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MODELING THE VULNERABILITY OF INTELLIGENCE QUOTIENT AS APPLIED TO EDUCATIONAL STRATEGIC MANAGEMENT

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Abstract
Intelligence quotient formulation is both mathematically and psychologically tractable. In this study, a mathematical model has been used to assess the vulnerability of intelligence quotient with application to educational strategic management. One research question guided the study and its findings are discussed in relation to educational strategic management. The analysis of the results obtained has revealed that as the modified mental age ranges from 3 years to 5 years, the IQ ranges from the estimated value of 15 to 25, when the modified mental age ranges from 6 years to 11 years, the IQ also ranges from the estimated value of 30 to 55, and as the modified mental age ranges from 12 years to 16 years, the IQ falls within the estimated value of 65 to 80. It is therefore our recommendation that the Federal Ministry of Education stipulated school age for various educational levels in Nigeria be enforced as follows: pre-nursery (3 months-2 years), nursery (3-5) years, primary (6 – 11) years, while 12 years upwards for post-primary.

Keywords: Modeling, vulnerability, intelligence quotient, educational, strategic management.

Introduction

Intelligence as defined by Spearman (1904) is an ability to use the knowledge that has been obtained in a productive way. Intelligence quotient is the measurement of someone's intelligence relative to his or her peers and is expressed as a number obtained by dividing the mental age by the actual or chronological age then multiplied by one hundred. The abbreviation "IQ" came from the German term Intelligence Quotient which was originally coined by psychologist Stern William in 1912 and used as a scoring method for his students at the University of Wroclaw, then scores from the test were used to estimate intelligence. Some research carried out on IQ scores showed that it is associated with factors like academic achievement, body mass index(BMI), height and weight, gender, location, parental social status, biological parental IQ and the mechanisms of inheritance (Kpolovie, 2017; Tabriz, 2015; Oommen, 2014; Tapas et al., 2016). The relevance of IQ scores is also recorded in their use for the assessment of intellectual disability, evaluating job applicants and educational placement among others. IQ is a pivotal factor in strategic management which is the management of an organization's resources to achieve its goals and objectives. Strategic management involves setting objectives, analyzing the competitive environment, analyzing the internal organization, evaluating strategies and ensuring that management rolls out the strategies across the organization (Kenton, 2022; Hardgrove & Lenowitz, 2019). Two approaches involved in strategic management are the prescriptive approach which suggests how strategies are developed and the descriptive approach which suggests how these strategies are put into practice. The strategic management approach can be used in educational systems but a proper understanding of the precariousness of the system has to be evaluated. To handle the system effectively without flaws, specific, measurable, achievable, relevant and timebound "SMART" vulnerability management should be adopted.

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Vulnerability is defined as a flaw in a system that can expose it to attack and the educational systems are not exempted from it thus a model to identify threats to the intelligence quotient in education is necessary and it is called the vulnerability assessment process. It involves the use of appropriate testing tools that offer the system a better understanding of its assets and provide direction on how to assess the risks associated with those weaknesses. In this study, a scientific model had been proposed to evaluate the vulnerability of IQ. Modeling is an essential and inseparable part of many scientific disciplines. It is defined as a mathematical or computational algorithm or a systematic description of objects and phenomena of real life to make them easier to be understood (Frigg & Hartmann, 2009). It requires selecting and identifying relevant aspects of a situation in the real world and conceptualizing it in a model that will facilitate its understating. Thalheim (2010) defined a model as a well-formed, adequate and dependable instrument that represents origins, with its criteria of well-formedness, adequacy and dependability usually accepted by its community of practice within some context and must correspond to the functions that a model fulfils in utilisation scenarios. A scientific model seeks to represent empirical objects, phenomena and physical processes logically and objectively used to amplify human thought processes (Griffiths, 2010). Intelligence quotient is useful in many areas as listed earlier but not much research works on other perspectives of studying the intelligence quotient with its educational strategic management dimensions have been recorded. It is against this background that we have proposed in this study to explore modeling the vulnerability of IQ as it applies to educational strategic management.

The application of intelligence to educational psychology concerning learning patterns is called Intelligence Quotient (IQ). Resign and Drenth (2007) defined IQ as the whole of cognitive or intellectual abilities required to obtain knowledge and to use that knowledge in a good way to solve problems that have a well-described goal and structure. To achieve this, several research works were reviewed. A study on increased schooling and its effect on IQ was examined by Brinch and Galloway (2012). They reviewed the various educational reforms in Norway that increased the number of years of compulsory schooling from 7 years to 9 years in the 1960s. The reform created a new unified type of middle school for grades 7-9 and standardized the minimum academic curriculum at the middle school level. It primarily affected education for adolescents aged 14 years to 16 years hence the youths were provided with additional two years of standardized education. The study reported that the years of schooling had a substantial effect on IQ scores measured at the age of 19 years which means that education occurring even as late as the middle teenage years can indeed have a statistically significant and size-able effect on IQ scores.

Also, Deary and Johnson (2010) in their analytical perception of intelligence and education observed that educational attainment may represent a proxy for IQ that is, people with higher IQs stay longer within education, gaining more and higher qualifications. It also reported that higher IQ test scores may lead to educational success and entry into well-remunerated and high-status employment with a concomitantly high salary. Oommen (2014) in a study on factors influencing IQ concluded that individual IQ is multifactorial and is determined by a multitude of factors which include both nature and nurture. These two work together in determining human intelligence. Even though genetic susceptibility plays a crucial role in the IQ of the individual, various modifiable environmental factors like education, premature birth, nutrition, pollution, drug and alcohol abuse, mental illnesses, and diseases can influence an individual's IQ. These modifiable factors can reinforce or weaken genetic susceptibility.

Kasperson et al. (2003) proposed a vulnerability analysis framework that illustrates the complexity and interactions involved in vulnerability analysis in which attention was drawn to the array of factors and linkages that potentially affect the vulnerability of some human-environment systems. These frameworks make use of nested flowcharts to show how social and environmental forces interact to create situations vulnerable to sudden changes, while Ford and Smith (2007) proposed an analytical framework based on research with Canadian arctic communities. The framework utilized historic information including how communities have experienced and addressed climatic hazards, with information on what conditions are likely to change, and what constraints and opportunities there are for future adaptation. Ford et al. (2007) suggested two stages in assessing vulnerability, first, by documenting exposures and current adaptive strategies. Second, an estimate of directional changes in those current risk factors that characterize the community's future adaptive capacity. Other related works in the area of modelling for strategic management of educational system and policy making can be found in the research contributions made by Oberkampf et al. (2002), Ihrig (2012), Tolk (2015), Jeffrey (2017) and Owen (2018).

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In this study, we are interested in solving $the\ IQ$ problem involving two explanatory variables which are mental age (m) and actual age (c). Our present IQ formula can be considered a foundational formula on which other IQ models can be built. From the pieces of literature read and cited in the present study (Spearman, 1904; Resing & Drenth, 2007; Deary & Johnson, 2010; Brinch & Galloway, 2012), it was found that the vulnerability of the IQ due to the explanation of the explanatory variables is not a popular area of research and it is against this background that we tackled this problem using an analytical method with the expectation of forming a realistic educational policy.

Problem Specification

The vulnerability of the intelligence quotient due to the changes in the values of the model parameters that define the dynamics of this psychological system is rarely studied. The variables considered in the present study are the mental age(m) and the chronological age(c) since they are the core determinants of Intelligence Quotient (IQ) whereas IQ is calculated as a ratio of mental age(m) and chronological age(c) multiplied by 100. Hence, it has become necessary to evaluate the effect of decreasing the mental age on intelligence quotient and its implications on the formulation of educational policies for sustainable development.

Research Question

The core research question to be addressed in this present study is:

1. How can the vulnerability of the intelligence quotient be measured analytically with respect to a decreasing mental age?

Mathematical Formulation

The Intelligence Quotient (IQ) as defined and popularly known depends on two important variables which are the mental age and the actual age or chronological age.

Mathematically, Intelligence Quotient (IQ) is defined as follows:

$$\mathrm{IQ}(m,c) = 100 \times \left(\frac{m}{c}\right) \quad (1)$$

Where,

m is the mental age

c is the actual or chronological age.

For this work, we have used the following parameter values m = 20 and c =21

Method of Analysis

For this analysis, an analytical method was used to calculate the vulnerability of IQ using an average undergraduate actual age (m) of 21 years and a chronological/mental age (c) of 20 years as defined by Resign and Drenth (2007).

By substituting m = 21 and c = 20 into equation (1), the intelligence quotient can be computed thus:

$$\mathrm{IQ}(21,20) = 100 \times \left(\frac{21}{20}\right) = 100 \times 1.05 = 105$$

Similarly, we can calculate the effect of decreasing the mental age as a percentage of the proportion depleted using the following formula:

$$\text{Proportion depleted (\%)} = \left[1 - \frac{IQi}{105}\right] \times 100 \quad (2)$$

Where IQ_i is the new IQ due to the decrease in the value of the mental age (m).

i) Using m = 21, c = 20 and our calculated IQ of 105,

$$\text{Proportion depleted (\%)} = \left[1 - \frac{105}{105}\right] \times 100 = [1-1] \times 100 = 0 \times 100 = \mathbf{0\%}$$

When the age value of c is fixed and the value of m is varied from 3 to 16, we have consistently applied the formulae defined in (1) and (2) above to obtain the following results

ii) Using m = 3, c = 20 and calculated IQ of 105, we obtain the following

$$\mathrm{IQ}(3,20) = 100 \times \left(\frac{3}{20}\right) = 100 \times 0.15 = 15$$

$$\text{Proportion depleted (\%)} = \left[1 - \frac{15}{105}\right] \times 100 = [1 - 0.14286] \times 100 = 0.8571 \times 100 = \mathbf{85.7\%}$$

iii) Using m = 4, c = 20 and calculated IQ of 105

$$\mathrm{IQ}(4,20) = 100 \times \left(\frac{4}{20}\right) = 100 \times 0.2 = 20$$

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Proportion depleted (%) = $\left[1-\frac{20}{105}\right] \times 100 = [1-0.1905] \times 100 = 0.8095 \times 100 =$ **81%**

iv) Using m = 5, c = 20 and calculated IQ of 105

IQ(5,*20*) = $100 \times \left(\frac{5}{20}\right) = 100 \times 0.25 = 25$

Proportion depleted (%) = $\left[1-\frac{25}{105}\right] \times 100 = [1-0.2381] \times 100 = 0.7619 \times 100 =$ **76.2%**

v) Using m = 6, c = 20 and calculated IQ of 105

IQ(6,*20*) = $100 \times \left(\frac{6}{20}\right) = 100 \times 0.3 = 30$

Proportion depleted (%) = $\left[1-\frac{30}{105}\right] \times 100 = [1-0.2857] \times 100 = 0.7143 \times 100 =$ **71.4%**

vi) Using m = 7, c = 20 and calculated IQ of 105

IQ(*7,20*) = $100 \times \left(\frac{7}{20}\right) = 100 \times 0.25 = 35$

Proportion depleted (%) = $\left[1-\frac{35}{105}\right] \times 100 = [1-0.3333] \times 100 = 0.6667 \times 100 =$ **66.7%**

Using m = 8, c = 20 and calculated IQ of 105

IQ(*8,20*) = $100 \times \left(\frac{8}{20}\right) = 100 \times 0.4 = 40$

Proportion depleted (%) = $\left[1-\frac{40}{105}\right] \times 100 = [1-0.3810] \times 100 = 0.6190 \times 100 =$ **61.9%**

If we continue to evaluate the IQ and its proportion depleted for *m* = 9, m =10,m = 11, m = 12, m = 13, m =14, m =15 and m =16 while *c* is fixed at 20 years using the same formulae defined in(1) and (2),we obtain the following results which are presented in the next section.

Results

Table 1: Evaluating the vulnerability of decreasing the mental age on the IQ: m=21 and c= 20

	M	c	$IQ(21,20)$	$IQ_i = \frac{100m}{c}$	Effect (%)
1	21	20	105	105	0
2	3	20	105	15	85.7
3	4	20	105	20	81
4	5	20	105	25	76.2
5	6	20	105	30	71.4
6	7	20	105	35	66.7
7	8	20	105	40	61.9
8	9	20	105	45	57.1
9	10	20	105	50	52.4
10	11	20	105	55	47.6
11	12	20	105	60	42.9
12	13	20	105	65	38.1
13	14	20	105	70	33.3
14	15	20	105	75	28.6
15	16	20	105	80	23.8

Average of the effect (%) = 51.11

Discussion of Findings

From our analysis of the result in Table 1, the following key observations can be made. The first observation points to the fact that as the modified mental age ranges from 3 years to 5 years, the IQ also ranges from the estimated value of 15 to 25, the second indicates that when the modified mental age ranges from 6 years to 11 years, the IQ also ranges from the estimated value of 30 to 55, and the third indicates the fact that as the modified mental age

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ranges from 12 years to 16 years, the IQ also ranges from the estimated value of 65 to 80. It is also worth noting that by using the calculation of a statistical average value of 51.1% IQ vulnerability, we found that the following values of the model parameter *m* such as 3, 4, 5, 6, 7, 8 and 9 tend to predict a higher volume of the vulnerability of the IQ, whereas the following model parameter values of *m* such as 10, 11, 12, 13, 14 and 15 indicate a relatively lesser vulnerability volume which can be attributed to the choice of our model parameter values of *m* and *c*. the evidence of depletion from the Table 1 results shows that the varied values of IQ_i are each less than the constant IQ (20,21) value of 105. From the analysis of the results presented in Table 1, both pre-primary and primary age groups (3 years - 9 years) support a popular ideology that a decreasing variation of mental age can lead to a relatively steady decrease in IQ level which will ultimately support a dominant depletion pattern that accounts for the vulnerability of IQ due to the variation of the mental age when the actual age is fixed (Brinch & Galloway).

Conclusion

The key conclusion of this pioneering research is the fact that IQ tends to be more vulnerable to a decreasing variation of the mental age for a fixed estimated value of the actual age of the learner. This research concluded that mental age can lead to a relatively steady increase in the IQ if enhanced, although it is difficult in African learning system for parents to support educational experts to monitor the intelligence of their children due to some factors. These factors could be economic (school fees), society (friends and peer groups), early marriages, farming or fishing and many more. Due to the aforementioned factors, it has become difficult for parents to support educational experts to monitor the intelligence of their children in the educational system of learning.

Recommendations

The researchers would also advise that the Federal Ministry of Education stipulated school age for various educational levels be enforced. That is, pre-nursery (3 months – 2 years), nursery (3 – 5) years, primary (6 – 11) years and 12 years upwards for post-primary.

Suggestion for further studies

The researchers hereby suggest a further study on an appropriate approximate partial differential equation model that will test for its sensitivity which is an ideal and important aspect of controlling a severe loss of IQ.

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