Predicting Mathematics Students' Continuance Intention toward Learning Mathematics

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https://doi.org/10.24191/ajue.v17i3.14503

Received: 30 June 2021
Accepted: 15 July 2021
Date Published Online: 31 July 2021
Published: 31 July 2021

Abstract: The success of learning mathematics depends largely on students' satisfaction in learning the subject. This, along with other factors such as perceived usefulness in learning mathematics, will eventually increase students' intention to continue learning mathematics. This study integrated the Expectancy Confirmation Model (ECM) and perceived enjoyment, with the main purpose of developing a fitting structural model that investigates whether the ECM model can be extended and used in the context of mathematics students' learning continuance. The study used a correlational research design conducted on 12 tertiary colleges in the northwestern zone of Nigeria. Proportionate stratified random sampling technique was employed to select 366 Nigeria Certificate in Education (NCE) III mathematics combination students for this study out of a total population of 2761 NCE III mathematics students based on the Cochran formula. The findings indicate that the most significant factor affecting the college of education (COE) mathematics students' continuance intention is the belief of their perception of the usefulness of learning mathematics to their daily life activities. Satisfaction and perceived enjoyment in learning mathematics also positively influence students' intention to continue studying mathematics. The current research adds to the theory by replacing the ECM's confirmation of expectation construct with the construct of perceived enjoyment and introducing new associations to describe mathematics students' continued intention to learn mathematics.

Keywords: Mathematics, Tertiary colleges, Colleges of education, Expectation Confirmation Model (ECM), Continuance Intention, Partial Least Square (PLS).

1. Introduction

Mathematics is made a compulsory subject in primary and secondary schools in Nigeria and a foundation for scientific and technological expansion (Azuka, 2000; Mahmud et al., 2020). Thus, well-trained mathematics teachers must be produced at colleges of education (COEs) in Nigeria to teach the subject at the Basic Education level. COEs were established to produce highly motivated and trained Nigeria Certificate in Education (NCE) teachers through actual teaching, investigation, and community

service for the Basic Education level (NCCE, 2012). In recent times, the enrolment and desire to accept mathematics as a course of study by students at tertiary institutions and COEs particularly in Nigeria have not been encouraging (Salman et al., 2011). Most studies focused on instructional strategies for teaching mathematics and neglected influencing factors which affect students' continuance intention of studying mathematics. In Nigeria, several studies revealed that students' attitudes toward learning mathematics were generally negative; this negative attitude contributed to their low desire to accept mathematics as a course of study at tertiary institutions (Suleiman & Muhammad, 2016). In this case, many students perceive mathematics as a challenging school subject due to the negative impression they receive from their past generations who had bad experiences with under qualified mathematics teachers. As students have the perception that mathematics is the most difficult subject in school, it is not meant for everyone and not everyone passes it, many students do not concentrate on learning the subject and spend little time practicing it in COEs (Dauda et al., 2016).

The perceived usefulness of studying mathematics can be characterized as the degree to which students feel that learning mathematics can help them achieve their long-term goals. It is a variable of continued information system (IS) usage intentions and has been shown to affect satisfaction on various occasions. In previous studies, perceived usefulness showed a strong influence on users' satisfaction (Junjie, 2017; Bhattacherjee, 2001) and was the main predictor of continuance intentions (Muqtadiroh et al., 2019; Daneji et al., 2018; Wu & Chen, 2017; Junjie, 2017; Shiue & Hsu, 2017). Likewise, for studies related to mathematics, perceived usefulness was also found to be influencing continuance intention toward learning the subject (Zogheib, Zogheib & Elsaheli, 2015; Guo, Marsh, Parker, Morin, & Yeung, 2015; Mohamed & Waheed, 2011). In other words, if students feel that learning mathematics is very useful to them, they will be more pleased (satisfied) with it and are inclined to continue studying mathematics.

Perceived enjoyment in learning mathematics is defined as the amusement of learners from learning mathematical subjects (Rakoczy et al., 2019). Researchers have studied the association between satisfaction and subjective enjoyment in different places and conditions extensively (e.g., Joo et al., 2017; Jung & Jung, 2012). Perceived enjoyment was shown to be an indicator of faculty members' satisfaction with e-learning resources by Sorebo et al. (2009) where a high level of enjoyment of e-learning leads to greater satisfaction in higher educational institutions (Sorebo et al., 2009). Personal satisfaction with Internet Protocol Television (IPTV) services is heavily affected by perceived enjoyment (Jung & Jung, 2012). The greater the individuals' perceived enjoyment of the service is, the greater the users' service satisfaction will be. Lin et al. (2005) analyzed that perceived enjoyment has a substantial impact on satisfaction between subscribers of a website.

Several scholars reported a strong link between perceived enjoyment with continuance intention (e.g., Vecter & DeWet, 2016; Oghuma et al., 2016; Kim, 2010). Perceived enjoyment was revealed to have a major impact on continuance intention in adopting mobile services (Kim, 2010; Thong et al., 2006). People with greater perceived enjoyment were more likely to adopt a website (Lin et al., 2005).

Satisfaction is a good mental condition that emerges from a positive assessment of technology use (Lin et al. 2005). Satisfaction in learning mathematics refers to the students' view of happiness and achievement in learning the subject (Saha et al., 2010). Previous studies have shown a lack of understanding on continuance intention toward learning mathematics. A review study of 30 papers written between 2005 and 2017 on the desire to continue learning technology was undertaken as part of a research to evaluate the influence of satisfaction on continuance intention. The findings of the appraisal exposed that there was a significant association between satisfaction and intention to continue in the setting of e-learning (Rahman et al., 2017). Additionally, Bagci and Celik (2018) stated that a continued intention to use web-based distance learning has been strongly influenced by satisfaction. Furthermore, Shiue and Hsu (2017) noted that satisfaction with game-based learning (GBL) was positively associated with learners' continuous use of GBL; and Zogheib, et al (2015) demonstrated that satisfaction positively influenced student's intention to adopt and use technological tools in a mathematics teaching space. Other studies also showed the significant impact of satisfaction on continuance intention (Daneji et al, 2019; Junjie, 2017; Lee, 2010).

According to the GBL model, learners' intention to continue learning is dictated by their satisfaction and understanding of the learning usefulness and can be based on Bhattacherjee's (2001) ECM which has its roots in expectation confirmation theory (ECT). Learners' satisfaction is determined by their perceived usefulness and the degree to which their learning standards are fulfilled. Usually, learners have some prospects and hopes about learning before studying. Once learners' expectations are attained, they become satisfied with their level of learning, thus enhancing their continuance intention of learning. Therefore, this research is novel in investigating whether the ECM of IS continuance usage intention construct can be extended and used in the context of mathematics learning students' continuance intention. The researcher focuses on the relationships between the construct's perceived usefulness, satisfaction, and continuance intention as proposed by Bhattacherjee (2001) while integrating the construct of perceived enjoyment.

2. Literature Review and Hypothesis Development

The ECM supports the theoretical foundation of this study. This model originated from the ECT of Oliver (1980) that was developed in the marketing domain to assess consumers' satisfaction and post-purchasing manner. Bhattacherjee (2001) extended ECT to build the ECM of IS continuance and linked the continuance decision of IS users to that of the consumer repurchase decision. According to him, both scenarios followed a sequence: (a) making initial acceptance of IS or purchase decision, (b) experiencing preliminary use of the product/service, and (c) making the post-purchase decision or continuing the use of IS or reversal of the initial decision (Bhattacherjee 2001). Many studies have used the model in studying continuance usage intention since its inception in 2001 by Bhattacherjee (e.g., Junjie, 2017; Ismail et al., 2012; Lee, 2010; Chiu & Wang, 2008; Thong et al., 2006).

The research model was created using Bhattacherjee's (2001) IS continuance intention and adding the construct of perceived enjoyment, as seen in Figure 1. The variables examined in this research include satisfaction with learning mathematics, perceived usefulness in learning mathematics, perceived enjoyment in learning mathematics, and continuance intention of learning mathematics. Based on the theoretical background, five hypotheses were proposed.

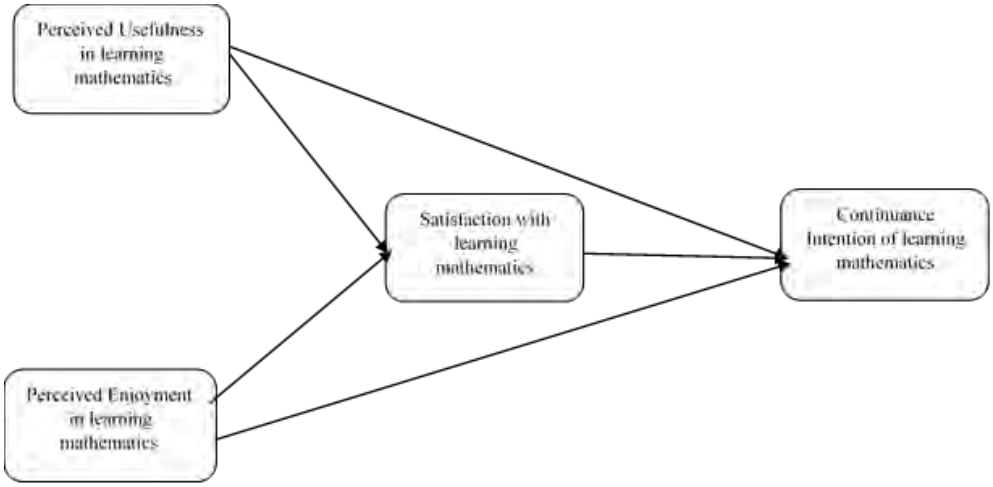

Fig. 1. Proposed research model

The degree to which students assume that studying mathematics can enhance their academic achievement and everyday lives were calculated by perceived usefulness. As hypothesized by ECM, perceived usefulness is strongly associated with satisfaction (Junjie, 2017; Sørebø et al. 2009; Bhattacherjee, 2001) and continuance intention (Daneji et al., 2019; Muqtadiroh et al., 2019; Rahmat et al., 2021; Wu & Chen, 2017; Junjie, 2017; Joo et al, 2017; Shiue & Hsu, 2017; Lim et al., 2020). As a consequence, it was predicted that students' perceptions of the usefulness of studying mathematics would

boost their mathematics learning satisfaction and their intention to maintain mathematical learning. Therefore, two hypotheses were suggested:

H_1: The perceived usefulness of studying mathematics has a positive impact on students' satisfaction with the subject.
H_2: The perceived usefulness of mathematics learning has a positive impact on students' intentions to continue learning mathematics.

Perceived enjoyment in learning mathematics refers to the fun and pleasure mathematics students derive in learning mathematics courses apart from the anticipated benefits of studying mathematics. For research related to the perceived enjoyment of learning mathematics, Venter and De Wet (2016) revealed that the constructs of fun, imagination, immersion, and sensation were the greatest significant constructs in the intention of continuous use. Additionally, perceived enjoyment has been investigated in many contexts of studies such as mobile instant messaging (Oghuma et al., 2016), wireless services (Kim, 2010), e-learning (Thong et al, 2006), and mobile mathematical games (Vecter & De Wet, 2016; Vecter, 2016).

Therefore, it is expected that students who perceive learning mathematics as interesting are more likely to concentrate on the learning of the subject. This will in turn enhance their intention to continue learning mathematics. Thus, two hypotheses were proposed:

H_3: Students' perceived enjoyment of learning mathematics has a positive influence on their level of satisfaction with learning mathematics.
H_4: Students' perceived enjoyment of learning mathematics has a positive influence on their level of intention to continue the learning of mathematics

The degree to which students' wishes and aspirations regarding studying mathematics are fulfilled or surpassed can be described as satisfaction. The link between satisfaction and continuance intention was developed based on the main theory (Daneji et al., 2019; Muqtadiroh et al., 2019; Daneji et al., 2018; Wu & Chen, 2017; Junjie, 2017; Shiue & Hsu, 2017). It is expected that if the students are satisfied with learning mathematics, their continuance intention to study mathematics will increase. Hence, the following hypothesis was suggested:

H_5: Students' level of satisfaction with learning mathematics has a positive influence on continuance intention to study mathematics.

3. Research Methodology

With the main emphasis of the research being the continuance purpose of studying mathematics, a correlational analysis design was applied in this study where a questionnaire was used to gather data from mathematics students of higher education institutions. To predict a model on students' continuance intention of studying mathematics, Partial Least Square (PLS-SEM) was employed for data analysis. The predicted model was based on the IS continuance intention model. To assess the research model, data was obtained using self-administered questionnaires distributed to 366 mathematics students from 12 higher education institutions in Nigeria's northwestern region. Among all the questionnaires distributed, only 339 questionnaires were filled up and returned. They were therefore used for the analysis. The respondents' background information is displayed in Table 1.

Table 1. Respondents' demographic profile

Variable	Classification	Frequency	Percentage (%)
Gender	Male	256	75.5
	Female	83	24.5
Age	18 – 20	97	27.7
	21 – 23	176	51.9
	Above 23	69	20.4

The measurement instruments employed in the present study were adopted from past studies, with some adjustments made in the phrasings to echo the mathematics learning context. These instruments were presented to experts for validation on the adjustment made and all the observations were taken note of. The content validation of the questionnaire by experts was considered 'excellent'. The items related to continuance intention (13 items) and satisfaction (11 items) were adopted from Roca et al. (2008) and Bhattacherjee (2001). Meanwhile, items related to constructs of perceived enjoyment and perceived usefulness (5 items) were adopted from Vandecandelaere et al. (2012). All items were rated on a 5-point Likert scale that ranged from "strongly disagree" to "strongly agree", and from "extremely dissatisfied" to "very satisfied". The questionnaire was divided into two sections. Five items on the background information of the participants with two closed-ended queries (institution's name and gender) and three open-ended queries such as the age of the respondent, state of the institution, and respondents' major were included in the first section while the second section contained 29 items to measure the study constructs. Before actual data collection, the validity and reliability of the adopted instrument were proven using a pilot study with 30 participants.

4. Findings

SmartPLS was used as the major tool for analyzing the collected data. PLS-SEM can produce small parameter estimation bias when the nature of the sample population is unclear (Sarstedt et al., 2016), such as in this study and most social science research in general.

4.1 Measurement Model

To evaluate the relations stated in the proposed study model, a two-step technique was adopted as suggested by Anderson and Gerbing (1988). First, fitness and construct validity of the measurement model were examined by measuring the reliability, convergent validity, and discriminant validity. Next, the structural model was examined to investigate the strength and the direction of the relationships hypothesized in the research model. PLS-SEM was employed in this study due to its capability in evaluating a series of interrelationships among latent constructs together within a model (Awang, 2015).
Convergent validity refers to a set of items that come together to examine a single construct (Kline, 2015). Construct validity was evaluated based on the standards that the indicator's (construct's) estimated coefficient was significant on its recommended fundamental construct factor. The measurement model was assessed using Fornell and Larcker's (1981) criteria:

Table 2. Recommended criteria

Measurement model criteria	Accepted level
Factor loading (k)	>0.5
Construct reliabilities (CR)	≥ 0.7
average variance extracted (AVE)	>0.5

Table 3. Cronbach's alpha, internal consistency, and AVE.

Constructs	α	Composite Reliability	AVE
Continuance Intention	0.885	0.911	0.597
Perceived Usefulness	0.887	0.912	0.599
Perceived Enjoyment	0.907	0.928	0.684
Satisfaction	0.913	0.930	0.626

Data reliability was measured by Cronbach's α to assess internal consistency. Cronbach's alpha (α) values of each construct were shown and each of the Cronbach's α was above the recommended value of 0.7 (Hair et al., 2017). This finding specifies that the variables have high internal reliability. Besides that, the construct reliability (CR) of variables ranged from 0.911 to 0.930, while the average variance extracted (AVE) values that ranged from 0.597 to 0.684 were higher than the variance due to measurement error. Therefore, all three criteria for convergent reliability and validity were satisfied. The item factor loading, the CR of each construct, and the AVE satisfied the recommended threshold values (refers to Table 2, 3).

The square root of the AVE of each variable and constructs relationships were adopted in evaluating discriminant validity (Awang, 2015). The square root of the AVE of each variable shared between constructs should be lower than the association to itself. Variables attaining this are said to have acceptable discriminant validity. From the results of this analysis, it is clear that the model also satisfied the rule of discriminant validity (refers to Table 4). Hence, the results of the measurement model of this study with its convergent and discriminant validity measures are satisfactory. Before performing the second stage of analysis (structural model), the collinearity issue should be addressed. As recommended by Hair et al. (2017), VIF values of less than 5 indicate that the relationship between exogeneous and endogenous constructs do not have a collinearity issue. Since all VIF values recorded were less than 5, collinearity is not a problem.

Table 4: Discriminant Validity

Variables	Enjoyment	Intention	Satisfaction	Usefulness
Enjoyment	0.827			
Intention	0.277	0.773		
Satisfaction	0.317	0.431	0.791	
Usefulness	0.200	0.446	0.332	0.774

4.2 Structural Model

Results related to hypothesis testing are summarized in Figure 2. Path coefficients are shown above each path and R^2 are the percentages presented in each endogenous variable. According to Chin (2010), a structural model describes a theoretical model with a collection of structural equations to assess the inner path model. In this analysis, the basic criteria used for evaluating the structural model in this study were path coefficient (β) and coefficient of determination (R^2) for the endogenous variable.

Based on Figure 2, the structural model analysis confirms the acceptable level of explained variance (R^2) for all endogenous variables. The R^2 values of dependent variables are 0.176 for satisfaction and 0.306 for continuance intention. The model explains 17.6% of variation in satisfaction with the influence of perceived usefulness and perceived enjoyment being statistically significant, showing a moderate level of acceptance (Cohen 1988). The value 17.6% represents the predictive accuracy of the COE mathematics students' level of satisfaction toward studying mathematics on the influence of perceived usefulness and perceived enjoyment in studying mathematics. Finally, 30.6% of variation in continuance intention is clarified by perceived usefulness, perceived enjoyment, and satisfaction with learning

mathematics, which are statistically significant. In other words, 30.6% signifies the sum of variance in the continuance intention of studying mathematics explained by the three hypotheses that are connected to it. The combined influence of the independent variables on the continuance intention of studying mathematics by mathematics students at 30.6% indicates a moderate level of acceptance (Cohen, 1988).

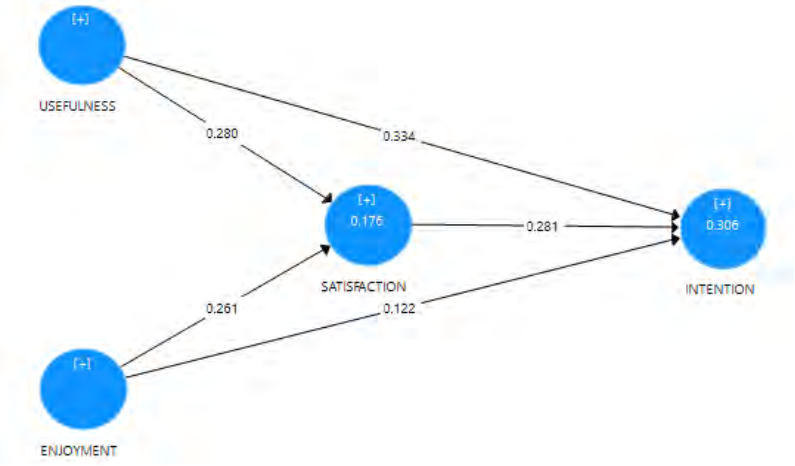

Fig. 2 Structural model Path coefficient (Bootstrapping Method)

Hypothesis 1 (H_1) observed the relationship between COE mathematics students' perceived usefulness in learning mathematics with their satisfaction with learning mathematics, which was supported ($\beta = 0.280$, $T = 5.532$, $P < 0.05$). This establishes that the COE mathematics students' perceived usefulness had a positive influence on students' satisfaction with learning mathematics. This is very clear because the level of belief the COE mathematics students have about the importance of studying mathematics determines the level of their satisfaction in studying mathematics. This can be ascertained from the response of their belief about the usefulness of studying mathematics where almost all of them agree that mathematics is useful to their daily life activities and future study. This belief provides them with satisfaction in the way they are learning mathematics which eventually leads to their intention of continuing to study mathematics.

Hypotheses 2 (H_2) examined the association between COE mathematics students' perception of usefulness in learning mathematics with continuance intention of learning mathematics that was supported ($\beta = 0.334$, $T = 4.129$, $P < 0.05$). Hence, it can be derived that COE mathematics students' perception of usefulness has a positive and significant influence on the continuance intention of learning mathematics. The understanding of the significance of mathematics by COE mathematics students may come from the recognition and respect they accord as mathematics students. Teachers from the management and students from the schools where they attend for one-semester teaching practice allow them (NCE mathematics students) to realize the usefulness of mathematics, resulting in their continuance intention.

Hypotheses 3 (H_3) which studied the connections between COE mathematics students' perceived enjoyment in learning mathematics with their satisfaction in learning mathematics was supported ($\beta = 0.261$, $T = 4.148$, $P < 0.05$). Therefore, it is understood that COE mathematics students' perceived enjoyment significantly and positively influences students' satisfaction in learning mathematics. Mathematics students are willing to take more mathematics courses and occasionally organize tutorial classes for their colleagues who are non-mathematics students to teach them basic general mathematics courses (GSE courses) that are offered to all COE students. Apart from their outstanding performance during teaching practice, they also organize career talks for secondary school students. All these are indications that they enjoy the study of mathematics and receive satisfaction when studying mathematics.

Hypotheses 4 (H_4) analyzed the relationship between COE mathematics students' perceived enjoyment in learning mathematics with their intention to continue learning mathematics. This hypothesis was supported ($\beta = 0.122$, $T = 2.418$, $P < 0.05$), showing that the students' level of perception of enjoyment

in learning mathematics has a strong impact on their continuance intention of learning mathematics. Their intentions to continue studying mathematics may be due to the cordial relationship with their mathematics lecturers, and the way mathematics lecturers take their time in simplifying their lectures to make sure that all their students are carried along. Another reason that they enjoy studying mathematics and even have the intention to continue studying mathematics is the support and encouragement they receive from the schools where they conduct their one-semester compulsory teaching practice.

Hypotheses 5 (H_5) assessed the association between tertiary colleges' mathematics students' level of satisfaction in learning mathematics with their continuance intention of learning mathematics. The hypothesis was supported ($\beta = 0.281$, $T = 4.601$, $P < 0.05$), proving that the level of satisfaction of COE mathematics students has a significant influence on the students' continuance intention towards learning mathematics. Mathematics students of COEs in Nigeria are very much satisfied with their experiences in learning mathematics. This is why they are actively participating in college academic activities like quiz and class tutorials, improvising instructional materials and taking them to where they are doing their teaching practice, and participating in union activities (see Table 5).

Table 5. Path Coefficient.

Relationships	Original Sample (O)	Sample Mean (M)	SD	t	*P-value*	Decision
Usefulness→ Satisfaction	0.280	0.283	0.068	5.532	0.000	Significant
Usefulness → Intention	0.334	0.336	0.060	4.129	0.000	Significant
Enjoyment → Satisfaction	0.261	0.263	0.063	4.148	0.000	Significant
Enjoyment → Intention	0.122	0.122	0.050	2.418	0.016	Significant
Satisfaction → Intention	0.281	0.281	0.061	4.601	0.000	Significant

5. Discussion

The key purpose of the current study is to evaluate whether the ECM can be extended to the students' continuance intention of learning mathematics by integrating the construct of perceived enjoyment to the IS continuance model in Nigerian context. It is a unique and novel attempt in the context of mathematics learning at tertiary colleges in Nigeria. This study has found support for all the five hypotheses to extend ECM of IS continuance intention with perceived enjoyment. The findings show that mathematics students of COE are willing to learn and continue to learn mathematics more when they feel that they are satisfied with the level of usefulness of mathematics to their daily life activities and future ambition.

The findings of this study reveal that COE mathematics students' perception of usefulness in learning mathematics is the most influential factor in determining their satisfaction in learning mathematics. This finding is supported by much prior research (Junjie, 2017; Sørebø et al. 2009; Bhattacherjee, 2001). Furthermore, COE mathematics students' perceived usefulness in learning mathematics significantly influences their intention to continue the learning of mathematics, in line with the findings of multiple past studies (Deneji et al, 2019; Muqtadiroh et al, 2019; Daneji et al, 2018; Wu & Chen, 2017; Junjie, 2017; Joo et al, 2017; Sørebø et al. 2009). Results show that once mathematics students perceive that learning mathematics will enhance their day-to-day activities and future life ambition, they will be more satisfied with the learning of mathematics, and their intention to continue to study mathematics will be increased.

Also, COE mathematics students' satisfaction in learning mathematics plays a vital role in explaining their continuance intention of learning mathematics. This hypothesis is inconsistent with the original ECM theory and previous studies (Daneji et al, 2019; Muqtadiroh et al, 2019; Daneji et al, 2018; Wu & Chen, 2017; Junjie, 2017; Sørebø et al. 2009, Bhattacherjee, 2001).

Thus, the results show that COE mathematics students' level of enjoying learning mathematics have a major influence in determining their extent of satisfaction with learning mathematics. This finding is in concord with prior literature (Oghuma et al, 2016; Jung & Jung, 2012). Also, continuance intention of learning mathematics by these students is significantly influenced by their perceived enjoyment of learning mathematics, as supported by some past researches (Joo et al, 2017; Vecter & DeWet, 2016; Oghuma et al, 2016; Kim, 2010; Thong et al., 2006; Lin et al., 2005). These findings may be attributed to the specific context of this study, considering that students with a high level of enjoyment in their learning will easily become more satisfied, thus leading to their continuance intention of learning mathematics.

6. Conclusion and Implications

We believe that this research offers important contributions in terms of theory development and practice. The present study makes theoretical contributions by replacing the construct of confirmation of expectation from ECM with the perceived enjoyment construct and suggesting the novel associations to explain the mathematics students' continuance intention of learning mathematics. Additionally, the results of this study reveal that the mathematics students of COE perceive usefulness and enjoyment in learning mathematics as significant constructs that determine their satisfaction in learning mathematics, which in turn lead to their intention to continue studying mathematics. Therefore, mathematics curriculum developers at all levels of education need to include topics that expose the importance of mathematics to other subjects and daily life activities from the early stages of education in their next curriculum development, as this will help in solving the problems of low desire to accept mathematics as a course of study at tertiary institutions in Nigeria. Also, they should attempt to introduce new teaching strategies to make mathematics more enjoyable for the majority of students. In sum, curriculum implementers who are lecturers and teachers should be patient and friendly with their students as the results of this study show that once students enjoy the learning of mathematics, they easily become satisfied with their learning and this allows them to develop a positive intention of continuing their study in mathematics.

7. Study Limitations

However, this study has its limitations. Data in this study was collected from only mathematics students of COE in the northern part of Nigeria. Other researchers should test the model on students of universities and polytechnics. Besides that, this research integrated only the perceived enjoyment construct to ECM to clarify the students' continuance intention to learn mathematics. For further improvement, some researchers may integrate other important variables into ECM and test for their possible relevance in the continuance intention theory.

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