# EXPLORING THE VALIDITY OF A SATELLITE TRANSMISSION AND RECEPTION MODULE USING STRUCTURAL EQUATION MODELLING APPROACH

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**Abstract:** Satellite reception and transmission module is a form of a curriculum used for training radio, television, and electronics work craftsmen at the technical college level in Nigeria. The validity of the modules used for training craftsmen in technical colleges is central to their suitability for the realization of set goals. This study was designed to determine the validity of a satellite transmission and reception module. To do this, an analysis centred on structural equation modelling with confirmatory factor analysis was done. A 72-item structured questionnaire was used to collect data from 195 subject matter experts. The study revealed among others that all four components of the module were retained through exploratory factor analysis. Confirmatory factor analysis was used to test the model. The results showed that the indices were: CMIN/DF = 1.459, CFI =.925, GFI =.919, and RMSEA =.077. These indicated that there was a good fit. Cronbach's alpha was used to estimate the internal consistency of the factors, and it was acceptable for all of them. On the basis of these, the module is deemed reliable and valid. Hence, it is recommended for adoption for the training of radio, television, and electronics work craftsmen in technical colleges in Nigeria.

**Keywords:** **S**atellite transmission and reception, Module, Structural equation modelling, validity, Confirmatory factor analysis.

## 1. INTRODUCTION

The centrality of technical and vocational education in the economic development of a nation like Nigeria cannot be overemphasized. It has been stressed that the gateway to the survival of a nation is through scientific and technological education, of which technical and vocational education is a huge part (Oludipe, 2011). The design of the Nigerian educational system is such that technical colleges are the institutions that provide training in career and technical disciplines with the aim of bringing into being the skilled workforce referred to as craftsmen, needed for the technological and economic development of the nation (Federal Republic of Nigeria [FRN], 2013). One of the trades in which people are trained at the technical college level is radio, television, and electronics work. Radio, television, and electronics work (RTVEW) designed to equip technical college graduates with sellable skills in consumer electronics work (Uduafemhe & Raymond, 2019). The curriculum or course specifications used for training the craftsmen is divided into smaller units called modules. According to Uduafemhe, Raymond, Usman, and Idris (2018), a module is a well-defined short course of study that forms part of a larger academic course or training programme, which when successfully completed can be used for employment purposes without having to complete the larger course. The modules used for training RTVWE students include; basic electricity, electronic devices and circuits, radio communication, radio and audio frequency amplifiers, television, and satellite transmissions and reception (National Board for Technical Education [NBTE], 2001).

The satellite transmission and reception (STR) module is an aspect of the technical college curriculum that equips students with skills in the broadcasting of digital radio-frequency signals and the conversion of the signals into a form that can be viewed on a television set (Uduafemhe, 2019). The objectives outlined by NBTE (2001) for craftsmen who have completed the STR module are that they should be able to: (1) understand the basic concepts of satellite transmission and reception; (2) know the principles of operation of TV; and (3) understand the principles of TV camera and closed-circuit TV. The STR module can be divided into four main components, namely; satellite transmission, satellite reception, television cameras and closed-circuit television (NBTE, 2001). Each of these components is designed to include themes or topics otherwise referred to as contents that help in the realization of the objectives of the module. According to Jayanthi (2017) that curriculum contents denote things that are taught in schools, including topics, concepts, subject matter, knowledge, and ideas within a certain discipline with a view of focussing them to produce modification in a person and to the world around him. As good as the contents of the STR module are, the module is only useful to society if it is valid. In support of this, Cumyn and Harris (2012) noted that the importance of validity evidence is a theme that permeates every aspect of the content definition. In essence, the validity of the modules used for training craftsmen in technical colleges is central to their suitability for the realization of set goals. In corroboration of this, Syahropi, Fauzi, and Rifai (2019) hinted that one of the satisfactions of educational attainment of those who successfully completed their studies is the fact that the resources that aid learning are available in harmony with the government policies designed to foster knowledge, values, skills, and attitudes. Syahropi et al. further revealed that a learning resource such as a module is only qualified for use if it has been subjected to a validity test. The satellite transmission and reception module, whose validity is the focus of this study, is a part of the researcher’s previous content development work.

Validity is an important part of the development of educational resources. The concept of validity has been defined by notable scholars in relation to tests. For instance, Mohajan (2017) remarked that validity concerns what an instrument measures, and how well it does so. As stated in Syahropi et al. (2019), validity is the magnitude to which a measuring instrument prudently and accurately executes its purpose as a measuring instrument. It is the extent to which an instrument measures what it is intended or purports to measure, which is determined by the correlation between its results and some other criterion of what it was devised to measure (Chime, 2012). However, validity does not exist only for measuring scales. Important educational resources like curriculum contents need to be properly validated for them to be usable. As stated in Chabalengula, Mumba, Lorsbach, and Moore (2008), the term curricular validity is used to denote the extent to which an assessment tool tests cover in the content themes in a syllabus. To Alvion (2015), curricular validity refers to the authenticity of the subject matter or content selected and included in a curriculum. Therefore, curricular validity may be defined as the extent to which the contents of a curriculum of a course or trade achieve the objectives it is designed to achieve.

There exist a number of validation processes, some of which are: face validity, content validity, construct validity, concurrent validity, and predictive validity. But not all types of validity are applicable in curriculum content validation. The two types of validities that are best suited for validating the contents of a curriculum are curricular and content validity. Curricular validity can be used to describe how well the items on a test represent the curricular objectives of an institution. Essentially, curricular validity is the correspondence between a test and the objectives of a curriculum. Therefore, there is a relationship between curricular and content validity. Content validity refers to the extent to which test items represent the tasks, skills, or knowledge of a domain of interest, as described by the course objectives (Chakwera, 2014). In establishing the validity of a curriculum, certain measurement procedures are necessary. It is noteworthy to state that appropriate validation measures do not give room for wide variability in the attainment of objectives, nor do they bring about perfect stability. In essence, validation does aid in better control of the achievement of objectives. The approaches to validation of educational resources like modules as used by scholars include Cohen kappa (Syahropi et al. 2019), Aiken's V formula (Retno, Saputro & Ulfa, 2018; Devitri & Djamas, 2019), and factor analysis.

Factor analysis is a statistical procedure for finding out the most important cause of a phenomenon by observing the data when expressed as functions of a number of possible causes. To Gerber and Price (2018), factor analysis is a technique employed to find out the degree to which common variance (the intercorrelation between measures) occurs among variables or items within the item pool for a developing measure. In the same vein, Kumar (2013) construed factor analysis as a statistical process employed in describing variability among correlated observed variables in relation to possessing the potentiality of fewer number of unobserved variables referred to as factors. The motivation of factor analysis depends on the fact that there are often several variables included in the research design, and it typically helps to condense the variables to a reduced set of factors, mainly targeting the understanding of the data matrix of the causal structure. The association of each variable with the causal factor is communicated by what is known as factor loading (Cutillo, 2019). Factor analysis is one of the structural equation models developed in 1904 by Spearman (Olkin and Sampson, 2001). Structural equation models represent an assemblage of procedures that are frequently utilized for demonstrating dependency (arguably “causal”) relations in multivariate data in the behavioural and social sciences (McDonald & Ringo Ho, 2002). To Byrne (2010), structural equation modelling is a statistical procedure that tests hypotheses using a confirmatory method in analysing the structural theory with reference to a particular phenomenon. Similarly, Ćurković (2012) remarked that a structural equation model is a multifaceted complex statistical hypothesis. There are two main parts of SEM. They are; measurement and path models. The measurement model denotes a set of observable variables as multiple indicators of a smaller set of latent variables, which are factors they all have in common. The path model refers to the associations of dependency between the latent variables. However, in SEM, the term structural model can be used when the composite of measurement and path models is intended.

Characteristically, structural equation modelling symbolizes “causal” processes that generate observations on multiple variables. Structural equation modelling is linked to two important procedures: (a) that the causal processes under study are represented by a series of structural (i.e., regression) equations, and (b) that these structural relations can be modelled pictorially to enable a clearer conceptualization of the theory under study. Hence, a typical structural equation model consists of a measurement model and a structural model, while the measurement model has to do with observed responses or ‘indicators’ to latent variables and sometimes to observed covariates, the structural model specifies relations among latent variables, and regressions of latent variables on observed variables (Khine, 2013). As noted by Byrne (2010), the beauty of structural equation modelling is that a hypothesized model can then be tested statistically in simultaneous analysis of the entire system of variables (including validity and reliability) to deduce the degree to which it is consistent with the data. Therefore, if goodness-of-fit is satisfactory, the model contends for the plausibility of the proposed relationship among variables; if it is insufficient, the tenability of such relationships is excluded. Kline (2011) postulated six important steps in structural equation modelling, they are: model specification, model identification, construct operationalization, parameter estimation, hypotheses evaluation, and model respecification. With the aid of these six steps, SEM provides the ability to assess the unidimensional, reliability, and validity of each individual construct in a study (Nazim & Ahmad, 2013).

### 1.1 Statement of the Problem

Before certifying the curriculum of any subject area irrespective of the level of education for use, the contents are first subjected to a validation process after they are developed. Unfortunately, there is a dearth of evidence suggesting that the curriculum contents developed in technical and vocational education (TVE) fields are subjected to proper validity tests. A cursory inspection of some works such as Fabiyi (2016), Ajunwa, Raymond, Usman, and Owodunni (2018), Ariba (2016), and Mohammed (2016) show that most content development studies done in the field terminated at face validity, and so statistical figures are not supplied to establish the depth of the validity of the contents developed. This may be attributed to the fact that most of the researchers in TVE lack the requisite skills to properly validate curriculum contents. Hence, validating the satellite transmission and reception module is not out of place as it would not only make it more suitable for training RTVEW craftsmen to help boost their chances of employment and economic empowerment but will also serve as a guiding document to researchers in technical and vocational education on how to properly validate the contents of a curriculum.

### 1.2 Objectives of the Study

The aim of the present study is to explore the validity of a satellite transmission and reception module using structural equation modelling approach. Specifically, this study was designed to:

1. Perform an exploratory factor analysis on the contents of the satellite transmission and reception module using structural equation modelling approach.
2. Perform a confirmatory factor analysis on the contents of the satellite transmission and reception module using structural equation modelling approach.

### 1.3 Research Questions

The following research questions guided the study:

1. What is the result of the exploratory factor analysis of the satellite transmission and reception module using structural equation modelling approach?
2. What are the indices produced when confirmatory factor analysis is performed on the satellite transmission and reception module using structural equation modelling approach?

## 2. METHODOLOGY

Structural equation modelling with confirmatory factor analysis was adopted for this study. The adoption of this design is buttressed by the affirmation made by Yin, Umar, and Lok (2018), who hinted that confirmatory factor analysis affords the researcher greater flexibility in developing a hypothesis about the construct structure of the variable of interest. In order to eliminate extraneous variables, 195 subject matter experts (SMEs) were drawn from 21 television stations, seven higher institutions offering Electrical and Electronics Technology Education, and 15 technical colleges in Niger, Kwara, Federal Capital Territory-Abuja, and Kaduna states of the Federal Republic of Nigeria.

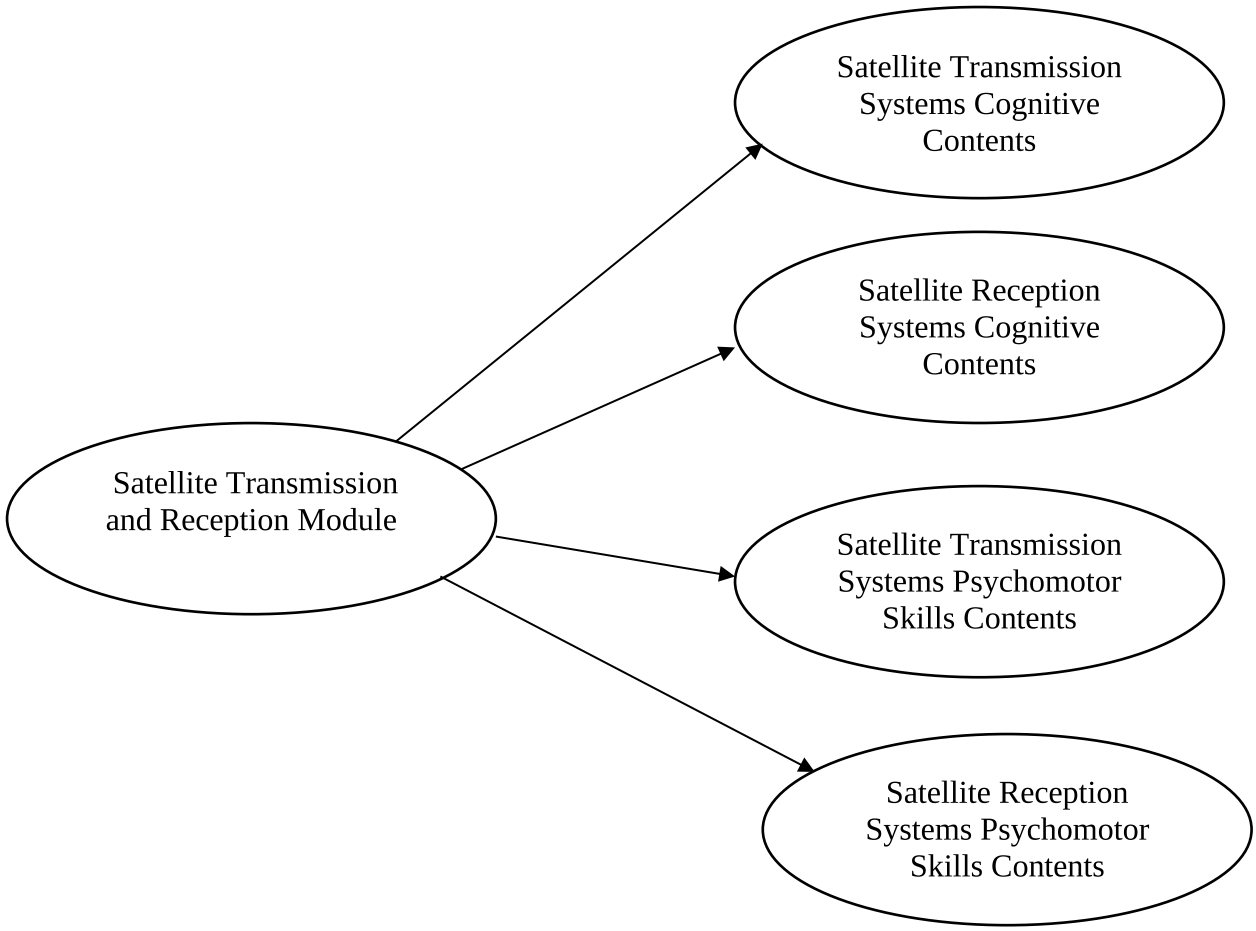


Figure 1: Four-Factor Model

A structured questionnaire titled: "Satellite Transmission and Reception Systems Contents Validation Questionnaire" (STRSCVQ) was used for data collection. The questionnaire had two parts: I and II. Part I was used to elicit responses on the personal data of respondents. These were gender, years of experience, industry of work, and specific SME group. Part II contained 72 questionnaire items on a four-point rating scale: strongly agree (SA=4), agree (A=3), disagree (DA=2), and strongly disagree (SD=1). Figure 1 shows the four-factor model of the questionnaire that describes the components, that is; satellite transmissions systems cognitive contents, satellite reception systems cognitive contents, satellite transmissions systems psychomotor skills contents, and satellite reception systems psychomotor skills contents.

Three experts, who are also electrical and electronics teachers, validated the instrument. Meanwhile, STRSCVQ was pilot tested using 35 SMEs in Kano State. The coefficient of internal consistency of the STRSCVQ was calculated using Cronbach's alpha. The reliability coefficient was 0.83, which is in congruence with a standard benchmark coefficient of 0.70 and above, at which an instrument is considered reliable (Yin, Umar, & Lok, 2018). The instrument was administered with the help of six research assistants. The collected data were analysed at a significance level of 0.05. The analysis of moment structure (AMOS) version 22 was used to evaluate the measurement and structural model of the study. The metrics of evaluation used include the following: comparative fit indices (CFI), goodness of fit indices (CMIN/DF), and root mean square error of approximation (RMSEA).

## 3. RESULTS

Before SEM was performed to answer research question one, skewedness and kurtosis tests were conducted to examine the normality of the data. Exploratory factor analysis of varimax component analysis was then performed. The extraction method was a correlation matrix with eigenvalue (>1). The results from the Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's test of sphericity was 0.745 at a p level of 5%. This revealed that the four factors had a sufficient number of items. In addition, the results of the Pearson correlation of the items showed that item 66 (r = 0. 729) had the highest correlation accounting for 99.164% of the total variance explained. Similarly, item 4 (r = -0.173), which accounted for only 0.139% of the total variance explained, had the least correlation.

To answer research question two, exploratory factor analysis was performed on the 72 item questionnaire based on the four components of the module. The four factors analysis is based on the four components (constructs) of the module. Namely; satellite transmission systems cognitive contents, satellite reception systems cognitive contents, satellite transmission systems psychomotor contents, and satellite reception systems psychomotor contents were performed. The four factors are shown in figure 2. Items with factor loadings of 0.30 or less were removed from the model, leaving only those whose factor loadings were greater than 0.30 and were used for confirmatory factor analysis (CFA). Factor analysis with varimax allowed the selection of four factors with latent roots greater than 1. All four factors were considered in the calculation because they all had more than three items, satisfying the prescription of Brown (2015). Despite the exclusion of 21 items across the four factors, the residual items account for a total of 80.14% of the total variance explained. Satellite transmission systems cognitive content (STScog), being the first factor and has 16 items, explained 22.24% of the variance. In the same vein, satellite reception systems cognitive content (SRScog) with 12 items explained 19.04% of the variance. The third factor, satellite reception psychomotor skills content (STSpsycho) with 15 items explained 23.67% of the variance.

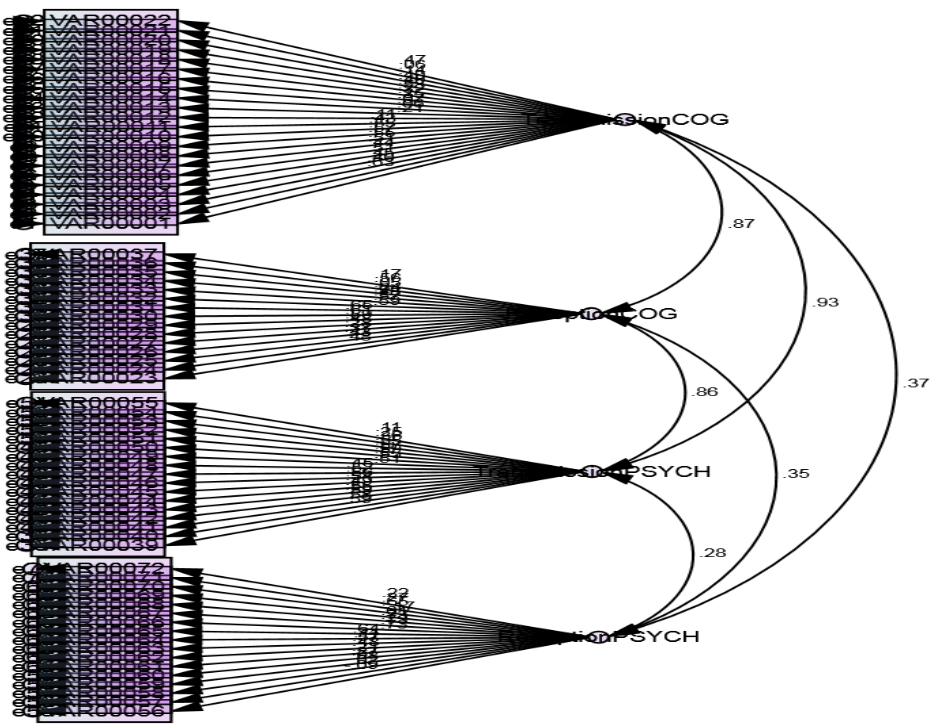


Figure 2: Four-factor model with all 72 items.

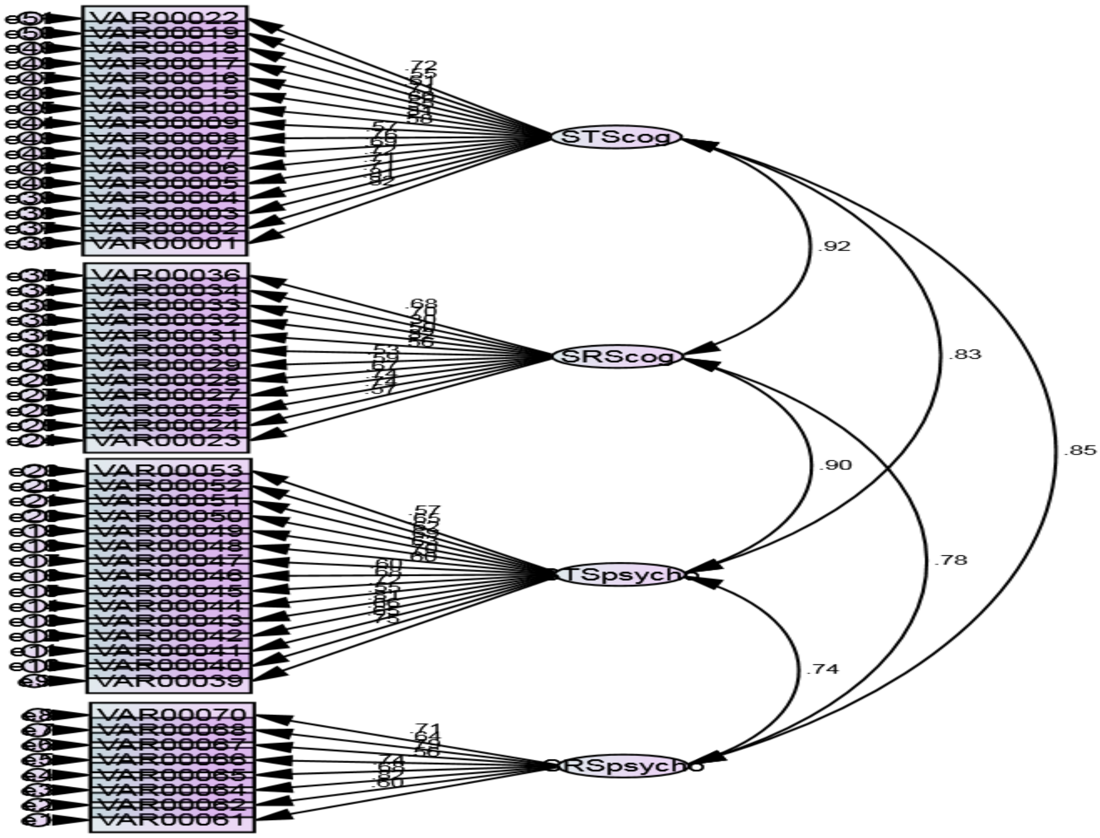


Figure 3: Four-factor model with 51 items.

The total variance explained accounted for by the fourth factor, satellite reception systems psychomotor skills contents (SRSpsycho), which had eight items, was 15.18%. Confirmatory factor analysis was done to improve the module through structural model configuration. This was based on maximum likelihood criteria that took the multivariate normality criteria of the items into consideration. The output of the modified of the model was produced from the analysis of discrepancy of parameter estimates, residual values, and modification test. The final model was built from the exploratory factor analysis earlier done and tested. Refer to Figure 3. The results of the CFA show that the overall goodness of fit of the model was CMIN/DF = 1.459, CFI =.925, GFI =.919, RMSEA =.077. In line with the submission of Khine (2014), an RMSEA value below 0.10 is a good fit. Also, the result of the analysis presented a positive correlation for the items ranging from 0.303 to 0.825.

## 4. DISCUSSION

From the analyses of the data in which exploratory factor analysis was utilized to validate the 72-item questionnaire. Factorial analysis by principal component with varimax rotation was subsequently used, and 21 items were extracted while 51 items were retained. These 51 items cut across the four factors. The four factors of the module, all of which had more than three items, were found to be valid. This is in line with the submission of Brown (2015), who postulated that a factor with three items is reliable. In addition, the four factors with the 51 items explained 80.14% of the total variance. The internal consistency, as estimated using Cronbach's alpha, was adequate for each factor. Additionally, the analysis revealed a positive correlation for the items of the factors. The confirmatory factorial analysis that was performed revealed that Model 2 has a very good fit with the indices (CMIN/DF = 1.459, CFI =.925, GFI =.919, RMSEA =.077). Yin and Fitzgerald (2015), Yin, Umar, and Lok (2018) used similar results of goodness of fit to adjudge the instrument they used for their respective studies as reliable and valid. This implies that with a valid module for training RTVEW students, the broad goals of the technical college as well as the specific objectives of RTVEW trade, will be better achieved.

## 5. CONCLUSION AND RECOMMENDATION

Satellite transmission and reception module was designed to equip radio, television, and electronics work students with skills in the installation and maintenance of satellite transmission and reception system components. There is hardly any better state that the module can be to be more able to enhance the chances of realizing this aim than when it is reliable and above all valid. Therefore, this study employed structural equation modelling to explore the validity of a four-factor, 72 item satellite transmission and reception systems module. Results obtained by confirmatory factor analysis indicated the existence of strong unidimensional among the four factors. At the end of the process, 51 items based on the goodness-of-fit statistics for the factors were found to have the required statistical parameters needed for them to be considered valid. Hence, it is recommended for adoption for the training of radio, television, and electronics work craftsmen in technical colleges in Nigeria.

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