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Review

A software ability network in service oriented Architecture

S. Rajalakshmi

Department of Computer Science and Engineering, SCSVMV University, Kanchipuram, Tamil Nadu, India.

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In recent days, Service-Oriented Architecture (SOA) is used as a proficient resolution to integrate and potentially distributed in the software firm and enterprise. Architectures explore great vital role of network evaluation of the system. In a SOA-network value based environment, Pattern proven the solutions and design is one of the most important issues that must be considered because of the loosely coupled nature of SOA. However, there are many functionalities and deal with software Architect services such as flexible, speed, efficiency reliability and so on. SOA brings additional settings of proper governance of design pattern which becomes a critical issue. In this paper, we propose an Architect for Service Oriented Pattern based enterprise can play in transformation terms applying the quality conceptual for framework.

Key words: Service-oriented design, service Intelligence, performance management systems and quality management in SOA

INTRODUCTION

Software architecture, Hofmeister et al. (1999), intuitively denotes the high level structures of a software system. It can be defined as the set of structures needed to think about the software system, which comprise the software elements, the relations between them, and the properties of both elements and relations. Applying the term “architecture” to software systems is a metaphor that refers to the classical field of the architecture of buildings. Garlan and Shaw, 1993, The term “software architecture” is used to denote three concepts: high level structure of a software system, discipline of creating such a high level structure and documentation Bosch (2004) of this high level structure. Software architecture exhibits the following characteristics: multitude of stakeholders, separation of concerns, quality-driven, recurring styles and conceptual integrity. Software architecture (SA) is considered to be the most importance to the software development life-cycle Outi et al. (2009). It is used to represent and communicate the system structure and behavior to all of its stakeholders with various concerns. SA facilitates stakeholders in understanding design decisions and rationale, further promoting reuse and efficient evolution. One of the major issues in software systems development today is systematic SA restructuring to

*Corresponding author. E-mail: gomathyck@gmail.com. Tel: +251910185903.

accommodate new requirements due to the new market opportunities, technologies, platforms and frameworks.

According to Pressman, Sobiesiak and Yixin (2010) “One goal of software design is to derive an architectural rendering of a system”. Architectural design, detailed design and design reviews provide the most important steps in a cost effective software development process. Software engineering activities are goal directed in order to produce working software in a timely manner within some cost constraints Al Dallal, (2010). For complex computer based systems, software architecture plays a very important role in its success or failure. Software architecture is “the overall structure of the software and the ways in which that structure provides conceptual integrity for a system”. Software architectural design is immensely challenging, strikingly multifaceted, extravagantly domain based, perpetually changing, rarely cost-effective, deceptively ambiguous, and perilously constrained with some exceptions. Service oriented architecture modeling is performed considering various stages of network performing the functionalities and services Xu et al. (2006). This model consists of three stages: architectural analysis, architectural synthesis and architectural evaluation. The model has been extended to include two more stages, implementation and maintenance. All stages are supported by architectural knowledge. The architectural analysis stage serves to define the problems an architect must solve. An architect examines architectural concerns and context in order to come up with a set of architecturally significant requirements.

Another major issue in software systems development today is quality Frigo and Steven (1998). The idea of predicting the quality of a software product from a higher-level design description is not a new one. During recent years, the notion of software architecture has emerged as the appropriate level for dealing with software quality (Rasool and Nadim, 2007). This is because the scientific and industrial communities have recognized that Software Architecture sets the boundaries for the software qualities of the resulting system. The aim of analyzing the architecture of a software system is to predict the quality of a system before it has been built and not to establish precise estimates but the principal effects of architecture (Abdelmoez et al., 2009). Designing architecture so that it achieves its quality attribute requirements is one of the most demanding tasks an architect faces (Taylor et al. 2009). It is demanding for several reasons including lack of specificity in the requirements, shortage of documented knowledge of how to design for a particular quality attributes, and the trade-offs involved in achieving quality attributes (Outi et al., 2009). It would be desirable to have a method that guides the architect so that any design produced by the method will reliably meet its quality attribute requirements.

Literature review

Software architecture provides the solution for which technical and operational problem can be resolve easily. Lots of researchers proposed variety of papers for the given work are given below:

Pradip Peter Dey (2011), presented a strongly adequate software architecture defined along with some other software quality attributes which contributed in formative assessments of software architecture. The architectural categories were not constrained by a particular programming language, or domain. Software engineers have strived for the strongly adequate software architecture. However, software architecting was an iterative process and formative assessments guide that the architects to improve the qualitative aspects in an iterative process. The categories proposed in given paper have intended to help reviewers in formative assessments. The role of formative assessments has stressed during the development process in order to produce revised architectures from initial work or working progress.

Outi et al. (2009) proposed an approach that used SA in software architecture design. A responsibility dependency graph has been given as input and architecture styles and design patterns were used as transformations when searching for a better solution in the neighborhood. The solution was analysed with regard to quality and effectiveness. The experimental results achieved with given approach showed that although extremely high quality values have achieved with given approach, their “true” quality as evaluated by examining the Unified Modeling Language (UML) class diagrams was not actually as good. However, when combining the solution achieved with SA with a GA implementation, the actual quality of the produced solutions increased as well as the calculated metric values. The proposed paper would suggest that further work should be done with studying the combination of these two algorithms in software architecture design. Studying the definition of evaluation functions for simulated annealing and genetic algorithm should be done as well, as using the same function apparently gives quite different types of solutions when using the different algorithms. Their future work attend to these questions as well as deriving real test cases to further evaluate the approach, and adding more design patterns to cover a larger search space of possible architectures. They have planned to implement a multi-objective fitness function primarily for the GA implementation.

Abdelmoez et al. (2009) given a paper in which Software Architecture Risk Assessment (SARA) tool designed and implemented as a tool for computing and analyzing architectural level risk factors like maintainability-based risk, reliability-based risk and requirement-based risk. By manipulating the data acquired from domain experts and measures obtained from Unified Modeling Language (UML) artifacts, SARA Tool used in the design phase of the software development process to improve the quality of the software product and identify critical components that have high risk levels. They used the product line architecture of a Microwave Oven to demonstrate the usage of SARA tool in assessing PLA. The modified version of the Microwave Model has been aggregated to consist of 9 sequence diagrams and two class diagrams. There were a total of 14 optional and variant classes. From the product line architecture a total of 96 validated product members, were generated with the instantiation process.

Ampatzoglou et al. (2011) suggested a methodology for exploring designs where design patterns have been implemented, through the mathematical formulation of the relation between design pattern characteristics and well known metrics, and the identification of thresholds for which one design becomes more preferable than another. The given approach assisted goal oriented decision making, since it was expected that every design problem demands a specific solution, according to it was special needs with respect to quality and expected size. Their methodology has been used for comparing the quality of systems with and without patterns during their maintenance. Thus, three examples that employ design patterns have been developed, accompanied by alternative designs that solve the same problem. All systems have been extended with respect to their most common axes of change and eleven metric scores have been calculated as functions of extended functionality. The results of the analysis have identified eight cut-off points concerning the Bridge pattern, three cut-off points concerning Abstract Factory and 29 cut-off points concerning Visitor. In addition to that, a tool that calculates the metric scores has been developed.

Christian and Mila (2011) described how component-based systems with multiway cooperation focused on the basis of an architectural constraint that went beyond common acyclicity requirements. The given analysis have concerned on the property of deadlock-freedom of interaction systems and given a polynomial-time checkable condition that ensured deadlock-freedom by exploiting a restriction of the architecture called disjoint circular wait freedom. Roughly speaking, given architectural constraint disallowed any circular waiting situations among the components such that the reason of one waiting was independent from any other one. On the other hand, if their approach failed, the information provided by the entry interactions has given a hint of which components were involved in a potential deadlock. With given information, a software engineer has taken a closer look at given potentially small set of components and either resolve the reason manually or encapsulate given set in a new composite component that has equivalent behaviour, was verified deadlock-free with another technique, and now causes no problems in the remaining system. Their approach used as a design pattern to ensure that a system was correct by construction. If a software engineer sticks to the composition rule imposed by their architectural constraint, a subsequent application of their condition after each composition step facilitated a correct system design in an automatic and convenient way. They concluded the paper with an overview of the current state of affairs in their work on interaction systems. In their research perspective, they followed ideas that ultimately allowed for correctness by construction. They followed the philosophy to develop and investigate design patterns or architectural constraints that were amenable to the formulation of efficiently checkable conditions for the properties in question.

Germán et al. (2010) given a paper in which SAME tool computed the similarity between cases by considering the particular dimensions of connector catalogues. The attributes and values for these dimensions depend upon the overall design context, the application domain and the designer's perspective of the problem. As a consequence, the results of the similarity are function biased. So far, they have taken a simple approach based on the structural characteristics of components playing similar roles when attached to connectors. However, a stronger compatibility check required the components to be also equivalent from a behavioral point of view. A related drawback indicated that there was a lack of behavioral modelling in the C&C architectural specifications. In the current SAME implementation, the designer gives details about the way components behave when interacting with each other's. The proposed method prevented the adaptation of the object-oriented solutions to generate behavioral diagrams - such as sequence diagrams - that provided a more complete picture of the object-oriented implementation to the designer. The behavioral aspect of materializations is a topic for future work. SAME provided an editor for the creation of materialization experiences, the specification of the interaction models was still a highly manual task. To overcome the given situation, they were planning to extend the SAME Eclipse Plugin which provides a user-friendly interface that supported the construction of interaction models for the materialization experiences.

PROBLEM DEFINITION

In present time, software architecture is a major issue in any software organization, which develops software for some particular organization or firm. Lots of things affect software development life cycle. To design any software designs we have to keep some points in mind to develop effective software in reasonable time and cost. Here we described the following issues, which have to be removed at the time of software design phase (Hofmeister et al. 1999):

What is the most essential part for a software development industry to do to get the main out of its software architects and provide software architectures of the top essential quality?
What should be steps to measure the capability?
In what way the "theory of software architecture competence" look like?
What are the possible organizational practices presently at work to enhance capability?

SOA framework

The desire for enterprise systems that have flexible architectures, detailed designs, implementation agnostic and operate efficiently continues to grow. A major effort towards satisfying this need is to use SOA. Moreover, there is new research and development in order to achieve more demanding capabilities (example, workflow service composition with run-time adaptation to changing Quality of service attributes) that have been proposed for service- based systems, especially in the context of system. A basic concept is for SOA to enable specifying the creation of services that can be automatically composed to deliver desired system dynamics while satisfying multiple Quality of service attributes. As shown in Figure 1. A fundamental SOA concept is to enable flexible composition of independent services in a simple way. The simple concept is crucial since it separates details of how a service is created and how it may be used. This kind of modularity is defined based on the concept of brokers and its realization as the broker service. The SOA conceptual framework lends itself to the separation of concerns ranging from application domains (example, business logic) Information Technology (IT) infrastructure is one of the choices of programming languages and operating systems. The interoperability at the level of services means loose coupling of reusable services. The high-level description of the SOA principals does not account for the operational dynamics of SOA, especially with respect to time-based operations. Therefore, understanding the dynamics of a service-based system using simulation is important. Simulation can also support specific kinds of service-based software systems that are targeted for business processes with specialized domain Knowledge.

SOA resources

Enterprise applications typically require different kinds of interfaces to the data they store and the logic they implement: data loaders, user interfaces, integration gateways and others. Despite their different purposes, these interfaces often need common interactions with the application to access and manipulate its data and invoke its business logic. The interactions may be complex, involving transactions across multiple resources and the coordination of several responses to an action. Encoding the logic of the interactions separately in each interface causes a lot of duplication. As shown in Figure 2. A Service Layer defines an application's boundary and its set of available operations from the perspective of interfacing client layers. It encapsulates the application's business logic, controlling transactions and coordinating responses in the implementation of its operations

SOA architectural model

Service-Oriented Architecture (SOA) has been widely promoted by analysts and IT vendors as the architecture capable of addressing the business needs of modern organizations in a cost-effective and timely manner. Perceived SOA benefits include improved flexibility and alignment between business processes and the supporting enterprise applications, lower integrations costs (in particular for legacy applications), and numerous other advantages. Although, SOA can play an important role in inter enterprise business-to-business (B2B) applications, SOA is primarily regarded as an intra-enterprise architecture used for internal integration. SOA adoption was initially driven by the emergence of Web Services and related technologies and the need to provide a more effective enterprise computing architecture oriented modelling. SOA is explored in network drivers using in service oriented distributed enterprise applications. Service oriented architecture is generally the structure of components in a program or system, their inter-relationships, and the principles and design guidelines that control the design and evolution in time. Software engineering, a design pattern is a general reusable solution to a commonly occurring problem within a given context in software design. A design pattern is not a finished design that can be transformed directly into source or machine code. It is a description or template for how to solve a problem that can be used in many different situations. Patterns are formalized best practices that the programmer must implement in the application Object-oriented design. Patterns typically show relationships and interactions between classes or objects, without specifying the final application classes or objects that are involved. Patterns that imply object- orientation or more

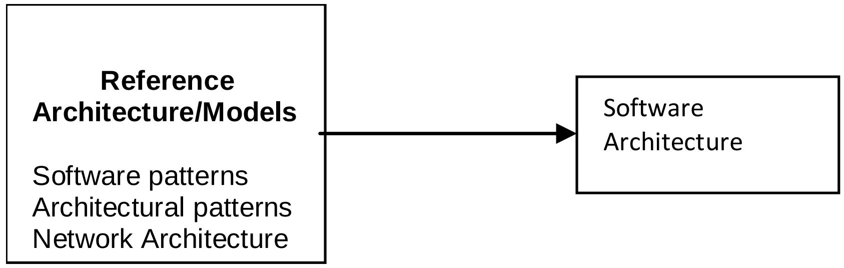

Figure 1. SOA framework model.

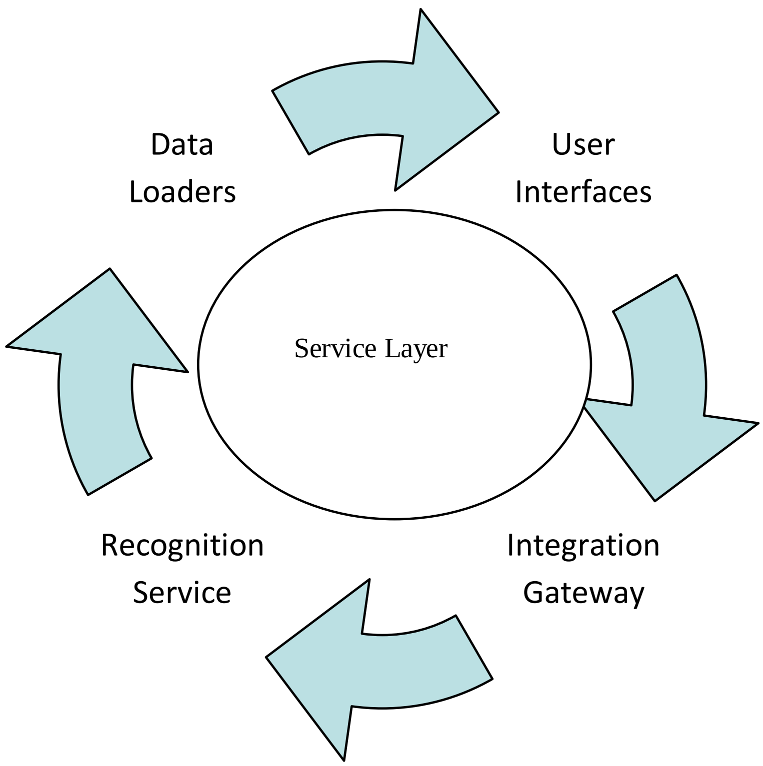

Figure 2. SOA resource activities.

generally mutable state are not as applicable in functional programming languages.

The Software Architect will be responsible for contributing specialized technical knowledge in multiple development efforts using object-oriented analysis and design, Service Oriented Architecture (SOA) and distributed systems. Principle responsibility will be the design and implementation of an enterprise-class platform to enable application supportability and performance management. SOA is the aggregation of components that satisfy a design needs. It comprises components, services and processes. Components are binaries that have a defined interface (usually only one), and a service is a grouping of components (executable programs) to get the job done. This higher level of application development provides a strategic advantage, facilitating more focus on the business requirement. SOA isn't a new approach to software design; some of the notions behind SOA have been around for years. A service is generally implemented as a coarse-grained, discoverable software entity that exists as a single instance and interacts with applications and other services through a loosely coupled (often asynchronous), message-based communication model. The most important aspect of SOA is that it separates the

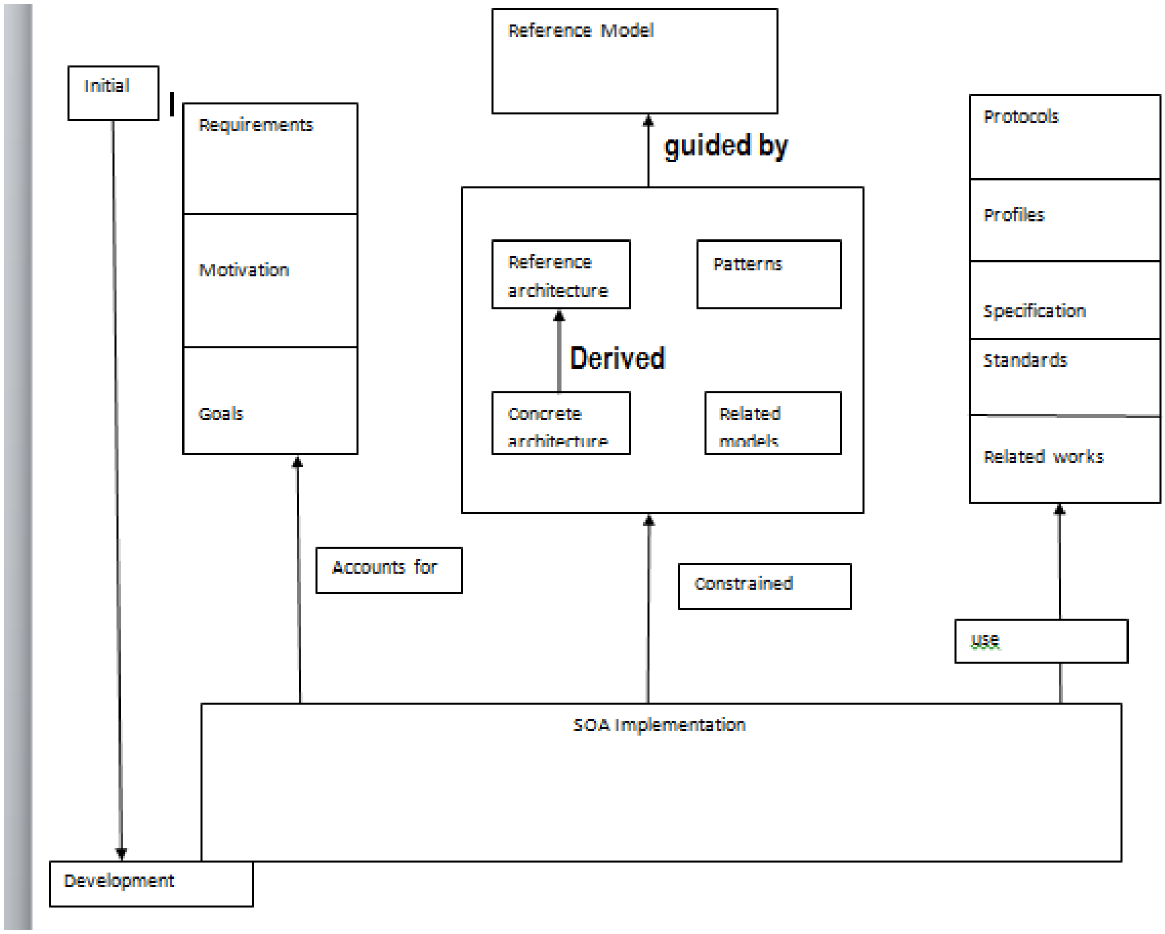

Figure3. SOA proposed architect design.

service's implementation from its interface. Service consumers view a service simply as a communication endpoint supporting a particular request format or contract as shown in Figure 3.

Reference architecture is a more concrete artifact used by architects. Unlike the reference model, it can introduce additional details and concepts to provide a more complete picture for those who may implement a particular class. Reference architectures declare details that would be in all instances of a certain class, much like an abstract constructor class in programming. Each subsequent architecture designed from the reference architecture would be specialized for a specific set of requirements. Reference architectures often introduce concepts such as cardinality, structure, infrastructure, and other types of binary relationship details. Accordingly, reference models do not have service providers and consumers. If they did, then a reference model would have infrastructure (between the two concrete entities) and it would no longer be a model. The reference model and the reference architecture are intended to be part of a set of guiding artifacts that are used with patterns. Architects can use these artifacts in conjunction with others to compose their own SOA. The concepts and relationships defined by the reference model are intended to be the basis for describing reference architectures that will define more specific categories of SOA designs. Specifically, these specialized architectures will enable solution patterns to solve a particular problem. Concrete architectures may be developed based upon a combination of reference architectures, architectural patterns and additional requirements, including those imposed by technology environments. Architecture is not done in isolation; it must account for the goals, motivation, and requirements that define the actual problems being addressed. While reference architectures can form the basis of classes of solutions, concrete architectures will define specific solution approaches.

Visibility and Real World Effect are also key concepts for SOA. Visibility is the capacity for those with needs and those with capabilities to be able to see and interact with each other. This is typically implemented by using a common set of protocols, standards, and technologies across service providers and service consumers. For consumers to determine if they can interact with a specific service, Service Descriptions provide declarations of aspects such as functions and technical requirements, related constraints and policies, and mechanisms for access or response. The descriptions must be in a form (or can be transformed to a form) in which their syntax and semantics are widely accessible and understandable. The execution context is the set of specific circumstances surrounding any given interaction with a service and may affect how the service is invoked. Since SOA permits service providers and consumers to interact, it also provides a decision point for any policies and contracts that may be in force. The purpose of using a capability is to realize one or more real world effects. At its core, an interaction is “an act” as opposed to “an object” and the result of an interaction is an effect (or a set/series of effects). Real world effects are, then, couched in terms of changes to this shared state. This may specifically mutate the shared state of data in multiple places within an enterprise and beyond.

The concept of policy also must be applicable to data represented as documents and policies must persist to protect this data far beyond enterprise walls. This requirement is a logical evolution of the “locked file cabinet” model which has failed many IT organizations in recent years. Policies must be able to persist with the data that is involved with services, wherever the data persists. A contract is formed when at least one other party to a service oriented interaction adheres to the policies of another. Service contracts may be either short lived or long lived.

Contribution of the paper

Software architecture is a main concern to improve the experience in current industry for producing quality software at reasonable time and cost. It will examine some of the essential issues, which play an important role in software architecture design and it explored five different phase in organization by which we can provide most essential practices which will be unique models of industry and human behavior that can be given on software architecture design and will be used to help organization and also enhance the architectural capability of personal and organizations.

Phase I: It will analyze the duties, skills and knowledge. We will analyze the work of individuals. In which the skills he/she has and how much knowledge he/she have? We will divide knowledge on the basis on domain specific and technology specific.

Phase II: In this phase we will analyze the human performance technology. It can be measured in the terms of time and cost.

Phase III: In this phase we will analyze the organizational learning. It analyze the learning phase through providing some questionnaires, conducting interviews, identifying change in knowledge and organizational performance.

Phase IV: In this phase we analyze the organizational coordination. In what manner we can provide co-ordination, coordination will be for a team or for some team. The main concern part is generating an inter-team coordination model for firm developing a single product or a closely related set of products.

Phase V: In this phase we will manage the task using neural network. In this phase we will have a group of task using neural network as the main task will be executed.

It will select best task among the group of task. There are number of task an organization has to perform. But the main concern is to know which of the task will be executed first. Choosing the best task according to the environment factors and availability of employees is the best practice in the real world. Software architecture is the set of significant decisions about software of organization which include security, task management, maintainability, performance, resilience, reuse, usability. Our main aim is to enhance these constraints in a proper way. In any organization lots of tasks will be present to perform. Here we will give some priority weightage to each task. In the case of a neural network (NN) based task scheduler, once the job parameters are exactly trained for a particular schedule, it will never miss that given scheduling pattern for that particular task.

CONCLUSION

This paper proposed new intelligence with service oriented architect paradigm to enable system quality to connect with software architectural models from which it is possible to extract precisely information. Our scheme has been proven to have software design with quality in the standard model. A systematic complexity analysis and extensive experiments shows that our proposal is also efficient in terms of computation and design of network used to describe different varieties of messages in SOA.These features of service with network analysis framework scheme a talented solution to group-service oriented communication with access control in various types of design.

Conflict of Interests

The author have not declared any conflict of interests.

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Full Length Research Paper

The comparison of logistic regression models, on analyzing the predictors of health of adolescents, having multinomial response in Jimma Zone South-west Ethiopia

Girma Tefera[1]*, Legesse Negash[2] and Solomon Buke[2]

[1]University of Wisconsin School of Medicine and Public Health, Ethiopia.
[2]Department of Statistics, College of natural science, Jimma University. Ethiopia.

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Self- reported health status is the most commonly used measures of subjective and global measure of health because it is simple, economical and easy to administer. The objective of the study is to compare the performance of logistic regression models having multinomial response and identify the factors affecting health status of adolescents. Based on two stage sampling technique 2084 adolescents were interviewed to study the health status of teenagers in Jimma zone. In this article, we reviewed the most important logistic regression model and common approaches used to verify goodness-of-fit, using software R. We performed formal as well as graphical analyses to compare ordinal logistic regression models using data sets of health status. The results obtained from both baseline category logit model and ordinal logistic regression showed that sex of adolescents, source of drinking water and educational status significantly affect health status of teenagers. It was also found that a cumulative logit model containing these predictors provided the best description of the dataset among baseline category logit model, adjacent category logit model and continuation ratio model.

Key words: Adolescents' health status, multinomial logistic regression and ordinal logistic regression models, model comparisons using Akakie information criteria (AIC), goodness of fit.

INTRODUCTION

"Self-assessed", "self-reported" or "self-rated health" questions such as "How would you rate your current health status and would you say that it is very good, good, moderate/fair or poor/bad?" are among the most commonly used measure of subjective evaluation of health status. Past studies have found this type of question to be a useful global measure of health (Zimmer et al., 2000).

The health status is usually classified as very good, good, moderate and poor/bad. When the researchers are

*Corresponding author. E-mail: girmastat@gmail.com. Tel: +251910185903.

interested in finding the determinants of self reported health status, usually two separate binary logistic regression models are required to develop by grouping the response variable into two categories. This task is tedious and cumbersome due to estimation and interpretation of more parameters.

In many epidemiological and medical studies, ordinal logistic regression model is frequently used when the response variable is ordinal in nature. The study has made an effort to identify the predictors of health status of adolescents using an ordinal logistic regression model and multinomial logit model and selecting the appropriate models among them.

The aim of the study is to compare the efficiency of multinomial logistic regression models and ordinal logistic regression models as well as identifying the significant predictors affecting self reported health status of adolescents.

MATERIAL AND METHODS

Baseline category logit (BCL) model

Even if the response is ordinal, we do not necessarily have to take the ordering into account. One category is arbitrarily chosen as the reference category. If it is the first category, then the logits for the other categories are defined by,

$$\log it\left(\pi_j\right) = \log\left(\frac{\pi_j}{\pi_1}\right) = x_j^T \beta_j \text{ for j = 2, ..., J},$$

$$\hat{\pi}_j = \hat{\pi}_1 \exp\left(x_j^T \beta_j\right) \text{and } \hat{\pi}_1 = \frac{1}{1 + \sum_{j=2}^{J} \exp\left(x_j^T \beta_j\right)}$$

Often, it is easier to interpret the effects of explanatory factors in terms of odds ratio than the parameters ***β***. The odds ratio for exposure for response *j* (*j* = 2,…,J) relative to the reference category *j*=1 is,

$$OR_j = \frac{\pi_{jp} / \pi_{ja}}{\pi_{1p} / \pi_{1a}}$$

, Where, π_{jp} and π_{ja} denote the probabilities of response category ***j*** (***j*** = 1, ..., *J*) according to whether exposure is present or absent, respectively.

Cumulative link models (CLM)

A cumulative link model is a model for an ordinal response variable, yi that can fall in j = 1. . . J, categories. Then yi follows a multinomial distribution with parameter πij, where πij denotes the probability that the i[th] observation falls in the j[th] response category. We define the cumulative probabilities as,

$\gamma_{ij} = P(y_i \leq j|x) = \pi_{i1} + \ldots + \pi_{ij}$

$$\gamma_{ij} = \frac{\exp\left(\theta_j + x_i^T \beta\right)}{1 + \exp\left(\theta_j + x_i^T \beta\right)}$$

Where θj is the cut points or intercept for each logit and β is vector of slopes for each logit. The CLM was originally proposed by Walker and Duncan (1967) and later called the proportional odds model by McCullagh (1980). The cumulative logits are also defined by Agresti (2002, 2007).

$$\log it\left(\gamma_{ij}\right) = \log it\left(P(y_i \leq j)\right) = \log\left(\frac{P(y_i \leq j)}{1 - P(y_i \leq j)}\right) = \log\left(\frac{\pi_{i1} + \pi_{i2} + \ldots + \pi_{ij}}{\pi_{i(j+1)} + \ldots + \pi_{iJ}}\right)$$

The odds ratio of the event y ≤ j at x1 relative to the same event at x2 is

$$OR = \frac{\gamma_j(x_1)/(1 - \gamma_j(x_1))}{\gamma_j(x_2)/(1 - \gamma_j(x_2))} = \frac{\exp\left(\theta_j + x_1^T \beta\right)}{\exp\left(\theta_j + x_2^T \beta\right)} = \exp\left((x_1^T - x_2^T)\beta\right)$$

This is independent of j. Thus the cumulative odds ratio is proportional to the distance between x1 and x2 which made McCullagh (1980) to call the proportional odds model (POM).

Adjacent Categories Model (ACL)

Another general model for ordered categorical data is the adjacent category model. As before, we let πij be the probability that individual i falls into category j of the dependent variable, and we assume that the categories are ordered in the sequence j=1, ..., J. Now take any pair of categories that are adjacent, such as j and j+1. We can write a logit model for the contrast between these two categories as a function of explanatory variables:

$$\log\left(\frac{\pi_{ij}}{\pi_{ij+1}}\right) = \theta_j + x_i^T \beta_j \quad \text{j=1,2, ... ,J-1}$$

Here, π_{ij} is i[th] adolescence falls in j[th] health rate category, $\pi_{i(j+1)}$ is the probability of i[th] adolescent falls in (j+1)[th] health rate category.

Continuation Ratio Model (CRM)

Feinberg (1980) proposed an alternative method to the POM for the analysis of categorical data with ordered responses. The continuation ratio model can then be formulated as,

$$\log\left(\frac{P(y = y_j \mid x)}{P(y > y_j \mid x)}\right) = \theta_j + x_i^T \beta \quad \text{j=1,2, ..., J-1}$$

And could essentially be viewed as a ratio of the two conditional probabilities, P(y= yj|x) and P(y >yj|x). The odds ratio for continuation ratio for the k[th] covariate x_k can be obtained directly from its model.

$$OR = \frac{P\left(Y = y_j \mid x_k^{(1)}\right) / P\left(Y > y_j \mid x_k^{(1)}\right)}{P\left(Y = y_j \mid x_k^{(0)}\right) / P\left(Y > y_j \mid x_k^{(0)}\right)} = \exp\left(\beta_k \left(x_k^{(1)} - x_k^{(0)}\right)\right)$$

The proportional odds assumption

By proceeding with the model given by (logit (γij) = θj + x_i^T *β*) the assumption of the covariate effects are invariant to the cut points, thus implying proportionality in the odds ratios. The proportional odds model can be considered as a series of J− 1 binary logits where the *β's* are constrained across the models such that: $\beta 1 = \beta 2 = \ldots = \beta J{-}1 = \beta$.

Goodness of fit and deviance

The goodness of fit or calibration of a model measures how well the model describes the response variable. Assessing goodness of fit involves investigating how close values predicted by the model with that of observed values. The goodness-of-fit x^2 process evaluates predictors that are eliminated from the full model, or predictors that are added to a smaller model. The question in comparing models is whether the log-likelihood decreases or increases significantly with the addition or elimination of predictor(s) in the model.

A more general measure called the deviance is defined for generalized linear models and contingency tables. The deviance is closely related to sums of squares for linear models (McCullagh and Nelder, 1989; Nelder and Wedderburn (1972). The deviance is defined as minus twice the difference between the log-likelihoods of a full (or saturated) model and a reduced model: $D = -2(\ell reduced - \ell full)$

The full model has a parameter for each observation and describes the data perfectly while the reduced model provides a more concise description of the data with fewer parameters. A special reduced model is the null model which describes no other structure in the data than what is implied by the design. The corresponding deviance is known as the null deviance and analogous to the total sums of squares for linear models. The null deviance therefore also denoted the total deviance. The residual deviance is a concept similar to residual sums of squares and simply defined as: $D_{resid} = D_{total} - D_{reduced}$. A difference in deviance between two nested models is identical to the likelihood ratio statistic for the comparison of these models. Thus, the deviance difference, just like the likelihood ratio statistic, asymptotically follows a χ2-distribution with degrees of freedom equal to the difference in the number of parameters in the two models.

Model comparison with likelihood ratio tests

Model selection includes the choice of the type of model and variable selection within a model type. In this framework, the parameters estimating method with numerical integration has the advantage of being based on likelihood statistics. Thus, models can be ordered according to likelihood-based measures, such as Akaike's information criterion or Schwarz's Bayesian criterion (which judges a model by how close its fitted values tend to be the true expected values, as summarized by a certain expected distance between the two). In selecting a model, we should not think that we have found the “correct” one. Any model is a simplification of reality. However, a simple model that fits adequately has the advantages of model parsimony. If a model has relatively little bias, describing reality well, it provides good estimates of outcome probabilities and of odds ratios that describe effects of the predictors.

A general way to compare models is by means of the likelihood ratio statistic. If we consider two models, m0 and m1, where m0 is a sub-model of model m1, that is, m0 is simpler than m1 and m0 is nested in m1. The likelihood ratio statistic for the comparison of m0 and m1 is $LR = -2(\ell 0 - \ell 1)$, where ℓ0 is the log-likelihood of m0 and ℓ1 is the log-likelihood of m1. The likelihood ratio statistic measures the evidence in the data for the extra complexity in m1 relative to m0. The likelihood ratio statistic asymptotically follows a χ2 distribution with degrees of freedom equal to the difference in the number of parameter of m0 and m1. The likelihood ratio test is generally more accurate than Wald tests. Cumulative link models can be compared by means of likelihood ratio tests with the anova method. Here, AIC is used for model selection and comparison. $AIC = -2l(\hat{b}) + 2P$, where $l(\hat{b})$: - the maximum log likelihood and p is the number of parameters. That is, a model having a smaller AIC value is the preferable model.

RESULT AND DISCUSSION

Results

The data comprise 2084 adolescents aged 13-17 years who were interviewed to study the health of adolescents in South west Ethiopia, Jimma zone. The adolescents' response was recorded on four ordinal scales (poor, moderate, good and very good). But counts for responses ”poor” and “moderate” heath rate are amalgamated into one category “poor/moderate” due to sparse cell counts (poor, 1.1% and moderate, 5.6%). From the total of 2084 adolescents, 81.2% had very good health status, 12.1% had good health status, and 6.7% had poor/moderate health status.

The significant variables in BCL model (using R package: MASS, R function: stepAIC) are used to determine a model with the minimum possible AIC (Akakie information criteria). Accordingly, sex, source of water and educational status are the selected variables to yield the minimum possible AIC of all the combinations. So, we fit the BCL model which consists of the variables that yield the minimum AIC, as the lowest AIC is the better fit (Table 1).

The maximum value of the log-likelihood function for the fitted model is -1241.5, giving the likelihood ratio chi-squared statistic 2(-1241.4+1260.5) = 38.1. The statistic, which has 8 degrees of freedom (10 parameters in the fitted model minus 2 for the minimal model), is significant compared with the X^2 (8) distribution (p-value < 0.0001), showing also the overall significance of the model. That means the null hypothesis of all slope parameter is zero is rejected (at least one coefficient of the parameter is different from zero). The AIC value is 2503 = (-2*(-1241.5) +2*10) for the above BCL model.

A difference in deviance between two nested models (Table 1) is identical to the likelihood ratio statistic for the comparison of these models (Holtbrugge and Schumacher, 1991). The deviance of the additive model which includes all covariates is 2467.8 and the deviance of the model which only includes the three predictors (that is, sex, source of water and education) is 2482.997. Therefore the likelihood ratio statistics which is 15.2= (2482.997-2467.8), asymptotically follows a χ2-distribution with degrees of freedom the difference in the number of parameters of the two models, 22-10 =12 (that is, $X^2(12)$).

Table 1. Base line category logit model.

	Base line category logit model			
Predictors	**log (π2/ π1)** **Good vs. poor/moderate health status**		**log (π3/ π1)** **Very good vs. poor/moderate health status**	
	Estimate (SE)	**OR (95% CI)**	**Estimate (SE)**	**OR (95% CI)**
Intercepts (β_{0j})	-0.01(0.41)		1.14(0.33)	
Sex				
Female	Ref	1		1
male	-0.18(0.21)	0.84(0.55, 1.28)	0.41(0.18)	1.5 (1.06 , 2.13)
Source of water				
Unprotected	Ref	1		1
Tap or Protected	0.38(0.28)	1.46 (0.85 ,2.51)	0.55(0.22)	1.74 (1.12 ,2.70)
Educational status				
No schooling	Ref	1		1
Primary school	0.44(0.37)	1.56 (0.75 , 3.23)	0.81(0.30)	2.26(1.25 ,4.07)
Secondary or more	0.10(0.47)	1.11 (0.44 , 2.78)	0.33 (0.38)	1.39 (0.66 ,2.93)

SE=standard error of the estimate, OR=odds ratio and CI= confidence interval.

Since the likelihood ratio statistics shows a p value of 0.23, it implies that we fail to reject the null hypothesis, H_0: $\beta_p = \beta_c = \beta_g = \beta_w = 0$ (the slope coefficients for place, cooking place, workload and garbage disposal are zero). Therefore, the model which only includes the three predictors (that is; sex, source of water and education) is better than the model which includes all covariates. Likewise when we compare the BCL model of Tables 1 and Table 2, we are obtaining the likelihood ratio of 3.97 with 2 degrees of freedom having p value of 0.14. This also implies that the model which consists of the three predictors is better than the model having additional one predictor (Table 1). Besides, it has minimum AIC; it implies that the model including only the three predictors is the parsimonious model for the BCL model.

When we check the proportional assumption of CLM, after obtaining the possible combinations of covariates which reduce the AIC value, the score test for the proportional odds assumption is 4.3 which follows a χ2-distribution with degrees of freedom 4= (4 *(3-2)), that is $X^2(4)= 9.49$, having p values of 0.37. It implies that the proportional odds assumption is satisfied. And the likelihood ratio tests for ACL model and CRM for checking the proportional odds assumption are 6.27 and 4.4 having p values of 0.18 and 0.36 respectively. Therefore, there is no evidence against the proportional odds assumption. Hence, the proportional assumption holds for both models, so, we do not need to fit the non proportional odds model.

The second column of estimates in Table 2, for example, gives the log-odds of responding in category 1 ("poor/moderate") versus other categories ("good" and "very good"), the log-odds of responding in categories 1 and 2 ("poor/moderate" and "good") versus category 3 ("very good"). The estimate of ACL model gives the log-odds of responding in category 1 ("poor/moderate") versus category 2 ("good") and category 2 ("good") versus category 3 ("very good"). The estimate of CRM gives the log odds of adolescents fall in one category of health status given the other better health status categories. Since the sign of the coefficients for a predictor is the same for all ordinal logistic regression models (Table 2), they have similar interpretations. For instance, the estimate of sex is -0.51, -0.31 and -0.49 for POM, ACL and CRM respectively. So the odd ratios of male adolescents for all models are less than one, implying that males have slightly better health than females.

The log-likelihood function for the CLM is -1243.6, giving the likelihood ratio chi-squared statistic 2*(-1243.6+1260.515) = 33.9. The statistic, which has 4 degrees of freedom (6 parameters in the fitted model minus 2 for the minimal model), is significant compared with the X^2 (4) distribution (p-value < 0.0001), showing the overall significance of the model. That means at least one coefficient of the parameter is different from zero. For ACL model and CRM, the likelihood ratios are 31.76 and 33.68 with $X^2(4)$ respectively (p value <0.0001 for the two models), showing also the over all significance of the models. The likelihood ratio statistics of POM for the two nested models; that is, for fitted model on Tables 1 and 2 is 1.58, which asymptotically follows a χ2-distribution with

Table 2. Ordinal logistic regression models for selected predictors.

	Ordinal logistic regression model								
	Proportional odds model			Adjacent category logit model			Continuation ratio model		
Predictors	**Estimate (SE)**	**OR (95% CI)**	**P-value**	**Estimate (SE)**	**OR (95% CI)**	**P -value**	**Estimate (SE)**	**OR (95% CI)**	**P - value**
Intercept$_1$ (θ_1)	-1.62 (0.24)			0.081 (0.18)			-1.68 (0.23)		
Intercept$_2$ (θ_2)	-0.43 (0.24)			-1.18 (0.169)			-0.93 (0.22)		
Sex									
Female	Ref	1			1			1	
Male	-0.51 (0.11)	0.6 (0.48,0.75)	< 0.001	-0.31 (0.08)	0.73 (0.63,0.86)	< 0.001	-0.49 (0.11)	0.61 (0.49,0.76)	<0.001
Source of water									
Unprotected	Ref	1			1			1	
Tap or Protected	-0.35 (0.15)	0.71 (0.52,0.95)	0.025	-0.25 (0.103)	0.78 (0.63,0.95)	0.013	-0.32 (0.15)	0.73 (0.55,0.97)	0.028
Educational status									
No schooling	Ref	1			1			1	
Primary school	-0.57 (0.21)	0.56 (0.37, 0.86)	0.008	-0.40 (0.14)	0.67 (0.51,0.88)	0.004	-0.54 (0.20)	0.58 (0.40,0.87)	0.007
Secondary (more)	-0.28 (0.27)	0.75 (0.45, 1.27)	0.290	-0.18 (0.18)	0.83 (0.59,1.18)	0.297	-0.27 (0.25)	0.77 (0.47,1.25)	0.290
Score test		4.2564			6.27			4.389	
Df.		4			4			4	
p-value		0.3724			0.18			0.356	
AIC		2499.171			2501.265			2499.35	

SE=standard error of the estimate, OR=odds ratio and CI= confidence interval.

degree of freedom 7 - 6 = 1 (that is, $X^2(1)$). Since the likelihood ratio statistics shows a p value of 0.21, it implies that we fail to reject the null hypothesis of Ho: β_w =0, (the coefficient of workload). Therefore a model which excludes this variable is preferable than a model which includes it. Like wise, the likelihood ratio statistics of the two nested models for ACL model and CRM are 0.57 and 1.68 respectively, which follows a $\chi 2$-distribution with each degree of freedom 7 - 6 = 1 (that is, $X^2(1)$). The likelihood ratio statistics shows a p value of 0.45 and 0.20; it implies just as the POM, we fail to reject the null hypothesis of Ho: β_w =0 for ACL model and CRM. Generally, a model which is fitted using the three predictors (that is, sex, source of water and education) is better than a model which is fitted using the four univaritly significant predictors or a model which includes all predictors for CLM, ACL model and CRM respectively. Having the maximum likelihood value for each model, it is possible to have their AIC value. Accordingly, the AIC value of POM is 2499.2, the AIC of ACL model is 2501.3 and the AIC of CRM is 2499.4.

Comparison of models

We used the likelihood ratio test to compare nested models, whereas AIC is used to compare the non-nested models. We compared all models using statistical criteria of log likelihood, goodness of fit and AIC. But choice of model should depend less on goodness of fit.

The ACL model corresponds to a BCL model. One can fit ACL by fitting the equivalent BCL model. But the construction of the ACL model recognizes the ordering of *Y* categories. To benefit from this model parsimony requires appropriate specification of the linear predictor. Since explanatory variable has similar effect for each logit, advantages accrue from having a single parameter instead of 2= (3-1) parameters describing that effect.

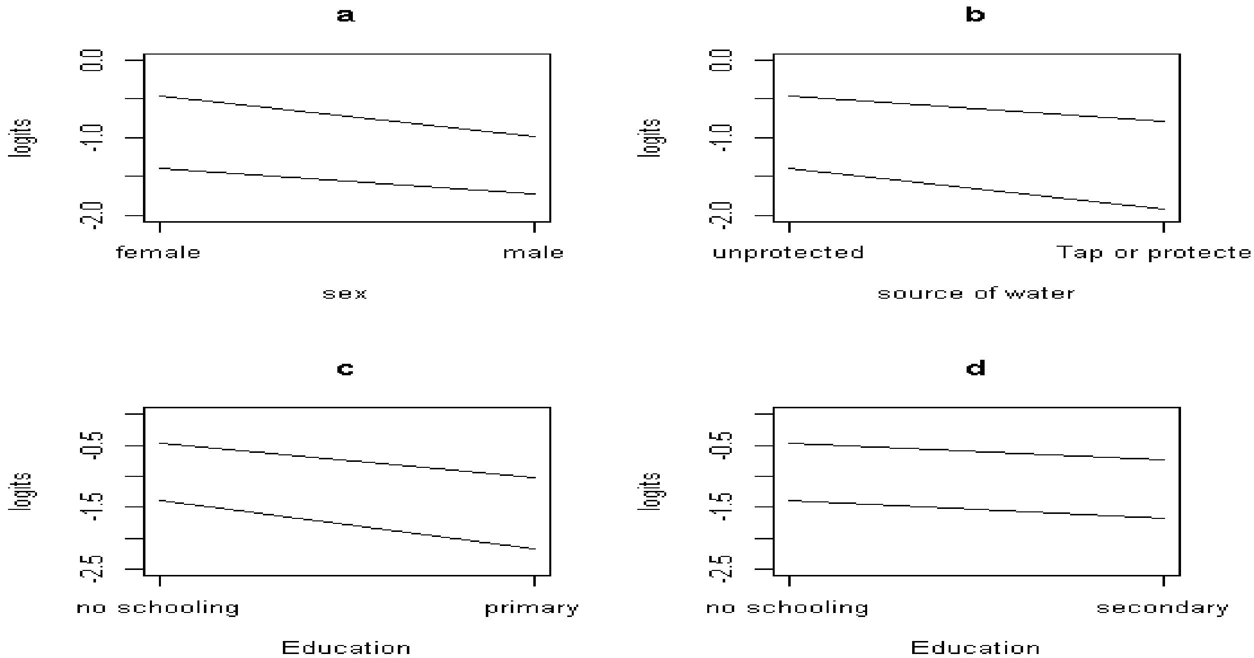

Figure 1. Proportional assumption of CLM.

When used with this proportional odds form, ACL model fits well. Besides it has minimum AIC value as compared with BCL model.

Usually, the fit of both CLM and CRM is similar for many data sets. Here also the fit of the two models is almost similar. When we see the AIC values of the two models, the AIC of CLM is slightly smaller than that of CRM, has also slightly higher goodness of fit (p=0.79) than CRM (p=0.78) and proportionality is satisfied in better way than other models as its p value is the largest of all. Besides this, the CRM, is not invariant under an amalgamation of adjacent categories; for this reason, CRM is suitable in circumstances where the individual categories of the response are intrinsically of interest. So, CLM is better than CRM for this data set.

When we see the best model among the selected models, CLM fits well for this data set. It is also better than ACL model since it has minimum AIC value and goodness of fit for CLM has larger p value (0.79) than ACL model (0.65). Therefore, POM is the parsimonious model. Because, it satisfies the proportional assumption, has less number of parameters as compared with BCL model, shows model adequacy, has better goodness of fit and has smaller value of AIC as compared with the other models.

Generally, ordinal logistic regression model is better than nominal logistic regression model for this data set.

The final appropriate model is CLM that has two logits in which each logit is only different with their cut point values because of the fulfillment of the proportional odds assumption for this data set. The effects of the explanatory variables are the same across the three logit functions: $\text{logit}(\gamma ij) = \theta_j - 0.51\ sex_{male} - 0.35\ swater_{tap} - 0.57 educ_{primary} - 0.28\ educ_{secondary}$; Where, sex_{male} = male adolescences, $swater_{tap}$ = tap or protected source of water, $educ_{primary}$ = primary education $educ_{secondary}$ =secondary education; i = 1, 2. . . 2084 and j = 1, 2 (Figure 1).

DISCUSSION

The POM and CRM are the most widely used in epidemiological and biomedical applications (Ananth and Kleinbaum, 1997) while other models for analysis of ordinal outcomes have received less attention. This is because both models may be interpreted in terms of odds ratios (familiar to epidemiologists), basic underlying assumption of each model—equality of β's and statistical models may be plausible biologically. Armstrong and Sloan (1989) reported that usually both CLM and CRM are similar for many data sets. Here also the fit of the two models is almost similar in this study.

The POM can be viewed as a model nested with the unconstrained PPOM, and according to the deviance, the unconstrained partial proportion odds model is better than POM as it has a smallest p value (p<0.05) and the proportionality assumption is violated (Ananth and Kleinbaum,1997; Peterson and Harrell, 1990). But in this study POM is the selected model as the assumption is satisfied and had minimum AIC. Usually BCL models are better than ordinal logistic regression models when the proportional odds assumption is violated; in such cases BCL model can be treated as an alternative model for ordinal logistic regression model.

According to this study, CLM was found to be the better model than other models as it had minimum AIC, satisfied the proportional assumption and had better goodness of fit. Besides AIC, an intuitive choice between CLM and CRM can also be based on the goals of statistical analysis.

This finding is consistent with the results of other studies. For example; educational attainment was significantly associated with self-rated health, in the expected directions and females were slightly more likely than males to report fair or poor self-rated health (Veenstra, 2011).

Conclusion

Ordinal logistic regression models were better than nominal logistic regression model. Among ordinal logistic regression models the CLM or proportional odds model was an improved fit as compared to the rest models for any combination of variables in the data set. We also found that sex, source of drinking water and educational status of the adolescents had a significant effect on their health as they were the possible combinations to yield the minimum AIC in the CLM. Being literate and using of tap or protected water had a positive contribution for a better health status of teenagers but high workload which was univariatly significant had a deteriorate impact on state of health and boys were less likely than females to report a deteriorate state of health.

Conflict of Interests

The authors have not declared any conflict of interests.

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Cognitive effects of curriculum model and school type on science learning: Implication for production of quality young scientists

Moemeke, Clara Dumebi[1]* and Konyeme, Josephine Ese[2]

[1]Department of Curriculum studies and Educational Technology, College of Education, Agbor, Delta State, Nigeria.
[2]Integrated science Department, College of Education, Agbor, Delta State, Nigeria.

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The study focused on determining the influence of curriculum models and school type variables on students' cognitive learning outcome in science. Opinions vary as to variables that affect science learning outcomes among boys and girls. Research reports have also contradicted one another on the disparity that exists between the sexes in achievements in science and in participation in science occupations. This study is an attempt in establishing empirically the effect of these variables on science learning outcome as well as proffer possible remedies to poor science achievement among learners. Four null hypotheses were tested in the study. Two hundred and ten (210) SS2 science students in nine intact classes from three secondary schools (one from each senatorial zone) in Delta state, Nigeria were taught six concepts in biology using three curriculum models (Traditional Expository Approach (TEA), Hypothetico-Predictive Learning Cycle (HPLC) and Descriptive Learning cycle (DLC)) for ten weeks. The three sampled schools consist of one All-boy, one All-girl and one co-educational school respectively. A 3x3x2 factorial design was employed while data was collected using three instruments (Test of scientific reasoning skill, test of attitude towards science and test of achievement in science). The resulting data was subjected to Analysis of Variance (2-way ANOVA) with repeated measures as well as graphical display. Result showed that while outcome varied along test types, with attitude most favoured, there was no interaction with either school type or gender. However, HPLC proved more effective in improving students' learning outcome across school types and gender. It was concluded that while all school types had the same effect on learning outcome of science students, there is need to employ adequate curriculum models that afford learners opportunity to learn science the way scientist do as well as provide adequate and conducive physical, social and psychological science learning environments for all school types and for both sexes.

Key words: Teaching science, learning cycle model, instructional methods, learning outcome, curriculum model, School type.

INTRODUCTION

One of the outstanding natural endowment of Nigeria as a nation is her human population. This great asset if well harnessed has the potential of producing high caliber human capital necessary for lifting the country into

*Corresponding author. E-mail: claramoekphd@yahoo.co.uk, Tel: +2348037438405.

economic, political, and technological prosperity. Many nations such as United States of America, China, Japan, and even India have utilized their human capital base as launching pad for national prosperity. For this to happen, human capital development through quality education of the citizens (male and female) was given paramount attention. In Nigeria, about half of her population is made up of female gender. It means that for any meaningful development of the country, both sexes must contribute their quota equitably in the world of work. Any lopsidedness or tilt may not augur well in the overall interest of the nation. The existence of gender differences in the learning of and achievement in science and Mathematics has been a subject of academic research for many decades and in many countries (Lee and Lockheed, 1990; Omoifo, 1996, 2004; Tambo et al. 2011) such as Zimbabwe and Nigeria. Despite efforts to engender equity, disparity seems to persist in gender participation and achievement in science and science related jobs and profession especially in developing nations like Nigeria. While indicators have shown a gradual reduction in gender gap in educational access at the primary school in Nigeria (Okogwu, 2009), the same cannot be said of science achievement (Zembar and Blume, 2011), scientific reasoning skill acquisition (Lawson, 2002; Musheno and Lawson, 1999), entry into science related jobs and professions and scientific attitude exhibition.

Studies in the effect of learning environment on students' performance in learning outcome (Hopkin, 2001; Mallam, 1993) revealed significant differences in the achievement of single-sex and co-educational students. Young and Fraser (1994) had earlier stated that most differences in learning outcome previously attributed to gender were actually due to school type. Efforts have also been made in research to identify factors or instructional elements that moderate how girls and boys learn science (Moemeke and Omoifo, 2008). The study shows that girls tend to benefit from curriculum models that emphasize inquiry, hands-on, hypothetico-predictive enquiries and those with visual information prompts (Moemeke, 1999) the same way it benefits low ability learners. In the middle of the 1990s, there was a tilt in research opinions towards co- education. Dale (1969) proposed substantial benefits in educating boys and girls in co-educational setups. Top of his reasons is that it provides avenue for provision of equal opportunities for both sexes. He argued that there was no evidence that coeducation has negative effect on education of girls. However, researches by American Association of University women in the 1990's (Elwood and Gripps, 1999) and Shaw (1995) called for a rethinking of issues of girls' education. They reported that girls in the single sex schools tend to achieve higher in Science and Mathematics even when their laboratories were less well equipped and with less qualified teachers than the boys schools. Different researchers have given reasons for higher achievement of girls in single sex girls' schools to include:

Self-concept which is the total belief that people have about their competence and ability is higher in girls from single sex schools than in girls from coeducation (Kassin et al. 2008; Tully and Jacob, 2010).
Other people's perception affects people's self-concept and as such teachers' communication, attitude and expectation of girls in single sex schools is higher than girls in coeducation. (Tambo et. al, 2011; Kassin et. al., 2008)
Reduced possibility of sex-role stereotyping in single-sex girls school compared to coeducation girls where there is possible high level of fear of success and assuring of leadership roles among girls (Lee and Lockheed, 1990)
Teachers' gender bias that exists latently in coeducational classrooms which promote subject choice bias in favour of boys' dominance, spitefulness and negative competitiveness (Tambo et. al, 2011).

The mediating role of curriculum model in determining achievement of students in schools in the different school types and for different levels of learning outcome is a major focal point of this study.

Statement of the problem

In the recent past, premium has been placed on learning environment as a factor in students' achievement in science. Such environments include both the physical and psychological spheres in which learning occur. An earlier study by Moemeke and Omoifo (2010) has implicated School type in this milieu. They showed that students from single sex schools performed better than their counterparts from co-educational schools in science. Some other studies have implicated high self- esteem among students from single sex schools as a possible determinant of achievement since it was found to be higher in single sex institution (Cardona, 2011; Lee and Lockheed, 1990). However, in terms of number of students enrolled for science subjects in schools, students from All-boys' school were found to opt for science subjects than girls in All-girls schools. The trend was maintained in coeducational schools (Jackson, 2011). Does it then mean that girls are reluctant to opt for science subjects even when taught using the same curriculum model with their male counterpart? The inconclusiveness of research evidence calls for further studies on the effect of school type on achievement in schools. It is likely that other variables such as curriculum model, intelligence, school location, and ethos as well as school management practices interfere with results hence the variation. This study therefore asks: To what extent does curriculum model and school type influence male and female students' achievement in science? Is there any learning outcome that is specially preferred by single sex or coeducational schools? Is there any interaction effect of curriculum model and school type on students learning outcome? It is hoped that this study will clear the air on these aspects of science learning research and as such give evidence based information for further actions towards gender equity in science classrooms as well as towards achievement of the Education for All (EFA) and Millennium Development Goals (MDGs) elements as it concerns gender and achievement of goals of science and technology education.

Research hypotheses

To enable this investigation, the following null hypotheses were stated.

1. There is no significant difference in learning outcome of science students from single sex and coeducational schools based on curriculum pedagotronics.
2. There is no significant difference in the learning outcome of girls from all-girls and their counterparts from coeducational schools in science learning outcome.
3. There is no significant difference in the learning outcome of boys from all-boys and their counterparts from coeducational schools
4. There is no significant interaction effect of curriculum model and school type on learning outcome in science.

METHODOLOGY

The independent variables in the study are curriculum model with three levels (Descriptive learning cycle, Hypthetico-predictive learning cycle and expository approach), school type with three levels (All-boys, All-girls and co-educational) and sex with two levels (Male and female). The dependent variable is learning outcome in three levels (Scientific reasoning skills, Attitude towards science and Achievement in science). The descriptive learning cycle (DLC) as proposed by Karplus and Their (1967) is sequenced approach, which begins with Exploration during which the learner explores the problem of study so as to raise questions which will form a pedestal to the second phase known as term introduction. In this phase, the teacher clarifies and defines concepts, which the exploring students may have come across in the first phase but could not make enough meaning out of. The third phase is the concept application phase during which the teacher and students develop a pattern that enables them to draw a link between concepts within and across disciplines. The HPLC follows the same pattern as the DLC except that there is a conscious effort to lure the learners into two important process skills of science — hypothesizing and predicting which enables them to raise their own hypotheses, make predictions based on their perceived evidence and by so doing reveal their misconceptions/ alternative conceptions about the problem. This exercise provides a platform for fruitful exploration that will follow. The Traditional Expository Approach (TEA) did not involve the learning cycle model. Instead, the approach was teacher- dominated. Students only received facts from the teacher except for few questions that may arise from the students which teacher clarifies.

Nine intact classes of SS2 students from three secondary schools in the three senatorial zones of Delta state Nigeria were used for the study. Each intact class selected from a zone received one of three treatment types for a period of two months (8 weeks). One of the three school types was purposively selected from each zone (All-boys, All-girls and Coeducational schools). A non-equivalent pre-test-post-test control group design without randomization was adopted within the quazi experimental domain. A total of 210 students consisting of 94 coeducational, 47 All-girls and 69 All-boys students participated in the study. Data was collected using three instruments. They are:

1. Test of Scientific Reasoning Skills (TRS) which is a 10- item test of logical reasoning in Biology. The instrument was adapted from Lawson (1992) logic task as used by Norman (1997) and tests for knowledge of relationship, logic of relationships and drawing conclusions based on identified relationships. The reliability coefficient of 0.62 was determined using K-R 21 formula statistically.
2. Test of Attitude towards Biology (TATB). The instrument is a 29-item 4-point likert with items framed either positively or negatively and from strongly agree, agree, disagree and strongly disagree. Scoring will be done from 4 to 1 in that order. The reliability coefficient of 0.78 was determined by Crombach alpha.
3. Test of Achievement in biology concepts (TAB). The instrument is a 45-item multiple choice instrument. The items are derived from past West African Senior School Certificate Examination (WASSCE) and National Examinations Council Examination (NECO) past question papers in selected concepts taught during treatment. The topics covered by the test were selected from the SS2 syllabus in Delta state. A reliability coefficient of 0.80 was calculated using K-R formula 21 statistically.

Treatment lasted for 10 weeks. The first and last weeks were used for the administration and collection of pretest and posttest data for the study respectively. The six selected concepts were taught within the remaining eight weeks. Three types of classroom procedures were drawn for the three curriculum models for the six lessons. Thus, a total of eighteen planned lessons were taught (see sample of lesson plan attached as appendix). All lessons were taught by the lead researcher and her partner to ensure uniformity while the science teachers in the selected schools acted as research assistants.

Data management and analysis

Data that resulted from the exercise were coded. The curriculum models (TEA, DLC and HPLC) were coded as 1, 2 and 3 respectively. School type which is a second independent variable in the study was coded 1 for coeducational schools, 2 for all-girls schools, and 3 for all-boys schools. Sex was also coded 1 for males and 2 for females. The dependent variable which is learning outcome consists of three levels (scientific reasoning skills, achievement in Biology concepts and attitude towards biology) was coded as A, B and C respectively. A one-way repeated measure Analysis of Variance (ANOVA) was adopted as statistical tool in this study using learning outcome as repeated measures. Differences found to be significant at 0.05 alpha level was subjected to post hoc analysis to determine the source of the significance.

ANALYSIS AND RESULTS

Hypothesis 1: There is no significant difference in learning outcome of science students from single sex and coeducational schools based on treatment.

A one-way ANOVA with repeated measure on one

Table 1. One-way ANOVA repeated measures for learning outcome, and coeducational and single-sex school types.

Hhhuy77675	Source	Sum of Squares	df	Mean Square	F	Sig.
(a). Within-subjects effects						
	LO	29044.420	1.022	28408.501	186.898	.000*
	LO * ST	302.367	1.022	295.747	1.946	.164
	Error(LO)	32323.705	212.656	152.000		
(b). Between-subjects effects						
	Intercept	1916868.555	1	1916868.555	5971.821	.000*
	ST	222.671	1	222.671	.694	.406
	Error	66765.000	208	320.986		

α= .05 * significant at p< .05.

factor was conducted to determine whether there was a statistical significance in learning outcome between science students from Coeducational and Single-sex schools. The independent variable included a between-subjects variable, School Type (Coeducational and Single-sex schools), and within-subject variable, repeated measures of Achievement test (AcT), Attitude test (AtT), and Scientific reasoning (SrT). The dependent variable was the test scores performance (in percentages) recorded in each test. Statistical significance was set at an alpha level of .05. The analysis tested if the assumption of Sphericity was violated or not. Mauchly's test indicated that the assumption of sphericity had been violated, X^2 (df=2) =647.57, p<.05, therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (E=.51). Table 1 shows that the learning outcome of science students in AcT (Mean=53.78, SD=.768), AtT (Mean=64.54, SD=.922), and SrT (Mean= 48.07, SD=.925) are significantly different, F (1.02, 212.65) =186.89, p=.000. These results suggest that science students' performance generally varies with respect to the test type; it shows peak performance in AtT (64.54), followed by AcT (53.78) and SrT (48.07).

Furthermore, findings show that there was not a statistically significant interaction in the learning outcome between the Test type (AcT, AtT, or SrT) and School Type (Coeducational or Single), F (1.02, 212.65) =1.94, p = .164. Thus, these results indicate that learning outcome of science students is statistically significant irrespective of the school type. Specifically, learning outcome for science students within Coeducational schools is statistically different; the same trend applies to their counterparts within Single-sex schools (Figure 1). This goes to show that science students' performance in the test types is similar despite the inherent differences in the sex-orientation, academic, and administrative structures of the distinct school types (Coeducational or Single-sex schools). Moreover, the findings in Table 2 also show that the average performance between students in Co-educational (Mean=54.87, SD=1.07) and Single-sex (Mean=56.03, SD=.96) schools was not significantly different, F (1, 208)=0.694, p=.406. Therefore, the average performance of science students in Co-educational schools is similar to that of their counterparts in Single-sex schools. However, single sex schools maintained a slight edge over their coeducational counterparts in scientific reasoning as is seen in Figure 1. To determine if there is any difference in the learning outcome of the overall sample from single-sex and co-educational school due to curriculum model applied, data is presented in Table 3.

A one-way ANOVA with repeated measure was conducted to determine whether the adoption of the Curriculum Models (CM) significantly affected the Learning Outcome (LO) of science students from Coeducational and Single-sex schools. In other words, the analysis sought to find out whether the performance of science students in Achievement test (AcT), Attitude test (AtT), and Scientific reasoning test (SrT) was influenced by the type of CM adopted. The independent variable CM was adopted – it was measured at three levels [Expository Approach (TEA), Descriptive Learning Cycle (DLC), and Hypthetico-Predictive Learning Cycle (HPLC)] - while the dependent variable was the performance scores (measured in percentages) for each test. Statistical significance was set at 0.05 level of significance. Mauchly's test indicated that the assumption of sphericity had been violated, X^2 (df=2) =13.34, p<.05, therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (E=.873). Table 3 shows that the LO of all science students was statistically significant given F(1.02, 210.83)=178.345 and p<0.05; this result suggests that the average score of the science students in (at least) one of the three test is significantly different from the rest. In essence, the average performance of students in the given tests i.e AcT, AtT, and SrT were not similar. This difference is further highlighted in Table 4 which shows that students' performance in AtT (mean score=64.260) was significantly better than AcT (mean score=53.550) and SrT (mean score=48.101), whereas their performance in AcT (mean score=53.550) was significantly better than SrT (mean

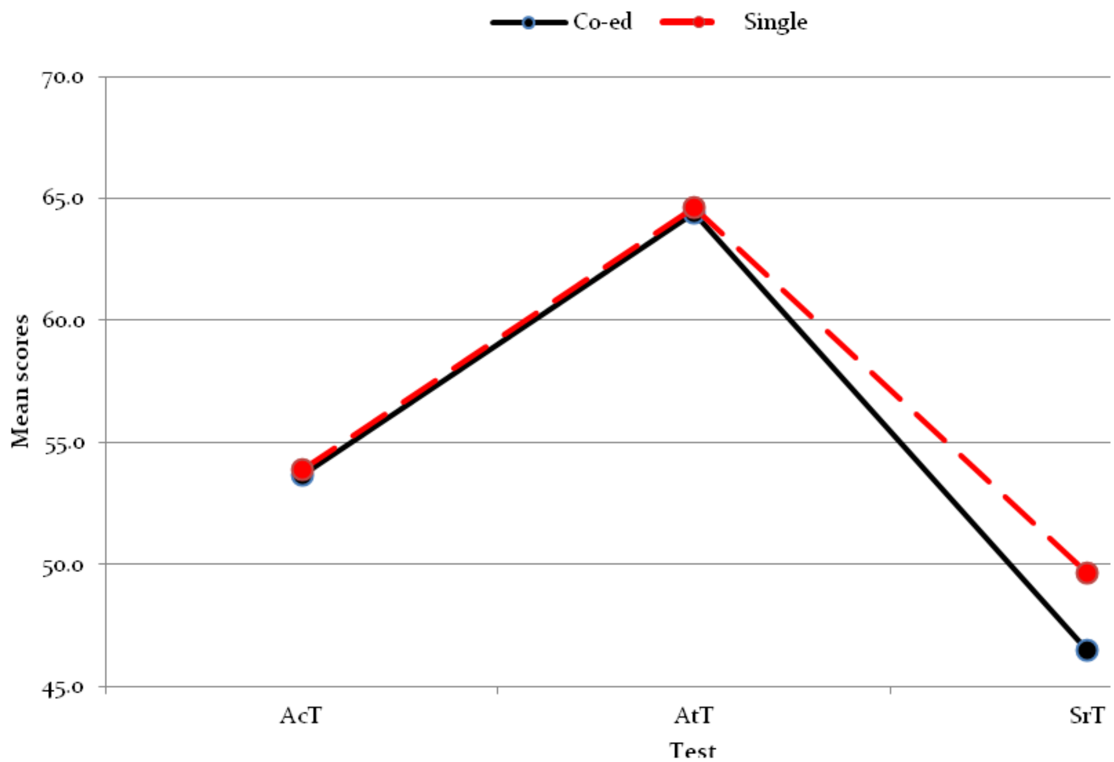

Figure 1. Graphical representation of subjects' performance in the three tests by school type.

Table 2. Mean scores for learning outcome, and single-sex and coeducational school types.

Variables		Mean	Std. Dev	95% CI	
				Lower	Upper
Learning outcome					
AcT		53.78	0.77	52.27	55.30
AtT		64.54	0.92	62.72	66.36
SrT		48.07	0.92	46.25	49.89
School type					
Co-ed	AcT	53.688	1.141	51.438	55.938
	AtT	64.426	1.370	61.725	67.126
	SrT	46.489	1.374	43.780	49.199
Single sex	AcT	53.879	1.028	51.854	55.905
	AtT	64.655	1.233	62.224	67.086
	SrT	49.655	1.237	47.216	52.094

score=48.101). Thus, from a generic point of view, science students (a combination of Coeducational and Single-sex schools) performed best in the AtT test, and least in SrT test.

Furthermore results in Table 3 (LO*CM) shows that the CM effect on LO of all science students was statistically not-significant given $F(2.04, 210.83)=0.688$ and $p>0.05$; this suggests that the order of performance of science students in the three test (AcT, AtT, and SrT) was not significantly influenced by the CM adopted. Specifically, this implies that irrespective of the nature/kind of CM adopted (whether TEA, DLC, or HPLC), the order of performances in the respective tests was still the same. Emphasis on this outcome is evidenced in Table 4 for TEA, the students performed best in AtT (mean score= 48.056) and least in SrT (mean score=43.333); for DLC,

Table 3. One-way ANOVA repeated measures for learning outcome of science students of Coeducational and Single-sex schools based on Curriculum model.

Sections	Source	Sum of Squares	df	Mean Square	F	Sig.
(a). Within-subjects effects						
	LO	27923.929	1.02	27417.167	178.345	.000
	LO * CM	215.498	2.04	105.794	.688	.506
	Error(LO)	32410.575	210.83	153.731		
(b). Between-subjects effects						
	Intercept	1895418.677	1	1895418.677	7101.732	.000
	CM	11740.351	2	5870.176	21.994	.000
	Error	55247.320	207	266.895		

α= .05; * significant at p< .05.

Table 4. Mean scores and standard deviations of learning outcome of coeducational and single-sex science students [based on curriculum model adopted].

Variables		Mean	Std. Dev	95% CI		Group
				Lower	Upper	
(a) *Learning outcome*						
AcT		53.550	.717	52.137	54.963	B
AtT		64.260	.860	62.564	65.956	A
SrT		48.101	.892	46.341	49.860	C
(b) *Learning outcome based on curriculum model adopted*						
TEA	AcT	48.056	1.330	45.433	50.678	B
	AtT	57.667	1.596	54.520	60.813	A
	SrT	43.333	1.656	40.069	46.598	C
DLC	AcT	54.065	1.138	51.822	56.308	B
	AtT	64.878	1.365	62.186	67.570	A
	SrT	47.439	1.416	44.647	50.231	C
HPLC	AcT	58.529	1.249	56.066	60.993	B
	AtT	70.235	1.499	67.280	73.191	A
	SrT	53.529	1.555	50.463	56.596	C
(c) *Curriculum Model*						
TEA		49.685	1.218	47.285	52.086	C
DLC		55.461	1.042	53.407	57.514	B
HPLC		60.765	1.144	58.510	63.020	A

the students performed best in AtT (mean score=64.878) and least in SrT (mean score=47.439); for HPLC, the students performed best in AtT (mean score=70.235) and least in SrT (mean score=53.529). Therefore the curriculum model did not significantly affect how the students performed in the tests. However, based on Table 3, the result shows that the performance of science students differed significantly based on the CM adopted, it yielded F(1.02, 210.83)=178.345 and p<0.05; this result indicates that students' overall LO score (cumulative score for AcT, AtT, and SrT) is significantly different for (at least) one of the CM adopted. This difference is further highlighted in Table 4 which shows the outcome of a Bonferroni post-hoc test. The post-hoc test shows that students' overall LO score for HPLC (mean score=60.765) was significantly higher than DLC (mean score=55.461) and TEA (mean score=49.685), whereas their overall LO score for DLC (mean score=55.461) was significantly higher than that of TEA (mean score=49.685). Thus, science students (a combination of Coeducational and Single-sex schools) had the best LO score when HPLC model was applied, and least LO score when TEA model was applied. In concluding the analysis, Curriculum model adopted will not significantly influence the learning outcome of science students from Coeducational and Single-sex schools.

Hypothesis 2*: There is no significant difference in the learning outcome of girls from All-girls and their counterparts in coeducational schools.*

A one-way ANOVA with repeated measure was conducted to determine whether there was a statistical significance in learning outcome between female science students from Coeducational and Girls-only schools. Mauchly's test indicated that the assumption of sphericity had been violated, X^2 (df=2) =13.34, p<.05, therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (E=.873). Table 5 shows that the learning outcome of all female science students are significantly different, F (1.75, 150.18) =57.684, p=.000. In particular, they performed similarly in AcT (Mean=60.95, SD=1.523) and AtT (Mean=60.37, SD= 1.355), whereas they performed significantly low in SrT (Mean=45.94, SD=1.453). As the results imply, all female science students are intellectually stronger in AcT and AtT than SrT.

Furthermore, findings show that there was not a statistically significant interaction in the learning outcome between the Test type (AcT, AtT, or SrT) and School Type (Female science students from Coeducational or Girls-only schools), F (1.75,150.18) =1.16, p = .311. Thus, these results indicate that learning outcome of female science students is statistically significant in both school types. Specifically, female science students within Co-educational schools performed similarly in AcT (Mean=60.19, SD=2.225) and AtT (Mean=58.37, SD= 1.981) but significantly low in SrT (Mean=46.34, SD=2.124); invariably implying that they are intellectually stronger in AcT and AtT than SrT. This same trend applies to their counterparts within Girls-only schools; similar performance in AcT (Mean=61.70, SD=2.079) and AtT (Mean=62.38, SD=1.850), but significantly low in SrT (Mean=45.53, SD=1.984); see Table 4. However, a closer look at the performances shows that those from Girls-only schools performed marginally higher in AcT and AtT, than their counterparts in Coeducational schools (Figure 2).

Moreover, the findings in Table 6 show that the average performance between female science students in Coeducational (Mean=54.97, SD=1.64) and Girls-only (Mean=56.54, SD=1.53) schools was not significantly different, F (1, 86)=0.492, p=.485. Therefore, the average performance of female science students in Coeducational schools follows the same pattern as that of their counterparts in Girls-only schools except that girls in single sex schools registered higher mean scores in AcT and AtT (Figure 2). A one-way ANOVA with repeated measure was conducted to determine whether the adoption of the Curriculum Models (CM) significantly affected the Learning Outcome (LO) of female science students from Coeducational and Girls-only schools. In other words, the analysis sought to find out whether the performance of female science students in Achievement test (AcT), Attitude test (AtT), and Scientific reasoning test (SrT) was influenced by the type of CM adopted. The independent variable was the CM adopted – it was measured at three levels [Expository Approach (TEA), Descriptive Learning Cycle (DLC), and Hypthetico-Predictive Learning Cycle (HPLC)] - while the dependent variable was the performance scores (measured in percentages) for each test. Statistical significance was set at 0.05 level of significance. Mauchly's test indicated that the assumption of sphericity had been violated, given X^2 (df=2) =12.18, p<.05, therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (E=.881). Table 7 shows that the LO of female science students was statistically significant given F(1.76, 149.79)=61.343 and p<0.05; this result suggests that the average score of the female science students in (at least) one of the three test is significantly different from the rest.

In essence, the average performance of female students in the given tests that is, AcT, AtT, and SrT were not similar. This difference is further highlighted in Table 4 which shows that female students' performances in AtT (mean score=64.260) and AcT (mean score=53.550) was not significantly different, yet their scores in both tests was significantly higher than SrT (mean score=48.101). This implies that female science students performed best in the AtT and AcT tests, and least in SrT test.

Furthermore, results in Table 7 that is, LO*CM, shows that the CM effect on LO of female science students was statistically not-significant given F(3.52, 149.79)=2.066 and p>0.05; this suggests that the order of performance of female science students in the three test (AcT, AtT, and SrT) was not significantly influenced by the CM adopted. As such, irrespective of the type of CM adopted (whether TEA, DLC or HPLC), the result indicates that the order of performances in the respective tests was still the same. Emphasis on this outcome is detailed in Table 4: for TEA, the female students performed similarly in AtT (mean score=54.19) and AcT (mean score=53.81), and performed least in SrT (mean score=39.35); for DLC, the female students performed similarly in AtT (mean score= 56.98) and AcT (mean score=59.73), and performed least in SrT (mean score=47.67); for HPLC, the female students performed similarly in AtT (mean score=70.67) and AcT (mean score=71.68), and performed least in SrT (mean score=51.48). Therefore the curriculum model did not significantly affect how the students performed in the tests.

However, based on Table 8, the result shows that the performance of female science students differed significantly based on the CM adopted, it yielded F(2, 85)=24.92 and p<0.05; this result indicates that female students' overall LO score (cumulative score for AcT, AtT, and SrT) was significantly different for (at least) one of the CM

Table 5. One-way ANOVA repeated measures for learning outcome, and females in coeducational and girls-only school types.

Sections	Source	Sum of Squares	df	Mean Square	F	Sig.
(a). Within-subjects effects						
	LO	12675.583	1.746	7258.568	57.684	.000*
	LO * ST	254.704	1.746	145.854	1.159	.311
	Error(LO)	18897.730	150.181	125.833		
(b). Between-subjects effects						
	Intercept	816810.664	1	816810.664	2480.765	.000
	ST	161.917	1	161.917	.492	.485
	Error	28316.149	86	329.258		

α= .05 * significant at p< .05.

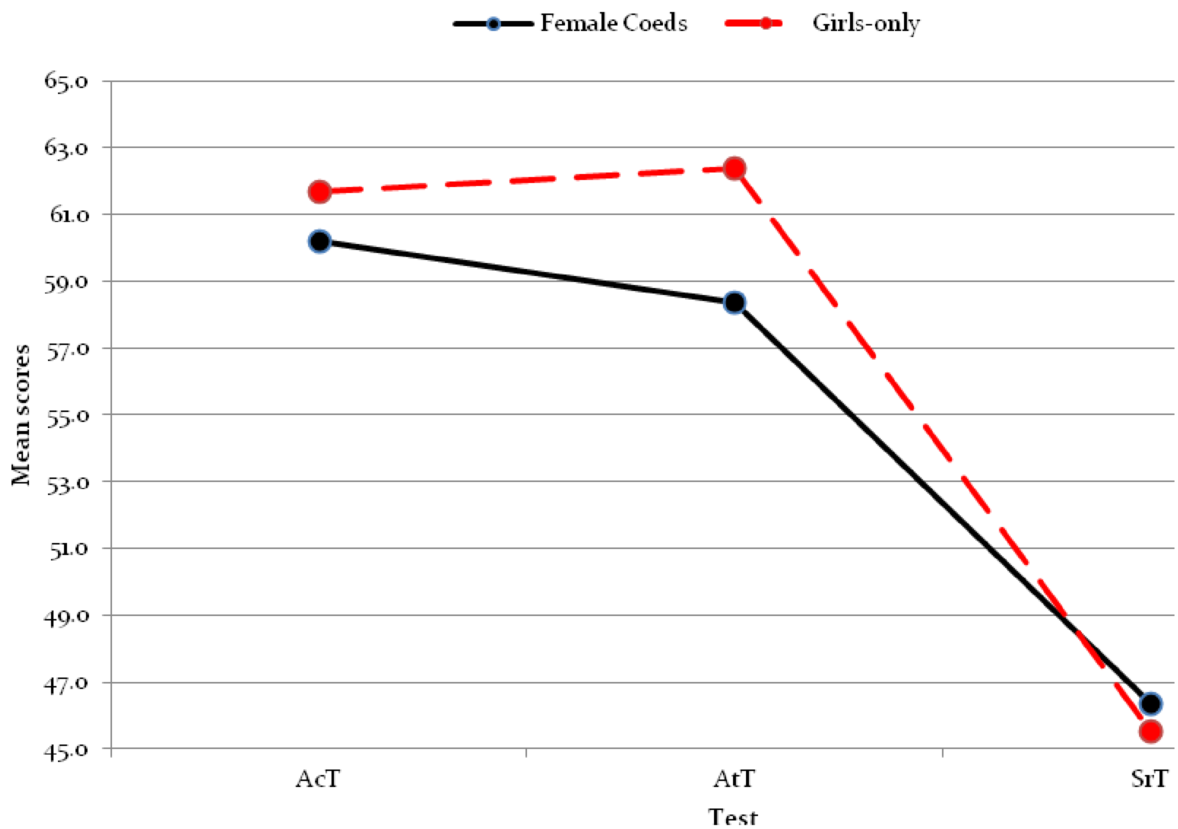

Figure 2. Graphical representation of performance of girls in the three tests from single-sex and Co-educational schools.

adopted. This difference is further highlighted in Table 4 which shows the outcome of a Bonferroni post-hoc test. The post-hoc test shows that female students' overall LO score for HPLC (mean score=64.61) was significantly higher than DLC (mean score=54.79) and TEA (mean score=49.12), whereas their overall LO score for DLC (mean score=54.79) was significantly higher than that of TEA (mean score=49.12). Thus, female science students had the best LO score when HPLC model was applied, and least LO score when TEA model was applied.

Hypothesis 3*: There is no significant difference in the learning outcome of boys from all-boys schools and their counterparts from Coeducational schools.*

Table 6. Mean scores for learning outcome, and females in coeducational and Girls-only school types.

		Mean	Std. Dev	95% CI	
				Lower	Upper
Learning Outcome					
AcT		60.949	1.523	57.922	63.975
AtT		60.375	1.355	57.680	63.069
SrT		45.937	1.453	43.047	48.826
School Type					
Co-ed	AcT	60.195	2.225	55.771	64.619
	AtT	58.368	1.981	54.430	62.307
	SrT	46.341	2.124	42.118	50.565
Girls-only	AcT	61.702	2.079	57.570	65.834
	AtT	62.381	1.850	58.702	66.059
	SrT	45.532	1.984	41.588	49.476

Table 7. One-way ANOVA repeated measures for Learning outcome of female science students in Coeducational and Girls-only schools based on Curriculum model.

Sections	Source	Sum of Squares	df	Mean Square	F	Sig.
*(**a). Within-subjects effects***						
	LO	13181.131	1.762	7479.787	61.343	.000
	LO * CM	887.876	3.524	251.918	2.066	.097
	Error(LO)	18264.558	149.790	121.935		
(b). ***Between-subjects effects***						
	Intercept	830185.055	1	830185.055	3930.895	.000
	CM	10526.498	2	5263.249	24.921	.000
	Error	17951.568	85	211.195		

α= .05; * significant at p< .05.

A one-way ANOVA with repeated measure was conducted to determine whether there was a statistical significance in learning outcome between male science students from Coeducational and Boys-only schools. Mauchly's test indicated that the assumption of sphericity was not violated, X^2 (df=2) =2.74, p>.05, hence the analysis results are based on the assumption that there is homogeneity across the students' performance scores. Table 9 shows that the learning outcome of all male science students are significantly different, F (2, 240) =100.365, p=.000. This implies that all male science students generally performed similarly in AcT (Mean= 67.18, SD=1.094) and AtT (Mean=64.59, SD=1.163), whereas they performed significantly low in SrT (Mean=49.53, SD=1.169). As the results imply, male science students are intellectually stronger in AcT and AtT than SrT.

Furthermore, findings show that there was a statistically significant interaction in the learning outcome between the Test type (AcT, AtT, or SrT) and School Type (Male science students from Coeducational or Boys-only schools), F (2, 240) =6.77, p = .001. Thus, these results indicate that the statistical significance in learning outcome of male science students is not similar in both school types. Specifically, male science students within Coeducational schools performed similarly in AcT (Mean=67.69, SD=1.646) and AtT (Mean=66.46, SD= 1.749) but significantly low in SrT (Mean=46.60, SD=1.759); invariably implying that they are intellectually stronger in AcT and AtT than SrT. However, this same trend does not equally apply to their counterparts within Boys-only schools; a marginal statistical significance was observed between AcT (Mean=66.67, SD=1.443) and AtT (Mean=62.72, SD=1.533), and a significantly low performance in SrT (Mean=52.46, SD=1.541). Thus, male science students in Boys-only schools have distinct learning outcomes in each test type, while their co-educational counterparts have similar learning outcomes

Table 8. Mean scores and standard deviations of learning outcome of female coeducational and Girls-only science students [based on Curriculum model].

Variables		Mean	Std. Dev	95% CI		Group
				Lower	Upper	
(a) *Learning Outcome*						
AcT		61.402	1.338	58.743	64.062	A
AtT		60.954	1.112	58.743	63.164	A
SrT		46.168	1.354	43.476	48.860	B
(b) *Learning outcome based on Curriculum Model adopted*						
TEA	AcT	53.806	2.250	49.333	58.280	A
	AtT	54.199	1.870	50.481	57.917	A
	SrT	39.355	2.277	34.827	43.883	B
DLC	AcT	59.733	2.287	55.186	64.280	A
	AtT	56.983	1.901	53.203	60.762	A
	SrT	47.667	2.315	43.064	52.269	B
HPLC	AcT	70.667	2.411	65.874	75.460	A
	AtT	71.679	2.004	67.695	75.664	A
	SrT	51.481	2.440	46.630	56.333	B
(c) *Curriculum Model*						
TEA		49.120	1.507	46.124	52.116	C
DLC		54.794	1.532	51.748	57.840	B
HPLC		64.609	1.615	61.399	67.820	A

Table 9. One-way ANOVA repeated measures for learning outcome, and **males** in coeducational and Boys-only school types.

Sections	Source	Sum of Squares	df	Mean Square	F	Sig.
(a). Within-subjects effects						
	LO	21777.147	2	10888.573	100.365	.000*
	LO * ST	1469.168	2	734.584	6.771	.001*
	Error(LO)	26037.520	240	108.490		
(b). Between-subjects effects						
	Intercept	1313793.960	1	1313793.960	5200.929	.000*
	ST	11.796	1	11.796	.047	.829
	Error	30312.904	120	252.608		

α= .05 * significant at p< .05.

in AcT and AtT and distinct for SrT (As shown in Figure 3). However, the findings in Table 10 show that the average learning outcome between male science students in Coeducational (Mean=60.25, SD=1.26) and Boys-only (Mean=60.62, SD=1.11) schools was not significantly different, F (1, 120)=0.047, p=.829. Therefore, the average performance of male science students in Coeducational schools is similar to that of the counterparts in Boys-only schools.

A one-way ANOVA with repeated measure was conducted to determine whether the adoption of the Curriculum Models (CM) significantly affected the LO of male science students from Coeducational and Boys-only schools. In other words, the analysis sought to find out whether the performance of female science students in Achievement test (AcT), Attitude test (AtT), and Scientific reasoning test (SrT) was influenced by the type of CM adopted. The independent variable was the CM adopted – it was measured at three levels [Expository Approach (TEA), Descriptive Learning Cycle (DLC), and Hypthetico-Predictive Learning Cycle (HPLC)] - while thedependent variable was the performance scores (measured in percentages) for each test. Statistical significance was set at 0.05 level of significance. Mauchly's test indicated that the assumption of sphericity had been violated, given X^2 (df=2) =8.02, p<.05, therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (E=.938).

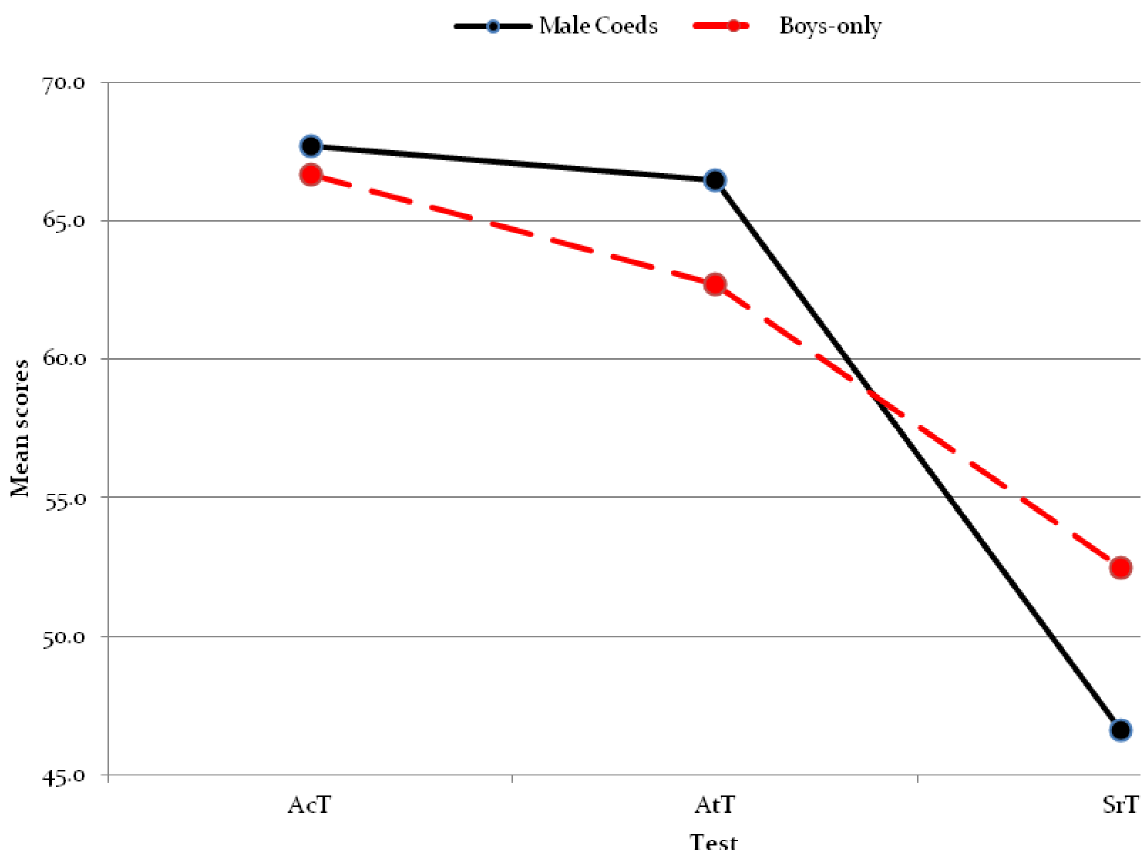

Figure 3. Graphical representation of the performance of boys from boys-only and coeducational schools in the three tests.

Table 10. Mean scores for Learning outcome, and Males in Coeducational and Boys-only school types.

Variables		Mean	Std. Dev	95% CI	
				Lower	Upper
Learning Outcome					
AcT		67.18	1.09	65.02	69.35
AtT		64.59	1.16	62.29	66.89
SrT		49.53	1.17	47.22	51.85
School Type					
Co-ed	AcT	67.698	1.646	64.439	70.957
	AtT	66.461	1.749	62.998	69.923
	SrT	46.604	1.759	43.122	50.086
Boys-only	AcT	66.667	1.443	63.810	69.523
	AtT	62.719	1.533	59.684	65.753
	SrT	52.464	1.541	49.412	55.515

Table 11 shows that the LO of male science students was statistically significant given F(1.88, 223.32)=87.109 and $p<0.05$; this result indicates that the average score of the male science students in (at least) one of the three test is significantly different from the rest. In essence, the average performance of male students in the given tests

Table 11. One-way ANOVA repeated measures for Learning outcome of male science students in Coeducational and Boys-only schools based on Curriculum model.

Sections	Source	Sum of Squares	df	Mean Square	F	Sig.
(a). Within-subjects effects						
	LO	18022.782	1.877	9603.638	87.109	.000
	LO * CM	2885.650	3.753	768.825	6.974	.000
	Error(LO)	24621.038	223.323	110.249		
(b). Between-subjects effects						
	Intercept	1243838.262	1	1243838.262	6754.836	.000
	CM	8411.991	2	4205.996	22.841	.000
	Error	21912.709	119	184.140		

α= .05* significant at p< .05.

Table 12. Mean scores and standard deviations of learning outcome of male Coeducational and Girls-only science students [based on Curriculum model adopted].

Variables		Mean	Std. Dev	95% CI		Group
				Lower	Upper	
(a) Learning Outcome						
AcT		66.530	1.083	64.386	68.675	A
AtT		63.498	.907	61.703	65.293	B
SrT		49.924	1.183	47.582	52.266	C
(b) Learning outcome based on Curriculum Model adopted						
TEA	AcT	61.793	2.159	57.518	66.068	A
	AtT	53.419	1.807	49.840	56.997	B
	SrT	47.586	2.357	42.918	52.254	B
DLC	AcT	67.846	1.612	64.654	71.039	A
	AtT	61.887	1.350	59.214	64.559	B
	SrT	47.308	1.760	43.822	50.794	C
HPLC	AcT	69.951	1.816	66.356	73.547	B
	AtT	75.189	1.520	72.180	78.199	A
	SrT	54.878	1.983	50.952	58.804	C
(c) Curriculum Model						
TEA		54.266	1.455	51.385	57.147	C
DLC		59.013	1.086	56.862	61.165	B
HPLC		66.673	1.224	64.250	69.096	A

that is, AcT, AtT and SrT were not similar. This difference is further highlighted in Table 6 which shows that male students' performances in AcT (mean score=66.53) was significantly higher than AtT (mean score=63.49) and SrT (mean score=49.92), whereas their performance in AtT (mean score=63.49) was significantly higher than SrT (mean score=49.92). This implies that male science students performed best in the AcT tests, and least in SrT test. Furthermore, results in Table 11 that is, LO*CM, shows that the CM effect on LO of male science students was statistically significant given F(3.75, 223.32)=6.974 and p<0.05; this indicates that the order of performance of male science students in the three test (AcT, AtT, and SrT) was significantly influenced by the CM adopted. As such, the result indicates that the order of performances in the respective tests varied based on the CM adopted. Emphasis on this outcome is detailed in Table 12: for TEA, the male students performed best in AcT (mean score=61.79) but similarly in AtT (mean score=53.42) and SrT (mean score=47.59); for DLC, the male students

Table 13. Two-way ANOVA repeated measures for curriculum model and school type on learning outcome in science.

Source		Sum of Squares	Df	Mean Square	F	Sig.
(a). Within-subjects effects						
	LO	29527.269	1.830	16134.616	141.822	.000
	LO * Trt	1768.378	3.660	483.148	4.247	.003
	LO * ST	1247.479	3.660	340.831	2.996	.022
	LO * ST*CM	1712.281	7.320	233.911	2.056	.045
	Error(LO)	41848.096	367.841	113.767		
(b). Between-subjects effects						
	Intercept	1941616.663	1	1941616.663	9966.734	.000
	CM	18837.870	2	9418.935	48.349	.000
	ST	1687.677	2	843.839	4.332	.014
	ST*CM	1702.478	4	425.619	2.185	.072
	Error	39156.753	201	194.810		

α= .05* significant at p< .05.

performed best in AcT (mean score=67.85) than AtT (mean score=61.89) and SrT (mean score=47.31); for HPLC, the male students performed best in AtT (mean score=75.19) than AcT (mean score=69.95) and SrT (mean score=54.88). Therefore, the curriculum model significantly affected how the students performed in the tests.

However, based on Table 13, the result shows that the overall performance of male science students differed significantly based on the CM adopted, it yielded F(2, 119)= 22.84 and p<0.05; this result indicates that male students' overall LO score (cumulative score for AcT, AtT, and SrT) was significantly different for (at least) one of the CM adopted. This difference is further highlighted in Table 11(b) which shows the outcome of a Bonferroni post-hoc test. The post-hoc test shows that male students' overall LO score for HPLC (mean score=66.67) was significantly higher than DLC (mean score=59.01) and TEA (mean score=54.27), whereas their overall LO score for DLC (mean score=59.01) was significantly higher than that of TEA (mean score=54.27). Thus, male science students had the best LO score when HPLC model was applied, and least LO score when TEA model was applied.

Hypothesis 4*: There is no significant interaction effect of curriculum model and school type on learning outcome in science.*

A two-way ANOVA with repeated measure was conducted to determine whether there was a significant interaction effect between curriculum model and school type on learning outcome of science students. Mauchly's test indicated that the assumption of sphericity was not violated, X^2 (df=2) =19.492, p<.05, therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (E=.873). The analysis output shows that the learning outcome of science students are significantly different, F (1.83, 367.84)=141.82, p=.000. This implies that while all science students generally had similar high outcome in AcT (Mean=64.05, SD=.882) and AtT (Mean=62.48, SD=.730), they performed significantly low in SrT (Mean=48.09, SD=.894). As the results imply, science students are intellectually stronger in AcT and AtT than SrT.

Moreover, findings in Table (14) show that the overall learning outcome of science students is significantly different across the Treatment types applied (i.e TEA, DLC, and HPLC), F (2, 201) =48.35, p = .000. Hence these results indicate that the learning outcome is significantly different for at least one treatment type; specifically, learning outcome was found to be similar between TEA (Mean=51.89, SD=1.058) and DLC (Mean=56.70, SD=.948), but was significantly high for HPLC (Mean=66.02, SD=1.021) treatment. This finding suggests that while TEA and DLC curriculum models appear to have relatively low learning outcome effect among science students generally, its effect was worse for Coed students and girls (Figure 4). The HPLC model on the other hand seemed to be a more beneficial and effective approach to improving learning outcome of all groups especially for girls. The improvement in the outcome scores of the Coed group is a pointer to that effect. Table (14) also shows that learning outcome is significantly different across the School types (that is, Coeducational, Girls-only, and Boys-only), F (2, 201) =4.332, p = .014. The results indicate that learning outcome is significantly different for at least one school type: learning outcome for Coeducational (Mean=57.29, SD=.843) and Girls-only (Mean=56.73, SD=1.176) science students was found to be similar, whereas their counterparts from Boys-only schools (Mean=60.59,

Table 14. Mean scores for curriculum model, school type and learning outcome in science.

Variables	Mean	Std. Dev	95% CI	
			Lower	Upper
Learning Outcome				
AcT	64.051	.882	62.312	65.789
AtT	62.476	.730	61.036	63.915
SrT	48.097	.894	46.334	49.861
Treatment (CM)				
TEA	51.899	1.058	49.813	53.985
DLC	56.702	.948	54.832	58.571
HPLC	66.023	1.021	64.010	68.036
School Type				
Co-ed	57.297	.843	55.634	58.960
Co-ed	56.728	1.176	54.409	59.047
Single	60.598	.983	58.661	62.536

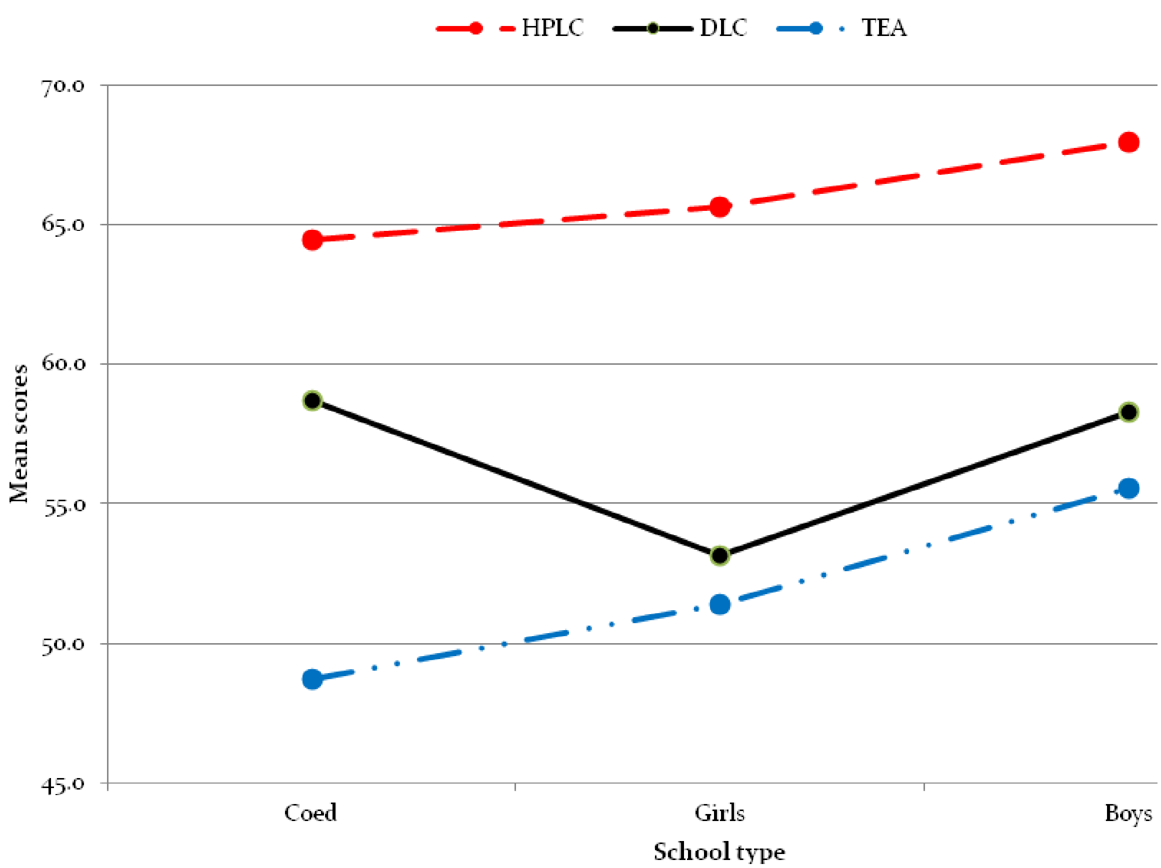

Figure 4. Graphical representation of interaction of school type and curriculum model on learning outcome.

SD=.983) have a significantly higher learning outcome in all curriculum models (Figure 4). Furthermore, Table 14(b) shows that there is no significant interaction effect between School type and Treatment on learning outcome, F (4, 201) =2.185, p = .072. The results indicate that the significant difference in learning outcome appears to be similar across different treatment types for each school type, and vice-versa (As shown in Figure 4).

Discussion of results

The study centered on the effect of curriculum model (treatment type) and school type on science students learning outcome. One of the results of the study is that there is a significant difference in the learning outcome of science students (mean = AcT= 53.69, ArT =64.54 and SrT=48.07 respectively). Science students in the study recorded highest mean scores in attitude (mean=53.69) and least in scientific reasoning (mean 48.07).The high attitude outcome is in line with the Bishop (1980), Lawson (1995) and Moemeke (2010). The high attitude outcome of the subjects in the study may be attributed to method of instruction and social and interactive variables associated with the instructional practices in the study.

The study recorded an improvement in the achievement of the subjects in the same school type over their scientific reasoning skills. The improved achievement in science conforms to explanation given by Simpson and Oliver (1990) and Hegarty-Hazel (1990) that attitude towards science influence and induce achievement but not vice vasa. It means that if instructional practices successfully boast science students' attitude towards doing science a possible increase in the achievement outcome might result. The significant difference in the learning outcome in all school types indicated that school type variables operate similarly respective of ethos characteristics or sex-orientation of the schools. Another finding of the study also showed similarity in the performance of science students in the different levels of learning outcome in the Coeducational and single-sex schools. Though the single-sex schools showed slight superiority in learning outcome (mean=56.03) over the Coeducational subjects (Mean=54.87), the difference was not statistically significant. This is at variance with the previous study reported by Bishop (1980) and Moemeke and Omoifo (2010) whose studies reported statistically significant differences in favour of single-sex school subjects. This may be unconnected with the recent re-organization of school ownership in Delta State, Nigeria (the study area) in which most single-sex schools were handed over to missionary owners and a consequent mass exodus of former single-sex school students to Coeducational Government owned schools. This prevailing situation may have cushioned the effect of school type since the transfer students still bear their foundation ethos back ground. This calls for regular intermittent studies of this sort to monitor variations in the learning outcome of the different school- types. However, the relatively higher scientific reasoning score of subjects of single-sex schools (49.66) over coeducational counterparts (46.49) is indicative of their superior performance in scientific reasoning (As shown in Figure 1).

The study also compared statistically the performance of girls in single-sex schools and their counterparts in Coeducational schools along the three levels of learning outcome. A significant difference was found in their performance in the three outcomes in both schools types. Girls in both school types performed evenly in attitude and achievement in science concepts and lowest in scientific reasoning skills. The result of this study is at variance with that reported by Mallam (1993), Granleese and Joseph (1993), Young and Fraser (1994), Lee and Lockhead (1990), Lee and Marks (1990) and Hopkins (2001).The studies referred to above advanced reason for the performance to include:

1. Reduced opposite sex interaction and distractions
2. Increase commitment to academics as a consequence of reduced distraction
3. Removing feelings of inferiority and inhibition in Coeducational girls and
4. High self-esteem in All- girls subjects among others.

This present study result conforms to Brustaert and Brake (1994) who did not find any such difference. It is pertinent to note here that the present result suggests some cognitive or intellectual connection between the performance of girls and the type of outcome which they prefer. The low scientific reasoning performance recorded in both school types suggests that there is need to focus deliberate instructional practices on helping girls generally to improve their reasoning skill and consequently decision making ability. Moemeke and Omoifo (2010) had earlier recommended that instructional strategies which reduce mental tasks while solving problem are more beneficial to girls as it is to low ability learners. The many steps in organizing mental thought processes towards reasoning scientifically in a problem situation is likely to have posed serious problems during scientific reasoning and responsible for the low outcome level. However, worthy of note is the marginal superior mean of girls from girls-only schools in achievement (61.70) and Attitude (62.38) over girls from coeducation schools (60.1 and 58.37) respectively. These differences are however not significant at the 0.05 alpha level used in this study.

This trend is also maintained by boys from boys-only and their counterparts in coeducational schools (AcT > ArT > SrT). In comparison, the higher test scores of boys in coeducational schools in achievement and attitude over the boys from boys-only schools may be psychological and linked to natural tendency for boys to dominate science classrooms especially in culturally influences classrooms such as those in Nigerian in which males tend to be emotionally more balanced than females and the need to boost masculine ego. In the area of scientific reasoning, boys from All-boys schools showed superiority (As shown Figure 3) indicating their superior thinking sequences and possible better utilization of problem solving repertoires. The non- significance of the differences in the performance of Boys from Boys-only school and those from coeducational schools shows similarity in their performance patterns. This may also be linked to the recent administrative reorganization of schools that resulted in mass movement of students from single-sex schools to Government-owned coeducational schools due to introduction of fees in such single-sex schools taken over by their previous missionary owners.

The respect to hypothesis four, result showed that while learning outcome varied similarly according to types within each treatment group and school- type, the HPLC produced significantly highest overall outcome across all measures in all school types. It means that the HPLC was a more potent curriculum model for boosting performance in all outcome measures. This result in similar to Douglas and Kahle (1977), Hurst and Milkent (1996), Lavoie (1999) and Lawson et al (2000) in which HPLC model produced better outcome in all measures across all ability levels and all school types. This potency is linked to certain attributes of the HPLC Model such as helping learners test their knowledge claims, reducing cognitive dissonance associated with multiple science views, helping learners develop adequate logical patterns as well as exposing their misconception or alternative conceptions for possible remediation. The deliberate emphasizing of predictive exercises prior to the learning cycle phase must have provided the impetus for better learning. Though the DLC was found to produce better outcome than the TEA (As shown in Figure 4), the difference was not statistically significant. This result is similar to previous studies by Westbrook and Rogers (1994).

SUMMARY

The study focused on identifying differences in learning outcome across the different measures (achievement in science concepts, attitude towards science and scientific reason) in the different school types (single sex and coeducational) taught with the Learning Cycle Curriculum Model (DLC and HPLC) and the Traditional expository approach (TEA). 210 SS ll students participated in the study in the current 2012/2013 academic session. Four null hypotheses were tested. The study lasted for ten weeks. Sample (intact classes) was drawn from the Coeducational, Boys-only and Girls- only schools. Data generated were analyzed using the one- way repeated measures ANOVA and two-way repeated measures ANOVA respectively. Result showed similarity in learning outcome patterns of subject from all school- types and in all measures but different in terms of magnitude with Attitude towards science (AtT) most enhanced followed by Achievement in science concepts (AcT). There was no significant variation between each school-types. However single sex school/subjects proved superior in scientific reasoning when compared with their counterparts from Coeducational schools for both sexes.

CONCLUSION

Based on the finding of this study the following conclusions were made.

School type variable has no significant effect on science students learning outcome. The pattern of performance in the difference learning outcome measures is the same in all school types.

Among the entire sample, students performed most in attitude towards science, followed by achievement in science concepts and least in scientific reasoning skill with students of single-sex schools having marginal superiority in scientific reason skill.

Within each school type, the performance in learning outcome of students of the same sex conform to the same pattern but with significantly better performance recorded by students of Girls- only schools in Attitude towards science and Achievement but not in scientific reasoning skill.

Males from coeducational schools showed better performance in Achievement in science concepts and Attitude towards science than their counterparts in single sex (boys-only) schools. However, the boys-only subjects were significantly better than their counterparts in scientific reasoning skill exhibition.

On a similar note, science students had significantly different overall LO score based on the CM adopted. Specifically, the best overall LO score was obtained when HPLC model was applied, while the least overall LO score was obtained when TEA model was applied. This could imply that HPLC model is the best model (of the three CM) for LO. It however did not discriminate among sexes.

RECOMMENDATION

Based on the findings of this study earlier highlighted, it is hereby recommended that:

All schools should be provided with adequate and enabling learning environment conducive for learning. These include physical, Psychological and social environments since there seem to be no disparity in learning outcome based on school types.

Teachers and counselors in secondary schools should guide coeducational girls adequately to improve their self-concept, confidence in their ability to learn science and on how to reduce the distractive presence of the opposite sex so as to compete favorably with the opposite sex in science.

The Government should set up some single sex school to be administered and managed by government. The present situation in which all the single- sex secondary schools have been given back to their missionary initial owners may have accounted for some extraneous results in this study.

Teachers in secondary schools should adopt instructional/curriculum model that emphasize the acquisition of scientific reasoning skills since it is a major objective of teaching science at all levels. This will help the learners of science acquire the necessary habit of mind for experimental and productive science.

Teachers in secondary schools should teach science subject using the Hypothtico- predictive learning cycle since it is found to produce the highest learning outcome (Achievement, Attitude towards Science and scientific reasoning) irrespective of school type or administrative mode.

IMPLICATION FOR PRODUCTION OF FUTURE SCIENTISTS

The study holds huge implications for realizing Nigeria's dream of producing indigenous scientists from her schools to meet her scientific and technological needs. If this dream must become a reality, science teachers must be adequately trained to innovate in the area of new pedagogic strategies that improve learning outcome in science. Continuous implementation of the senior secondary school curriculum using the expository approach undermines the objective of helping students develop habits for investigative science. The poor outcome level of the expository group, in all outcome measures and from all school- types, points to its weakness as a method of teaching science in this century. In this age of technology, development of physical and thinking skills has become paramount. The hypothetico-predictive learning cycle affords learners opportunity to get involved in the intellectual process of learning science by participatory activities thereby making science fun. There is no doubt that though the pattern of performance in the three levels of learning outcome seemed the same in all three school types, there also seem to be some social and psychological aspects of school environment that interfered with other achievement variables in the science classroom. The influences of mixed gender classroom on choice of subjects, career choice are stereotypical. Creating classrooms which provide conducive environment for learning is essential for all genders.

SUGGESTIONS FOR FURTHER STUDIES

The study is by no means conclusive. Further research is needed to determine variables that operate in Nigeria senior secondary school that affect science learning outcomes. Psycho-social aspects of coeducational and single sex schools need to be properly understood. Further studies are also needed in determining how best to encourage the acquisition of scientific reasoning skill as an outcome of instruction.

Conflict of Interests

The authors have not declared any conflict of interests.

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