CONSTRUCTION AND FACTORIAL VALIDATION OF AN INSTRUMENT FOR STUDENT ASSESSMENT OF TEACHING EFFECTIVENESS FOR EDUCATIONAL RESEARCH AND STATISTICS INSTRUCTION

[1]Njideka Gertrude Mbelede, *ng.mbelede@unizik.edu.ng*
[2]Ifeoma Clementina Metu, *ic.metu@unizik.edu.ng*
[3]Lydia Ijeoma Eleje, *li.eleje@unizik.edu.ng*
[4]Nneka Chinyere Ezeugo, *nc.ezeugo@unizik.edu.ng*
[5]Ezinwa Amauche Uju, *au.ezinwa@unizik.edu.ng*

[1,2,3,4&5] Department of Educational Foundations,
Faculty of Education, Nnamdi Azikiwe University, Awka,
Anambra State, Nigeria.

Abstract

This study aimed at the development and validation of an indigenous scale for evaluation of teaching effectiveness for Educational Research and Statistics as a University-wide course considering the debate in literature about the validity of Students' assessment of Teaching Effectiveness. The research process was in five phases. A total of 588 students filled the online questionnaire, out of which 470 (79.93%) were females and 118 (20.07%) were males. Using varimax rotation, the EFA computed extracted three-factors model, namely, course content coverage, teacher-student rapport and teaching and learning to measure teacher effectiveness which was determined to be a good fit for the data. The results of the study revealed Cronbach's Alpha value of 0.772 showing high internal consistency and validity evaluation from 0.799 to 0.409 factor loadings based on the eigenvalue cut-off of .40. Item reduction resulted in 19 items.

Key words: Exploratory factor analysis; factorial validation; teaching effectiveness; research and statistics

Introduction

Educational research and statistics is an important course offered by education students at undergraduate and postgraduate levels in Nigerian universities. The course introduces students to the rudiments of research methods and statistics for academic writing, statistical data analysis, and project writing. It is a prerequisite course that must be offered and passed before certification of education students. The course is designed to enable education students develop research skills in designing, conducting, analyzing academic research projects under supervision of a mentor. More so, It equips education graduates with core attributes that will enable them carry out action research to solve social problems in their locality and those that affect the achievement of national

education goal (Longe, 2023). Educational research and statistics as a course of study enhances students' ability to search for, locate, extract, organize, evaluate and present information that is relevant in solving educational problems (Mizan, 2022; Zach, 2022). Since we live in information and technology driven global world where e-tools are used for educational and research purpose; strengthening students' capacity through building their research skills is paramount.

Due to the importance educational research and statistics as a course of study, there is need to ensure that it is taught effectively by the teacher for mastery of content and acquisition of research skills by the students. Teacher effectiveness therefore is an essential factor in ensuring that instructional objectives and expected learning outcomes are attained. Teacher effectiveness is a multifarious term that includes numerous components: self-control strategies, classroom design techniques, teaching to appropriate behaviours, accurate and timely consequences and student teacher relationships (Centre for Teacher Effectiveness (CTF), 2023). These elements interact in diverse ways to cause changes in student learning outcomes (Danielson, 2010; Darling-Hammond et al, 2000; Hawthorne, 2022) even in educational research and statistics as a course of study. Teachers who excel in all of these areas are more likely to foster good, productive learning environments in which children can thrive. However, these aspects of teacher effectiveness may vary based on the situation, such as grade level, subject area, and student demography. In contrast, the components listed below give a general framework for understanding the underlying characteristics of effective teaching. Some of these key aspects are: content and pedagogical knowledge, classroom management, planning and instructional delivery, assessment as a tool for learning, professional development and reflection.

Hence, for effective teaching, teachers must have a thorough understanding of the subject matter as well as the principles of effective instruction (Hawthorne, 2022; Shulman, 1986). This expertise enables them to create and deliver engaging and challenging lessons for all learners. This is to say that a teacher who is well-versed in both course content and pedagogical knowledge may employ clear and succinct explanations, relevant examples, and thought-provoking questions to help students grasp complicated concepts. Teachers more so, must be capable of establishing a good and productive learning atmosphere in which students feel protected, respected, and motivated to study (Brophy, 2006). This entails creating clear behavioral standards, employing effective classroom management tactics, and cultivating positive attitudes. Hence, a teacher with good classroom management skills may set clear rules and procedures, offer positive reinforcement, and respond to disruptive conduct in a timely and consistent manner.

Teachers must be capable of preparing and delivering teaching that is linked with state standards and curriculum goals (Guskey, 2005). This entails employing a variety of

teaching approaches and strategies in order to engage pupils and foster deep learning. To address the requirements of all learners, a teacher experienced in instructional design and delivery may employ a number of instructional methods such as lectures, group work, hands-on activities, and technology all targeted at achieving specific instructional and general educational objectives.

Assessment for learning requires teachers to be able to use assessment data to inform their instruction and make judgments about how to best support student learning (Hawthrone, 2022; Black & William, 1998). This entails collecting information about student progress using a range of assessment methods and providing students with timely and specific feedback. In assessment for learning, the teacher employs formative assessment techniques such as observations, exit tickets, and quizzes, to collect data on student development during instruction. This information can then be utilized to modify instruction, help students to learn persistence, managing impulsivity, listening with understanding and empathy, thinking flexibly, metacognition, striving for accuracy, questioning and problem posing, amongst other positive habits (Gloria *et al*, 2017; McCallum & Milner, 2021; Xuan *et al* 2022) and offer students with the assistance they require to succeed.

Teachers need to be committed towards continuous professional growth. This includes reflecting on their teaching approach, soliciting input from others, and taking advantage of professional development opportunities. To stay current on best practices in teaching, a teacher who is committed to professional reflection and development may seek feedback from peers, attend workshops, seminars and conferences, or read professional publications.

The need to assess teacher effectiveness through student progress has been stressed (Hawthorne, 2022). In other words, for a decision regarding whether teaching is effective to be considered trustworthy, it must be weighed against student growth. This can be ascertained through proper assessment and evaluation of the instructional process. Teacher effectiveness in the course of instruction is made manifest through a three-part process: lesson planning, lesson presentation and following through to ensure mastery and retention of content taught. These processes according to Danielson (2010), could be factored into domains: student-teacher rapport, establishing student goals, classroom organization, course content, teaching and learning. Hence, for proper assessment of teacher effectiveness, these factors must be considered. Researchers (Arop, *et al*., 2020; Bichi, 2017; Onyekuru, & Ibegbunam, 2013; Oviawe, 2016) asserted that teacher effectiveness has significant relationship with student performance, not minding the gender. They opined that both male and female teacher effectiveness equally affect students' academic performance. Though Kaidese (2011), found low teacher effectiveness among pre-vocational subject teachers in Ogun State and advocated the use

of ICT-driven pedagogy, modern classroom practices and assessment techniques to enhance their teaching effectiveness though with no emphasis on how this assessment should be done.

Whether teaching at the undergraduate or graduate level, it is important for teachers to strategically assess the effectiveness of their teaching by measuring the extent to which students in the classroom are learning the course material. The measurement of student learning through assessment is important because it provides useful feedback to both teachers and students about the extent to which students are successfully meeting course learning objectives. For Stassen *et al*., (2001), Ugodulunwa (2020), Wiggens and McTighe (2005) as cited in Fisher (Jr) (2023), assessment is the systematic collection and analysis of information to improve student learning. This definition captures the essential task of student assessment in the teaching and learning process. Student assessment enables instructors to measure the effectiveness of their teaching and determine the metrics of measurement for student understanding of and proficiency in course learning objectives as well as linking student performance to specific learning objectives. As a result, teachers are able to institutionalize effective teaching choices and revise ineffective ones in their pedagogy. They argue that assessment provides the evidence needed to document and validate that meaningful learning has occurred in the classroom. Assessment is so vital in their pedagogical design that their approach encourages teachers and curriculum planners to first 'think like an assessor' before designing specific units and lessons, and thus to consider up front how they will determine if students have attained the desired understandings (Fisher Jr. 2023). However, researchers have dealt on teacher effectiveness in education and other fields, within Nigeria and internationally, the part it plays on success and life goal attainment of learners (Fisher (Jr) (2023; Hawthorne 2022; Stassen *et al*., 2001;) but not much has been done on the development and standardisation of instrument to assess teachers with respect effectiveness during instruction university-wide educational courses in Nigeria.

The key beneficiary in classroom instruction delivery is the learner. In other words, the learner to a great extent determines the successful completion of the learning process. Agreeing to this, David and Macayan, (2010); Doyle (2004) and Angelo (2004) as cited in Fisher (Jr.) (2023), viewed that teaching in the absence of learning is just talking and that a teacher's effectiveness is again about student learning. However, all teachers realize that what a student learns is not always within the teachers' control. Student assessment is therefore a critical and influential measure of teacher effectiveness (Chen, 2007; Clotfelter *et al*, 2010) which consist of assessment of most visible teaching habits of teachers in classroom settings to personal characteristics such as communication styles, attitudes, and other dispositions evident in a teacher. Thus, students who are the direct consumers of the services provided by teachers are in a good position to assess and evaluate their teachers' performance (David & Macayan, 2010). Though Wachtel (1998)

advanced argument on student evaluation of their teachers, recent scholars advocated the idea owing to their position of the student in the teaching and learning process (Clotfelter, *et al* 2010; Fisher, 2023; Hawthorne 2022; Oviawe, 2016; Rink, 2013). Since student ratings are the most influential indicator of teaching effectiveness as perceived by recent researchers, active engagement and meaningful input from students can be vital to the success of teacher assessment systems in educational Research and Statistics. Nonetheless, no instrument known to the researchers have been developed and validated for students' assessment of teaching effectiveness in Educational Research and Statistics. Such instrument will help to identify causes of students' poor performances in the course. this instrument also, will help to provide feedback to teachers and management for improvement.

More so, the importance of a valid and reliable assessment instrument for assessing educational outcomes has been well recognized (Otaya *et al*, 2020; Schmid et al 2020). The issue at stake is on dearth of a valid and reliable student evaluation of teaching effectiveness instrument for use as a component in the assessment of teachers' productivity. Such instrument will be needed for university wide courses such as educational research and statistics in Nigeria.

Method

Development of the Student Assessment of Teaching Effectiveness Scale (SATES). The development of the Student Assessment of Teacher effectiveness scale involved a systematic process of analysis that followed established procedures (Tavacol & Wetzel, 2020). The process included five phases. First, the researchers conducted a detailed literature review of teacher effectiveness and scales used by students to evaluate teachers. Researchers searched databases in the social sciences (PsychINFO), education (ERIC), as well as Google Scholar for all English- language journal articles and books published from 2015 to 2023. From literature, the researchers identified five element of teacher effectiveness: self-control strategies, classroom design techniques, teaching to appropriate behaviours, accurate and timely consequences and student teacher relationships (Centre for Teacher Effectiveness (CTF), 2023; Danielson, 2007; Darling-Hammond *et al*, 2000; Hawthorne, 2022)

Second, the researchers analyzed the factors identified and concluded that these five factors were the best synthesis of the existing literature and modified them as: student-teacher rapport, establishing student goals, classroom organisation, course content coverage and teaching and learning process.

Third, based on our literature review, researchers identified key areas and developed questions under each of these five factors. A total of 25 items were developed,which were generated by the authors based on the above analysis.

Fourth, a panel of three experts (two from Measurement and Evaluation and one from Educational Psychology) reviewed all the items and provided feedback. Experts were asked to focus on content, wording of each item, uniqueness of each item compared to other items on the scale, and the type of factor covered by each item. All of the SATES survey questions were rated using a five-point scale in which 5 was strongly agree and 1 was not applicable. The experts' feedback was incorporated into the scale.

Fifth, an early version of the instrument was pilot tested with a group of 20 undergraduate students from faculty of education in Abia State University, Uturu who were asked to complete the scale and comment on items that were confusing, difficult to understand, or difficult to rate. They were also asked to comment on the overall content and format of the instrument. Their feedback was used to revise the instrument.

Sample Selection and Procedure. One thousand names were randomly generated from the social media platforms of 300 and 400 level students from the two universities under study (Nnamdi Azikiwe University and Chukwuemeka Odimegwu Ojukwu University. Participants received in the mail a letter describing the purpose of the study and copy of the survey. A total of 588 (58.8%) students filled the online form out of which 470 (79.93%) were females and 118(20.07%) were males.

Analysis of the Data. Validation of the Instrument: Exploratory factor analysis (EFA) for model generation (Tavacol & Wetzel, 2020) was used to determine the underlying dimensional structure of perceived teacher effectiveness. In particular, data were analyzed using a two-step process. In the first step, an EFA with Maximum Likelihood (ML) and varimax rotation was performed to analyze the interrelationships between the instrument items and domains to uncover the unknown underlying factorial structure (dimensions) of teacher competence. In the second step, the identified factorial solution was refined by eliminating items that, correlated highly between two factors, failed to load, did not psychometrically strengthen the internal consistency of the factors identified, or were not in tune with the underlying factor on which they loaded.the path model and scree plot were as well constructed to help strengthen the result of EFA. A set of specific criteria was defined a priori to assess the plausibility of the models tested (Tavacol & Wetzel, 2020; Yolanda, 2013). The cutoff used to include items in a factor was set at a value of .40 or higher (Beavers et al 2019; Minitab, 2021; Tavacol & Wetzel, 2020). Pairwise deletion was used for EFAs (N = 488).

Results

EFA Analyses

Table 1: Factor Loadings of items in order of weight according to factors

Dimension	Original code	Statement	Factor Loadings	Eigenvalues	Explained Variance (%)	Alpha
Course content coverage	16	The teacher always came to class well prepared.	0.797	10.772	19.9	.590
	17	The teacher has mastery of the course content.	0.700			
	24	The teacher presented lectures in a systematic manner.	0.673			
	25	The teacher explained concepts clearly.	0.603			
	14	The teacher spent the full time allotted for each lecture.	0.602			
	23	The teacher always involved students in class activities.	0.564			
	15	The teacher maintained decorum in the class.	0.541			
	11	Scheduled classes commenced on time.	0.506			
	22	The teacher motivated students to learn.	0.476			
	19	The examination reflected the course content.	0.446			
Teacher-student rapport	5	The teacher encouraged me to ask questions in class.	0.799	1.427	14.6	.634
	4	The teacher encouraged me to work hard.	0.696			
	8	The teacher encouraged me to participate in class.	0.633			
	6	The teacher provided me with the course specifications at the beginning.	0.409			
Teaching and learning	20	The teacher provided clear feedback on assignments.	0.653	1.357	13.8	.500
	10	The teacher encouraged my learning group.	0.511			
	12	The teacher make-up classes for missed lectures.	0.467			

21	I was comfortable with the pace the teacher used in covering the course content.	0.449
2	The teacher was available for help.	0.420

Using varimax rotation, three distinctive factors were extracted in the initial EFA (course content coverage, teacher-student rapport and teaching and learning) using maximum likelihood factoring method as in table 1, since the study does not target at reduction of items of the instrument but rather measure a latent construct. From the 25 total items entered in the analysis, all the 25 had loadings over .40 and contributed to increase the internal consistency of each of the three factors identified. The first factor included ten items and was labeled course content coverage, second factor has four items and was labeled teacher-student rapport while the third factor labeled teaching and learning included five items with eingen values of 10.772, 1.427 and 1.357 respectively. Together, they explained 48.3% of the variance. Factor 1 (course content coverage) explained 19.9% variance , factor 2 (teacher-student rapport)explained 14.6%, factor 3 (teaching and learning) explained 13.8%. Three cross-loadings were identified in factors 2 and 3 respectively(items 7, 9 and 13 of the original instrument), while two items (1 and 18)did not load at all and were deleted, hence not part of the final draft.

Table 2: Factor Correlations

	Factor 1	Factor 2	Factor 3
Factor 1	1.000	0.590	0.634
Factor 2	-	1.000	0.500
Factor 3	-	-	1.000

The inter-factor correlation for the sub scales reflects a strong relationship between content coverage and teaching and learning activities (r=.634). Similarly, teacher-student rapport and teaching and learning (r = .500) are also strongly correlated. Moreover, a strong correlation exist between content coverage and teacher-student rapport (.590).

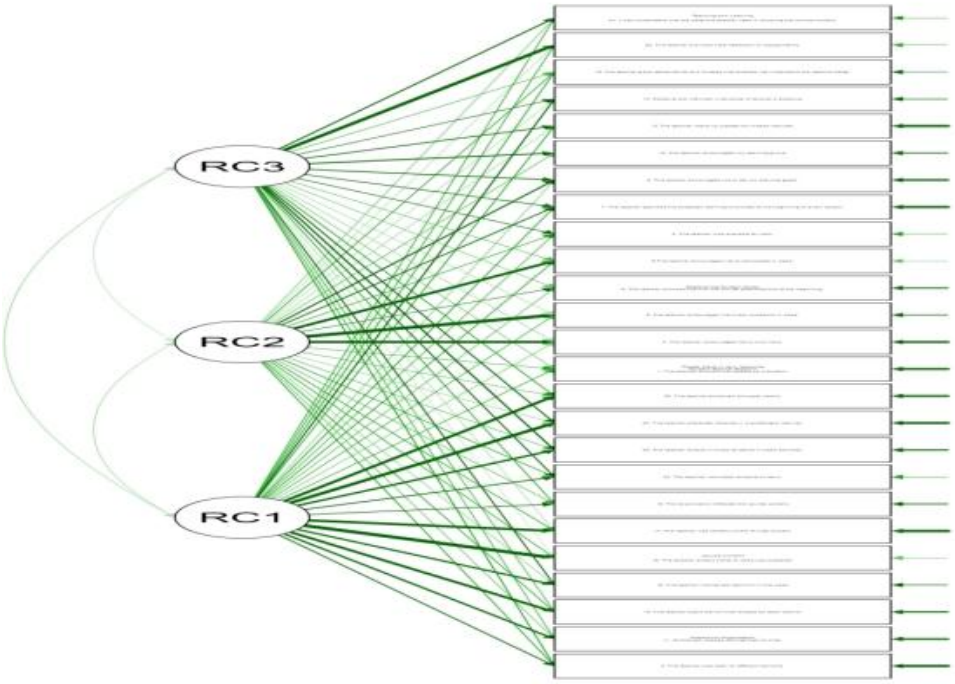


Fig. 1: Path model of the EFA loadings of the three factors.

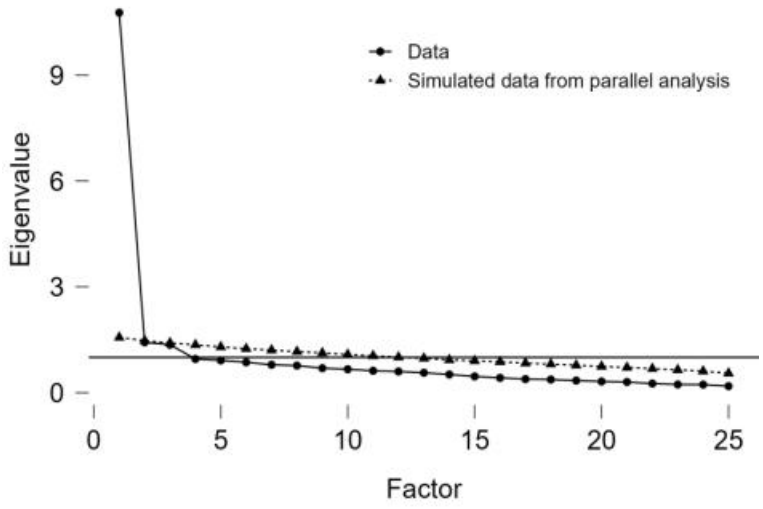


Fig. 2: Scree plot

The scree plot displays the number of the factor versus its corresponding eigenvalue. The scree plot orders the eigenvalues from largest (10.772) to smallest (0.185).

Discussion

This study yielded strong psychometric data to support a three-factor model to measure teacher effectiveness which was determined to be a good fit for the data. This finding is consistent with researchers' difficulty in operationalizing measures of teacher effectiveness in university faculty wide courses. In this study, there was strong correlations among the factors, the three separate factors are distinct and explain equally large proportions of the variance in the data. Moreover, the results support a cognitive component (content coverage), a affective component (teacher-student rapport), and a psychomotor component (activities of teaching and learning) related to the behavioural objectives of instruction delivery. The finding that the three-factor model yielded stronger psychometric properties might reflect the agreement that a complete and successful teaching and learning process must involve the three domains of educational objectives (FGN, 2013). The final draft of the instrument has a total of 19 items, (course content coverage has 10; teacher-student rapport has 4items while teaching and learning has 5items).

Limitations of the Study

This study was only limited to two universities in the South-Eastern part of Nigeria with 488 students as participants. Therefore it is not guaranteed that the results of this study also hold true to other universities either in Nigeria or internationally.

Conclusion

The SATES is a psychometrically sound scale that measures the multidimensional aspects of teacher effectiveness in higher education. This is reflected in the results of its reliability evaluation (Cronbach's Alpha value of 0.772 showing high internal consistency) and validity evaluation (from 0.799 to 0.409 factor loadings based on the .40 cut-off for screening of items).

Recommendations

The SATES has gone stages of testing its reliability (Cronbach's Coefficient Alpha formula) and validity (ML with Varimax Rotation) in the process of establishing its psychometric properties. However, to have a more detailed property of SATES, further study is still recommended. Confirmatory Factor Analysis (CFA) is recommended to be carried out on SATES to determine redundant items to further strengthen its psychometric powers by future researchers.

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