

The Psychosocial Cost of Intentional Homicide on Academic Achievement in Mathematics at the Secondary Level in Jamaica

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ABSTRACT

Intentional homicide is among the major violent crimes that has eclipsed the macroeconomic challenges in Jamaica. The discourse of violent crimes and the sub-standard academic performance of students have been an ongoing dilemma for decades; but, they (i.e., homicide and academic performance) are being in separate spaces — criminology and education respectively. This research is timely as it seeks to 1) evaluate the statistical relationship between mathematics performance and intentional homicide rates in Jamaica, 2) determine a model that can explain the predictability of mathematics performance in CSEC from intentional homicide in Jamaica, and 3) explain a perspective as to how intentional homicide is retarding critical thinking skills of Jamaicans. For this study, the average pass rate in CSEC Mathematics for the studied period (1989-2017) was $39.5\% \pm 12.4\%$, which means that 60% of Jamaican candidates who wrote the annual CSEC examination in mathematics were unsuccessful. A significant statistical correlation existed between the CSEC Mathematics pass rate and homicide rate ($P=0.004$). Furthermore, the statistical association is a moderately inverse one ($r_{xy}=-0.512$). Furthermore, 23.0% (adjusted R^2) change in success rate in CSEC Mathematics performance among Jamaican candidates can be explained by a 1% in homicide rate in Jamaica. The cost of intentional homicide is profound on cognitive development of infants/children and this must be brought into educational psychology, learning theorizing and social biology, particularly in the study of learning mathematics.

Keywords: Cognitive domain, Crime, Intentional homicide, Murder, Mathematics, Psychobiological factors

INTRODUCTION

Crime and violence have been and continue to be, a major concern for countries in the developing world, especially Latin America and the Caribbean [1-17]. The crime problem has been echoed by one of the leading Caribbean criminologists, Professor Harriott, who stated that this is among the leading national concerns. In fact, Harriott [15] opined that “The problem of crime in the Caribbean — its causes, its consequences, and its control — emerged as a major concern during the 1990s” (p. 1). Some twenty-seven years after 1990, crime and violence have worsened in the Caribbean and have become center stage of all national discussions. “The traditional pattern of criminal offending in the Caribbean has been characterized by low rates of violent crime and relatively high rates of property crimes” [15]. This reality has subsequently changed in the last 2 decades. An empirical study by Bourne et al. [18] found that in 1970 the intentional homicide per day in Jamaica was 0.4 and this increased to 3.3 in 2013. For decades, Jamaica has been struggling with how to lower the intentional homicide rates. The murder situation in Jamaica can be further contextualized by comparing it with other geopolitical spaces of larger population composition. In 2013, the population of New York was at least 7 times that of Jamaica;

yet the latter’s homicide rate was greater than the former locality [18].

Intentional homicide is among the major violent crimes that have eclipsed the macroeconomic challenges in Jamaica. A national cross-sectional descriptive study that was conducted by Powell et al. [19] found that crime was identified as the leading national problem followed by unemployment and then education. In Jamaica, the murder phenomenon dates back to slavery [3] and this has only geometrically increased post the 1990s. Although the Powell et al. [19] study revealed that three main national problems in Jamaica were crime, unemployment and education, the education pheno-

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-menon has been researched separately from the homicide and/or unemployment. The reality is that for years' students have been underperforming in mathematics and homicide has never been investigated as a consequence of this situation [20-22]. In a comprehensive discussion of violent crimes, Jones [23] includes students' performance in schools and this would suggest that both phenomena are viewed on separate planes. With Professor Harriott [15-17,24,25] outlining that most of the violent crimes are committed by and against poor young men in inner-city communities, the cost of intentional homicide is excluded from educational attainment discourse. There is evidence that crime and violence have resulted in fear of criminal victimization. We therefor ask, is there an association between intentional homicide and performance in mathematics at the secondary level?

For decades, there have been many debates on the performance of Jamaican candidates in mathematics, particularly at the primary and secondary levels. The discourse on mathematics performance in Jamaica is totally

based on the dismally low performance of students on the Caribbean Secondary Examination Certificate (CSEC). In 2016, 56 out of every 100 Jamaicans who wrote the CSEC Mathematics paper were unsuccessful [26]. Using statistics from 2000-2016, the rate of success in CSEC Mathematics has never risen beyond 57%, which occurred in 2015 [26]. Various stakeholders have been highly concerned about the under-performance of Jamaican candidates at the CSEC level in mathematics simply because of the importance of the subject to: 1) Critical thinking; 2) Social and educational advancement; 3) Problem-solving skills; and 4) Its importance to other disciplines such as Medicine, Statistics, Economics, Architecture, Computer Science, and so on. Even at the primary level, there is dismally low performance of students in mathematics (**Tables 1 and 2**) [22]. One of the explanations of the sub-standard performance in mathematics has been ascribed to the attitude of teachers as well as students [27]. A question that requires immediate empirical investigation is, "Does intentional homicide impact critical thinking skills and account for the sub-standard performance in mathematics?"

Table 1. Performance of Jamaican students on the grade 4 numeracy test, 2009-2015.

Year	Mastery (%): Jamaica
2009	45.0
2010	38.0
2011	46.0
2012	51.0
2013	56.0
2014	54.0
2015	61.0
2016	57.1

Source: Student Assessment Unit, MOE, Kingston, Jamaica, various years

Table 2. Performance of Jamaican students success rates in grade six achievement test mathematics (GSAT or Grade 6), 2009-2016.

Year	%
2002	51.0
2003	48.0
2004	44.2
2005	57.8
2006	53.0
2007	46.0
2008	55.0
2009	53.0
2010	57.0
2011	62.0
2012	63.0
2013	61.0
2014	60.0
2015	56.0
2016	57.0

Source: Ministry of Education, Youth and Information, various years

The discourse of violent crimes and the sub-standard academic performance of students have been an on-going dilemma for decades; but, they are being in separate spaces — criminology and education respectively. Harriott [16,17] indicated that “The communities of the marginalized urban inner-city poor are most affected by this murderous violence” (p. 242), suggesting that intentional homicide could be accounted for other challenges to include low academic performance. This research is timely as it seeks to: 1) Evaluate the statistical relationship between mathematics performance and intentional homicide rates in Jamaica; 2) Determine a model that can explain the predictability of mathematics performance in CSEC from intentional homicide in Jamaica; and 3) Explain a perspective as to how intentional homicide is retarding critical thinking skills of Jamaicans.

THEORETICAL FRAMEWORK

The theoretical framework for this study squarely rests on two theories. These are: 1) Theory of emotion; and 2) Cognitive development. Although the theory of emotion is outside of the education, it offers insights into emotional reactions with behavioural outcomes and this provides an understanding of how an event can change psychobiological conditions of people. Within this context, homicide that is an event can provide a certain emotion, and this can be applied to the area of education like the theory of cognitive development.

Theory of emotion

One of the Caribbean leading criminologists, Prof. Harriott, has been arguing that the Caribbean region has undergone a crime problem since the 1990s [15-17,24,25] and this appears to have worsened with time. In 2007, group of academicians in the Department of Government at the University of the West Indies conducted a cross-sectional probability study of 1,332 Jamaicans and findings revealed that crime and violence was listed as the leading national problem [19]. The issue of fear of crime and its influence on human behaviour must be a part of all human inquiry because of the impact of crime, particularly intentional homicide. Using empirical data, Harriott [24] found that the fear of crime is influencing peoples’ apprehension and behaviour in many aspects of their existence. Fear that is a psychological component of human emotion [28,29] means that human emotion offers insight into how homicide can influence cognition and general human behaviour. Hence, this research employs the theory of emotion to examine how intentional homicide influences mathematics performance.

The scientific discourse of human emotion evolves with the work of Darwin [30], the evolutionary theory of emotion. This theory offers the perspective that emotions exist to serve the adaptive role. In fact, emotion motivates humans to respond to various stimuli or to the environment in which they are in because they seek to survive or succeed in life.

James-Lange Theory of emotion was the first empirical work on the matter of measuring emotions and how people respond to different situations [31]. James-Lange theory of emotion indicates that humans and animals experience different events and that peoples’ nervous system explains their physical reactions to the situation. This means that the nervous system accounts for the physiological changes in the body such as increased heart rate, trembling, and upset stomach. Those physical actions do influence emotional reactions such as fear, anger and sadness. From this perspective, this denotes that one’s heart rate increases when one begins to tremble.

William James believed that the human body directly changes with excitement and that explains why feelings differ with changes in emotions. Hence, he proposed that:

Event ==> Arousal ==> Interpretation ==> Emotion

James and Lange are of the opinion that experiencing an emotion (example, fear or anger) is an expression of real feelings. Why? This suggests that without the real physiological response that caused the emotions, it therefore would be improbable to experience the emotions when they occurred. Simply put, the physiological feedback must exist in order to actually experience the genuine emotion. On the other hand, Cannon-Bard theory of emotion is in direct contradiction to James-Lange theory of emotion [32]. The Cannon-Bard theory of emotion that is equally referred to as the Thalamic theory of emotion states that humans experience emotions, and this experience causes a physiological reaction in the form of sweating, trembling, and muscle tension. Furthermore, Cannon-Bard theory of emotion suggests that people can simultaneously experience feelings of fear and physical reaction. The Cannon-Bard theory differs from other theories of emotion such as the James-Lange theory of emotion, which argues that physiological responses that occur as a result of emotions. Unlike James-Lange theory of emotion, Cannon-Bard's theorizing indicated that emotions may be experienced and the human body may not necessarily see a physiological reaction:

Event ==> Simultaneous Arousal and Emotion

This denotes that there is a neurobiological science to emotion and that stimulating an event and sensory signals are transmitted by the brain activity, the thalamus. Such reality suggests that the thalamus will receive a signal, and this relays the information to two structures (i.e., the amygdala and the brain cortex). Amygdala accounts for the prompt response in the form of emotions, and the brain cortex is for the slower reply. Simultaneously, the autonomic nervous system sends a direct signal to muscles as well as the other bodily parts (i.e., increase in rate, change in rhythm, and more). As a result, this theory indicates stimulation/arousal and emotion as a combined response to a stimulating event. Within the context of the theory of

emotion, there is no doubt that homicide stimulates some psychobiological responses, which is the event, and this becomes an arousal and emotions in the cognitive domain that account for developing the needed skills and competence for mastering mathematical problem-solving among students who experience or are in homicidal environments.

Cognitive development

Piagetian and Vygotskian theories of cognitive development are widely used in education as an explanation of how learning takes place [33,34]. Piaget's theorizing offers the perspective that people's experiences and biology are simultaneously acting to shape cognitive development. He believed that a child acquires knowledge by way of four stages (i.e., sensorimotor (birth to 2 years); preoperational state (ages 2-7 years); concrete operational (ages 7 to 11 years) and the formal operation stage (ages 12+ years). Piaget contended that at the formal operating stage, the adolescent or young adult becomes involved in abstract reasoning and hypothetical problem solving and deductive and induction reasoning. It is at this stage, he postulated that the individual is able to solve multiple problems and begins to form theory of the world in which he/she lives. This means that as an infant grows or ages, he/she begins to construct from concrete to abstract the world in which he/she lives.

Vygotsky, on the other hand, theorized that children actively construct knowledge and begin to understand the world through their experiences and actions [34]. This means that development of the child is based on what he referred to as the zone of proximal development (ZPD), thus, when things are too difficult for the learner to master independently; assistance learning will take place and mastering of the concept will become easier.

Cognitive development has vividly outlined that the acquisition of knowledge is psychobiological experience and as such one's experiences or encountered situations have a direct effect on the learning process of humans. With experienced events having a role on arousal and emotion, it follows that exposure to crime, especially intentional homicide, will not only have a bearing on physiological situations as anger, trembling and sweaty palms, but this will have a psychological impact on the cognitive development of the people and by extension the learning process. Hence, theories of emotion and cognitive development set a framework for understanding how learning can be influenced by external events that can result in internal stimuli that will have an impact on the learning of students in schools.

METHODS AND MATERIALS

Time series data were employed for this study. Data were taken from publications from various government departments on macroeconomics [26]. The timeframe for the present study was from 1989 to 2017. Data were recorded, stored, and retrieved using the Statistical Packages for the Social Sciences (SPSS) for Windows, Version 25.0. The level of significance that is used to determine statistical significance is less than 5% (0.05) at the 2-tailed level of significance. Descriptive statistics were calculated for all the independent variable — intentional homicide and murder rates — and annual CSEC Mathematics success rates, which is the dependent variable. Pearson's Product Moment Correlation was performed on all the explanatory and outcome variables. The three critical assumptions of multiple linear regressions (i.e., normality, multi-collinearity and linearity) were tested. Normality assumption was tested by way of skewness. The closer to zero the skewness value was, the more likely the distribution was a normal one. As it relates to multicollinearity, the acceptable value for tolerance which does not indicate a problem of multicollinearity for this study was six [35]. For this study all the tolerance values were below six. In addition, a model will be created for the purpose of determining the predictability of intentional homicide on annual CSEC performance in mathematics among Jamaican candidates.

RESULTS

For this study, the average pass rate in CSEC Mathematics for the studied period (1989-2017) was $39.5\% \pm 12.4\%$, which means that 60% of Jamaican candidates who wrote the annual CSEC examination in mathematics were unsuccessful. Further analysis of the CSEC Mathematics passes for Jamaican candidates revealed that the highest successful rate occurred in 2015 (62%) and the least success rate was 20.4% in 1997 (**Annex 1**). A deduction that can be made from the statistics (**Annex 1**) is that Jamaican candidates at the secondary level have been underperforming in mathematics, and this is retarding tertiary level labour stock in the society because mathematics is a compulsory course in many disciplines at this level of study. On the other hand, over the last almost 3 decades, the average annual number of intentional homicide in Jamaica was 1,086 people ± 358 people, with a daily average number of intentional homicide being 3 people. The statistics (**Annex 1**) showed that in 1989, the number of daily homicide was 1 person and this has exponentially increased to 4 in 2017. **Table 3** revealed that intentional homicide rate for the 29-year period was 41.7 ± 13.5 .

Table 3. Descriptive analysis CSEC mathematics passes for Jamaicans and homicide, 1989-2017.

Details	Mean ± Standard deviation
CSEC Mathematics pass rate for Jamaicans	39.5% ± 12.4%
Annual number of intentional homicide in Jamaica	10861 ± 358
Intentional homicide rate in Jamaica per 100,000 population	41.7 ± 13.5
Daily number of intentional homicide in Jamaica	3 ± 1

Bivariate correlation

For the 29 year period (1989-2017), only 25 years were used in the analysis because of 4 missing years of data. A significant statistical correlation existed between the CSEC Mathematics pass rate and homicide rate ($P=0.004$).

Furthermore, the statistical association is a moderately inverse one ($r_{xy}=-0.512$). This means increased intentional homicide rate in Jamaica decreases success rate in CSEC Mathematics performance, and vice versa (**Table 4**).

Table 4. Correlations of CSEC mathematics pass rate and homicide rate.

		CSEC Math pass rate	Homicide rate
Pearson Correlation	Math	1.000	-0.512
	Homicide rate	-0.512	1.000
Sig. (1-tailed)	Math		0.004
	Homicide rate	0.004	
N	Math	25	25
	Homicide rate	25	25

Multivariate analysis

This section of the findings tests the hypothesis that homicide rate in Jamaica inversely influences success rates in CSEC Mathematics performance of students, which is expressed in Equation (1).

$$M_t = \alpha_t + \beta_t H_t + u_t \quad (1)$$

Where, M_t represents success rate in CSEC Mathematics for time period t and H_t denotes intentional homicide rate per 100,000 in time period t , α_t indicates the constant, β_t means the coefficient or rate of change success rate in CSEC Mathematics given a 1% change in intentional homicide rate and u_t being the error term.

The data for intentional homicide rate and success rate in CSEC Mathematics of Jamaican candidates aptly fits a linear model ($F(1, 23)=8.189$, $P=0.009$). In addition to the aforementioned issue, all the assumptions of linear regression were tested for and upheld for this work (**Annex**

2). As such, a linear model can be used and analysis for this study (Equation 2):

$$M_t = 53.3\% - 0.008H_t \quad (2)$$

The values for Equation (2) are taken from **Table 5**. Equation (2) can be interpreted as if there were no intentional homicide in Jamaica, the success rate in CSEC Mathematics on average would be 53.3% and with 1% in intentional homicide rate, mathematics success rate on the CSEC examination decline by 0.008%. Furthermore, 23.0% (adjusted R^2) change in success rate in CSEC Mathematics performance among Jamaican candidates can be explained by a 1% in homicide rate in Jamaica. The findings offer some insights into the psychology of homicide on mathematics performance at the secondary level in Jamaica and indicate that homicide is retarding the critical skills of students, which is shown in inverse correlation between success rate in CSEC Mathematics and homicide rate in Jamaica.

Table 5. Details of homicide rate.

Details	Unstandardized Coefficients		Beta	t	P value	95.0% CI	Correlations		
	B	Std. Error					Lower - Upper	Zero-order	Partial
Constant	53.325	5.317		10.029	<0.0001	42.326 - 64.324			
Homicide rate	-0.008	0.003	-0.512	-2.862	0.009	-0.013 - -0.002	-0.512	-0.512	-0.512

DISCUSSION

The matter of using a standardized examination or test to assess one's knowledge or performance level in any area is well established in psychological and educational research. In fact, Lindsley et al. [36] noted that examinations are used as a method of assessment of students' skills, knowledge and competence [37]. Therefore, low rates of success on tests speak to knowledge deficiency in the content area. As such, this study employs success rates in CSEC Mathematics to proxy secondary level students' knowledge level or lack of as this would allow for an understanding of whether the skills, knowledge and competencies have been mastered or otherwise by secondary students. From such a vantage point, the success or failure rates in CSEC Mathematics offer great insights into students' attitude, affective and cognitive domains. According to the Ministry of Education:

Mathematics continues to be an important component in the formation of the educated person and as such, mathematics education should reflect the goals of education in a dynamic society. We must therefore address not only the acquisition of skills and mastery of ideas. We must address more than the accumulation of facts and principles. Mathematics education in the age of information must place emphasis on the higher skills of discussion, interpreting and evaluation [38].

It can be deduced from the expressions of the Ministry of Education that there are some challenges among Jamaican students in the area of mathematics, which is also argued by Hill [39], Sinclair [40] and Benjamin [41]. With mathematics being important in an individual's life as well as for the society [40,42-46], the underperformance of pupils in this subject is therefore of paramount significance to human development. In an article entitled 'Math's Big Problem', Benjamin [41] opined that Jamaican students at the grade four level are under-performing in mathematics, with less than 55% of them mastering the principles and procedures in the discipline. The low performance of Jamaican children at the primary level in mathematics is, therefore, of concern as these accounts for the underperformance at the secondary level.

Over the last three decades (i.e., 1989-2017), particularly the last decade (i.e., 2007-2017), there has been much

discussion surrounding the issue of the quality of education in Jamaica [19,22,47-52], particularly the underperformance of secondary students in the discipline of Mathematics [53-55]. As a result of this discourse, there have been many calls for transforming the existing educational practices and principles in Jamaica, which includes re-vamping the teaching-learning process. The monitoring of students' learning is encapsulated in formative assessment and this has been a focus of many interventions and/or studies to address the underperformance in many courses including mathematics [56]. There is even a call from the Ministry of Education, Youth and Information for Jamaicans to embrace mathematics because of the importance of the discipline and people's inability to apply the subject or people's fear of the subject [57]. Jamaicans' fear of mathematics and their underperformance in the area is aptly captured in a statement made by the Minister of Education, Mr. Reid [50] that: "Steps are being taken by the Ministry to improve the performance of students in mathematics by, among other things, increasing the number of teachers qualified in the subject" [57,58]. Despite all the efforts of the Ministry of Education and scholars in the area of mathematics, in 2017, 58% of Jamaican candidates who wrote the Caribbean Secondary Examination Certificate in mathematics were unsuccessful, which represented a mild decline from 59% over the previous year (**Annex 1**). A question of importance in the underperformance of secondary students in Jamaica is "What next can we try to reduce the fear for the subject matter?"

To understand the extent of crime in a violent community, the words of Professor Harriott are fitting and insightful, and this one reads, "The effect of the fear of criminal victimization usually extends beyond altering the psychological states of individuals to influencing behavioural patterns" [17]. Harriott's perspective admits the psychological cost of homicide of residents of violent neighbourhoods and forwarded that the event of crime changes general behaviour. The issue is that crime produces fear, and fear of criminal victimization has multidimensional effect on humans. Fear is a factor in the discourse of underperformance in mathematics in Jamaica and this can be deduced from the Mr. Reid's [50] statement that "Maths is important, and we as a people should not be afraid of mathematics. We must conquer it. We must make it fun and

be able to apply it to some of the problems in our own personal lives and in the general society," he said" [57]. The issue of fear is an emotion that is retarding people's ability to successfully perform in mathematics. But, is fear of crime a factor that has been brought into the discourse? The fear of crime has been extensively studied in criminology [24,25,59], but its influence on mathematics performance is sparse in the literature. In Jamaica, there is evidence that much needs to be done as it relates to improving students' performance in mathematics, which is the rationale for this study. With the low success rate in mathematics, many students do not have the prerequisite skills for perusing tertiary level education, and if they do, they are unable to register for programmes that require mathematics. Outside of this reality, is there a psychology to intentional homicide that is retarding mathematics performance that has never been empirically investigated prior to now?

Fear is an emotion that has been empirically established as influencing human's psychobiological behaviour [28,29,31,60]. James-Lange theory of emotion has offered that humans and animals experience different events and that peoples' nervous system explains their physical reactions to the situation. With this theorizing, one's nervous system accounts for the physiological changes in the body such as increased heart rate, trembling, and upset stomach, and this could account for retarding brain activities in human functioning. When fear evolves in humans or animals, it changes the psychological function of the organism and slower the cognitive response of the person or animal. Professor Harriott has empirically established that fear is an emotion that influences psychobiological conditions and accounts for people's unwillingness to share information with the police [24].

With Cannon-Bard's theorizing that emotions can be experienced and the human body may not necessarily see a physiological reaction, it means that people who experience fear from homicide may not be showing physiological signs such as trembling and hand sweating, and if they do, these would not have been empirically examined before students write CSEC Mathematics. The current study has shown an inverse statistical correlation between intentional homicide and success rate in CSEC Mathematics from which we will theorize how the event of intentional homicide is retarding cognitive functioning of students, and this envelops a new approach in health and educational research. From the literature on emotion, we are theorizing that intentional homicide slows cognitive skills that are critical to the discipline of mathematics, and as such students who live in violence prone areas should be assessed for bodily changes such as increased heart rate change, change in rhythm and other physiological changes following upsurge of violence, especially homicide, and this could be signs of their inability to apply themselves effectively to successfully write mathematics examinations.

Intentional homicide is simply not a physical event; it has a psychobiological component that must be considered in the study of education as it influences students' performance in school, particularly retarding cognitive functioning that is required to successfully solve mathematical questions. There is a cost of intentional homicide that must be brought into the discourse of academic performance, especially mathematics that has alluded to substandard performance of students in mathematics. There is a psychology of intentional homicide that is undergirded in this research and one that has evolved as an explanation for the dismally low performance in mathematics in Jamaica. With there being evidence that fear is associated with criminal victimization [24,59] and that fear is an emotional response to perceived threat, it is also producing changes in brain function of people that is accounting for their inability to critically apply higher cognitive skills (i.e., interpretation, analysis, synthesis, and evaluation) that are needed to successfully understand mathematics. With a group of scholars postulating that "learning mathematics has become a necessity for an individual's full development in today's complex society" [61], this means that intentional homicide is destroying the future development of the society.

There is a psychology of homicide that must be brought into the discourse of education. Studies found that a significant statistical correlation existed between homicide and visitation to psychiatric hospitals [13,62-64], which means that intentional murders affect the psychological well-being of people. Witnessing intentional homicide is an event that is accounting for fear among Jamaicans. The anxiety that is associated with violence, particularly intentional homicide, is similar to that of a trauma and produces the same psychobiological reaction as fear. The reality is, students who are living in fear because of violence may be psychologically paralyzed and they may become hopeless, depressed and unable to apply the high level cognitive skills that are needed to problem-solve mathematical questions in CSEC Mathematics. The cost of intentional homicide is not noticed by those therein and so students from violent prove areas who write the mathematics examination are not cognizant that they are affected until the failing grade issued by the examination body. Professor McLymont [65] indicated that:

The Jamaican education system is still failing to prepare and qualify many of the nation's youth for higher educational pursuits or for the workforce. It is speculated that this is because of the predominant use of the traditional direct teaching methodology in the classrooms [66].

From McLymont's [65,66] perspective, the challenge of the underperformance of students is with the teaching methodology that is employed in the classroom; but this study showed that almost 25% of the performance in mathematics can be accounted for by homicide rates. This study is not refuting the vantage point purporting by

Professor McLymont [65,66]; but it is adding a new dimension to the discourse, the psychology of homicide. As such, it is easy to support a cognitive approach to teaching mathematics because it empowers the teacher as well as the students [67]. In fact, according to McLymont [65], “Cognitive coaching as a vehicle for teacher empowerment and professional enhancement will provide more opportunities for teachers to be more reflective, while being assisted by one who is considered a coaching partner or a critical friend” (p. 21), but still will not be able to correct the emotional reactions from the challenge of intentional homicide.

Based on Costa and Garmston [68], cognitive coaching is a non-judgmental, developmental, reflective model that is blended with psychological orientations of cognitive theorists and the interpersonal bonding of humanists and offers a basis for understanding how student learning can be achieved by way of using cognitive development by Piaget and Vygotsky. With this perspective as well as those of this study, the researchers are recommending that the psychology of homicide must be included in cognitive coaching in the teaching of mathematics. This is a part of the solution in addressing the underperformance of mathematics among Jamaican candidates, as cognitive coaching needs to include the value of intentional homicide in the psychology of teaching of mathematics. Gitaari et al. [69] have identified factors accounting for poor academic performance in mathematics, which include attitude, practice, class attendance, teaching strategies, instructional materials, qualification and experience of teacher, family background, and school environment, and this study is adding psychology of intentional homicide.

In fact, McLeod [70] in his article entitled “Research on Affect in Mathematics Education: A Reconceptualization” advocated three kinds of affect which will have an impact on the learning of mathematics; namely beliefs, attitudes, and emotions, which expand the challenges of the teaching-learning process in mathematics. This research concurs with McLeod’s [70] work that sees intentional homicide as an event that arouses emotion, and this arousal is stimulus encoded in the nervous system, and therefore retards the development of critical cognitive skills that are needed to learn mathematics. Domjan [71] postulated that memory failure may occur owing to interference, which would have resulted from the exposure to stimuli or events. This goes to the core of the challenges of students in learning mathematics as their exposure to violence may be interfere with proactive memory, which can explain the performance deficiencies. Scientists opined some explanations for the performance deficiency in a subject area. Hence, the “negative attitudes towards mathematics can be considered a serious problem in mathematics education”, as the matter goes to the cognitive domain and not merely the social aspect including mortality.

By way of meta-analysis, Ma [72] found that anxiety in mathematics has a negative influence on achievement and this speaks to the psychology of an event or stimulus account for changes in learning outcomes. The psychology of intentional homicide is creating additional arousal and anxiety for mathematics making it increasingly difficult for students to learn the complex and abstract algorithms in mathematics. Hence, the performance deficiency in mathematics is a deep matter relating to the attitude of the students towards the subject that is cultured by other people who do not know about the challenge of the subject. This accounts for both some teachers and students avoiding mathematics, as found by Lester [27], because of the belief that it is a difficult subject. On the other hand, Schoenfeld [73] opined that the development of understanding mathematical concepts are associated with students’ belief in the subject [72,74-76], which we are proposing is complicated by the psychology of attitude and the influence of the event of intentional homicide on the nervous system. The event of homicide makes it increasingly difficult to understand how arousal and emotions following exposure to crime affect students’ attitude to the subject by way of the psychobiology and the inclusion of social biases. In addition, Ma and Kishor’s work [74]; using meta-analysis, found a direct relationship between attitude toward mathematics and achievement, which denotes that one’s mental state influences behaviour including avoidance to learn the subject.

Another aspect of this work that must be equally argued like the psychological characteristics is the social marginalization of selected people in the society. The extent of the homicide problem in Jamaica is now referred to as a pandemic by a group of Jamaican scholars [77], which speaks to a social-coverage of a matter with multidimensional components. If homicide is classified as a public health concern in Jamaica by Bourne et al. [77], then this is a problem that extends beyond the field of criminology and/or education. The homicide pandemic is a psychobiological matter that has a particular social context, and as such must be addressed in this multidimensional manner. According to Harriott [16], ‘The communities of the marginalized urban inner city poor are most affected by this murderous violence’ (p. 242), which means that the cost of homicide in Jamaica is more a matter of poor urban people. From this perspective, it can be extrapolated that urban poor children in Jamaica are underperforming their more middle-to-affluent students in mathematics simply because of the disparity in exposure to violence, especially murders. Such a social fact means that the society is losing many children to continued social marginalization including psychoeconomic deprivation. There is much to the discourse of economic deprivation that is being experienced by poor people, particularly urban young males and so are violence and more so murder. With Harriott [16] postulating that intentional homicide is a young urban poor male phenomenon in the

Jamaica, it follows that the fear of crime and criminal victimization is a cultured reality for many people who reside in urban slums. Another psychological reality that is the lived experience for those in urban slum is what Harriott [15-17] explains: "They therefore regard themselves as having little hope of integration into the shrinking formal economy and increasingly competitive labour market" (p. 249), which speaks to not only economic marginalization of those residing in the community; but it also means psychological deprivation that influences attitude including the reluctance to apply themselves in problem solving of complex mathematical concepts. The extent of the psychological neglect of those in urban slums is embedded in what is said here: "The neglect of the police who may be frustrated by the interminable inner-city violence tends to foster self-help among the citizens of these areas" (p. 249). Undoubtedly if those are the realities of people in urban slums, then, their lived experience is one of perpetual psychological trauma so that their preoccupation with survival ability, peace and comfort that solving mathematical principles and understanding mathematical procedures is low on the list of these people. In fact, with the gravity of the violence undercurrent to which urban poor people are continuously exposed, it makes it increasingly difficult for them to learn mathematical concepts/principles that require concentration and a high degree of cognitive skills. Those violent communities that are homes for people in urban slums are difficult to escape from. These are psychological maze for urban slum residents and a milieu that is difficult to change for people who are desirous of providing their children with home environments that are conducive to studying difficult subjects like mathematics and the sciences.

Campbell and Wu [78] said that the home environment and family processes provide a network of physical, social and intellectual forces and factors which affect the students' learning. According to them, the family's level of encouragement, expectations, and educational activities in the home are related to socioeconomic status, which means that families from different socio-economic groups create different learning environments that affect the child's academic achievement. The matter of the underperformance of those in poor urban violence prone communities is enlarged by outside environment in the homes are that cannot be controlled by the marginalized families. The crime pandemic is pervasive in Jamaica and poor urban slum resident cannot change their homes in which they live and must raise children. The matter is serious beyond urban slum as Harriott [17] found that 2 in every 5 Jamaicans fear the risk of criminality, and this must be worse among the residents of the violent communities. Children who reside in violent urban slum communities are exposed to and experience continued barriers to complete assignment and master complex mathematics principles compared to those who reside in middle-to-affluent neighbourhoods. Because

children of urban slum cannot stop the violence, create a different community of live in or use a magic wand to create a conducive milieu of studying, the event of intentional homicide is accounting for the cognitive deprivation that is expressed in the low performance in mathematics at the CSEC level.

CONCLUSION

The importance of this study is critical to understanding the challenges of Jamaican students' inability to successful write mathematics at the secondary level. The reality is, the crime pandemic that is on-going in the society is destroying students' cognitive domain and this accounts for their underperformance in the area of mathematics. The seriousness of the mathematics underperformance in Jamaica is more than as outlined by the success rate of the students as in 2013, 43.3% of those who wrote the CSEC Mathematics examination were success; but the Ministry of Education stated that "With less than 20% of a given secondary cohort leaving the formal education system with mathematics qualifications, there is a small percentage of the population able to access the opportunities which are and will become available in the coming years" [53,79]. Such a claim means that the psychology of homicide is having an even more detrimental negative influence on students' cognition than that found by this study. As such, the need to begin a health, psychological, educational and social campaign in Jamaica is critical to the arresting of the psychobiological influence of homicide of cognitive domain of students. Therefore, we are proposing that the social environment in Jamaica is destroying the cognitive domain of its people and as such a more scientific investigation on the role of homicide on performance is needed in an effort to address the continued underperformance of students.

Learning is a cognitive activity, which, if influenced by negative events like intentional homicide becomes an arousal and this feeds into emotion that will affect the psychobiological state of student. The negative correlation between intentional homicide and mathematics success at the secondary level is an indication that the event, intentional homicide, is destroying the abstract development of children and this is evident in failure rate in mathematics. The fact is, mathematics that is an abstract science requires the cognitive development of infants into abstractions and if this is not developed, then students will experience difficulty in later life when they are required to utilize abstractions. We are proposing that negative association between intentional homicide and mathematics success rate at the secondary level is a clear indication that exposure to intentional homicide is retarding the development of abstractions in people and this accounts for their challenge in performing at a high level in mathematics. The current findings allow a deduction that the event homicide is destroying the formal operation stage of children's development and these accounts for their challenge in

mastering mathematics, which demands a high degree of abstraction.

In summary, intentional homicide is a psychobiological matter that has a social component, which is overly emphasized by way of the study of criminology or wider sociology and not much attention is placed on the cognitive-educational component. The cost of intentional homicide is profound on cognitive development of infants/children and this must be brought into educational psychology, learning theorizing, and social biology, particularly in the study of learning mathematics. The underperformance of students in mathematics is a combination of factors, and psychobiology is one of them that have been lagging in the educational discourse. The learning of mathematics includes certain processes that will make for understanding and how to grasp the skills and competencies in problem solving mathematical concepts as well as real life matters [80] and these are altered with the event of intentional homicide. As a result of the current findings, there is a proposal for the inclusion of learning styles, cognitive domain, parental involvement, reading levels, family background, teachers' qualification, teachers' experience, and internal motivation in future studies in the area of academic performance along with crime and violence in a society.

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