

A Qualitative Model for School Drop Outs in Uganda Using System Dynamics Modeling

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ABSTRACT

Although various universal education interventions have increased access to education in developing countries, the number of children who drop out of school in these countries is still alarming. In a bid to address school dropout problems, this research employed the System Dynamics methodology to critically examine the school education system in Uganda with the aim of providing a deeper understanding of the factors that could substantially improve school dropout rates in developing countries such as Uganda as well as suggest key leverage points that could lead to considerable improvement on the demand and supply for education. Various stakeholder viewpoints including the interplay of social, economic, political and technological forces that are associated with the provision and demand for education are presented. A qualitative model showing the influences associated with the demand and provision of primary education services and interventions that could possibly guide formation of policies towards lowering primary school dropouts are presented. Key leverage points and relevant information systems that could substantially lead to improved school dropout rates are suggested. Future work involves completing the different stages of the research methodology by building a quantitative model, performing simulations and testing the model with various “what-if?” scenarios to test different policies that could possibly improve the primary education system.

Keywords: Qualitative models, primary education, school dropouts, system dynamics, Uganda

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1. INTRODUCTION

System dynamics modeling has been used to address various real life problems in public policy implementation [1]; energy policy [2]; land use planning and development [3]; waste management [4], healthcare [5, 6], supply chains and logistics [7] and education [8, 9] among others. Such problems are often complex, ambiguous, non-linear depicting time delays, soft factors and interdisciplinary aspects; and are best investigated using System Dynamics methods [10]. System Dynamics (SD), a computer based modeling technique provides tools and techniques to unravel complexity and to create lasting interventions for chronic problems [10]. School dropout falls in the category of social aspects that can be addressed by these tools and techniques.

It is generally recognized that education is a powerful means to reduce poverty and inequality [11]. Education empowers people, improves individuals' earning potential, promotes a healthy population, is a major determinant of democracy and builds a competitive economy [12]. Increased campaigns to get children to school such as the Education

For All (EFA) campaign was birthed at the World Education Forum held in 1990. Although remarkable progress has been made in getting young children in developing countries into primary education, many still tend to drop out of school at a young age [13]. These children do not develop their full potential leading to wastage of scarce resources. The World Bank and UNESCO revealed remarkable increase in enrollment for primary education in sub-Saharan Africa since the start of the Education For All (EFA) campaign. The UNESCO 2004 statistics showed that in 30 developing countries, the survival rate to grade five (i.e. the proportion of children enrolled in grade one who eventually reached grade five) was below 75% and in half of the sub-Saharan African countries it was even below 66% [14]. For many developing countries, the problem has thus shifted from getting the children to school, to keeping them in school. Uganda experiences high primary school drop outs presenting the lowest primary survival rate (33%) in East Africa followed by Tanzania (78%), Rwanda (81%) and Kenya (84%) [14].

The average primary school completion rate in Uganda is 52% while the retention rates in primary school for boys and girls are 53% and 42% respectively [15]. Various universal education interventions such as Universal Primary Education (UPE) in Uganda have increased access to education in most countries. This, however, has increased the challenge of keeping these children at school especially in developing countries .

It was therefore, of prime importance to get a better understanding of the dynamics that drive the decision to stay in school or dropout especially in developing countries by employing the System Dynamics methodology.

1.1 Definition of the key theoretical terms

Two key theoretical terms are defined in this section. *System Dynamics* (SD) is a methodology for studying and managing complex feedback systems, such as those found in business and other social systems [16]. SD has been used to address practically every sort of feedback system. While the word system has been applied to all sorts of situations, feedback is the differentiating descriptor here. Feedback refers to the situation of X affecting Y and Y in turn affecting X perhaps through a chain of causes and effects.

School dropout refers to the number of pupils who were enrolled in a school at the beginning of the academic year but failed to complete the relevant level of education cycle. Transitional dropouts can be taken as the number of pupils who completed primary or secondary level of education but could not proceed to the next level for some reason. School dropout does not include pupils who transferred to another school. School dropouts leave the school system for a variety of reasons, often going back to their villages and not attending school any more.

1.2 The Ugandan Education System

This section provides an insight into the Ugandan Education System which was the main focus of the study. The primary school enrolment represents a steady increase from 2006 to 2009, a drop from 2009-2011 and then an increase to 2013 as demonstrated in Figure 1. As far as the levels are concerned, there is a steady decline from primary one (P1) to primary seven (P7) across all the years, reflecting a consistent high drop out rate. Pupils who enrolled in 2006 in primary one (P1) were 1,731,971. The number reduced to 1,213,483 in primary two (P2) and those that completed primary seven (P7) in 2012 were 564,217 reflecting an alarming drop out rate of 67.4% as highlighted in Figure 1.

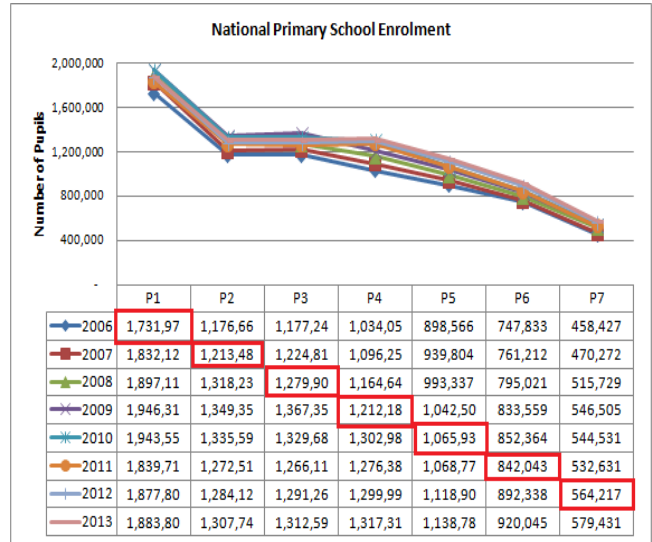


Figure 3: Ugandan National Enrolment for Primary Education (2006-2013)

(Data Source: Education Management Information System Annual School Census 2006)

These statistics demonstrate that despite various efforts, the number of school dropouts has persistently increased thereby presenting an urgent need for improved decision making towards minimizing dropout levels. The main objective of this research therefore, was to develop a better understanding of the intricacies associated with school dropouts for improved decision making in a policy environment that aims at minimizing dropout levels. The rest of this paper reviews related work (Section 2), describes the methodology employed in this research (Section 3) and Section 4 presents findings from field studies. Qualitative models are presented in Section 5 while research contributions and recommendations are presented in Section 6 and Section 7 respectively and future work.

2. RELATED WORK

This section highlights some of the research that has employed simulation and modeling techniques in education particularly in the study of school drop outs. A model using Agent based modelling was used to model a framework for schools and school districts with complex dynamic systems [17]. The model covered numerous factors ranging from individual attributes to federal policies. In the research, Agent Based Modeling strategy was used to help users better understand the attributes and relationships that may cause an intervention to success or fail. The underlying dynamics of the US educational system was explored using System Dynamics modeling in a study that concluded that the System Dynamics model generated insight into the hidden dynamics of the current education system and was found to be an

invaluable tool in the design of future scenarios [18]. In a study, a model that aims at identifying the importance of infrastructural facilitation on school enrollment and progression besides factors such as the quality of teaching and income levels was presented [8]. In yet another study on school constructions strategies for universal primary education, focusing on infrastructure challenges in sub-Saharan Africa and the constraints with special emphasis on affordability was presented [19].

A System Dynamics simulation model of a distance program at a leading institution in India was developed [20]. Results of the model were used to plan future investments of the distance education program. System Dynamics was found to be a suitable tool for a theoretical study of complex interactive systems and a powerful approach for analyzing the behavior of complex systems of over time. In yet another study, in Gujarat, India, the System Dynamics approach and the Cross Impact Analysis were employed to build a model aimed at identifying the importance of infrastructural facilities on school enrollment and progression beside factors such as quality of teaching and income level [21]. Simulation results showed that the infrastructure improvement would indeed increase the enrollment in primary education.

A System Dynamics model for studying the factors that impact the academic performance of primary school students residing in poor migrant neighborhoods with the aim of identifying the best government policies that could improve the system state in the shortest time possible was employed [22]. Simulation runs revealed that the most effective policies on academic performance were related to the improvement of infrastructure in schools, economic aid to the poor, adult education for parents and extra-curricular language for children with poor language backgrounds or minorities in slum areas. The study also demonstrates that social policies alongside educational policies should be the means to improve the children's conditions and provide opportunities for higher standards of living and upward mobility through education.

Although various System Dynamics models have been developed, they focus on isolated aspects of primary education. There is still need to employ the holistic approach to further understand the intricacies associated with the demand and supply of primary education services in the Ugandan context with the aim of alleviating the school dropout dilemma.

3. THE RESEARCH DESIGN

This study employed the System Dynamics modeling methodology which employs both qualitative and quantitative analysis [23, 24, 25, 26]. This paper focuses on systems thinking (qualitative) methods that facilitate deeper understanding of systems structure. It is postulated that systems thinking is an alternative medium for exploring and identifying knowledge gaps [27]. In order to understand the systems interrelated parts, there is need to understand the cause - effect linkages to benefit managerial decision making through the provision of tools that enable them to comprehend complex systems, share the observations and experiences that provide a clear understanding of the dynamic behavior [28].

This research used the five stage research design framework as shown in Figure 2 [26]. This framework is suitable for analyzing complex issues such as those presented by the school dropouts since it facilitates the researcher to identify the pertinent factors and variables in the referent system and shows the relationships among them. This paper focused on the qualitative aspect of system dynamics (stage 1 and 2) which involved the problem structure and the development of the qualitative models (causal loop diagrams).

During stage 1, the related literature was studied to identify key issues associated with school dropout. Key stakeholders were identified (Table 1), discussions and interviews with stakeholders were conducted and the findings formed the basis for the problem definition. During stage 2, the main variables and their behavior over time were analysed through field studies. After analysis of the data collected from the field, qualitative models (causal loop diagrams) were drawn and verified with the stakeholders.

The research investigated causes of school dropouts, facility and infrastructure adequacy, books and teaching staff adequacy and motivation. The scope of the study was limited to government primary schools in Katakwi district, Uganda. Katakwi district was chosen for the study based on high dropout rates reported in EMIS. The Ministry of Education and Sports (MOES) database was the main source of reference data. The information generated was randomly drawn from the 'worst performing' schools in the district based on MOES report [30].

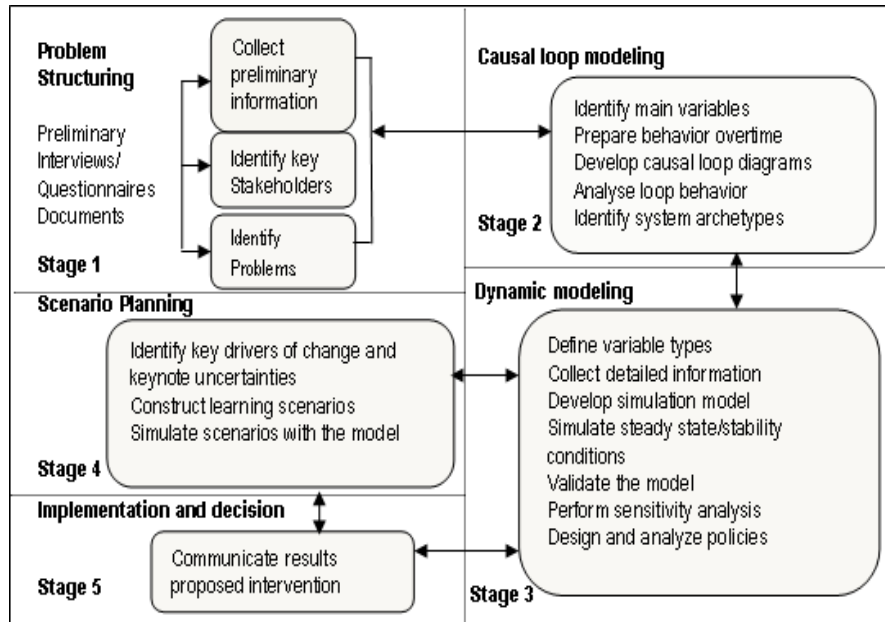


Figure 4: Research Design Framework based on Maani and Cavana [26]

3.1 The Primary Education Key Stakeholders

This section presents the key stakeholders in primary education system and their roles.

Table 7: Stakeholders and their aspirations

Stakeholder	Aspirations and Interests
Policy makers – Government / Donors	Lower national literacy levels, minimize school drop outs and have knowledgeable and skilled population.
Implementers of Policy –Ministry of Education and Sports	Provide education services to all parts of the country to ensure that pupils complete their levels of education.
District Education Services	Ensure that schools are properly managed and equipped by teacher recruitment, infrastructure development and maintenance.
Teachers	Provide teaching and counseling to pupils in a facilitated environment with good remuneration.
Community Leaders	Desire that the members of the community have adequate and quality education services and that the children attend schools.
Pupils/Guardians	Desire to have education services that are easily accessible, well facilitated in a good environment provided by motivated teachers and equipped classrooms.

Policies and funds for national education are provided by the Ministry of Education and Sports (MoES) and are implemented at the district level by the District Education Office (DEO). The school management is responsible for the supervision, inspections and funding of schools and reports to the DEO. The school environment consists of three main key stakeholders namely; the pupils, teachers and the local community leaders. The school is able to operate when the required facilities for example classrooms and sanitation are availed and maintained at a satisfactory level.

3.2 Field Studies

The field study provided the primary source of both data, which was collected mainly through interviews. Data was collected from the primary school pupils, District Education Officers, teachers, opinion leaders, community leaders and managers working with Non Government Organisations dealing with children related activities. These categories provided an opportunity to clarify a number of issues that arose both from literature reviews and interviews.

a) Sampling procedure

The population under study included all the 42,336 pupils in the primary schools in Katakwi District. All these could not be interviewed due to limited time and funding required to gather data from everyone in the population. Two approaches; the statistical estimation method and sample size calculator were used to estimate the sample size of the main respondents (pupils). At a 95% level of confidence, confidence interval of 5% the sample size calculator gave an

estimate of 377 while for the statistical method, the following simplified formula was employed [31]:

$$n = \frac{N}{1 + N(e)^2} \quad (\text{Equation 1})$$

where; n is the sample size,
 N is the population size (enrolment in Katakwi district 2009) = 42,366
 e is the level of precision = 0.05

$$n = \frac{42,336}{1 + 42,336(0.05)^2} = 396$$

The statistical and sample size calculator methods gave estimates of 396 and 377 respectively which were approximated to 400 respondents. The schools were categorised as urban and rural from which 10 schools were randomly selected in each category, making a total of 20 schools. Twenty pupils (Primary 5 - Primary 7) were then randomly chosen from each of the selected schools making a total of 400 respondents. The pupils were chosen from the upper primary section (Primary 5 to 7), because at this level they can read questions, understand and communicate intelligently with minimum guidance.

b) Data management and analysis

Data on various key variables including: socio-demographic characteristics, provision of service, adequacy of service, quality of service, distance from service and various causes of dropout was collected and was analyzed using SPSS 11 software. The analysis was used to generate descriptive statistics such as frequency distributions, cross tabulations and correlations.

4. PRESENTATION OF FINDINGS

This section presents the findings from the field. There was no significant divergence from the findings of the study and the information obtained from literature.

a) Factors associated with pupils' absenteeism from school

Figure 3 presents the reasons provided for missing a school year. The study showed that 52% of the pupils had attended school continuously without missing a school year. Of the pupils who had missed a school year, 15% reported domestic work as major reason, followed by lack of school fees (7%), lack of food, pregnancy (5%), chronic sickness (5%) and lack of interest (5%). Other causes of missing a school year included loss of parents, many children at home and lack of food at home. The pupil's reasons for dropout concurred with those provided by the community leader with varying percentages. The majority of pupils had a combination of problems that eventually led to school dropouts. For example 21% of the pupils mentioned that the initial problem was lack

of fees, which resulted in child labour, pregnancy and marriage.

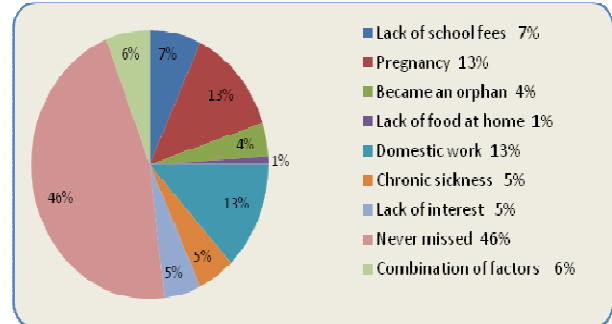


Figure 5: Reported reasons for missing a school year

b) Factors associated with school dropouts

Figure 4 presents the reasons provided for dropping out of school. The major cause of school drop out was found to be pregnancy (15%) and early marriages (15%). Other causes of school drop out included long distances to school (6%), lack of food at home (12%), child labour (8%), domestic work (6%), cultural influence (5%), and lack of interest (4%).

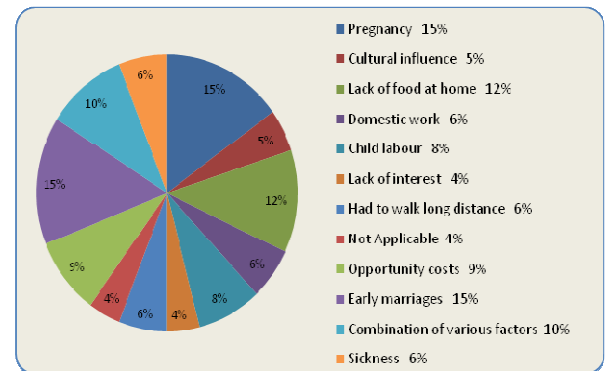


Figure 6: Reported reasons for dropping out of school

Teachers were asked about their opinions on school drop outs and the provision of education services. The majority of the respondents (84%) shared the same views on the causes of school dropouts with the pupils. 72% of the teachers cited inadequate funding as one of the key factors hindering the lowering of dropouts. The community and opinion leaders generally rated the quality of education as good with 56.7%. The distance from school was reflected to be moderate (53.3%), while 93.3% reported that food shortage was common in the communities.

Based on the study, the factors found to be associated with school dropouts characterized on the demand side include; pregnancy, loss of parents, lack of food at home, domestic work, child labour, lack of interest, and long distances to school.

The study revealed that in most cases one factor led to other causes hence compounding the problem such as depicted below;

- Lack of school fees → pregnancy → child labour and many children at home → marriage
- Loss of parents → lack of school fees → domestic work
- Lack of food → domestic work → lack of interest and sickness

c) Teachers' opinion on the adequacy of teachers, services and infrastructure

Figure 5 presents the teachers' opinion on the adequacy of teachers, services and infrastructure. The general feeling (100%) was that the teaching staff was inadequate with 70% of the respondents stating that this had an effect on school dropouts. 76% of the teachers reported that the school had a senior woman to advise the girls regarding sanitation matters while 20% reported that the girls lacked sanitary facilities. Lack of instruction or teaching materials was recorded at 84% with 76% stating that this had an effect on school dropout. The adequacy of classrooms (teaching space) was at 62% with 52% reporting that it had an effect on school dropouts. All respondents reported the availability of children counseling services in the school, however, 64% did not seem to know the effect it had on school dropouts. These results show that the number of teachers, classrooms, instruction materials in the primary schools are inadequate.

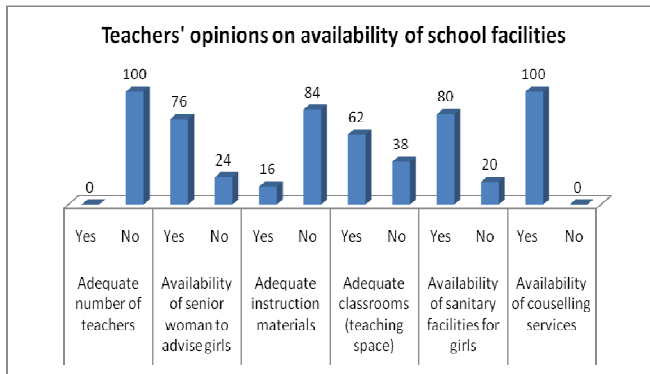


Figure 7: Teachers' opinions on school facilities

The primary school curriculum is comprised of four subjects namely: English, Mathematics, Social Studies (SST) and Science. In the study, primary school pupils were asked to rate their subject teachers. Results of the study shown in Figure 6 indicate that none of the mathematics teachers were found to be poor. Science and English teachers were generally rated as being good while SST teachers had a significant number (8.2%) of teachers who were rated as poor.

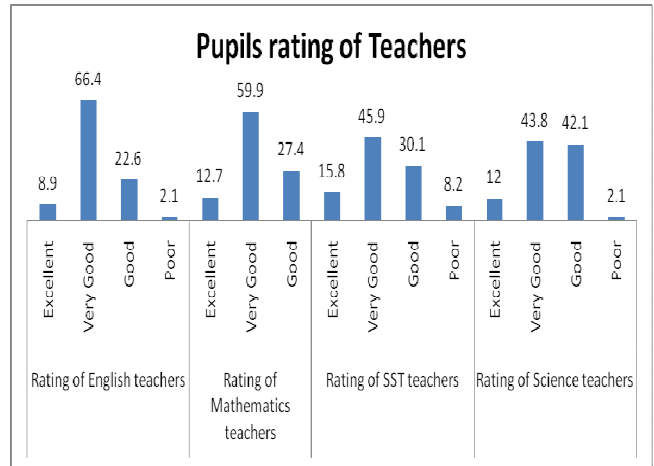


Figure 8: Rating of subject teachers

d) Motivation of Teachers

In Uganda, primary school teachers earn an average salary of 440,000 Uganda shillings which is an equivalent of US\$ 125.71 per month. The pay given to teachers is dismally low, compelling them to seek for alternative ways of survival which greatly impacts their performance and motivation to work. In the study, teachers were asked whether they had alternative sources of income and what could be done to increase their motivation. Figure 7 shows that 46% of the teachers had alternative sources of income while 54% did not. Only a small percentage (20%) of the teachers received supplementary income from the school.

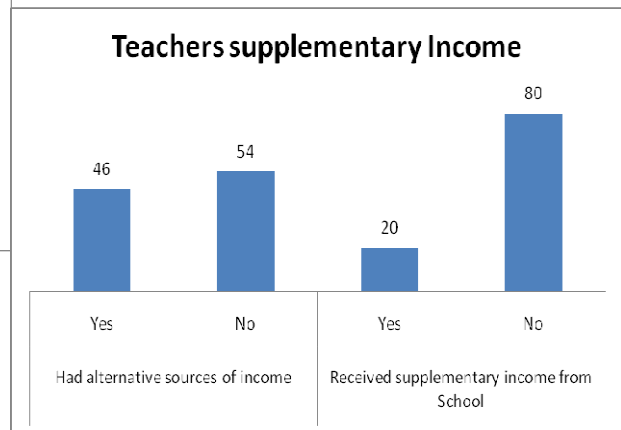


Figure 9: Teachers' supplementary income

Figure 8 shows that the main source of supplementary income was that paid by the parents (Parent Teachers Association). The highest motivating factor for teachers was staff housing (90%) as well as a combination of housing and staff lunch (10%). These however had a moderate effect (50%) on dropout rates.

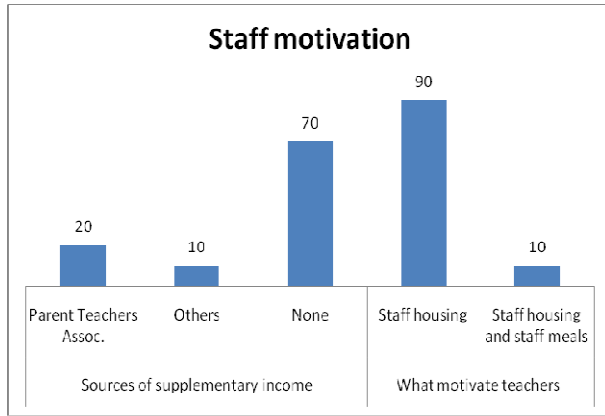


Figure 10: Teachers' supplementary income

Factors associated with the supply of education services included funding, infrastructure, staffing, quality of services and motivation of teachers. These factors are compounded by external factors which cannot easily be controlled such as economic environment, poverty, insecurity, environmental changes etc. To understand how these factors interrelate, cause-effect diagrams were used with the aid of System Dynamic tools. These factors put together form the network of dynamics involved in school dropout as seen in the next section.

5. SYSTEM DYNAMICS QUALITATIVE MODEL

The SD qualitative model is presented in two causal loop diagrams (Figure 9 and 10). Causal loop diagrams are considered as a representational system that allows us to view and describe reality, as well as provide theoretical knowledge by highlighting the relationships between variables, their polarity and direction of influence [25]. System dynamics provides qualitative description, exploration of complex systems in terms of their processes, information, organizational boundaries and strategies [30]. These causal loop diagrams are made up of reinforcing and balancing loops, the two foundational structures of systems thinking. A reinforcing loop is one in which an action produces a result which influences more of the same action thus resulting in growth or decline. A balancing loop on the other hand attempts to move some *current state* (the way things are) to a *desired state* (goal or objective) though some *action* (whatever is done to reach the goal). The education system is divided into two sub systems namely: the demand for education and supply as illustrated in the sections below.

5.1 Dynamics involved with the Demand for Education

Figure 9 presents seven reinforcing loops (R1-R7) that portray the dynamics associated with school dropout as far as demand for education is concerned.

- *Loop R1 (Population growth loop)*, a reinforcing loop demonstrates a vicious cycle whereby the rapidly

growing population exerts pressure on the school facilities. An increase in infant population results in an increase in demand for education which further results in increased school enrolment thereby exerting pressure on the existing school facilities. Once the children do not have the necessary resources, their motivation is lowered leading to their dropping out of school.

- *Loop R2 (marriage loop)*, a reinforcing loop shows the dynamics resulting from early marriages and pregnancies. Increased early marriages/pregnancies resulting from either the family's need to boost their economic wellbeing through marrying off their daughters for bride price or girl child social pressures results in the school dropout of the girl child. On the other hand, with increased dropouts there is a tendency for girls to be forced into early marriages. With higher levels of school dropouts, literacy levels keep rising thereby resulting in higher poverty levels which results in insufficient basic school needs (*Loop R4*), increased child labour (*Loop R5*) and sickness (*Loop R6*) resulting in a vicious cycle.
- *Loop R3 (society influence loop)* reveals that there exists cultural influences that prevent children especially girls from continuing in education. An increase in school dropouts results in an increase in the practice of the cultural influences since these are increased with increased levels of illiteracy resulting in yet another vicious cycle.

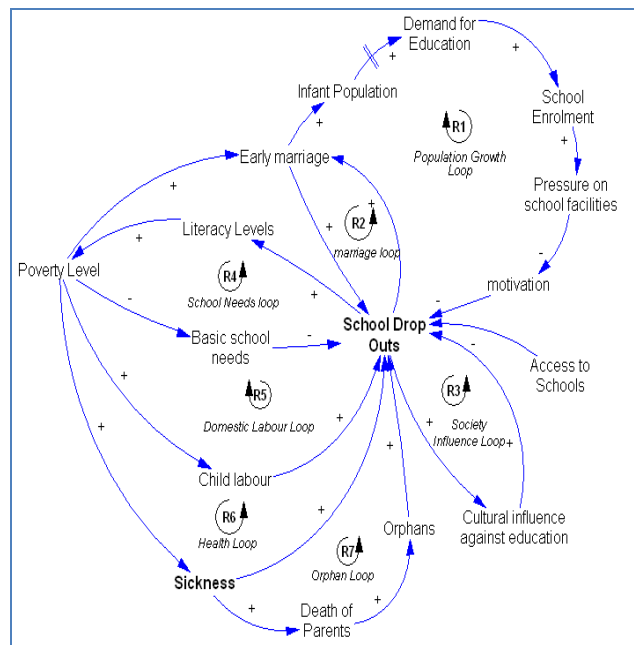


Figure 11: Causal loop diagram showing factors associated with school drop outs on the demand side

- *Loop R4 (school needs loop)* illustrates the vicious cycle resulting from the low social economic status of the population. With increased poverty levels, children are not able to have the basic school needs which results in school dropouts, low literacy levels leading to increased poverty levels.
 - *Loop R5 (domestic labour loop)* demonstrates that with increased poverty levels children are forced to work thereby dropping out of school which contributes to the illiteracy levels thereby resulting in higher poverty levels. In Katakwi district, where the study was undertaken, many of the children dropped out of school to participate in the planting and chasing of birds from the gardens and grazing of animals during the farming seasons.
 - *Loop R6 (health loop)* demonstrates the dynamics arising from chronic illnesses of the children such as HIV/AIDS as well as other kinds of diseases. In a developing country like Uganda, there are healthcare challenges such as lack of drugs, funds, healthworkers etc. With such challenges, children are not able to access healthcare services due to high poverty levels which results in dropping out of school.
 - *Loop R7 (Orphan loop)* demonstrates that illnesses such as HIV/AIDS and other factors lead to the death of parents/guardians which results in orphans lacking parental care hence resulting into dropping out of school.
- balancing loop (Loop B1) and two reinforcing loops (R8 and R9).
- *Loop B1 (school dropout loop)*, a balancing loop illustrates that government intervention boosts the teachers' motivation thus improving the quality of teaching and performance and thereby lowering the levels of school dropout. This is done through various interventions such as the Universal Secondary Education, Universal Primary Education as well as improving the teachers' remuneration and the available infrastructure and providing better resources.
 - *Loop R8 (pressure on resources loop)*, a reinforcing loop demonstrates that pressure on school facilities lowers the quality of educational service thereby lowering the performance. With decreased performance, the number of school drop outs increases thus increasing the early marriages, infant population thereby increasing the demand for education. As the demand for education increases, school enrolment and pressure on school facilities increases resulting in a vicious cycle. This shows that as the population increases, the resources become inadequate and are unable to support the growing population. Efforts should be made by government to ensure that the resources in the schools match the demand thereby minimising school dropouts.
 - *Loop R9 (workload loop)* is the outer loop that illustrates that an increase in teacher workload, lowers teacher motivation which lowers effective teaching and the quality of education service. This results in lowered performance in schools leading to an increase in the number of children who drop out of school. Increased school dropouts result in early marriages which in turn increases the infant population thereby increasing the demand for education, school enrollment and then the teacher workload as shown below.

The loops associated with the demand for education majorly focus on the socio-economic status which is associated with the poverty levels. This demonstrates that long term strategies to improve demand for education should be directed towards lowering the poverty levels. The causal loop diagram shows the dynamics associated with the demand for education and particularly factors associated with school drop outs. The next causal loop diagram presents the dynamics involved in the supply of education.

5.2 Dynamics involved in Supply of Education

Figure 10 shows the dynamics involved in dropout on the supply side. The supply of education is explained using one

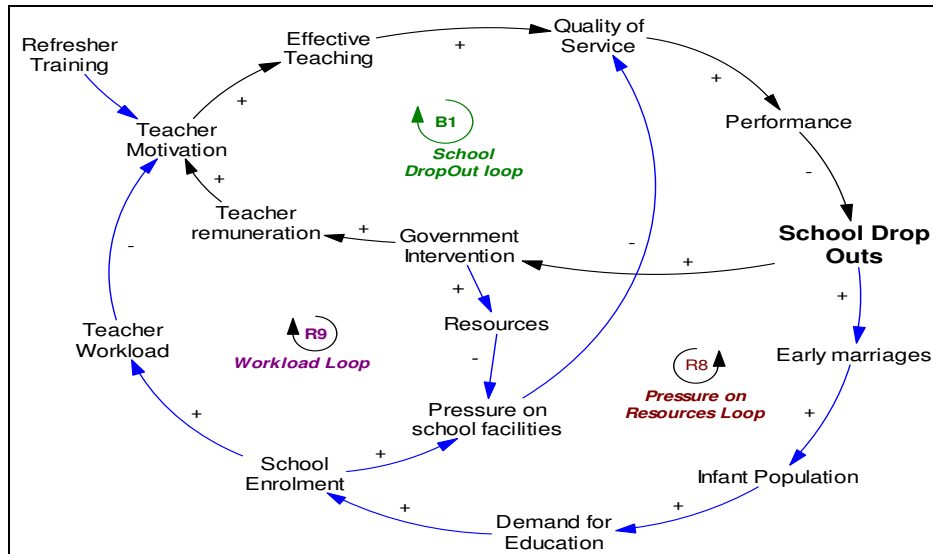


Figure 12: Causal loop diagram showing factors associated with school drop outs on the supply side

5.3 Insights from the Qualitative Model

This section looks at the key leverage points which could lead to a considerable improvement on the demand and supply for education. Maani and Cavana [10] define the leverage points as interventions or actions that can have lasting impact on the system in terms of reversing the trend or breaking a vicious cycle. This vicious cycle demonstrated by school dropout is typical of the “fixes that fail” archetype. While efforts have been made to encourage school attendance, these are not addressing the underlying causes of school dropouts. Efforts should be made to address leverage points as opposed to dealing with symptoms of the problems.

Intervention designed should be directed towards interrupting or modifying academic, school, or personal problems that are negatively affecting pupils’ performance. Some of the suggested interventions for improving the primary education system and lowering the school dropouts include the following:

- a) *Literacy levels* - There is urgent need to lower the literacy levels and poverty levels. Low levels of literacy result in people’s inability to appreciate the benefits of education. In an attempt to alleviate poverty many have been filled with desire for bride price resulting in early child marriages and pregnancies. In most cases the poor parents have encouraged girls to get married in order to get bride price to support their families. Others children end up going for child labour and domestic labour.
- b) *Resources* - Government should step up the resources to meet the demands of the growing population.

Currently inability to provide for scholastic materials is predominant. Campaigns that encourage parents to have the children they can afford to look after should be introduced to reduce the pressure on limited resources especially in developing countries like Uganda.

- c) *School feeding programs* - There is need to strengthen school feeding programs. It is evident that food shortages caused by adverse weather conditions (drought and floods). Many families often go with one meal a day which is inadequate. The feeding program at school could motivate many of the pupils originating from such families.
- d) *Funding* - Government should increase the funding for education as well as increase the monitoring and evaluation of education programs. Currently government provides funds for schools although these are often inadequate, untimely, and misappropriated as the managers who do not have sufficient skills to manage big funds. The monitoring and evaluation is not regular and is often done in an adhoc manner when a loss is reported.
- e) *Motivation of teachers* - Teacher remuneration should be improved to enable them meet their needs. Teachers are still ranked among the lowest paid civil servants yet they are expected to serve diligently. Those who retire often die before getting their gratuity. A few are provided with accommodation at school and lunch with no alternative sources of income to supplement their salaries. The staffing levels are not good and many teachers complain of overloads which all result into a de-motivated workforce.

- f) *Curriculum* – The curriculum should be revised such that it is more relevant while addressing the basic issues faced by the community. Many students who after graduating from universities and failed to get employed for more than five years are used as reference points by parents bent to encourage their children to dropout. They see it as a wastage of resources offering no future expected benefits.
- g) *Community* - The community leaders should be vigilant and actively participate on education issues. Many have been reported to connive with the parents on issues of defilement, pregnancies and early marriages as long as they are given something to remain silent.

5.4 Proposed Information Systems

There is need to employ early warning systems in the identification of students at risk of dropping out. Studying the indicators made readily available by the early warning system can help school officials target students in need with appropriate interventions as well as providing effective and appropriate dropout-prevention strategies. Below are the highlights of the proposed system:

Child: In the proposed system, the following particulars for child born will be captured.

- i. Photograph of the child, name, year of birth and sex
- ii. Parents' names, addresses, telephone numbers
- iii. Home location: Local council, village, parish, county, district
- iv. School particulars
- v. In general, the database must include unique student identifiers to track pupils by grade level and across schools, as well as enrollment information, demographics, achievement information, attendance, behavior grades or discipline information, and dropout information among others.

School: Each school will have a custom designed work station which can update the pupils' records. The school should be able to send information (compressed format) to the district and central servers. The data is then uploaded onto the district database through a fixed wireless terminal. Updates of schools are compiled to facilitate decision making processes at the district level. Reports on the performance of the various schools are generated and the data is then uploaded to the national database.

District level : Each district should have a server and each server should be connected to the rest of the district servers preferably with a high speed WAN links. All the district servers should then be connected to the national server. At the district level, data can be used to prepare forecasts, analysis and plans for the district. The reports generated can be used for monitoring and tracking of resources, as well as

preparing requisitions and facilitate distributions of supplies to the various schools. The data from all the districts is compiled to obtain the national performance. The data can then be used to enhance the decision making process for long term plans.

National level: At national level, an Education Management Information System linking all schools and districts should be used for support and monitoring of education activities, decision making and planning for improved national education services.

District-level early warning systems should be coordinated with school-level early warning systems to maintain information on individual pupil and schools over time. Once the key characteristics most appropriate for the local context are revealed by the exploratory analyses, the district can play a key role in facilitating and developing early warning systems through:

- i. Creating data collection systems that allow schools to easily collect key early warning data;
- ii. Monitoring the use of data to identify students at risk of dropping out at the school level;
- iii. Supporting continuous data analysis at the school level, across schools, and district wide;
- iv. Training school-level staff on data collection and analysis;
- v. Targeting district funding and resources to support schools in identifying : students early, intervention strategies for at-risk pupils, and promote collaboration among schools across the district or region;
- vi. Developing strategies to refine and improve continuously the predictive power of indicators in the local context; and including an on-track indicator as an accountability measure for schools in the district [32].

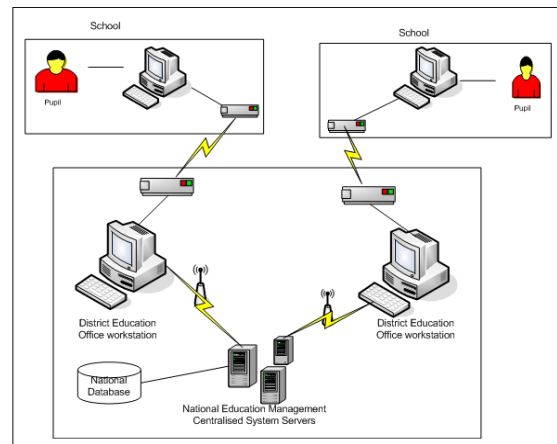


Figure 13: District Level Early Warning System

Maintaining accurate and up-to-date data about the programs in which teachers participate can generate actionable information about the most effective strategies for keeping students in school. Early warning systems allow schools to capture the actual scope of the dropout challenge one student at a time. The introduction of a monitoring system comes with a number of benefits which include:

- i. Improved response time to the most likely school dropout cases.
- ii. Improved sharing and dissemination of reliable information on dropout.
- iii. Improved coordination and monitoring of education supply in response the demand growth.
- iv. Reduction of school dropout by prevention rather than cure.
- v. Improved management capacity in schools and district levels.
- vi. Improved allocation of resources in response to specific dropout risk groups

The use of information systems through web-based technologies can increase the quality of service delivery in the education sector by providing timely, reliable and accurate information.

6. RESEARCH CONTRIBUTIONS

The research shows the benefits of employing Systems Thinking to understanding systems with complex interactions such as those presented in primary school education system. A abroad integrated view of the dynamics associated with primary school drop outs is generated by capturing diverse stakeholders view points. The analysis of variables and relationships present the potential feedback loops and time delays which facilitate the understanding of primary school dropout issues and the system as a whole. The development of causal loop diagrams provide a good foundation for the design and implementation of information systems that meet the stakeholder requirements, the development of quantitative models (stock and flows) and can be used for training and learning since they present a holistic approach to the primary education system.

7. RECOMMENDATIONS

The research recommends a holistic way of understanding complex problems as opposed to focusing on symptoms or even isolated aspects of the system. The alternative approach to policy understanding problems associated with school dropouts strengthens the existing traditional methods of statistical regressions used in most dropout researches. An information system that monitors the school drop outs at all levels will go a long way in minimizing the drop out levels. The government should design interventions that address all the aspects of primary school education mentioned in the research as opposed to addressing problem symptoms.

8. CONCLUSION AND FUTURE WORK

This paper demonstrates the benefit of employing the system dynamics methodology in the understanding of the primary education system particularly school drop outs in Uganda. The study presents an in-depth analysis of the possible causes of school drop outs in the Ugandan context. The feedback loops that are generated are used as the first step in suggesting both short and long term strategies towards alleviating the school dropout dilemma. The study provides insight in the underlying causes of the problems. The dynamics of the whole system including; cultural beliefs and influences, economic situation, finances, government policy, and exogenous factors such as international market changes, political upheavals, insurgency, HIV/AIDS, population growth that puts pressure on natural resources among others may all contribute directly or indirectly to the visible problem. Future work involves completing the different stages of the research methodology by building a quantitative model, performing simulations and testing the model with various “what-if?” scenarios to test different policies that could possibly improve the primary education system.

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