommend persons to pursue his programme, but would instead recommend that they pursue other graduate programmes at UTech.

Other recommendations were given by graduate students to improve the services. These included addressing the noise level in some areas where classes are held, distinguishing undergraduate from graduate students, erecting stop-lights at the main campus gate, and collaborating with the University of the West Indies especially as it relates to the sharing of laboratories.

## How Feedback from Graduate Students are Handled

Graduate students responded that they did not have a problem when they wanted to access information about the programme they were pursuing. Some students however expressed that they had a problem seeking clarification on some of the information received. Notwithstanding this, most of the students commended personnel in Admissions, as well as some of their coordinators within their colleges and faculty who made themselves available to assist after registration. All students with the exception of two had positive feedback on issues which they encountered during the registration process. The students from the COBM complained about the length of time it took to make contact with personnel in that college to get pertinent information. One person spoke to bias in the system. He quoted:

The university has a fundamental cultural issue that is negatively impacting on its ability to serve its clients. This resides with employees who decide to rank persons

in order of importance and hence decides who should be attended to first and who should be ignored.

Overall, the graduate students felt that the personnel were willing to assist them once contact was made with them. When asked how long it took for them to receive feedback after reporting an issue, the responses ranged from immediately to two days, with the exception of three students who expressed a time in which they received a response which ranged from one to five months. The findings on how students perceive the length of time it takes for them to receive feedback and the findings in studies done by Ravindran, Kalpana, and Ramya (2011) and Dehghan, Zenouzi, and Albadvi (2012) reiterates the importance of giving feedback to customers. These researchers confirmed that quick response is one of the key drivers of customers' satisfaction or dissatisfaction.

The areas which the graduate students were asked to give their perception of in this study were the same areas students were asked to rate in a study done by Farivar, Khanbashi and Esmaeelinezhad (2011). The areas are categorized in the five quality dimensions defined as tangibles, reliability, responsiveness, assurance, and empathy. The study done by Ashmed, Nawaz, Ahmad, Ahmad, Shaukat, Usman, Rehman and Ahmed (2010) was also conducted using these dimensions. Reliability a dimension which includes timely registration process, maintenance of error free records, teaching quality of faculty, priority of students' interests, and readiness to respond to students' requests was not seen as a significant factor to improve student satisfaction. The findings of this study however refutes the study by Ashmed, Nawaz, Ahmad, Shaukat, Usman, Rehman, and Ahmed (2010) in this regard, as graduate students at UTech expressly believe that the items mentioned under reliability above are critical service areas which influence student satisfaction. Reasons outlined for choosing graduate programmes at UTech were attributable to the strengths of the institution in terms of uniqueness of programme offerings, the high level of flexibility these afforded to students who had to balance time and family, reasonable payment plans, the practical teaching styles of competent lecturers and the advanced technology utilized on the campus.

## Conclusions

A sore point in the findings is the lack of resources at UTech. The university's administration will need to take a closer look at how it can increase the resources in keeping with its graduate offerings and student population. Although the programme offerings have been rated as excellent, students still expect high quality service delivery and the availability of resources in order to function properly. Humphrey and McCarthy (1999) emphasized the need for the number of resources to increase as the amount of students increase, and improvement to the services offered.

Both studies by Hoyer & MacInnis (2001), and Keith (2005) authenticate each other in reiterating that satisfied customers form the foundation of any successful business as customer satisfaction leads to repeat purchase, brand loyalty, and positive word of mouth. Singh (2006) in discussing the customer satisfaction theory which was used to underpin the study highlighted that satisfaction involves the following three psychological elements: cognitive (thinking/evaluation), affective (emotional/feeling), and behavioural. This theory validates the findings in all three areas. The study sought to ascertain graduate students' perception of the service offered to them which represents the cognitive (thinking/evaluation) and affective (emotional/feeling), the two first psychological elements in Singh's theory. The findings which answer the question of whether or not graduate students would recommend other persons to pursue studies at UTech point out the third psychological element. The thoughts of the students influence their feelings thereby impacting their behaviour. UTech therefore has an opportunity to improve its service delivery to remain economically viable and competitive.

One area in the study that has added to the literature review is the findings of graduate students' perception about the establishment of a graduate students' lounge where students can network. This is an area in which other universities offering graduate programmes could explore in an effort to offer better quality service to their students. Two other areas that were looked at in the study that contributed to the literature review were the findings on why students chose to pursue graduate studies at UTech, and the ways in which graduate programmes are promoted at UTech. Other researchers not only in education could conduct

research to find out why customers chose their organization to conduct business, and how customers feel about how the organization is marketed.

## Recommendations

The administration should:

1. Place more focus on acquiring the additional resources needed to complement the total university population. Where possible laboratories and classrooms could be designated for graduate students.
2. Develop a strong service culture that is understood by everyone, and carried throughout the university.
3. Ensure that colleges, faculties, and other units such as Admissions, Finance, and Student Services improve their efficiency and effectiveness when providing service which will meet and exceed students' expectations.
4. Develop a flexi work system for staff in units to accommodate graduate students who attend classes beyond normal working hours.
5. Establish a graduate students' lounge for networking of students.
6. Find more creative ways of marketing the programmes.
7. Develop a full online registration system for graduate students.
8. Increase the frequency of the cleaning of restrooms.
9. Work with colleges/faculties to provide developmental workshops for graduate students, example academic writing and career development.

The colleges/faculties should:

1. Work with the relevant units to develop and offer more online modules.
2. Encourage lecturers to use more technology in the delivery of their modules.
3. Ensure that students are aware of the services offered in their school, and how these services can be accessed.
4. Assign students to academic advisors or mentors who can guide them throughout the duration of their programme.
5. Inform undergraduate students of the graduate programmes available and encourage them to continue studying at UTech.

The staff should:

1. Develop a system whereby students' queries are resolved within the minimal time possible, and ensure members of staff are armed with the relevant information that students will need.

The students should:

1. Ensure that they take time to find out about the services offered by their college/faculty and utilize them.
2. Help to develop a vibrant alumni base, which will enable networking, and solicit possible assistance in the form of grants and sponsorship for the university to increase its resources.

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# The Relationship between Traumatic Life Events and Depressive Symptoms among a Sample of Jamaican University Students

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## Abstract

*The study of trauma within the Jamaican context has mainly surrounded injury related trauma (Mitchell, 2001; Ward et al, 2010) and there is no study to-date that exploring traumatic life events in a holistic way. Therefore, the objective of the study was to determine the prevalence of traumatic life events and the relationship between these events and symptoms of depression in a sample of Jamaican university students. Particular focus was given to the effect on this relationship of moderator variables such as gender, socioeconomic status (SES) and region (urban/rural). To achieve this, a demographic data sheet, the Traumatic Life Events Questionnaire and the Beck Depression Inventory-II were administered to a sample of university students (N=282) within the Kingston and St. Andrew area. The results indicated that 99% of the students reported experiencing at least one traumatic event in their lifetime; male university students reported more traumatic experiences in comparison to female students as well as experienced more violent events; males from urban areas experienced higher levels of traumatic events and fewer symptoms of depression than*

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*males from rural areas who also experienced high levels of traumatic events; lower Socio-economic status was associated with more abusive, sexually abusive and violent traumatic life events; and university students who reported a higher number of traumatic events report significantly more symptoms of depression. Given the findings, it is recommended that further research in the area is undertaken, as the experience of traumatic events in one's lifetime has potential implications for mental health.*

**Key Words:** Traumatic Life Events; Depressive Symptoms; Mental Health; University Students

## Introduction

The studies on traumatic life events have surrounded the experiences of Post-Traumatic Stress Disorder, chronic illness, accidents, violent acts, types of abuse and other stressful experiences such as death of a loved one (Kendler et. al, 1999; Blaauw et. al, 2002; Compton, 2003; Gearon et. al, 2003; Latzman and Swisher, 2005; Zatzick, et. al, 2014). According to Clayton Tucker-Ladd (2000), trauma not only incorporates psychological problems such as post-traumatic stress disorder, but refers to experiences of events such as war combat, rape, holocaust, violent abuse, serious accidents and the diagnosis of cancer in either oneself or one's loved ones. He argues that trauma is any event that is perceived by the individual as disturbing and stressful and having an impact that ranges from moderately upsetting for a few days or weeks to intensely disturbing over a much longer duration (Tucker-Ladd, 2000). Tucker-Ladd (2000) further stated that trauma includes events that are non-life-threatening such as: death or suicide of a loved one, difficult childbirth, failure or loss of a job and a very stressful divorce. In addition to the aforementioned conceptualization of trauma, it is argued that an adolescent's view of trauma may include the incarceration of his/her parent or a parent's revelation of a past suicide attempt (Giaconia et. al, 1995 as cited by Becker, et. al, 2003).

Most of the studies on the prevalence of traumatic experiences /events have been conducted as a subset of a larger study on Posttraumatic Stress Distress Disorder and as such utilize the definition of trauma as given in the DSM. The

largest prevalence study found in the literature was conducted on a representative sample of persons in the United States between the ages of 15 years and 54 years (Kessler, Sonmega, Bromet, Hughes and Nelson, 1995). This study revealed that more men (60.7%) reported experiencing at least one traumatic event than women (51.2%). Of these 32.5 % of the men and 22.3 % of the women reported three or more traumatic events in their lifetime. The main types of trauma that were frequently reported by the persons in the sample were: witnessing somebody being badly injured or killed (50.1%), being involved in a fire, flood or natural disaster (34.1%) and being involved in a life-threatening accident (38.8%). These events were also reported by more men than women with women reporting more experiences of rape, sexual molestation, childhood parental neglect and childhood physical abuse. Another study conducted by Bernat, Ronfeldt, Calhoun and Arias (1998) on a sample of college students (aged 18- 49 years) revealed similar results. A sixty seven percent (67%) lifetime prevalence for at least one traumatic event with more men experiencing serious physical injury, serious accidents, physical assaults with and without weapons and witnessing serious injury or death. The women, on the other hand, reported having experienced more sexual types of trauma.

Within the Jamaican context, there is no known research on the lifetime prevalence of trauma or traumatic life events, but rather research on intentional and unintentional traumatic injuries as evidence in patient admittance to hospitals (Mitchell et. al, 2001; Ward et. al, 2010; Mowatt et. al, 2012; Hart et. al, 2012; Nelson-Imoru, et. al, 2014), exposure to violence (Pottinger, 2012), and cases of abuse (Johnson, 2005; Coore, 2006). Mitchell et. al 2001 study is one example of the type of study conducted within Jamaica regarding trauma. In their study, Mitchell et. al (2001) examined trauma patients admitted to the Intensive Care Unit (ICU) unit at the University Hospital of the West Indies (UHWI) in Kingston, Jamaica, where it was revealed that men are four times more likely than women to be admitted to this unit as trauma cases. The main causes of these traumatic admissions were motor vehicle accidents (45 %), gunshots (27.3%) and stabbings (10.5%). In another study conducted by McDonald and Dawkins (2001), a comparison was made between the number of trauma cases admitted and the types of injuries experience by patients at a rural hospital in Jamaica (St. Ann's Bay Regional Hospital) and patients at an urban

hospital (UHWI). The results of this comparison suggest that a similar proportion of the total number of cases at both hospitals were trauma related (18% at UHWI and 22% at St. Ann) and motor vehicle accidents accounted for the major intentional injuries at both institutions. Although the proportion of motor vehicle accidents at St. Ann were slightly higher than that for UHWI, this difference was not statistically significant. There was, however, a statistically significant difference in the prevalence of firearm injuries at both places (32% at UHWI and 18% at St. Ann's). These findings suggest that Jamaican males experience more trauma than their female counterparts and individuals in urban regions of the island experience more violent / assault type trauma than their rural counterparts.

In the aforementioned studies, violence (firearm injuries and stabbings) accounted for between 18 to 37.8 % of the cases of trauma admitted to the hospitals. A similar finding was also reported by Gardener, Powell, Thomas & Millard (2003) who studied the perceptions and experiences of violence among secondary school students in urban Jamaica. Gardener et. al (2003) revealed that 34% of their sample reported being victims of violence themselves at least once in their lifetime. Additionally, 60% of the students reported that they had at least one family member who had been a victim of violence and 37% reported that this violence resulted in the death of that family member.

The importance of studying traumatic life events is seen in their association with the development of health problems especially those related to psychological health. Several studies have illustrated that trauma is linked to the development of Post Traumatic Stress Disorder (Breslau et. al., 1995; Hubbard, Realnuto, Northwood & Master, 1995; Gearon, Kaltman, Brown & Bellack, 2003; Breslau et. al, 2004; Frans et. al, 2005) and most studies on the impact of lifetime exposure to traumatic experiences have centered on the development of this disorder. However, in cases in which the co-morbidity of other mental disorders with PTSD has been examined, Depression has been frequently found to occur with PTSD in persons exposed to traumatic life events (Hubbard et al., 1995; Breslau et. al, 2000; O'Donnell, Creamer & Pattison, 2004). Moreover, research which points to a link between traumatic experiences (including violence) and depression such as in Okan Cem Cirakoqlu, Dogan Kokdemir and Kursad Demirutku (2003) who found that attributions for the causes of

depression include trauma, loss, job related problems, disposition, intimacy and isolation further suggests the need to explore correlations between traumatic life events and depressive symptoms within the Jamaican context.

The concept of Depression as a psychological problem associated with experiences of traumatic events is also substantiated in other researches other than co-morbidity studies. Ginexi, Weihs, Simmens & Hoyt (2000) indicate that natural disasters are linked with increases in both depressive symptomatology as well as diagnosed cases of depression. Bernet & Stein (1999) reveal that patients with a Major Depressive disorder report significantly more emotional and physical abuse than a group of healthy comparisons and Kendler, Karkowski and Prescott (1999) found evidence for a causal relationship between stressful life events and major depression in their study of monozygotic twins who were matched for genotype and family environment. Other studies have also found a significant relationship between traumatic life events and the onset of depression or depressive symptoms (Breslau et. al, 2000; Blaauw, et. al, 2002; Crompton, 2003; O'Donnell et. al, 2004; Lutzman and Swisher, 2005).

According to the American Psychiatric Association, depression is a mental illness characterized by loss of energy, changes in appetite, irritability; sleep problems, feelings of worthlessness, difficulty concentrating, and suicidal or morbid thoughts (cited by Goldstein, 2004). In the Diagnostic and Statistical Manual of Mental Disorders IV-TR (DSM-IV-TR, 2000), Depressive disorders are classified under the broad spectrum of mood disorders. They include Major Depressive Disorder (single or recurrent episode), Dysthymic Disorder, and Depressive Disorder Not Otherwise Specified.

According to Kelly, Kelly, Brown & Kelly (1999) females often score higher on depression measures than males. However, few studies have examined this gender difference cross-culturally and the current consensus appears to be that the incidence of depression is unrelated to ethnicity (American Psychiatric Association, 1994 as cited in Kelly et. al., 1999) which was corroborated in Kelly's study of 143 students enrolled in introductory psychology classes at a mid-sized university, aged 17 to 40 years. The results of the study found a significant main effect for gender with females scoring higher than males. It is further suggested that a possible explanation for this difference may relate to how the groups cope with problems. For example, Zahn-Waxler (1993) as cited in Kelly

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et. al (1999) found that “females tend to internalize problems whereas males tend to externalize difficulties”. He further contends that this tendency to internalize problems may reflect cultural trends learned early in life by females, especially in “western societies”. Hence, the assumption based on this finding can be made that depression may have different measurement properties for women and men. “Much research has examined the influences of gender and gender roles on individual differences in self-reported depression. This research has typically assumed that such gender-related factors have stable relationships with depression, without considering the current stressful life events that individuals confront. Yet other research has established that stressful events pose a risk of increased depression” (Waelde, Silvern & Hodges, 1994). In addition, it has also been found that the incidence of clinical depression is substantially higher among women than men, that stressful life events are strong contributing factors and that gender roles may also be a contributor to this presumed gender difference (Waelde et. al., 1994). It was found that life events interact differently with gender and gender roles in conjunction with depression. As such, men and women are differentially vulnerable to negative events according to gender-typed socialization, which may encourage passivity and helplessness in women contrary to adaptiveness and instrumentality in men. This argument is said to account for the gender differences in depression.

Upmayu, Upmayu & Lester (2000), based on their study on depressive symptoms among U.S. and Indian college students said that a possible explanation of gender differences among male and female collegiate may be a result of each groups’ gender role orientation. It should be noted that according to Goldstein (2004), data from Student Health and Counseling Services shows that 17.8 percent of female students and 8.9 percent of male students at Washington University are currently diagnosed with depression. While corresponding national figures from a similar study are 14 percent and 7 percent (Goldstein, 2004). Research on the impact of socio-economic status (SES) on depression suggests that depression, like any other mental disorder is inversely related to SES (Everson et al, 2002; Lorant et. al, 2007). Additionally, regardless of gender, individuals who are wealthy tend to have lower levels of depression (Everson et. al, 2002; Lorant et. al, 2003; Lorant et. al, 2007). When SES is measured by educational attainment, occupational standing, household income and net

worth, it was found that only net worth is consistently related to depression (Everson et. al, 2002). Additionally, according to Mirowsky and Ross as cited by Hauser and McLean (2000), individuals with higher status as measured by education and income tend to have less depression.

Joiner, Wingate Gencoz & Gencoz (2005) found that stress, defined as actively contributing to the occurrence of one's own negative life events contributes to depression as well as depression or depressive symptoms acting as a contributor to stress. Dixon & Reid (2000) who examined the relationships among positive life events, negative life events, and depressive symptoms in a sample of college students found that negative life events may be viewed as a predictor of depressive symptoms, and as such increases in negative life events are also associated with increases in depressive symptoms. In addition, they also found a relationship between positive life events and depressive symptoms. They suggest that the results of their investigation may have many research and treatment implications as the results give some preliminary evidence that it may be important to consider both negative and positive life events when predicting depressive symptoms. Studies exploring depression among college students within the Jamaican context has shown that depression among university students is a significant problem (Lowe, et. al, 2009; Piko, 2009) and like international studies have found that females and persons living with a chronic illness reported significantly higher levels of depressive symptoms (Lowe, et. al, 2009).

Within the Jamaican context, the studies reviewed have mainly explored trauma in relation to injury to the body that possess a threat to either the life of the individual or his body parts example, Mitchell, et. al 2001 study or as exposure to violence and abuse, for example Pottinger (2012) and Johnson (2005) studies respectively. No study in Jamaica has been found that assesses the lifetime prevalence of traumatic experiences and their relationship to symptoms of depression/depression. Nevertheless the studies conducted provide information from which hypotheses can be generated about the experience of traumatic events in Jamaicans. Findings from the literature review make the connection between traumatic experiences to psychological problems such as depression (Ginexi et. al., 2000; Bernet & Stein, 1999; Kendler et. al, 1999) and show that this relationship is moderated by a number of factors including gender. In particular, males have been found to experience more traumatic

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events than females (Mitchell et. al, 2001, Kessler et. al., 1995), especially more violent events (Bernat et. al., 1998, Kessler et. al, 1995). As it relates to geographical location or area of residence, Breslau, Wilcox, Storr, Lucia and Anthony in their article published in 2004, compared the results of a study they conducted in a large mid-Atlantic city with their prior 1996 Detroit Area study on trauma exposure and posttraumatic stress disorder. Although they acknowledge that such a comparison is limited due to differences in the age range of the two studies (18-45 years in the Detroit sample and 20-22 years in Atlanta) and differences in the sampling techniques used, they found that the sample in the Atlanta study (taken mostly from urban areas) had a higher proportion of assaultive violence than the Detroit Area sample which was largely from suburban areas. This higher rate of violence in urban areas as opposed to rural areas was also indicated by Campbell and Schwartz (1996) as cited by Earls et. al (2000) who found a prevalence of 57% in suburban sample but 88% in an urban sample. Other studies have also found a significant relationship between urban versus rural variables and that of traumatic experiences (Moshiro et. al, 2005) as well as the incidence of depression (Galea et. al, 2007). The findings of the aforementioned studies highlighted could be suggestive that urban versus rural places of residence have an impact on the experience of traumatic life events and symptoms of depression.

It is upon this framework that the purpose of this study was to ascertain i) the lifetime prevalence of traumatic life events in sample of Jamaican university students; ii) the presence of depressive symptoms among students who experience traumatic life events; and iii) the relationship between gender, socioeconomic status, region (i.e. urban/rural) and traumatic life events.

## Methodology

### PARTICIPANTS

Two hundred and eighty two (282) university students (95 males, 178 females, 9 no gender identified), ages 17 to 52 years (mean = 23.44) participated in this study. Participants were obtained using convenience sampling, where partici-

pation was voluntary. Participants were informed that they could withdraw their participation at any time during the process without penalty. No specific identifying information was gathered on any participants.

## INSTRUMENTS

Participants completed a demographic data sheet devised by the researchers, the Traumatic Life Events Questionnaire (TLEQ) (Kubany et. al, 2000) and the Beck Depression Inventory-II (BDI-II). The demographic data sheet was developed to obtain basic descriptive information about the participants such as their age, gender, socioeconomic status, and region (urban/rural). It was postulated that these specific demographics impacted the types and incidence of exposed trauma, as well as the quality of one's coping mechanism as it relates to such trauma. Socio-economic status was determined by the income of the main breadwinner of the participant's home and was sub-divided into three (3) categories: Managerial & Professional, Technical & Clerical and Skilled & Unskilled. Regional classifications of Rural and Urban were determined by parish of origin, with Kingston, St. Andrew, St. Catherine and St. James classified as Urban and the remaining parishes as Rural.

The TLEQ is a twenty three (23) item, self-report measure used for screening purposes. The TLEQ explores and measures prior exposure to traumatic events, such as natural disasters, motor vehicle accidents, physical violence, life threatening illnesses, tragic death and sexual abuse in civilian populations, including college populations. Each event examined by the TLEQ asked participants to indicate whether they had experienced the event, as well as the frequency of occurrence and associated negative emotion responses, such as fear and helplessness. The content validity of the TLEQ is high as it assesses exposure to traumatic events. With a Kappa coefficients ranging from 0.70 to 0.91, the temporal stability for the TLEQ is high in areas that assess personal life experiences. Test-retest reliability for the TLEQ has Kappa coefficients ranging from 0.40 or higher for eleven (11) of the sixteen (16) items, and from 0.60 or higher for seven (7) of the items. Research suggests that there is low test-retest reliability for items assessing 'other accident', primarily because of the variation in responses.

The Beck Depression Inventory-II (BDI-II) is a self-administered, twenty-one (21) item, four-point rating inventory that assesses the participants depressive symptomology (affective, motivational, cognitive and physiological) during the past week. For the current study the BDI-II was used to measure participants' depressive symptoms by surveying several areas including relationships with others, physical indices of depression (e.g. loss of appetite) and outlook toward the future. Research with the BDI-II consistently indicated a high range of internal consistency ranging from 0.84 to 0.94; with the evaluation of content, concurrent and discriminant validity as well as factor analysis also being generally favorable. The revision of the measure from its original form enhanced its congruency with the diagnostic criteria for depressive disorders as outlined by the DSM-IV (Groth-Marnot, 1990). Lipps et. al (2007) in their validation of the measure among a cohort of Jamaican university students found an acceptable degree of reliability ( $\alpha = 0.90$ ) and concurrent validity as evidenced by high correlations with scores on the BSD ( $r = 0.74$ ) and the CES-D ( $r = 0.71$ ). The measure has shown applicability in both psychiatric and non-psychiatric populations, with alpha coefficients of 0.86 and 0.81 respectively (Beck et. al, 1988). The measure also demonstrates moderate correlations with other scales measuring depression such as the Hamilton Psychiatric Rating Scale for Depression (0.73) and the Zung Self-Reported Depression Scale (0.76) and the MMPI Depression Scale (0.76).

## PROCEDURE

The measures were first tested during a pilot study of twenty (20) participants chosen by convenience sampling in order to address any logistical issues. The researchers were then trained to administer the questionnaire packet. The measures were administered to participants during specified lecture times, as well as on the places of residence at a University within the Kingston and St. Andrew area. Participants were briefed about the purpose of the study as well as issues of consent and confidentiality. Participants were encouraged to read and sign an Informed Consent Form, as well as to answer the questions of the measures as honestly as possible.

## DATA ANALYSIS

The data was analyzed using the Statistical Package for the Social Sciences version 12.0 for windows (SPSS Inc. Illinois, United States). The data from the questionnaires were coded and basic descriptive statistics such as frequencies and ratios were ran on the data in order to have an adequate basis for interpretation. The prevalence of lifetime traumatic events experienced by participants was calculated by summing the number of affirmative responses to the 23 life events identified on the TLEQ to obtain a prevalence score (range 0–17, [alpha] = 0.5399). The questions on the TLEQ were then sub-divided to form three subscales Violence, Abuse and Sexual Abuse. The questions in the Violence subscale included: “Have you experienced the sudden and unexpected death of a close friend or loved one due to murder?”, “Have you been robbed or been present during a robbery in which the robber(s) used or displayed a weapon?”, “Have you ever been hit or beaten up and badly hurt by a stranger or someone you didn’t know very well?” and “Have you seen a stranger attack or beat up someone and seriously injure or kill him or her?”. Similarly, items on the Sexual Abuse sub-scale included questions related to unwanted sexual attention and having someone fondle or touch one’s sexual parts as a child (less than 13 years), an adolescent (between 13 years and 18 years) and as an adult. These questions were also included in the Abuse subscale with the addition of questions such as: “While growing up: were you physically punished in a way that resulted in bruises, burns, cuts, or broken bones?” and “Have you ever been slapped, punched, kicked, beaten up or otherwise physically hurt by your spouse, a boyfriend or girlfriend or some other intimate partner?”

The measure of depression was calculated by summing the 21 items on the Beck Depression Inventory to obtain a BDI-II score for symptoms of depression (range 0 to 31, [alpha] = 0.864). MANOVAS and 2 x 2 ANOVAS were used to determine the effects of gender, region and socioeconomic status on both the number of and main types of traumatic experiences. Additionally, the relationship between traumatic experiences and symptoms of depression and the effects of gender was assessed through the use of ANOVAS. To obtain a variable for the level of trauma, a median split of the prevalence score was conducted

and scores below the median were considered to reflect a low level of reported trauma and scores above the median, a high level of trauma.

## Results

### PREVALENCE OF TRAUMATIC LIFE EVENTS

The results of this study indicate that having experienced one or more traumatic event is common among the sample of university students. Approximately 99% of the respondents reported experiencing at least one traumatic event in their life time as defined by the TLEQ (see Table 1). This prevalence rate is notably higher than those obtained in studies conducted in the United States (Kessler et. al, 1995; Bernat et. al, 1999).

**Table 1:** Lifetime prevalence of traumatic events reported by the university students

Number of Traumatic Events	Prevalence Rates
One or more	99.6%
Two or more	97.5%
Three or more	91.5%
Four or more	80.1%
Five or more	64.1%

The most common lifetime traumatic events experienced by these university students were: natural disasters (96.8%), unexpected death of a loved one/ close friend (71.1%), sexual abuse (54.3%), unwanted sexual attention (42%) and loved one survival of life threatening event such as an accident, assault or illness (40%). For the three subscales of TLEQ, 78.6 % of the students reported a lifetime prevalence of at least one violent traumatic event, 67.9% reported a lifetime prevalence of at least one abusive traumatic event and 59.5 % reported lifetime prevalence of at least one sexually abusive traumatic event (see Table 2).

**Table 2:** Distribution of reported lifetime prevalence of traumatic events for the three subscales of the Traumatic Life Events Questionnaire

Subscale of TLEQ	At Least one Traumatic Event	Two Traumatic Events	Three or more Traumatic Events
Violence	78.6%	22.9%	11.1%
Abuse	67.9%	21.1%	7.9%
Sexual Abuse	59.5%	16.8%	2.2%

### PREVALENCE OF DEPRESSION

70.5% of the university students reported symptoms of depression which fall within the normal range and 39.5% reported symptoms of depression ranging from mild to severe. Of the latter group only 5.1% reported symptoms which could be classified as moderate or severe (See Table 3). This finding to other published work which reported done higher rates of reported symptoms of depression among university populations (Piko, 2009; Lowe et. al, 2009).

The relationship between of gender and types of traumatic life events reported by university students

Results of the univariate ANOVA using gender as the independent variable and the number of traumatic events reported as the dependent variable revealed one main effect for gender ( $F_{(1,260)} = 8.092, p <.001$ ). Male college students

**Table 3:** Distribution of the severity of symptoms of depression reported by university students as measured by the BDI-II

Severity of Depressive Symtoms	% of Students
Normal	70.5
Mild Depression	13.6
Mild – Moderate Depression	10.8
Moderate – Severe Depression	4.5
Severe Depression	0.6

**Table 4:** Mean number of traumatic events reported by male and female university students

Gendder	Mean Number of Traumatic Events
Females	5.725
Males	6.897

reported more traumatic experiences than female college students (see Table 4). These results appear consistent with previous literature identifying males experiencing more traumatic events in comparison to their female counterparts (Kessler et. al, 1995; Mitchell et. al, 2001).

One significant main effect for the 2(region) x 2 (gender) MANOVA of the subscales of the TLEQ (Violence, Abuse and Sexual Abuse) was found for Gender ( $F_{(3,250)} = 12.526, p < .01$ ). Further analysis of the univariate ANOVAS following the MANOVA indicated that this gender difference was only significant for violence subscale ( $F_{(1, 251)} = 26.768, p < .01$ ) with male university students reporting more experiences of violence than female university students (see Table 5). This finding corresponds with Kessler et. al (1995) and Bernat et. al (1998) studies indicating that males experience more violent events.

For the 2(Gender) X 3(SES) MANOVA of the subscales of the TLEQ, two significant main effects emerged. Firstly, a significant main effect for gender ( $F_{(3,256)} = 13.339, p < .01$ ). Inspection of the univariate ANOVAs revealed a similar finding that, the gender difference is only significant for the violence subscale ( $F_{(1, 258)} = 31.212, p < .01$ ). These results are consistent with previous studies conducted in the United States (Bernat et. al, 1999), where male participants were found to report significantly more traumatic experiences and significantly more violent traumatic experiences than females. However, in contrast to prior studies (Bernat et. al, 1999) there was no significant gender difference found for the number of reported sexual abuse or abuse-related traumatic events.

**Table 5:** Mean number of violent traumatic experiences reported by male and female university students

Gendder	Mean Number of Traumatic Events
Females	1.419
Males	2.325

SES also had a significant main effect ( $F_{(6,515)} = 2.671, p < .05$ ) and the univariate ANOVAS following the MANOVA revealed that this difference in SES is significant for all the subscales of the TLEQ; Violence ( $F_{(2, 258)} = 4.957, p < .01$ ), Abuse ( $F_{(2, 258)} = 3.708, p < .05$ ) and Sexual Abuse ( $F_{(2, 258)} = 4.758, p < .01$ ). The results of this finding suggest the following: (1) university students from lower socioeconomic backgrounds report more abusive traumatic experiences in comparison to university students from higher socioeconomic backgrounds (see Table 6); (2) university students from lower socioeconomic backgrounds report more sexually abusive traumatic experiences than university students from higher socioeconomic backgrounds (see Table 7); and (3) university students from lower socioeconomic backgrounds report more violent traumatic experiences than university students from higher socioeconomic backgrounds (see Table 8).

**Table 6:** Mean number of Abusive traumatic experiences reported by university students of different socioeconomic status

Socioeconomic Status	Mean Number of Abusive Traumatic Experiences
Managerial & Professional	1.047
Technical & Clerical	1.42
Skilled & Unskilled	1.592

**Table 7:** Mean number of Sexually traumatic experiences reported by university students of different socioeconomic status

Socioeconomic Status	Mean Number of Sexually Traumatic Experiences
Managerial & Professional	0.713
Technical & Clerical	1.029
Skilled & Unskilled	1.197

**Table 8:** Mean number of Violent traumatic experiences reported by university students of different socioeconomic status

Socioeconomic Status	Mean Number of Violent Traumatic Experiences
Managerial & Professional	1.62
Technical & Clerical	1.857
Skilled & Unskilled	2.303

THE IMPACT OF LEVEL OF TRAUMA, REGION, GENDER AND SOCIOECONOMIC STATUS ON THE SYMPTOMS OF DEPRESSION REPORTED BY UNIVERSITY STUDENTS

The results of the univariate ANOVA using region and the level of trauma (median split) as independent variables and the BDI-II score as the dependent variable revealed one main effect for level of trauma ( $F_{(1,160)} = 6.786, p < .05$ ). This indicates that the university students who reported a higher number of traumatic events report significantly more symptoms of depression as measured by the BDI-II in comparison to students who reported lower numbers of traumatic events (see Table 9).

**Table 9.** Mean score on the Beck Depression Inventory of university students who report high and low levels of traumatic events

Level of Trauma (Median Split)	Mean Score on BDI
Low Trauma	5.796
High Trauma	8.502

The main effect for region and the interaction were not statistically significant ( $p > .05$ ). Similar results were also found in the univariate ANOVA using gender and level of trauma as the independent variables and the BDI score as the dependent variable. The main effect for level of trauma was also significant ( $F_{(1,168)} = 8.422, p < 0.01$ ), however, the main effect for gender and the interaction of gender and level of trauma were not significant ( $p > .05$ ).

For the univariate ANOVA using gender and region as the independent variables and the BDI score as the dependent variable, a significant interaction was found for gender and region ( $F_{(1,158)} = 17.904, p < .01$ ), however, neither of the main effects were significant ( $p > .05$ ). This significant interaction suggests that, female university students from urban areas report significantly more depressive symptoms as measured by the BDI –II than female university students from rural areas. However, male university students from rural areas reported more symptoms of depression as measured by the BDI-II than male university students from urban areas.

The results of the univariate ANOVA using gender, region and level of trauma (median split) as independent variables and the BDI-II score as the dependent variable reveal a significant main effect for level of trauma ( $F_{(1,154)} = 4.563, p < .05$ ), a significant interaction for gender and region ( $F_{(1,154)} = 9.709, p < .01$ ) and a significant three way interaction for gender, level of trauma and region ( $F_{(1,154)} = 9.709, p < .01$ ). Additionally, it was found that 1) female university students from urban areas who reported low levels traumatic events report more symptoms of depression as measured by the BDI-II than female university students from rural areas who report low levels of experiences of traumatic events; 2) female university students from urban areas who report high levels of traumatic events report more symptoms of depression as measured by the BDI-II than female university students from rural areas who report high levels of traumatic events.

Additionally, it was also found that 1) male university students from urban areas who report low levels of traumatic events report more symptoms of depression as measured by the BDI-II in comparison to male university students from rural areas who report low levels of traumatic events; 2) male university students from urban areas who report high levels of traumatic events report less symptoms of depression as measured by the BDI-II than male university students from rural areas who report high levels of traumatic events.

The final univariate ANOVA conducted with level of trauma (median split) and SES as the independent variables and the BDI-II score as the dependent variable also revealed a significant main effect for level of trauma ( $F_{(1,167)} = 6.152, p < .05$ ). However, the neither the main effect for SES nor the interaction were significant ( $p > .05$ ).

## Limitations

There were several limitations in this study. Firstly, generalizability across populations is limited as a result of the accidental sampling procedures used and the educational background of the sample of participants. Due to the fact that only 2% of the Jamaican population actually obtain tertiary level education, it is likely that persons at university level differ from the wider population in a

variety of ways. Additionally, Nettles and Pleck (1995, cited in Rosenthal, 2000) indicate that college attendance is a possible mediator for the impact of stress. In light of these facts, the conclusions from this study do not provide information to accurately explain traumatic experiences and depressive symptoms in the wider Jamaican population.

In this study, level of trauma was measured as a median split of the sum of varying types of traumatic events, rather than by the intensity or frequency of exposure to trauma. Since several persons in the sample who reported experiencing traumatic events also indicated that these events did not cause fear or terror, this may suggest that our measure of trauma fails to adequately reflect whether the events were indeed perceived as traumatic. Finally, since the measures used for traumatic life events (TLEQ) has not been validated on the Jamaican population; it cannot be stated with reasonable certainty that the scale accurately assesses the occurrence of these events in this population.

## Conclusion

Despite the limitations of this study, this study is one of few that established the lifetime prevalence of traumatic events in a sample of Jamaicans, while examining the relationship between such events and the development of depressive symptoms. Previous studies conducted in Jamaica provide little information about traumatic life events beyond accidents and violent acts inclusive of physical assault (Mitchell et. al, 2001; Ward et. al, 2010; Mowatt et. al, 2012). Therefore this study adds to the body of literature going beyond the scope of what has been previously done. The use of the TLEQ in this study allowed for the examination of a wider scope of traumatic events as well as exploring whether these events are risk factors for depressive symptoms. The findings yielded from the research suggests that traumatic events have an impact on the psychological well-being of university students and that factors such as gender, socio-economic status and region (i.e. urban versus rural) can act as mediators. This is important, as Piko (2009) suggested that epidemiological research aids researchers and other health professionals understanding background variables influencing the onset of depression and may likewise aid in its treatment and

other interventions. Furthermore, taking note of traumatic life events within the Jamaica contexts is particularly important, not only in relation to the treatment of depression and symptoms possibly attached to PTSD but also in prevention of substance use and misuse as coping mechanisms among university students (Herrera Rodriguez, et al, 2012; Harrison et al, 2012) who may be particularly at risk during examination periods (Piko, 2009). Considering the limitations highlighted in this study, it is encouraged that additional research be undertaken on a wider scale, especially in conjunction with potential issues surrounding coping styles/strategies and substance use which this study did not explore.

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# Journal of Arts Science and Technology

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*The Journal of Arts, Science, and Technology (JAST)* is an international, multi-disciplinary, peer-reviewed journal aiming 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. *JAST* is published by the University of Technology, Jamaica, and is intended for readers in the scholarly community and for professionals in industry. Besides research papers, the journal publishes scholarly book reviews, conference papers, and commentaries.

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Author(s) should use Times New Roman, 1.5 spacing in MS Word, 12-point font, and left align.

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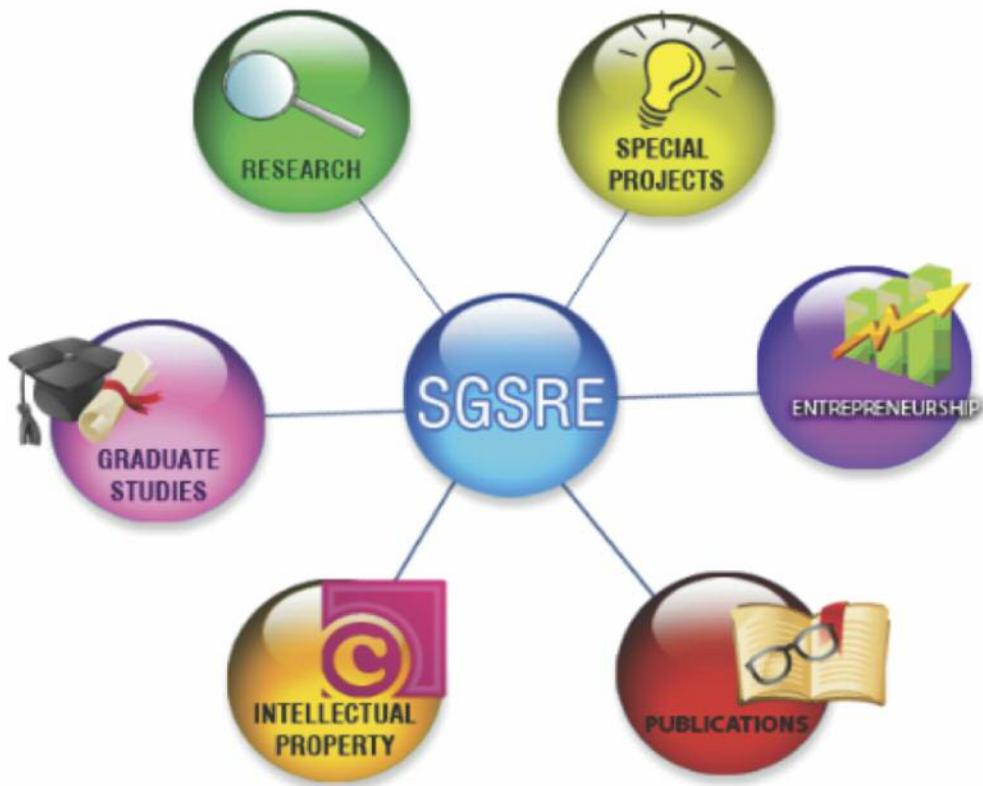
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