

TOWARDS QUALITY DELIVERY OF SCIENCE AND MATHEMATICS EDUCATION IN SCHOOLS AND COLLEGES IN GHANA

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1.0 INTRODUCTION

It would sound preposterous for me to engage in this great discourse since I do not live in Ghana, as I have been living in Zambia for many years now, even though I am originally from Ghana. However, I take consolation in the fact that I have been a professional teacher and lecturer for the past 44 years, with 10 years' teaching stint in Ghana, 11 years in Nigeria, and 23 years in Zambia. As a citizen of the global village, I think I am qualified to partake in this great debate of finding ways and means of delivering quality instruction in mathematics and science to our pupils, students and tutees in the primary and secondary schools along the length and breadth of Ghana. This quest, no doubt, will not only benefit Ghana in particular, but also it will benefit the whole world in general, as now we live in an era and arena of a global village, with unavoidable interdependencies.

In this paper, an eclectic and holistic approach will be adopted to address the multi-faceted nature of the topic which has many ramifications and undercurrents.

Having spent 7 years teaching students at the International School of Lusaka (ISL), I have been widely exposed to international schools' curricula, such as the Cambridge IGCSE and the International Baccalaureate (IB), on both of which programmes I was privileged to teach Business Studies, Business and Management, Economics, Social Studies, and the Theory of Knowledge. I also had the wonderful opportunity of mentoring and supervising IB students for their Extended Essays (EEs) in varied disciplines such as Geography, History, Economics, Business and Management, Islamic Studies, World Literature Essay, and Physics.

At ISL, we had tutors and tutees from more than 69 countries worldwide. We used to have workshops for teachers every Wednesday to brainstorm and engage in academic discourse on facets of pedagogy and best practice. It was at such fora that I came across great concepts such as the units of enquiry, backward design, enduring understandings, multiple intelligences of Howard Gardner, six hats of lateral thinking of Edward de Bono, critical thinking, among many other concepts.

I think nature has greater things to teach us out there in the wild (going on excursions and undertaking educational tours) than we can ever know of, sitting under the canopy of the cosy closets of classrooms which to some kids and teenagers are no different from prisons. This is why lots of Physical Education (P.E), extra-curriculum activities, Community Service, and Field Trips are good for our young ones whose bloods are hot and cuddling, yearning for action/activity-centred learning opportunities..

The great African-American naturalist, George Washington Carver, alluded to the fact of learning from nature in his writings. What prevents an historical excursion to the pyramids in Egypt, which excursion incorporates scientific and mathematical lessons in carbon dating, geometric lessons in Pythagorean triple, trigonometric fundamentals of angles of elevation and depression, Euclidean prime numbers, the papyrus reed and the science and history of paper making, lessons in myths and legends of the Nile in literature, multi-disciplinary aspects of tourism and its impact on the ecology, economy, human-animal interface, internecine conflict and its damaging effects on tourism, threats posed to historical artefacts by plunderers, and the menace of population explosion, need for eco-tourism, threats to tourists by terrorists, statistical records of terrorist incidents and tourist arrivals, among others. Such an eclectic and inter-disciplinary approach will greatly interest all students, and will leave no child behind.

Thus, learning should be integrative, eclectic, pragmatic, and real; challenging, interesting, and it should be in an overarching and cross-disciplinary manner. This will tax teachers to be versatile and multi-disciplinary at the early stages of education, up to the middle years of junior secondary school.

2.0 MORAL, RELIGIOUS BASE, AND ENVIRONMENTAL FACTORS FOR QUALITY EDUCATION

It is interesting to note that some of the great thinkers of our world came from strong religious and moral backgrounds, as well as from the world of philosophy. Here, I have in mind the French mathematician, Rene Descartes, the English theologian and mathematician, Thomas Robert Malthus, Sir Isaac Newton, William Shakespeare, Adam Smith, among others. An examination of the life history of Albert Einstein informs us that though of German-Jew ancestry, he lived and worked in Switzerland, where he schooled up to the diploma level, and never went to university.

He received sound and solid basic education which propelled him to think hard outside the box, and through self-discovery and hard thinking, he made a breakthrough with his quantum leap theory of relativity, which revolutionised all known axioms and assumptions extant in science. His stint at the Weights and Measures section of the Swiss Postal Services made him gain deep insight into issues of precision as well as relatedness of concepts. Up to today, I myself find it hard to define the concept of time, though Einstein gave us some idea. What is time? Is time finite, discrete, and continuous, in a continuum or an independent variable of nature?

Switzerland is a laidback country which is noted for its infatuation with conservatism, strict adherence to time management, and a rigour for precision. All these qualities are needed in the disciplines of science and mathematics. Had Einstein lived all his life in Germany or in Switzerland, he would perhaps not have made much impact on the world. He emigrated to the USA where he taught at Princeton University, and he gifted the world with his famous theory of relativity.

The Switzerland example, and Einstein's association with her, teaches us that time, place, circumstance and discipline are ingredients needed to succeed in the sciences and mathematics. Religion, moral mores, and knowledge of philosophy prepare people

to view life through refined lenses. Some people may argue that religions create divides, dogmas, stereotypes and parochialisms. This may be true to some extent. A broader view of religion and an open mind provide the discipline needed for one to think deeply outside the box, leading to the spirit of enquiry, discovery and exploration. Without religious faith, there is no self-identity and no basis for existence. Descartes once said, 'I think, therefore I am.' Without knowing oneself, one cannot relate well to other people and the world at large.

Therefore, schools in Ghana should return to basics, and allow missionaries to run schools, where discipline and moral values are inculcated as prerequisites for attaining excellence in science and mathematics. Discipline in time management and foundation for a morally upright life will help us come up with the truth and eschew corruption, parochialism, materialism, ethnocentricity, megalomania, narcissist tendencies, and a lot of neuroses. After all, all the great universities of this world such as Oxford (c.1096), Cambridge (c.1209), Bologna (11th Century), Harvard (1636), Paris (1150), Yale (1701), the University of London (Jeremy Bentham c. 1836), Princeton University (1746), among many others worldwide, sprouted out of religious orders as they were all started by priests and philanthropists, who presumably had higher ideals and visionary ideas.

A Nigerian, Dr Philip Emeagwali, is world famous for his fastest mathematical calculation in history because after his basic education in Nigeria, he went to the USA to pursue his master's and doctorate degrees. Professor Francis Ampanyin Kofi. Allotey, a Ghanaian physicist and mathematician, went to the UK in the 1950s for his A Levels, and subsequently for his master's degree from the University of London. He obtained his doctorate degree from Princeton University where Einstein once taught. If Allotey had not had a solid basic education in mathematics and the sciences in Ghana at Ghana National College in Cape Coast (the student pioneers in the 50s), he would not have made those stupendous gains when he went to study abroad.

The point being made here is that the examples of Einstein, Emeagwali and Allotey provide us an insight that a solid basic foundation in the sciences and mathematics is all it takes to take off and explore on one's own. Besides, adversity, the fear of God, and morally correct behaviour are ingredients for success in the sciences and mathematics. Great scholars of the past emerged from obscurity, humble beginnings, and situations of great deprivation. The story of Abraham Lincoln, the great American president, lawyer, statesman, and unifier, is a shining example of this fact.

The examples of the two Africans given above also point out that determination is important for success when later one finds oneself in salubrious environments in the advanced countries where excellent learning facilities abound. Without sounding racist or culturally-biased, we can say that the Chinese, Indians, Pakistanis, Sri Lankans, Moslems, and Arabs are excelling in schools and colleges in the First World because of their cultural beliefs, ways of life, and closed and strict family values.

That fact notwithstanding, empirical evidence evinces the fact that all human beings are equally endowed with creative genius at birth, the sense of wonder and imagination, and that circumstances of birth or heredity, the physical built and natural environments, circumstances of adversity and affluence, all juxtaposed, can be seen to impact and

impinge on the blossoming or dimming of those naturally-endowed gifts. Professor A.N. Whitehead of the UK once said that 'education is the purgation of the crudities of the mind'. As it were, he averred that education is a process of refinement and self-cleansing. John Locke gave us the concept of 'tabula rosa' or a blank white sheet of the mind at birth, on which the process of education makes an imprint, for good or for evil.

What is education? The Shorter Oxford Dictionary defines education as the process of leading learners and tutees to discover, or bringing out something from obscurity. The word education is said to be derived from its Latin root of 'educare'. Education here means formal education dispensed in a structured manner, in a school system which has a curriculum and assessment criteria to follow. Education aims to develop the mind, body, and soul of the individual in a holistic manner. In the UK and most Western countries, there is unfortunately now an imbalance in this trilogity or trinity, as undue emphasis is placed on developing only the mind and body, neglecting the spiritual component (cf. Sakyi, 2000). The same logic applies to the Ghanaian scenario.

It is a sad and tragic tragedy of monstrous proportions in the human development paradigm that religious education in schools worldwide is being relegated and sacrificed on the altar of human rights and expediency. Such a sorry state needs urgent mitigation and intervention. Indeed, it is the very reason why other nationalities are excelling in schools and colleges in the sciences and mathematics in other parts of the world. Take Hong Kong or Singapore for example. Lack of discipline is consuming us Ghanaians in every facet and faculty of life. See our excellent footballers who fail at the World Cup in Brazil, not for want of trying or lack of ability and skills, but because some of them and their managers and handlers are not disciplined. Why cannot we go for the best handlers in the world, irrespective of their nationalities? It boils down to greed, lack of exposure, among other variables. The onus now lies on our educational policy makers and administrators to rethink and reform our educational system so that the spiritual and moral aspects of education are shored up and given proper attention. Otherwise, we shall produce malformed beings, lacking souls with integrity, patriotism, altruism, hard work and ambition. (cf. supra/infra Sakyi, 2000)

There is also the need to shift away from rote-learning and the current exam-centred educational system in Ghana, which produces robotic products who cannot solve problems or apply their knowledge to creative endeavours. If the focus is shifted away from rote-learning for exams, then we will have reflective students who will reflect deeply on the meaning of life, and begin to realise their reason for existence, our common humanity, and our commonality as humans with three main quests to satisfy, namely, the mind's crave for sound knowledge or the truth, the body's crave for healthy nourishment, and the soul's craving for atonement and unity with nature, humanity and our creator. This approach can lead to a sound basis for take-off into the realms of excellence. That should form a watershed for breaking new grounds in the teaching of mathematics and science in Ghanaian schools and colleges.

Religious and moral dogma are what many fear, judging from the Jihads, Crusades, Inquisitions, Witch-hunting, among many past horrible horrors. But those are past and gone, and we have moved on, and have to move on. Religious education could be incorporated into social science, or in strictly religious-based faith schools, Religious and

Moral Education (RME) should be taught as one of the core subject areas. This should require some legislative reforms to reflect the composition of our national populations. Religious and Moral Education should be seen as a pillar, and vehicle for greater achievement in mathematics and the sciences.

Teacher selection, training, supervision and career development should also be done in a high quality manner. To have more science and mathematics teachers, special incentives should be created for them. The training of teachers should impart to them the skills of character training, and managerial skills of instilling strict discipline in schools. Now is the time to professionalise the teaching fraternity, by licensing them and applying strict rules and procedures of teacher oversight and gate-keeping. We need a long term strategic plan in all facets of life in Ghana to deliver quality education to guarantee our future competitiveness as a nation. (cf. see *Competitive Advantage of Nations* by Michael Porter)

3.0 STEM AND 3Rs Education

In our school days in the 50s and 60s, the emphasis was on 3Rs of proficiency in Reading, Arithmetic and Writing. We had mental drills with caning in schools. Students memorised the multiplication tables, periodic tables, formulae, poetry, among others. These are the basic ingredients of education which are even relevant today. Some aspects of these are still relevant as they were then. However, an integrative approach can be used to teach these 3Rs by incorporating into them science and mathematical concepts. The acronym STEM stands for Science, Technology, Engineering, and Mathematics. (www.scotland.gov.uk/science)

We will need a paradigm shift to incorporate the STEM logic in our schools. Our teachers and school administrators have become engrossed in eking a living for themselves from the harsh economic times, so much so that they pay scant attention to educational reform and pedagogical issues. Science, Technology, Engineering and Mathematics are the propellers of the engine of GDP growth. Therefore, we need to invest heavily in these areas, through investment in human capital and infrastructure. We need deliberate policies to incentivise our teachers and accelerate the growth of these educational vectors. In the 60s and 70s, UNESCO liberally funded science education in Ghana, and I remember using a UNESCO-published science book authored by Sam Adu Ampomah, the late one time Headmaster of GSTS in Takoradi. That was also the time we had the Entebbe Mathematics Project (EMP) of the New Mathematics, which was introduced in schools and colleges in Ghana, with heavy input by Professor Abbiw Jackson and Professor Kofi Nti.

STEM are the core subjects which every student needs in the 21st Century to survive. I will like to tweak it a bit by making it STEEMS, with the addition of English and Social

Studies or Social Science. We need to pay attention to the English Language aspect because it is the vehicle for our thought-processes and global communication. This applies more to the non-first language speakers. The Social Sciences are also equally crucial in this age of ICT fads, because we need to balance and manage the human-machine interface, to avoid creating hermits, recluses and unsocial beings. We need to refine our communication skills

However, we could add non-STEMS optional vocational subjects such as Metalwork, Bricklaying, Carpentry and Joinery, Fashion and Design, Physical Education, Art, Graphics, and Painting, among others. In this age of massive youth unemployment, our schools should help create budding entrepreneurs so that they can be useful to themselves after graduating, by becoming employers instead of employees. These vocational subjects require basic science and mathematics in their daily applications. We would want to replicate the success stories of the Richard Bransons, Bill Gates, Anita Broddicks, Nkulenus, Amoahs, Awuahs, Azumah Bandas, Swanikers, Agambilas, Mahamas, Donald Trumps, and Warren Buffets of this world in our Ghanaian schools.

This is where the teaching of mathematics and the sciences should emphasise hands-on practical training for immediate application to wealth-creation and commercial ventures. For example, in science classes, global challenges of pollution and global warming can be given as projects in the communities for students to research on, and devise solutions. In that way, they can discover market gaps and niches, even before they graduate. Learning will then not be perceived as a neat and linear process, but rather as a convoluted process of problem-solving, with the need for approaching issues from multi-dimensional perspectives.

The 3Rs should help every Tom, Dick and Harry to be able to draw up a business plan or proposal, and keep proper books of account. Our students will be able to communicate properly with stakeholders, and come up with critical thinking skills in assessing business cases, through research. Science and Mathematics will be deployed as practical tools for interpreting the world, and providing the means of sustenance. Our future farmers and artisans should have strong rudimentary foundations in mathematics, with emphasis placed on teaching basic concepts of fractions, logic, equations, sets, number systems, ratio, proportion and percentages, spatial relations in plane geometry, algebra, basic calculus and statistics, and rudimentary trigonometry. These are the basics for developing bigger ideas later on in life. At the least opportunity, teachers should point out in lessons, the practical applications of what their learners imbibe in science and mathematics.

4.0 IMPORTANCE OF THE HUMANITIES TO SCIENCE AND MATHEMATICS

We should understand that we cannot become great scientists or mathematicians if we neglect the humanities. It is from our legends, folklore and fairy tales, fables and local lore that we draw great inspiration, and also find some identity, and above all, provide some sanity to a humdrum life. These stories and lore awaken our imagination and our creative instincts, which in the end, help us to visualise abstract concepts in mathematics

and science. Homer's epic stories of the Illiad and Odyssey, Sophocles dramas, Shakespeare's plays and Charles Dickens and Jonathan Swift's fiction, kindle in us the spirit of adventure, passions to triumph, and emotions to feed our souls on. I would here point out that whilst putting the searchlight on mathematics and science, we should also not lose sight that the teaching of classics is on the wane worldwide, and it should also be a matter of great concern, because critical thinking skills can be acquired in studying the classics, our local Ghana Languages, despite the need for a lot of rote learning there.

The study of the classics and literature sharpens our intellect, provides us entertainment, and relaxes us to be able to tackle more strenuous work in mathematics and science. In the humanities, our children have their consciousness aroused to be able to revel in the abstract world of the perfect absolutes of Plato. Aristotle taught us how to discriminate and classify phenomena; using some agreed taxonomic criteria. John Locke gave us the idea of being precise in our definitions. Thus, through inter-disciplinary studies, we can help our students to be creative, and to see the relationships linking all knowledge as a holistic whole, instead of seeing knowledge as existing in discrete compartments or atomised as stand-alones. In college back in the mid-60s, some of our best scholars were science students, yet they were tops in French, History and Ghanaian Languages.

5.0 GLOBAL TRENDS IN EDUCATION

The teaching of science and mathematics in schools should have a fresh approach of thematic studies, units of enquiry, project work, peer learning, team teaching, community-based learning, internship, backward design, and enduring understandings, among others. We could modify the Socratic question-and-answer method, or use Montessori's play way methods in the teaching of mathematics and science.

We should encourage our students to participate more often in the Olympiads and Science Fairs. We should engage the corporate world so that they tell us the aspects of science and mathematics which they need in the world of work, so that teaching these subjects can be made more relevant to the demands of the labour market. Science and mathematics learnt in abstraction become meaningless, unless the learner perceives a direct link to the real world of work, life, and living.

Thus, school counsellors should hit the ground running to know the fortes of our students so as to fashion tailor-made educational menus for them, to equip them for their future careers. The era of massification of education in straight-jackets, and one-size-fits-all, is long gone. Rather, we should be thinking along the lines of mass-localisation and mass-customisation. I will recommend strongly that henceforth, first, each class should have two teachers to reduce the heavy workload of teachers in large-sized urban schools, second, to create jobs, and third, to enable students be assessed properly.

Learning abstruse formulae in mathematics and complex concepts in science puts off many a learner if they do not see their immediate applications in the real world of those arcane formulae. Perhaps, a few loony learners can excel in learning elegant and

convoluted formulae for the sake of self-fulfilment. The old school believe in the learning of theory for its own sake. This is the point of departure between them and the modern school of thought who think that what is learnt should have immediate practical application to human problems, and not for the purpose of passing exams.

We now live in an age of great distraction from ICT gadgets such as cell phones, computers, and social media networks such as Facebook, Twitter, LinkedIn, Whatsapp, Twoo, Picbum, MyZamana, Youtube, among others. These can be strategically canalised into whipping up the interest of our young learners who are infatuated by these fads. We can make our young ones cannibalise their fads by using them for devouring knowledge through knowledge sharing on these social media! Instead of being threats, we should turn them around to become strengths.

Countries such as USA, Germany, Sweden, Canada, Finland, Japan, Singapore, Hong Kong, and South Korea have long overhauled their school curricula, and have some of the best educational systems in the world today. They have taken best practice from around the world and localised content and delivery. China took the novel approach of sending out their students to the best schools and universities in the world. India indigenised their curricula and made their teachers write localised textbooks for their students. What do we see in Ghana? We have localised most of our school textbooks, but my own sampling of some of them shows that they are below par in terms of content quality. This is particularly so in subjects such as English, ICT, and Mathematics.

I was horrified when I went through my daughter's BECE ICT textbook and found the material belonging to the age of the dinosaurs! The content was anachronistic by say 20 or 30 years!

With heavy state subsidy of education, Indian students have always excelled in the sciences and mathematics because of easy access. They have fierce competition among themselves, and their parents and sponsors invest a lot of time and money in education. Furthermore, they are not bogged down by the mountain of so many strictures of human rights and rigmarole which stifle education in the UK, for example. There is therefore the need in Ghana to revisit the Education Act and some of the restrictive ordinances and statutes which inhibit the development of education. Ghana is not an island as she is globally connected in the global village, so we need to keep abreast with trends. The education authorities have to break out of their cocoons, or let down their hair a bit by bending backwards to embrace change.

When the former USSR saw that they were behind in the science race to space, they launched an aggressive science, technology and mathematics education drive in the 50s and 60s, during the Cold War. Their aim was to upstage the Americans by having a fast-paced industrialisation. However, they neglected the arts and humanities and that spelt doom for them because they ended up producing robotic people with little understanding and appreciation for the subtleties and finesse of the arts and humanities.

In Germany, they put a spin on practical education by adhering to a rigid progression in the school system, and not fast-tracking any student. Their Technikons and Arbiturs produced middle class artisans and mechanics needed in large numbers in their industrial estates. They allowed a lot of Turkish and other immigrants to come in to fill the

gap in the labour market. They made it compulsory for their students to acquire practical vocational skills from community-based skills training centres, apart from their normal academic and theoretical training in schools and colleges. Thus, they had a binary or parallel educational system which combined praxis or practicum with theoretical knowledge.

In the USA, education is made practical through internship and close collaboration with the corporate world. Education is integrated into the world of business and work. Learning is made flexible through the credit system. The corporate world sponsors a lot of research and they generously fund educational enterprises. They offer students opportunities to research and proffer solutions to industrial problems. Special education for child prodigies and physically, mentally and emotionally-challenged children are all well-catered for in the USA. However, I must say that I am not a great fan of the American educational system because of their disparate and unstandardized educational system, which to say the least, looks chaotic from the point of view of an outsider, especially at the pre-tertiary level. Howard Gardner's concept of multiple intelligences forms the basis of their education system, whereby every child is recognised as having strengths in certain knowledge areas. We in Ghana need to borrow a leaf by twining our schools with the corporate world to make education job market relevant, and realistic.

Howard Gardner's multiple intelligences concept is a pedagogical method which recognises that no child is a write-off because we are differently endowed; therefore education should be inclusive rather than exclusive, with no child left behind. The concept of multiple intelligences recognises areas of intelligence as spatial or motor intelligence, logic, music, aesthetic or creative intelligence, linguistic intelligence, emotional, and social intelligence. All these are innate, and it is the duty of educators to unearth the forte of each child. Once the particular strength of a child is known, then that strength can be used as a platform to introduce themes in mathematics and science in that forte area, which will be pleasurable to the student.

For example, one of my former IB students at ISL (International School of Lusaka), was a Physics major, but he had a strong passion for music, especially playing the guitar. He also took part in many school performances. His Extended Essay which I partially supervised was on the resonance of the different guitar strings made from different materials such as cat gut, metals, among others. Thus, he blended his passion for music with his science focus, and he achieved an excellent grade. Of course, he was an exceptionally-talented chap with leadership and excellent social networking skills.

This informs us that for a successful delivery of the teaching of mathematics and science in schools, we should devise eclectic, innovative, flexible and interesting methods which are overarching, inclusive, and iconoclastic. Teachers and learners have to think outside the box by traversing into untravelled roads and territories.

We cannot forget that the Ghana is a multicultural society, which poses many challenges to teachers in the teaching of science and mathematics. African children may find the culture of meeting deadlines deadly, a child from a Muslim home may not like Darwin's theory of evolution, a prude homestead may object to teaching sex education in schools to their children, among many other examples.

At the kindergarten level, we have to turn knowledge upside down by using revolutionary methods for 4 year olds to engage in units of enquiry on thematic topics such as pollution, globalisation, and human-animal conflict, conservation of fresh water resources and their management, the ecological system, among others. Parents are normally involved in the presentations made by their young kids.

Thus, there is the whole engagement of the school learning community in the education of the child. This is an insight which I gained whilst teaching at ISL. Children could be made to learn in groups so that they engage in peer group learning, and sharing ideas, through a process of mutual bonding. Through collaboration, they reinforce the learning process through learning by association, recall, practical assignments, and project work.

The teaching of science and mathematics should not be done in isolation but rather in association with other subjects such as history, music, drama, art, literature, social studies, among others, in a cross-disciplinary manner. For example, in history lessons, the life histories and achievements of mathematical and science geniuses such as Francis Bacon, Isaac Newton, Turing, Tim Berners Lee, Bertrand Russell, Aldous Huxley, Halley, Marie Curie, Stephen Hawking, Robert Dawkins, Isaiah Blankson, Alvin Klutse, Francis Allotey, Yanney Ewusi, Ashithey Ollennu, Konotey Ahulu, MacBaganlurin, Thomas Mensah, L.P. Baffour, Mawusi Dake, Erbynn, Oti Boateng, Omaboe, Phillips, Adzei Bekoe, Addai Mensah, S.I.K.O Odoom, among others can be brought to light to whip up the interest of children in the sciences and mathematics. They can pick up their role models from there.

Of greater importance is the need to impart to our students the facets of knowledge acquired from knowing about the Theory of Knowledge (TOK), which is incorporated in the IB curricula but not found in the London and Cambridge A Level curricula. TOK broadens the minds of students and helps them know the sources of knowledge. It also helps them to develop their critical thinking faculties. Alongside TOK, they should be exposed to novelty ideas such as the lateral thinking of Edward de Bono. In addition, all students should be made familiar with the scientific method associated with people such as Lakatos, Thomas Kuhn, Karl Popper, Wiggstein, and Francis Bacon.

The ideas and methods of psychoanalysts such as Freud and Carl Jung can be explored to understand thinking faculties in the conscious and unconscious state, and then efforts can be made on how to impart knowledge correctly, given challenges such as neuroses, psychosis, gender differences, social disparities and otherliness of some tutees. Special Education should be enhanced so that geniuses who are challenged mentally, socially and physically can be assisted.

With such understanding of psychoanalysis, educators will be better positioned to deliver quality and inclusive education to all, with no child left behind. The phobia of mathematics, the stereotyping which goes on with gender streaming in the study of mathematics and science will have to be dealt their death knell. Psychotherapy will need to be applied to those whose minds have been blocked by wrong mental images and stereotypes. We will need to encourage many of our girls to pursue mathematics and sciences to higher levels.

6.0 BACKWARD DESIGN AND ENDURING UNDERSTANDINGS -THE USA PERSPECTIVE

In backward design, educators in the USA make students realise their goals, objectives, assessment criteria, among others, from the onset, even before the learning process begins. It is also called understanding by design. In that way, all in the school learning community are put in the bigger picture so as to elicit maximum cooperation and support.

Thus, a compact or social contract is signed with everybody involved, so that they are aware of some concrete deliverables within a given timeframe, and at a specified cost, quantity, and quality, in terms of knowledge and skills acquired by students, contact hours put in by teaching staff, the quality of teaching aids prepared, numbers and percentage of students who pass summative and formative assessments, among others. According to the website, authenticeducation.org, backward design is a framework for improving student achievement.

It further deepens the student's understanding in applying principles, analysing issues, interpreting results and finally leading to effective student self-reflection. Backward design was developed in the USA by Grant Wiggins and Jay McTighe. According to other authorities, this method of backward design leads to enduring understanding, by students asking essential questions on a topic. The enduring understanding lasts throughout their life time because they would have carried away with them the bigger picture which will stay with them long after they have learnt a topic. That way, students gain deeper understanding and greater enlightenment. Thus, the dangers of the so-called "chew-pour-pass-and-forget" syndrome, associated with rote-learning in Ghana are overcome.

7.0 CONCLUSION

The quest for excellence in the teaching of mathematics and science in schools is not only a problem in Ghana as it is also a global issue. We cannot bury our heads in the sand and pretend that all is well. Experience of teaching in international schools is an eye-opener, in that one gets to know that the IB Diploma programme is far richer and pragmatic in content and delivery than our own JHS and SSS, and the overseas Cambridge GCSE, and Edexcel A Level curricula, which are bookish and examination-oriented, and are being phased out in the UK (see Vision 2030 of the Royal Society launched on 26 th, June, 2014).

Exam-based education such as our current BECE and SHS exam systems encourage rote learning or parroting, rather than building the foundations for critical thinking and developing entrepreneurial skills. Radical changes have to be introduced in the teaching of mathematics and science in Ghanaian schools. That will require reforms in the education statutes and ordinances. Attention should be paid to reviving Religious and Moral Education in schools across Ghana. Efforts should also be made to accept and deploy the use of social media in our schools as a means of grabbing the maximum attention of our young 3YK students who are obsessed with the new ICT fads and gadgets. We should rapidly embrace change.

Finally, some recent concepts which have been adopted in the USA , Scotland, and Australia include the STEM approach (Science, Technology, Engineering, Mathematics,), TIMES approach, and other approaches such as backward design, enduring understandings, multiple intelligences, units of enquiry (IB), project work, inclusive education, community-based learning, and integrative and holistic approaches such as thematic teaching.

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