MODIFIED NONLINEAR DYNAMICAL EQUATIONS FOR RELATIONSHIP IN MARRIAGES

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ABSTRACT

Love-stories are characterized by temporal fluctuations, experiment in the area of relationship are difficult to design but mathematical models play vital role in studying the dynamics of relationships and their behavioural features. The paper examines relationship between different couples who are living together as ideal couple or fragile couple and the divorcee. A modified nonlinear coupled dynamic model was used to predict and interpret the feature of the union of different individuals and it is adapted to local environment where the data collection is carried out. We also investigated several measures affecting marriages, different challenges in marriage were considered by the use of questionnaires, analyzed and the results were applied as parameters in the model. In other words, only few of the behaviour of the couples to each other are taken into account while the rest of the answers were kept frozen, results were used to confirm if the behaviour of certain number of individuals observed in real life can be explained through the answers provided by individuals in the survey which was included in the theory. Numerical simulations are also presented to show the effectiveness of the survey results.

Keywords: Non-linear, Mathematical model, relationship, marriages.
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INTRODUCTION

The study of dynamical system that is, a system which consists of a set of possible state together with a rule that determines the present state in terms of the past states has advanced tremendously many decades ago, making a big impact on science and technology (Liao and Ran, 2007). The dynamics of different systems both linear and nonlinear had been studied widely and interpreted with the aid of phase plots to show the behaviour of the system. It has come to our thought that no one, no matter our professional calling escapes the influence of death, sexual tension and or other related things. However, about approximately 80% of the people in the world do want to be involved in marriage and child bearing. The focus of this research work is to study fragile relationship between two individuals that is, husband and wife using a modified nonlinear differential equation called Couple dynamics which models marriage with the aim of identifying chaotic marriage as fragile couple. Marriage refers to mutual interaction between two or more individuals usually male and female as in the case for Nigeria. One of the earliest efforts at modeling marital relationships was by a group of researchers and mathematicians who teamed up to create a mathematical model that predicts future of marriages using a set of first order differential equations. Strogatz described a model called minimal model on love whose aim was to teach harmonic oscillation phenomena in the classroom (Sprott, 2004; Cheriff and Barley, 2011), but his model was unrealistic because he did not consider appeal of the couple in his differential equation. Appeal can be combination of different attributes like age, education, earning potential, social position e.t.c. Sprott (2001) in his paper presented to the Chaos and Complex system seminar in Madison, Wisconsin (2001) disagreed with Strogatz work and described a model of love and happiness which he referred to as Love model for Romeo and Juliet .Marriage can be viewed from different perspectives; but this work will focus on the Socio-psychology and Physics perspective.

Socio-psychologist perspective

Marriage exists to bring man and woman together as husband and wife to be father and mother to any children their union produces. Kefalas, Furstenberg, Carr and Napolitano (2011) identified two groups of marriage: marriage naturalist and marriage planners. Marriage naturalists are largely from rural area and are eager to get married while marriage planners delay their entry into marriage as a response to the haphazard transition to adulthood, they are based in city. The age at which people marry has risen therefore making the proportion of people getting married to fall (Cherlin, 2004; Ventura and Bachrach, 2000) because of the fear of divorce and this increases the growth in the proportion of children born to unmarried mothers. Stranger-Ross, Collins and Stern, 2005) in their work identified three different decisions of young adults on marriage i.e. reciprocity, dependence and autonomy. Reciprocity was practiced between the period of 1900-1950, dependence between (1950-1970) and autonomy (1970-2000). Human believe that love is the main foundation of marriage, according to (D'Vera, 2013) love has the highest percentage as the important reason to marry, the percentage for each reasons are Love 93%, Making A Life Long Commitment 87%, Companionship 81%, Having Children 59%, Financial Stability 31%.Marriage is an important goal, though it may not be the top priority but having a successful marriage is one of the most important things.

Physics perspective

We will notice that when Newton invented calculus. It put science on a mathematical foundation and Physics took off. The Psychologists has lagged behind using mathematics and with this, they are not exposed to models. This work will extract key elements into a model to make it predictive and interpretive. There are no general laws of marriage relationship as there are for Physics but, Newton's second law can be used to categorize relationship. It states that a body will continue in its state of rest or a uniform motion until an external force is being applied on it. This is to say that, couple that has no influence by external forces can be called 'ideal couple' while the other way round is called 'fragile couple'. Also, law of thermodynamics for sentimental relationship states that there is tendency for initial feeling of one another to fade away hence effort is required to sustain relationship as love is not enough (Jose-Manuel, 2010). Closeness between couple can be viewed from two aspects in this work. Firstly from semiconductor Physics and secondly from modeling with the aid of differential equation. Looking at the latter, marriages could start off happily but over time there could be challenges which can be referred to as "CHAOS" thereby left a wide forbidden gap between the conduction band (husband) and the valence (wife).

To appreciate this discussion in the light of physics, an analogy can be drawn between marital relationships and energy bands of solids. Lets recall that in the energy band, there is forbidden gap which is wide in an insulator (no feelings) and in metal there is no forbidden gap (existence of love), this shows that for love to exist between the individual there must occur a thermal excitation of electrons from the valence band to the conduction band, therefore husband can be attracted to his wife when his body is able to charge at sighting his wife, this is related to fundamental law of action between charges which states that "like charges repel and unlike charges attract". John Gottman, a clinical Psychologist and mathematicians James Murray and Kristin Swanson (2001) predicted the future of marriages by introducing a model but before developing the model, the team organized a conversation between couples and each partner was scored during the conversation using a strict set of criteria. The scores were then used to develop a model to predict and interpret future of marriages. Differential equation was used to generate a phase plot which predict how likely the relationship is to survive. Marriage dynamics therefore provides the foundation for a scientific theory of marital relations which necessitated the present study to give postulation(s) of possible stability in marriages such that the chaos therein could be controlled.

METHODOLOGY

Data presentation

Survey (using questionnaire) was conducted among young and old married men and women with the aid of questionnaires. The couples invited to fill the questionnaires were the fragile couples and the ideal couples. The survey papers used comprise of three sections. Total number of samples taken was above three hundred but one hundred questionnaires were used for the analysis while others were invalid. Ogun and Lagos states were the target areas of the study. This is shown in table 1.

MODEL DESCRIPTION- Couple dynamic equations

The recent modelling approach has received some attention in scientific community with its analysis contributing to a vast list of research in this field. The model used is the nonlinear coupled with two differential equations which were a modified from the existing model as in equations (1.0) and (1.1).

$$\frac{dX_1}{dt} = -a_1 x_1(t) + b_1 x_2(1 - e x_2^2) + (x_2^2 - x_1^2) + f(t) \quad \text{.....(1.0)}$$

$$\frac{dX_2}{dt} = -a_2 x_2(t) + b_2 x_1(1 - e x_1^2) + (x_2^2 - x_1^2) + f(t) \quad \text{.....(1.1)}$$

The challenges considered as parameters are:

$a_1 =$ *maltreatment,* $a_2 =$ *loneliness,* $b_1 =$ *wrong advice,*

$b_2 =$ *phone calls,* $f(t) =$ *periodic forcing,* $e =$ *fission (influence)*

$x_1 =$ *measure of orderliness/disorderliness in individual 1*

$x_2 =$ *measure of orderliness/disorderliness in individual 2*

Numerical results

The data collected from questionnaires were analyzed. The sample size was determined according to specified model. Demographic information in respect to the relationship length of participants were recorded but participants were inconsistent in the amount of demographic information provided. Not all questionnaires provided the necessary information for all the variables but the few that responded were picked for the analysis. The analysis results for some of the questions were used as parameter in the model.

In order to investigate the dynamics of the model overtime, the systems of equations were integrated using the fourth order Runge-Kutta methods in programming language to solve systems (3.1) and (3.2). Few of the parameters used were a1=0.4, a2=-0.7, b1=-0.7, b2= 0.8 and e=0.4. Figures 4a and 4c are the chaotic plots of those that agreed with the questions while figures 4e and g for those that disagreed and the respective time series plots were also shown. Those that agreed with questions showed more chaotic behaviour than those that disagreed. The numerical simulation to verify the effectiveness of the equation is presented in the diagram below.

Data analysis

Table 1: Survey results of 100 sampled couples

Questions	Undecided	Disagreed	Agreed	Invalid	Total
My spouse always maltreat and beat me	1 (83 answers)	2(2 answers)	3(15 answers)	0	100
Often my spouse ignores me	1(67 answers)	2(8 answers)	3(24 answers)	1	100
I counsel and advice from friends	1(69 answers)	2(5 answers)	3(24 answers)	2	100
I pick up my spouse phone when he/she is not around	1(69 answers)	2(4 answers)	3(27 answers)	0	100
My parent/ parent-in-law is in support of my divorce	1(82 answers)	2(2 answers)	3(14 answers)	2	100

The mean rating for each item was calculated by multiplying the number of answers in a category by its rating value obtaining a sum and dividing by the total number of answers for that item. To calculate the mean for the first item: for example, my spouse always maltreat and beat me.

Multiply answers by value

Undecided= $83(83*1)$

Disagree= $4(2*2)$

Agree= $45(5*3)$

Sum . $83+8+45=132$

Divide by N: $\frac{32}{100}=1.32$ *(mean rating)*

Graphical representation of data

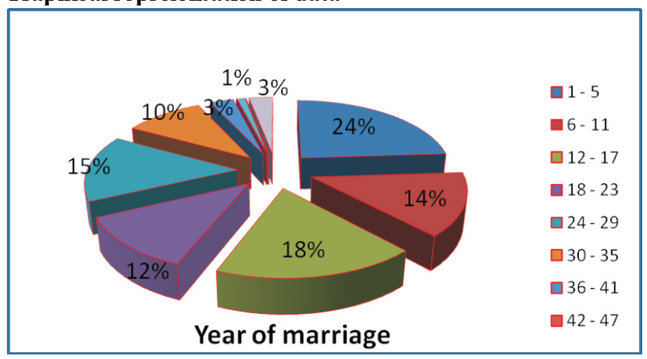

Figure 1 pie-chart showing year of marriage.

Fig. 1 depicts the purpose to observe the time trend as how couples introduce maturity into their marriage and the way they handle their problems

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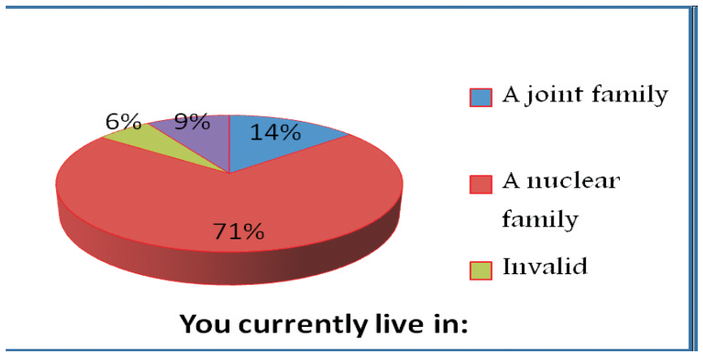

Figure 2: The pie-chart depicting the current living mode**.** The question address the nature living mode of couples as depicted in Fig. 2b namely a nuclear family, a joint family, others

It also shows the current day living style of couple's life whether or not they like to live with their elders or they prefer me, my spouse and children.

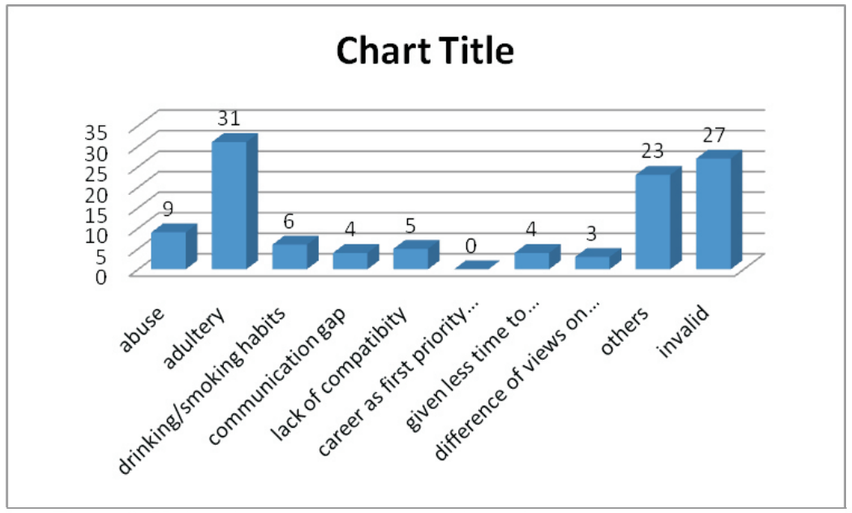

Figure 3: Under what circumstances would you divorce your spouse

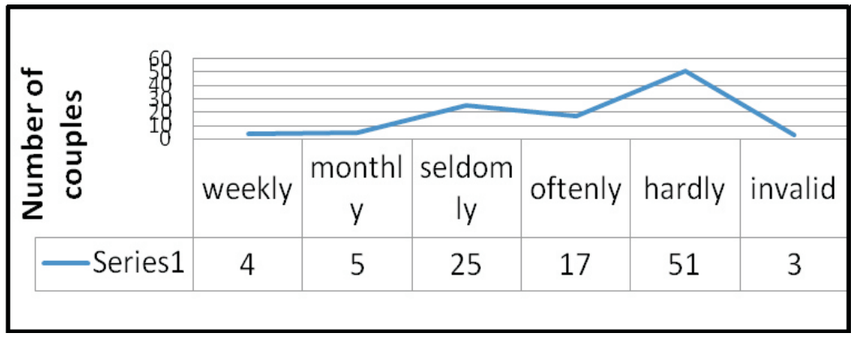

Figure 4: This is to know how often cou ples quarrel at home

Numerical Results

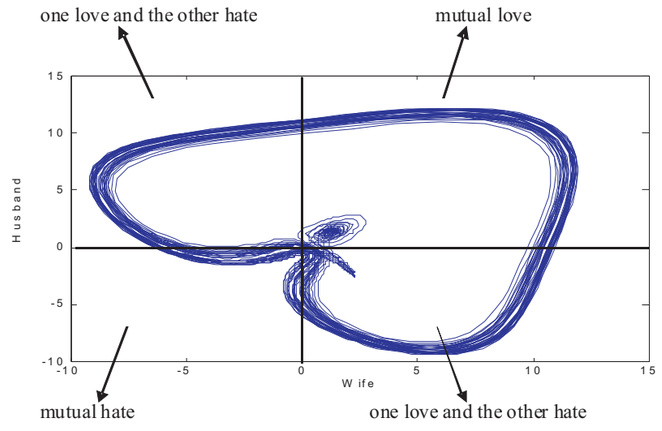

Figure 5 Chaotic behaviour of the couples that agreed with the questions being asked.

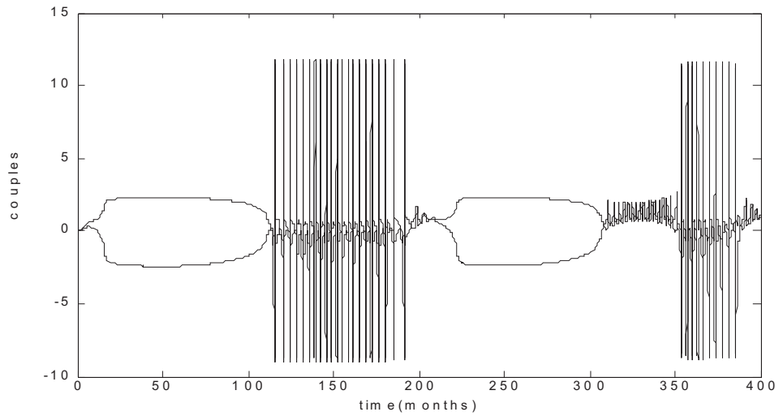

Figure 6: Chaotic behaviour of couple's dynamics with a periodic forcing from eq. 1.0 and 1.1

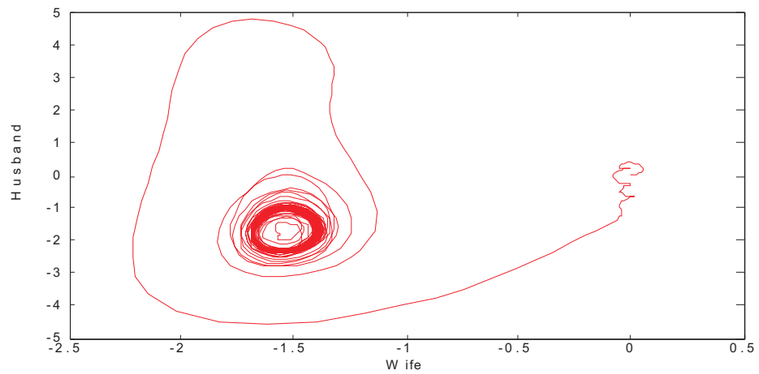

Figure 7: Chaotic behaviour of the couples that agreed to the questions, showing the chaoticity more to mutual hate axis.

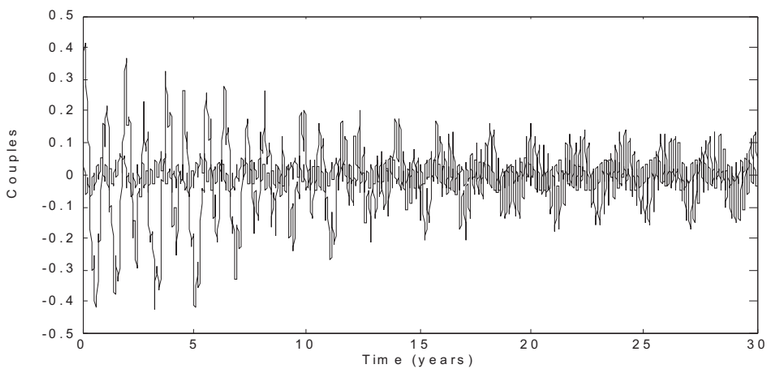

Figure 8: Chaotic behaviour of couples dynamics with a periodic forcing from eq. 8.1 and 8.2

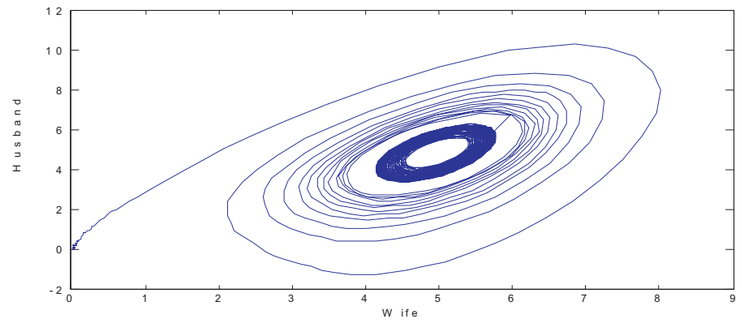

Figure 9: Chaotic behaviour of the couples that disagreed with the questions being asked base on the parameters used.

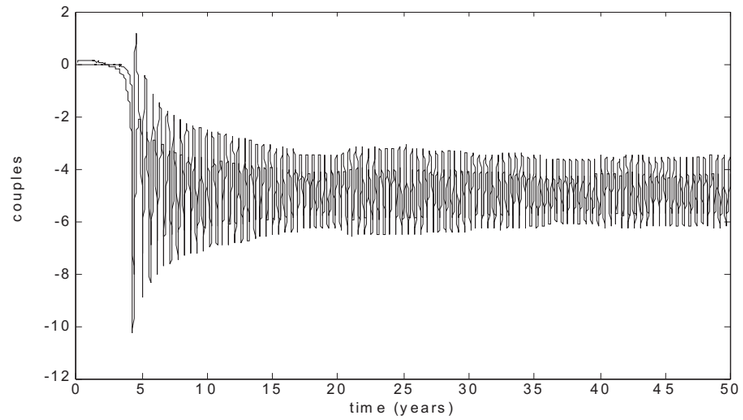

Figure 10: Chaotic evolution of the couples that disagreed to the questions

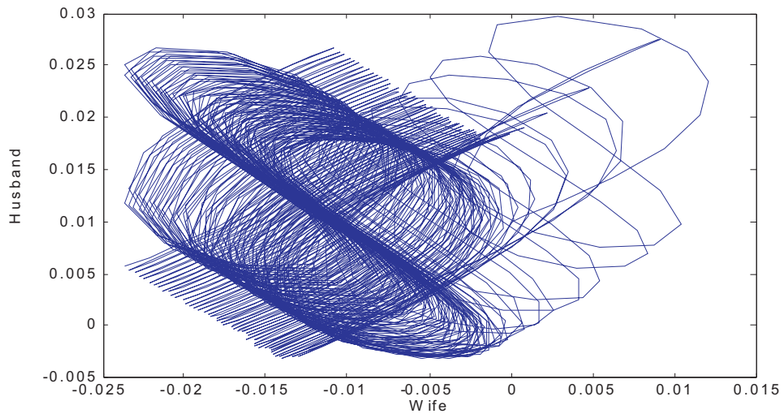

Figure 11: Strange attractor from the nonlinear dynamical systems (mean rating)

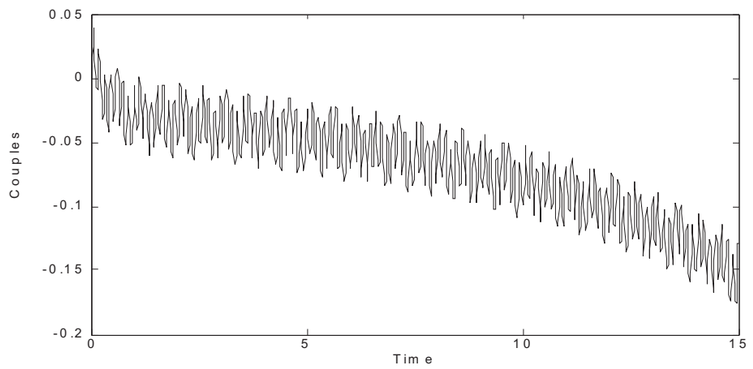

Figure 12: Chaotic behaviour of couples dynamics with a periodic forcing.

Conclusion

In the present work, we modify the linear love dynamic model by introducing nonlinear terms . The model was used to interpret the future of most marriages, numerical simulations were shown to illustrate the effectiveness and applicability of this design.

More so, this research was carried out to establish the reason behind the increasing divorce rate among young couples these days. However, the work also focuses on analyzing data with the aid of questionnaires, interprets the result with the aid of phase plots, time series and charts. Finding solutions to the problems young couples are facing is a problem with required solution that the current research work is attempting to un-ravel to allow reasonable stability to enhance marriage so that the socio-economic growth and development in the nation can be improved upon.

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