

A Model for Career Development in Nigerian Secondary Education

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Abstract: Secondary education is an important aspect of learning that must be properly structured and executed. Existing approaches aimed at improving secondary education especially in developing countries usually focus on identifying and solving the challenges of education from perspective of funds, infrastructure, government policies and teacher qualification. This paper rather addresses other challenges such as poorly designed time table and inconsistent learning pattern within schools. The paper therefore suggests an $(n \times n)/k$ Trojan Semi-Latin square model specifically for case where $n = 5$ and $2 \leq k \leq n$. An experiment was carried out using a school that teaches 15 subjects with 3 classes for Art and Science field of study respectively. The subjects used are based on the current WAEC syllabus for secondary education.

Date of Submission: 07-10-2019

Date of acceptance: 23-10-2019

I. Introduction

Secondary education is an important aspect of education which prepares students towards a specific field of study and consequently a career path. Nigerian schools share a common syllabus which is used to teach the students. The students are thereafter examined by a joint body known as West African Examination Council (WAEC). Over the years, Secondary education had purely focused on teaching and adhering strictly to the content of the syllabus especially for examination purpose. There is usually no consideration or major effort at shaping students into field of study which their academic performance usually detects. Students are left to choose their field of study based on whims and caprices. In some cases, the parents or guardians decides for their wards which field of study is best suited for them. Sometimes you see a student whose performance in science related subjects being coerced to study sciences. The Guidance and counselling units of secondary education (for schools that have such unit) do not have the adequate means of advising the students well because the results of the students are usually not available. On instances where they are available, there is still no adequate tool to analyse these results for proper information to be elicited.

Another challenge in secondary education and career development in Nigeria is that the WAEC as a body provides a syllabus but does not provide a unified time table of study to achieve the content of the syllabus. Secondary schools have the autonomy of designing their own time table to suit them. The implication is that subjects in different fields of study unavoidably clash as they are taught at the same time thereby preventing students to have adequate knowledge of specific subjects basic to their field of study. This challenge is made worst by the fact that it is usually difficult to get specialist teachers for specific subjects who may be attracted to teach in secondary schools. The field of study most affected by this is the sciences. Some subjects such as Technical drawing, Physics, Chemistry, Geography, Wood Making, Introductory technology and others seem to suffer due to lack of teachers. Based on these challenges, it is important to have a standard learning pattern that will ensure that subjects meant for different field of study are taught without clashes. In addition, it is pertinent to expose the students to specific field of study on time by ensuring that they receive adequate learning on the basic subjects for their field of study.

The project is therefore aimed at developing a model that enhances career development for students in Secondary schools. The specific objectives include:

- i. To classify secondary education subjects into Arts and Science fields of study.
- ii. To develop a learning pattern for the identified fields of study
- iii. To test the efficacy of the developed pattern on selected schools

The research questions include:

Research Question 1: Are there reasons to believe that most secondary schools lack adequate learning pattern for career development?

Research Question 2: How can the effect of the introduced learning pattern on students be measured?

II. Theoretical framework

The theoretical framework of the paper is divided into the technologies applied and literature review.

2.1 Technologies and Tools

The research will make use of the following technologies:

- a. **Latin square:** According to Chigbu et al (2006), a Latin square of order n is an array containing a set of n letters or symbols such that each letter occurs exactly once in each row and each column. Figure 1 shows two sets of mutually orthogonal Latin square of order $n = 3$ each containing a set of three letters with each letter occurring once in each row and each column.

A	C	E	B	D	F
C	E	A	F	B	D
E	A	C	D	F	B

Figure 1: Two sets of Mutually Orthogonal (3 × 3) Latin square

- b. **Semi-Latin Square:-** According to Bailey & Chigbu (1997), an $(n \times n)/k$ Semi-Latin square is an $n \times n$ array containing nk letters in such a way that each row-column intersection contains k letters and each letter occurs once in each row and once in each column. Semi-Latin squares are obtained from Latin squares. The concept of Semi-latin square will be used to develop the model for productive learning pattern. The square will ensure that subjects offered by students in different field of study do not clash. It will also ensure that learning pattern of the students based on subject context is not distorted. A typical example of a $(3 \times 3)/2$ Semi-Latin square on English alphabets A to F is given in Figure 2.

AB	CD	EF
CF	EB	AD
ED	AF	CB

Figure 2: (3 × 3)/2 Semi-Latin square

There is a special type of Semi-Latin square known as Trojan squares which are formed by superposition of mutually orthogonal Latin squares (Bailey & Chigbu, 1997). The Semi-Latin square in Figure 3 is actually a $(3 \times 3)/2$ Trojan square and the bipartite variety concurrence graph is also shown in Figure 2.

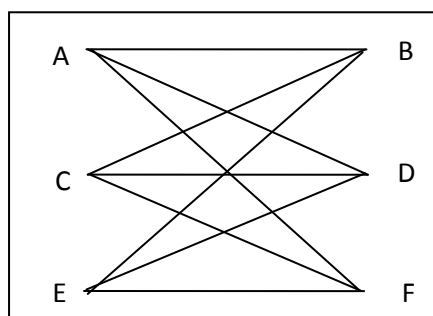


Figure 3: A (3×3)/2 bipartite variety concurrence graph

The Trojan square has some unique characteristics which make it a valid attribute for optimality test. Some of these characteristics include:

- a. **A- Optimality:** Which maximizes the harmonic mean of the canonical efficiency factors. Using notations we can state thus:

$$A = (t - 1) \left(\sum_{i=1}^{t-1} \frac{1}{e_i} \right)^{-1} \dots\dots\dots \text{Eqn 1}$$

b. **D- Optimality:** Which maximizes the geometric mean of the canonical efficiency factors. Using notations, we can also state thus:

$$D = \left(\prod_{i=1}^{t-1} e_i \right)^{\frac{1}{t-1}} \dots\dots\dots \text{Eqn 2}$$

c. **E-Optimality:** Which maximizes the minimum of the canonical efficiency factors. Symbolically, we state thus:

$$E = \min\{e_1, \dots, e_{t-1}\} \dots\dots\dots \text{Eqn 3}$$

2.2 Review of Related Literature

The importance of education in human emancipation cannot be over emphasized. According to Gbenu (2012), education not only enables individuals to fix themselves up in the society into which they have found themselves, it also equips individuals with the ability that will enable them explore the world, manipulate it for their survival. Adegbasan (2011) view education as a tool to for equipping the citizens of a country to improve their standard of living and solve basic problems in the society. Education indeed plays a major role in development of the economy. Unfortunately, in West Africa and many other developing countries, the quality of education especially at secondary school level is not satisfactory. It is true that quality of education cannot be measured directly (Becket & Brookes, 2005), but the quality of education could be measured by looking at the various challenges that affect the education process and the strategy adopted by different schools. The challenges of education in West Africa range from poor funding, lack of infrastructure, lack of qualified teachers to Government policies. (Kwame 2010). The poor performance in West African School Certificate Examinations (WASCE) organised by WAEC from 2006 till date attests to this (Ogundele et al).

Efforts had been made to tackle some of these challenges. The former President of Nigeria built a total of 169 Almajiri schools in the Northern part of the country to tackle the high rate of illiteracy in the region (Opejiobi, 2017). The current administration under President Mohammadu Buhari introduced a new programme called N-Power which is targeted at improving education by increasing the number of teachers (Abdulkareem, 2019). An analysis of the current administration’s progress made in education after 3 years recorded a 50% success (Azeezat, 2019). Similarly, Samuel et al (2016) writes on various educational reforms initiated by Ghanaian government to effect change and provide quality education to Ghanaians especially on Senior High School Education. Armah (2017), writes on educational challenges in Ghana and how to fix them. One of the strategies suggests a structural reform of the educational system. Johannes et al (2014) examines the performance driver for education in Togo. The authors discovered that uneven distribution of resources among regions and schools was a deterrent to smooth education. According to them an improved access to inputs, especially in the underserved schools, would go a long way to improving performance. Other education theories emphasis on proper monitoring, supervision, evaluation, inspection, quality control, access and equity as strategies for quality assurance in education (Ehinder, 2001; Ijaiya, 2001; Onocha, 2002; Ojedele, 2007). A notable effort at improving learning and education in general is seen in the work of Okereke & Ukekwe (2014). The authors clearly demonstrated how a (5 × 5)/4 Semi-Latin square model could be used to implement an effective teaching strategy in senior secondary education. However, the model appears not to be dynamic because it did not take into cognizance the possibility of some subjects not being taught in some schools. It didn’t also consider the introduction of new subjects into the curriculum. In addition, the model combines the subjects meant for Arts and Science students without assuming that some schools have separate classes for Art and Science students respectively. Recently, WAEC had introduced new subjects into their curriculum, hence the need to improve on the model.

However, both past and present efforts aimed at improving education especially in West Africa seem to focus on basic provision of tools, resources and government policies. The missing gap is that one has to look further inwards in order to proffer solutions at improving secondary education. The issue of harmonizing Time-table and learning pattern ought to be addressed. This is necessary because the award of WASCE certificate by WAEC is dependent on a uniform syllabus. If the suggested efforts are put in place and the pattern of learning is not addressed, then the major aim of education is defeated. According to Babalola (2007), quality of education can be gauged through students’ capacity and motivation to learn and the curriculum or the subjects to be learned. Research has shown that some subjects are taught randomly whenever a teacher is available. It is usually difficult for knowledge to cement if there is no organised learning pattern. Ajisafe et al (2015) lists time allocation as a challenge to studying Business Education in secondary schools. Similarly, Obetta (2016) identifies teaching time as part of the challenges facing Clothing and Textile teaching in Abia State, Nigeria. It is therefore necessary to look into the learning pattern of the subjects leading to a specific field of study. A well taught curriculum leads to functional education which will invariably transform the students to job creators instead of job seekers, thereby banishing poverty from their lives.

Again, adequate counselling is another missing gap to quality secondary education. The number of Counselors in secondary schools is dwindling. According to Arowolo (2013), the number of practicing Counselors in Nasarawa state present in their annual congress was recorded to be 100 while the estimated number of schools according to Vconnect (2019) is 302 in number. Obviously this is a pathetic number having a ration of 1 counselor to 3 schools. This is a true reflection of what is obtainable in other states. The argument is that if there are no counselors, then an expert system should replace them to do the job. The fact remains that the role of counselors in secondary education cannot be ignore. Secondary school education period is the period between childhood and the beginning of adulthood (Masha, 2003). Part of the roles of a counselor includes educational guidance, vocational guidance, psychological guidance (Abdullah, 2003). Indeed, secondary education needs the services of a counselor for the students to reach their full potentials (Foluke & Oluwabunmi, 2017; Owusu et al, 2018) . Unfortunately, most secondary schools do not have the luxury of having a Counselor nor a Counselling unit because there are very few qualified Counselors available. On the other hand, even when there are Counselors available, the several challenges they face continue to hinder them from effective duty. Abubaka (2015) lists some of the challenges as Lack of adequate and trained professional counselors, poor remuneration/ incentives, misconception and most importantly, lack of adequate and relevant psychological tests. It is no secret that even if Counselors are available, most depend on manual and psychological tools which may be prejudiced. The use of ICT and computer based tools are rare in the field. Almost every endeavour all over the world require the application of Computer. The first Computer Managed Counselling (CMC) was mainly used to assist counselors with the clerical and administrative tasks associated with their work, tasks that frequently inhibit their ability to undertake meaningful counselor interactions. Following the CMC, computers had been applied to counselling in schools. Katz & Offir (1994), talks about the effectiveness of computers in educational counselling through data storage and retrieval which provides counselors with up to date information on pupils that need counselling. The computer thus increases the efficiency of the counselling process. In recent times, Mihai (2012), agrees that with the application of ICT in counseling, it is possible to keep track of students' records and this means that their progress could be charted and used to support an evidence-based practice. Similarly, Oye (2012) believes that ICT would serve as an agent of change in counseling. A critical look at the introduction of ICT to counseling reveals that the focus is purely on the use of computer for storage and retrieval of students' records with a view of making the work easier for the counsellor. Unfortunately, this is not enough to say that students have received counseling. Complete counseling involves making prediction into the student's future based on the records at hand.

In order for proper counseling to take place, a standard learning pattern for the students has to be assured. The learning pattern ensures that students get the utmost and conducive subject sequence as well as time allocation for learning in the field of study of their choice. Such arrangement involves intricate measures. Okereke & Ukekwe (2014) believe that part of the challenges militating against qualitative education in both rural and urban part of Nigeria is based on the structure of lecture time tables. In order to tackle this challenge, the authors proffered a solution using the theory of Semi-Latin squares. According to Bailey & Chigbu (1997), an $(n \times n)/k$ Semi-Latin square is an $n \times n$ array containing nk letters in such a way that each row-column intersection contains k letters and each letter occurs once in each row and once in each column. The unique structure of Semi-Latin squares has found application in several aspects of life. It has been used in Agricultural experiments, sports, education and others (Bailey & Chigbu, 1997; Okereke & Ukekwe, 2014; Chigbu, 2009). The model proposed by Okereke & Ukekwe (2014) was limited to senior secondary education and was not fully implemented. There is therefore need for a more comprehensive and adaptive model which could cover the WAEC syllabus.

III. Methodology

The research will adopt an experimental approach and will be based on the current WAEC approved syllabus and listed subjects (WAEC, 2019). The recent WAEC syllabus classifies the subjects into four fields of study and core subjects as shown in Table1 as follows:

Table 1: 2019 WAEC Syllabus (WAEC, 2019)

Core Subjects	Humanities	Science/Math	Business Studies	Technology
1. English 2. Math 3. Trade 4. Comp-Stud 5.Civic Education	1. Nigerian Lang 2. Lit-In-English 3. Geography 4. Government 5. CRS 6. IRS 7. History 8. Visual Art	1. Biology 2. Chemistry 3. Physics 4. Further Math 5. Agriculture 6.Physical Education 7. Health Education	1. Account 2. Store Mgt 3. Office Practice 4. Insurance 5. Commerce	1. T-D 2. Metal Work 3. Basic Electricity 4. Electronics 5. Auto Mechanics 6.Building Construction 7. Wood Work 8. Home Mgt

	9. Music 10. French 11. Arabic 12. Economics		9. Foods & Nut 10. Clothing & Text
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Note: IRS – Islamic Religious Studies CRS – Christian religious Studies T-D -Technical Drawing
 Table1 shows 5 core subjects to be taken by every field of study. The fields of study include Humanities, Science/Mathematics, Business studies and Technology.

3.1.1 Model formulation

The 4 fields of study and core subjects are collapsed into two major fields of study as shown in Table2 as follows:

Table 2: Field of Study and associated subjects

S/n	Arts	Sciences
1	English	English
2	Math	Math
3	Trade	Trade
4	Comp-Stud	Comp-Stud
5	Civic Education	Civic Education
6	Nigerian Lang	Biology
7	Lit-In-English	Chemistry
8	Geography	Physics
9	Government	Further Math
10	CRS	Agriculture
11	IRS	Physical Education
12	History	Health Education
13	Visual Art	T-D
14	Music	Metal Work
15	French	Basic Electricity
16	Arabic	Electronics
17	Economics	Auto Mechanics
18	Account	Building Construction
19	Store Mgt	Wood Work
20	Office Practice	Home Mgt
21	Insurance	Foods & Nut
22	Commerce	Clothing & Text

It is worthy to note here that not all the listed subjects in Table 2 are taught in every secondary school. Most schools prefer to settle with the basic subjects obviously because of lack of teachers in some of the subject areas. In addition, the recommended number of subjects for candidates to take in WAEC is 8 or 9. For the purpose of this paper, an example is therefore given for the common situation of 15 subjects with 3 classes in a school. This is the most obtainable class structure in Nigerian secondary schools with exception of a few.

Definition 1: Let letter n represent the number of lecture periods in a school for a day and k represent the number of classes that exist in a level within a school, then an $(n \times n)/k$ Trojan Semi-Latin square exists as a model for that school if

- i. $n = 5$ and
- ii. $2 \leq k < n$.

Definition 2: Let letter n represent the number of lecture periods in a school for a day and k represent the number of classes that exist in a level within a school, then an $(n \times n)/k$ Non-Trojan Semi-Latin square exists as a model for that school if,

- i. $n = 5$ and
- ii. $2 \leq k = n$.

The implication is that a model exists only for schools that have from 2 classes and above and schools that teach at least nk subjects which is delivered in n periods within a day.

3.1.2 An Experiment

We shall use the most obtainable class structure in Nigerian secondary schools as an illustration.

a. Class Structure with 15 Subjects and 3 Classes each for Science and Arts Respectively: In such structure, a $(5 \times 5)/3$ Trojan Semi-Latin square will be most adequate structure for a learning pattern and lecture schedule. The model parameters are defined thus:

- n (lecture periods in a school for a day) = 5 and

- k (the number of classes that exist in a level within a school) = 3.
 - nk (total number of subjects taught in a school) = 15.
- Extracting the 15 most common taught subjects from the WAEC approved list for both Arts and Sciences, we have the table 3 as shown.

Table 3: Illustration with 15 Subjects and 2 Fields of Study

S/n	Arts		Sciences	
	Subject	Abbreviation	Subject	Abbreviation
1	English	ENG	English	ENG
2	Math	MATH	Math	MATH
3	Trade	TRADE	Trade	TRADE
4	Comp-Stud	COMP	Comp-Stud	COMP
5	Civic Education	CIVIC	Civic Education	CIVIC
6	Nigerian Lang	LANG	Biology	BIO
7	Lit-In-English	LIT	Chemistry	CHEM
8	Geography	GEO	Physics	PHY
9	Government	GOVT	Further Math	FMATH
10	CRS	CRS	Agriculture	AGRIC
11	IRS	IRS	Physical Education	PE
12	History	HIST	Health Education	HE
13	Visual Art	ART	T-D	TD
14	Music	MUSIC	Home Science	HOMEC
15	Economics	ECONS	Nigerian Language	LANG

The first 5 subjects are compulsory according to WAEC (2019) standard.

b. Experimental Constraints: The following constraints are observed in the system:

- Both Art and Science classes must offer the first 5 subjects in the table
- For such subjects, one teacher is expected to teach both Art and Science classes.

In order to take care of the constraints, we present two types of $(5 \times 5)/3$ Trojan Semi-Latin squares.

c. Conceptual Foundation

According to Chigbu et al (2006), a Latin square of order n is an array containing a set of n letters or symbols such that each letter occurs exactly once in each row and each column. A Latin square of order n is an array containing a set of n letters or symbols such that each letter or symbol occurs exactly once in each row and each column. Chigbu & Eze (2001) used the group theoretical-based procedure to construct Semi-latin squares. This paper shall adopt the same construction procedure. Hence the first $(5 \times 5)/3$ Trojan square for Art classes shall be constructed by superposition of 3 mutually orthogonal (5×5) Latin square as follows:

Latin Square 1		Latin Square 2		Latin Square 3	
SUBJECT	GROUP	SUBJECT	GROUP	SUBJECT	GROUP
ENG	(1,2,3,4,5)	BIO	(1,3,5,2,4)	HOMEC	(1,4,2,5,3)
COMP	(2,3,4,5,1)	CHEM	(2,4,1,3,5)	TD	(2,5,3,1,4)
TRADE	(3,4,5,1,2)	FMATH	(3,5,2,4,1)	HE	(3,1,4,2,5)
CIVIC	(4,5,1,2,3)	PHY	(4,1,3,5,2)	PE	(4,2,5,3,5)
MATH	(5,1,2,3,4)	AGRIC	(5,2,4,1,3)	LANG	(5,3,1,4,2)

The second $(5 \times 5)/3$ Trojan square for science classes shall also be constructed by superposition of 3 mutually orthogonal (5×5) Latin square as follows:

Latin Square 1		Latin Square 2		Latin Square 3	
SUBJECT	GROUP	SUBJECT	GROUP	SUBJECT	GROUP
ENG	(2,3,4,5,1)	LIT	(1,3,5,2,4)	HIST	(1,4,2,5,3)
COMP	(3,4,5,1,2)	GEO	(2,4,1,3,5)	ART	(2,5,3,1,4)
TRADE	(4,5,1,2,3)	GOVT	(3,5,2,4,1)	MUSIC	(3,1,4,2,5)
CIVIC	(5,1,2,3,4)	CRS	(4,1,3,5,2)	LANG	(4,2,5,3,1)
MATH	(1,2,3,4,5)	IRS	(5,2,4,1,3)	ECONS	(5,3,1,4,2)

d. The Model

Using the group theoretic-based construction approach, the learning pattern for Art and Science classes are thus presented in figures 4 and 5 respectively.

Time/ Days	8:00-9:00	9:00-10:00	10:00-11:00	11:30-12:30	12:30-1:30
MON					
A	MATH	ENG	COMP	TRADE	CIVIC
B	LIT	GEO	GOVT	CRS	IRS
C	HIST	ART	MUSIC	LANG	ECONS
TUE					
A	CIVIC	MATH	ENG	COMP	TRADE
B	CRS	IRS	LIT	GEO	GOVT
C	MUSIC	LANG	ECONS	HIST	ART
WED					
A	TRADE	CIVIC	MATH	ENG	COMP
B	GEO	GOVT	CRS	IRS	LIT
C	ECONS	HIST	ART	MUSIC	LANG
THUR					
A	COMP	TRADE	CIVIC	MATH	ENG
B	IRS	LIT	GEO	GOVT	CRS
C	ART	MUSIC	LANG	ECONS	HIST
FRI					
A	ENG	COMP	TRADE	CIVIC	MATH
B	GOVT	CRS	IRS	LIT	GEO
C	LANG	ECONS	HIST	ART	MUSIC

Figure 4: A (5x5)/3 Learning Model for Art Classes

Time/ Days	8:00-9:00	9:00-10:00	10:00-11:00	11:30-12:30	12:30-1:30
MON					
A	ENG	COMP	TRADE	CIVIC	MATH
B	BIO	CHEM	FMATH	PHY	AGRIC
C	HOMECEC	TD	HE	PE	LANG
TUE					
A	MATH	ENG	COMP	TRADE	CIVIC
B	PHY	AGRIC	BIO	CHEM	FMATH
C	HE	PE	LANG	HOMECEC	TD
WED					
A	CIVIC	MATH	ENG	COMP	TRADE
B	CHEM	FMATH	PHY	AGRIC	BIO
C	LANG	HOMECEC	TD	HE	PE
THUR					
A	TRADE	CIVIC	MATH	ENG	COMP
B	AGRIC	BIO	CHEM	FMATH	PHY
C	TD	HE	PE	LANG	HOMECEC
FRI					
A	COMP	TRADE	CIVIC	MATH	ENG
B	FMATH	PHY	AGRIC	BIO	CHEM
C	PE	LANG	HOMECEC	TD	HE

Figure 5: A (5x5)/3 Learning Model for Science Classes

IV. Discussion on Result

The developed model signifies the optimal arrangement of the subjects for the two fields of study. The result obtained shows that:

- i. there is 0% time clash of any subject
- ii. a logical learning pattern is followed in teaching the students

V. Conclusion

The paper presented a learning approach for students in secondary school. The example given is specifically for schools that teach 15 subjects and have 3 classes each for Science and art fields of study. The results shows a hitch free learning pattern for students and ensures that they focus on their chosen field of study as early as senior secondary school. The model therefore serves as a career counseling tool that ensures quality learning. It is expected that a good learning pattern will go a long way to shape the career of these students before they enter tertiary education.

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IOSR Journal of Computer Engineering (IOSR-JCE) is UGC approved Journal with Sl. No. 5019, Journal no. 49102.

Ukekwe, Emmanuel.C. " A Model for Career Development in Nigerian Secondary Education" IOSR Journal of Computer Engineering (IOSR-JCE) 21.5 (2019): 41-49.