Examining Pre-Service Teachers' Attitude towards ICT-Integration In Teaching And Learning Of Geometrical Constructions

Daniel Ashong[*], Douglas Darko Agyei[**], Helena Naa Korkor Tetteh[***]

[*] University of Cape Coast, Department of Mathematics and ICT Education, Ghana;
Berekum College of Education, Department of Mathematics and ICT, Ghana
[**] University of Cape Coast, Department of Mathematics and ICT Education, Ghana.
[***]Berekum College of Education, Department of Mathematics and ICT, Ghana

DOI: 10.29322/IJSRP.10.03.2020.p9989
http://dx.doi.org/10.29322/IJSRP.10.03.2020.p9989

Abstract- This study was designed to examine the effect of ICT-integration (use of Smart Notebook) on pre-service teachers' attitudes at a selected college of education in the Bono Region of Ghana. One group experimental design was used to examine 36 first-year mathematics major pre-service teachers' cognitive, affective and conative domains of attitude towards ICT-integration. The Tripartite model of attitude was used to examine the relationships and predictability of cognitive, affective and conative dimensions of attitude towards the integration of ICT-based intervention. A four point likert-Scale questionnaire instrument was used to collect data on all the four constructs involved in the framework. The questionnaire was administered on the pre-service teachers before and after the ICT-based intervention and the data were analyzed using correlation, regression, and paired samples t-test, based on which the research questions were answered. The results showed that all the dimensions have a strong influence on pre-service teachers' attitudes before and after the ICT-based intervention in teaching and learning of geometrical constructions. The cognitive domain reported the strongest relationship and the best predictor of pre-service teachers' attitudes while affective dimension showed the least relationship and least predictor of attitude before the ICT-based intervention. However, the Affective dimension reported the strongest relationship and best influential determinant of the pre-service teachers' attitude after the intervention. In addition, the study found significant differences in pre-service teachers' attitudes before and after the ICT-based intervention in teaching and learning of geometrical constructions. This study as well suggests that to influence pre-service teachers' attitudes positively, the affective (feelings) domain should be given more attention when designing ICT-integration lessons in the teaching and learning of geometrical constructions. It is therefore recommended that mathematics tutors in the colleges of education should identify such ICT-based interventions and use them in teaching and learning of mathematics to develop pre-service teachers' attitudes positively towards the subject.

Index Terms- Attitude, Cognitive, Affective, Conative, ICT-integration.

I. INTRODUCTION

In this current technological advanced world, both developed and developing countries are finding new and better ways of improving educational standards. Improved educational standards depend mostly on the quality of teaching and learning that take place in the classroom environment.

One of most concerned subjects to every government and other educational stakeholders is Mathematics and research indicates that performance of students in the Sub-Sahara Africa appears to be the least among their counterparts elsewhere (Ngware, Ciera, Musyoka, & Oketch, 2015) and TIMSS (2011; 2012) results also suggest same.

In Ghana, the search for new strategies in improving teaching and learning focused attention on teacher training education. This is because such institutions are mandated to train and supply teachers to the Basic Schools in the country. Based on government and stakeholder consultation forum, there was 99.0% endorsement for the revision of the National Teachers Education Curriculum Framework (NTECF, 2017) which now included in its cross-cutting issues, under the core skills the information and communication skills (ICS), and Information Communication Technology (ICT) which is also a key to effective communication in the 21st Century. This consequently, reflected in the National Teachers' Standards (NTS) under the professional practice, teaching and learning which puts many emphases on ICT-integration to enhance effective teaching and learning (NTS, 2017, (3(J))). In view of this ICT inclusion, more attention has been shifted to ICT integration in teaching and learning of mathematics.

As a result, most researchers in and out of Ghana have integrated ICT-Based Activity learning to specific topics in mathematics at different levels of the educational system aimed at improving teaching and learning of the subject. It is difficult, if not impossible to train any specialist of any kind without ICT knowledge in this Technological era. Again Maldague, Kuimova, Burleigh and Skvortsova (2016), expressed how important ICT-integration is to education as it influences motivation to learn, stimulates cognitive activity and independent work, enables effective classroom discourse and improve learning outcomes.

The ICT-Activity Based learning was employed by Agyei and Voogt (2014) on pre-service teachers at the university level, using spreadsheets and reported that teachers were significant components in determining the transfer of learning of ICT-enhanced activity-based learning. Again, the will skill tool model was used to establish the technology integration level of both prospective and practicing teachers at the secondary school level. The study came out that prospective and practicing teachers correlated positive attitude towards computers, which contradicts the findings of already existing literature (Agyei & Voogt; 2010). ICT-Activity Based learning was again modified and extended by Brouwer, Ekimova, Jasinska, VanGastel, and Virgailaite-Mecˇkauskaite (2009), to investigate the effectiveness of online assessment based on a computer-based mathematical assessment tool (Maple TA) in two preparatory remedial courses in two universities in the Netherland. The study suggested that there had been an improvement in both students' and teachers' mathematical knowledge and skills level. Hwa (2018) demonstrated the use of ICT-based learning to improve mathematics classroom discourse by applying a digital game-based learning situation in the form of entertaining and educating students at the same time in Malaysia. The study indicated that the digital game-based learning approach appeared to be more effective than the traditional or usual methods.

The literature reviewed to confirm the fact that the direction and current trends in both mathematics education research and practice is ICT-Activity Based learning classroom environment which allows students to construct their knowledge in the computerized learning environment. Most of the studies conducted in ICT integration education concentrate more on algebra and showed limited attention to the teaching of geometry, more especially geometrical constructions since most teachers consider using mathematical instruments (a pair of compasses and a ruler) as adequate as it provides Activity-Based learning. Therefore, this study is to add ICT touch to the activity-based learning approach in the teaching and learning of Geometrical Constructions. The study would focus specifically on evaluating the pre-service teachers' attitudes towards the use of ICT-Activity Based learning (SMART Notebook) in Geometrical Constructions classroom environment.

The main focus of this study was to examine first-year Pre-service Teachers' attitudes towards ICT-integration (using SMART Notebook application) in teaching and learning of Geometrical Constructions at a selected college of education in the Bono region of Ghana. The study explored the relationships and extent to which Cognitive, Affective and Conative (independent variables) dimensions influence pre-service teachers' attitude (dependent variable) towards ICT-integration in teaching and learning of Geometrical Constructions.

II. LITERATURE REVIEW ON ATTITUDINAL VARIABLES

After investigating the interaction between cognitive style, achievement scores and attitudes towards computers on university students reported no significant relationship between cognitive style and attitudes towards computers and, concluded that students' attitude towards computers is not influenced by their cognitive style (Altun, 2006). It was also reported (Abun, Magallanes & Incarnacion, 2019) that students' cognitive and affective correlates significantly to higher education and their academic engagement. In another study, Millar and Tesser (1990), indicated that one's attitudes have inconsistent predictability on the attitude-behaviour relationship and explained that attitude reports are based on whatever aspect of the attitude is salient when the report is given and that if the behaviour is intended to achieve a goal, then is likely to exhibit cognitive driven attitude. This suggests that attitudinal variables may predict attitude depending on the intended function of the attitudinal object. Ahn and Back (2018), in their study conducted on brand loyalty of customers, reported that cognitive, affective and conative domains have a positive relationship with brand attitude.

A practical study conducted by Chowdhury and Salam (2015), a measured attitude of internet shoppers against the attitudinal variables (Cognitive, Affective and Conative) and found that all these components have a positive and significant relationship with each other and overall attitude, except cognitive that related negatively with the attitude. Also, Huang, Beatson, and Lings (2015), in their study described the impact of concern as a factor of cognitive domain and attitude. The results showed that attitude was influenced directly by concern.

1.1. Theoretical / Conceptual framework (model)

The study was situated in the constructivist theory of learning as pre-service teachers actively participate and interact (Altuna & Lareki, 2015; Wilson & Myers, 2000) with the SMART Notebook to construct their knowledge as they go through a defined task in geometrical constructions. The lessons were embedded in activity-based learning as pre-service teachers manipulate the SMART Notebook resources on a computer to construct the defined task in geometrical constructions.

Attitude has been researched and studied for decades now and one important model that has helped describe attitude is the tripartite (or ABC model) model of attitudes. The ABC model decomposed attitude into three domains: Affective (how people feel), Conative (what people intend to do), and Cognitive (what people think). Attitude can also be described as feelings, intentions, and beliefs respectively. For this study, the constructs were contextually defined as how pre-service teachers feel about the ICT-integration in Geometrical constructions lesson using the SMART Notebook as a tool (affective); what pre-service teachers think about the lesson (Cognitive); and whether pre-service teachers intend to use the SMART Notebook in their geometrical constructions lessons during and after their Supported Teaching in Schools (STS) programme (Conative). Hence, the study adapted the Tripartite Model of Attitude (TMA) which was proposed by Sauro, (2019) as its conceptual framework. The framework explains the directional relationships between the independent variables (Cognitive, Affective and Conative) and the dependent variable (pre-service teachers' attitude) as used in the study. The overarching questions underpinning the study were in three folds:

(a) Is there any relationship between pre-service teachers' attitude towards ICT-integration (dependent variable) and cognitive, affective and conative (independent variables) respectively;
    (i) before the ICT-based intervention?

(ii) after the ICT-based intervention?

(b) To what extent do affective, cognitive and conative predict Pre-service teachers' attitude towards ICT-integration in teaching and learning of Geometrical Constructions;

(i) before the ICT-based intervention?

(ii) after the ICT-based intervention?

(c) Is there a statistically significant difference in pre-service teachers' attitudes before and after the ICT-based intervention?

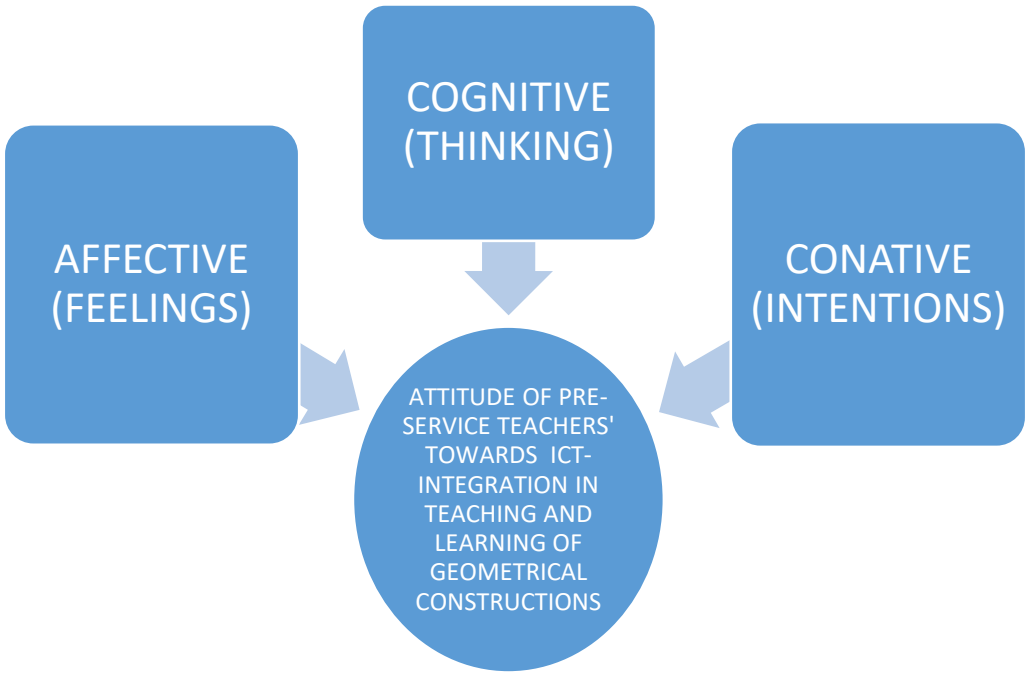

Figure 1: Conceptual framework of the study (Adapted from the Tripartite model of attitude (TMA): Sauro, 2019)).

III. METHODS

1.2. Research design

The design used for the study was a single-group experimental design, which measures the level of pre-service teachers' attitude (before and after) towards ICT-integration (SMART Notebook application) in the teaching and learning of Geometrical Constructions.

1.3. Instruments and Data Analysis

To answer the research questions raised, both descriptive (means and standard deviations) and inferential statistics (correlation and regression and paired samples t-test analysis) were used to study the internal characteristics of the constructs and their relationships respectively. Data was collected using a questionnaire designed based on the constructs operationalized in the framework. A four Likert-Scale questionnaire was designed using Strongly Agree (SA) as the highest scale to Strongly Disagree (SD) as the lowest scale. The questionnaire was divided into 5 parts of which the first part sorts personal information about the respondents and included age, gender, and programme. The other four parts were about the constructs (attitude towards ICT-integration in Geometrical Constructions, Cognitive, Affective and Conative) involved in the study. Apart from the questionnaire items on the pre-service teachers' attitude which was adapted from Maldague, et al., (2016)'s questionnaire on students' attitudes, all the items on the other three constructs were self-constructed purposely for this study.

1.4. Participants

The study targeted the first-year pre-service teachers at the colleges of education in Ghana. The college was conveniently selected and a purposive sample was employed to select the mathematics major first-year class (36 Pre-service Teachers) as the main participants for the study and one tutor who teaches the College Geometry Course at the selected college. The reason being that these pre-service teachers were being trained purposely as mathematics teachers and as such likely to teach mathematics during and after their Supported Teaching in Schools (STS) programme. Also, the first-year mathematics major class offers College Geometry as a course which includes Geometrical Constructions as a topic in the first semester.

1.5. Procedure

The pre-service teachers were introduced to the **Smart Notebook** application in two (2) hours section on how to use the resources in the application and were given two hours (from 6 pm to 8 pm) access for three consecutive days to practice and familiarized themselves with the Smart Notebook application. The researcher and the tutor (a regular tutor for the course), then designed two (2) lessons on geometrical constructions which were used for the study. The procedural issues that came up were also discussed and resolved during this period. The duration of each lesson was 2 hours for the two (2) days period. The same

questionnaire was administered twice (before the first lesson and after the second lesson) to measure pre-service teachers' attitudes before and after the ICT-based intervention respectively. The tutor who taught the lessons knew and have been using the application for her lessons in geometrical constructions at the college.

IV. RESULTS

The mean, standard deviation and Cronbach's Alpha for the various attitudinal variables show the reliability of the instrument used and the number of items under each variable including attitude towards ICT-Integration in geometrical constructions. It is also important to note that the questionnaires that did not have enough information were excluded in the analyses. For instance, out of the 36 respondents, 30 and 32 were used respectively for analyses on before and after the ICT-based intervention. The reliability of the variables was respectable using (Devellis, 2003) benchmarks (see Table 1).

Table 1: Descriptive Statistics (Mean and Standard Deviation) and Reliability of Variables

Variable (scale)	Mean	Standard Deviation	Number of Items	Number of Respondents (N)	Cronbach's Alpha
Attitude Towards Ict-Integration	30.03	4.482	10	36	.822
Cognitive	25.44	3.760	8	36	.796
Affective	25.06	3.900	8	36	.869
Conative	31.31	4.180	10	36	.825

Table 2 shows the descriptive of pre-service teachers who answered questions on attitude before the ICT-based intervention.

Table 2: Descriptive table for pre-service teachers' initial attitude towards ICT-Integration (before the intervention, N = 30)

Variables	N	Mean	Std. Deviation
Attitude1	34	2.51	.624
Cognitive1	36	2.60	.609
Affective1	34	2.53	.577
Conative1	34	2.52	.461

1.6. Pre-service teachers' attitude towards ICT-Integration and cognitive, affective and conative domains of attitude before ICT-based intervention

The first research question dealt with was whether there exists any relationship between pre-service teachers' attitudes towards ICT-integration (dependent variable) and cognitive, affective and conative (independent variables) respectively. To achieve this, a Pearson product-moment correlation was calculated between the various attitudinal variables and attitudes towards ICT-Integration before the ICT-based intervention. Correlations were significant for "cognitive "($r = 0.684$, $p < 0.001$), "conative" ($r = 0.567$, $p < 0.001$) and "affective" ($r = 0.395$, $p = 0.031$) at 0.01 and 0.05 levels of significance respectively. Though it appears that all the independent variables showed a positive relationship with pre-service teachers' attitudes towards ICT-Integration before the ICT-based intervention, however, the strongest relationship was between Cognitive and attitude towards ICT-Integration. This suggests that pre-service teachers were thinking more about how ICT was to be integrated into the teaching of geometrical constructions, (see Table 3).

Table 3: Relationship between Dependent variable and Independent variables (before the intervention, N = 30)

	Cognitive1	Affective1	Conative1

Attitude1	Pearson Correlation	.684**	.395*	.567**
	Sig. (2-tailed)	.000	.031	.001
**$P < 0.01$; *$P < 0.05$				

The correlational relationships before the ICT-based intervention were explored graphically. Figure 2 shows the relationship between attitude towards ICT-Integration and pre-service teachers' cognitive, affective and conative domains of attitude. There seems to be a more strong positive relationship between cognitive and attitude towards ICT-Integration. This is an indication that cognitive is the best predictor of pre-service teachers' attitudes towards ICT-Integration before the intervention.

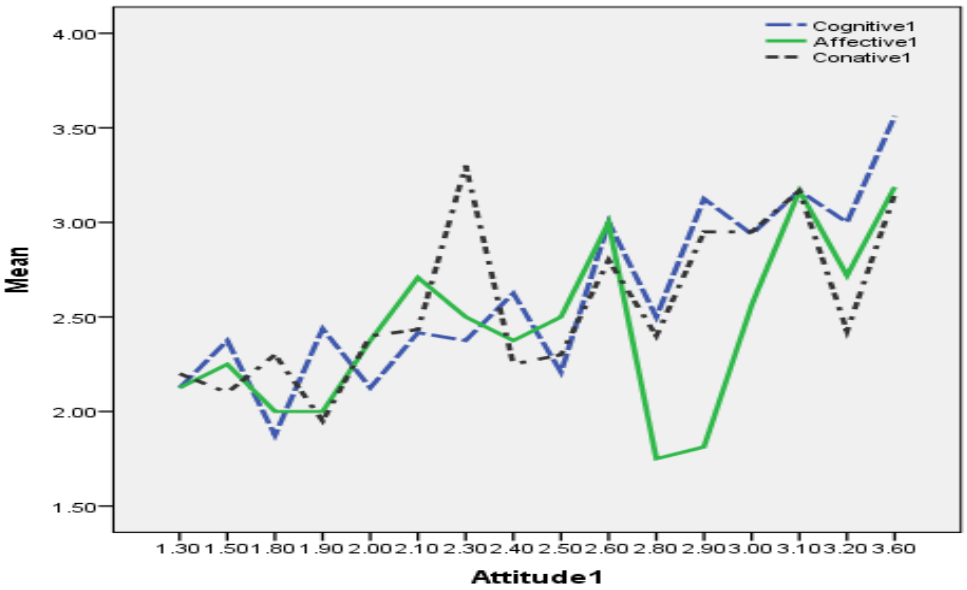

Figure 2: Pre-service teachers' attitude towards ICT-Integration
(before the ICT-based intervention)

4.1.2. ***Impact of Cognitive, Affective and Conative domains on attitude towards ICT-Integration in teaching and learning of Geometrical Constructions***

Research Question 2 sought to examine the extent of pre-service teachers' affective, cognitive and conative domains in the prediction of pre-service teachers' attitudes towards ICT-Integration in teaching and learning of Geometrical Constructions before the ICT-based intervention. A regression analysis model equation with cognitive and conative domains being positively related while the affective domain was negatively related to pre-service teachers' attitudes towards ICT-Integration. Thus, all three predictors were significantly related to pre-service teachers' attitude towards ICT-Integration ($R^2 = 0.508$, $F= (3, 26) = 8.957$, $p < 0.001$). Standardized coefficients of the predictors were observed as follows: 0.538, -0.009 and 0.253 for cognitive, affective and conative domains of pre-service teachers' attitude before the ICT-based intervention respectively.

The resultant regression model for the standardized coefficients was formulated as:

Pre-service teachers attitude towards ICT-Integration = 0.538Cognitive – 0.009Affective + 0.253Conative

As indicated in the regression model above, cognitive appeared to be the best predictor of pre-service teachers' attitudes towards ICT-Integration while conative appeared to be quite acceptable and affective was least acceptable. It is therefore clear that there is a positive relationship between the dependent variable and two of the independent variables, (cognitive and conative) with significant values of 0.006 and 0.170 respectively. The regression analysis verified that the F-value was significant indicating that the independent variables have an impact on the dependent variable (see Table 4).

Table 4: Coefficients of Predictors (Cognitive, Affective and Conative of Pre-service teachers' attitude towards ICT-Integration before the intervention, N = 30)

	R	R-square	F (Sig.)	Standardized coefficients	t	sig

Impact of Cognitive1, Affective1 and Conative1 on Pre-service teachers' attitude towards ICT-Integration	0.713	0.508	8.957(0.000)	.538 -.009 .253	3.018 -.054 1.410	.006 .957 .170
a. Dependent Variable: Attitude1, b. Predictors: (Constant), Conative1, Affective1, Cognitive1						

Table 5 shows the descriptive of pre-service teachers who answered questions on attitude after the ICT-based intervention.

Table 5: ***Descriptive statistics of pre-service teachers' attitude towards ICT-integration (after the intervention)***

Variables	N	Mean	Std. Deviation
Attitude2	34	3.00	.448
Affective2	34	3.13	.487
Cognitive2	36	3.18	.470
Conative2	36	3.13	.418

1.7. Pre-service teachers' attitude towards ICT-Integration and cognitive, affective and conative domains of attitude after ICT-based intervention

The first research question dealt with was whether there exists any relationship between pre-service teachers' attitudes towards ICT-integration (dependent variable) and cognitive, affective and conative (independent variables) respectively. To achieve this, a Pearson product-moment correlation was calculated between the various attitudinal variables and attitudes towards ICT-Integration after the ICT-based intervention. Correlations were significant for "cognitive" ($r = 0.535$, $p < 0.001$), "affective" ($r = 0.791$, $p < 0.001$) and "conative" ($r = 0.763$, $p < 0.001$) at 0.01 significant level respectively. It appears that all the independent variables showed a positive relationship with the pre-service teachers' attitude towards ICT-Integration after the intervention, however, the strongest relationship was between Affective and pre-service teachers' attitudes towards ICT-Integration. This implies that pre-service teachers had a positive feeling towards the integration of ICT in the teaching and learning of geometrical constructions, (see Table 6).

Table 6: Relationship between Dependent variable and Independent variables (after the intervention, N=32)

			Cognitive2	Affective2	Conative2
Attitude2	Pearson Correlation		.535**	.791**	.763**
	Sig. (2-tailed)		.002	.000	.000
**$P < 0.01$					

The correlational relationships after the ICT-based intervention were represented graphically. Figure 3 shows the relationship between attitude towards ICT-Integration and cognitive, affective and conative domains respectively. The results suggest a strong positive relationship between affective and attitude towards ICT-Integration. This means that affective is the best predictor of pre-service teachers' attitudes towards ICT-Integration after the intervention.

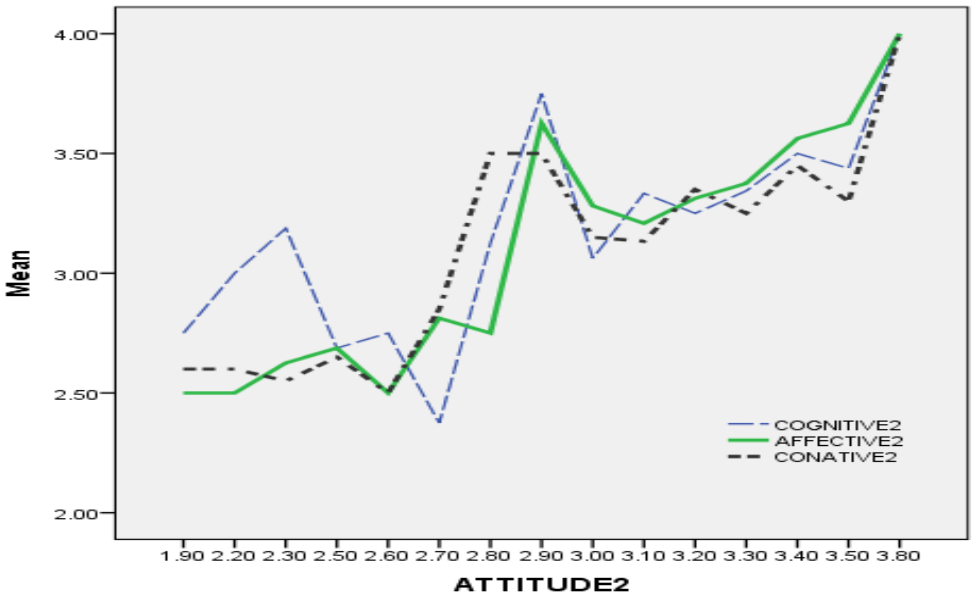

Figure 3: Pre-service teachers' attitude towards ICT-Integration
(after the ICT-based intervention)

1.7.1. Impact of Cognitive, Affective and Conative domains on attitude towards ICT-Integration in teaching and learning of Geometrical Constructions

Research Question 2 sought to examine the extent to which pre-service teachers' affective, cognitive and conative domains predict pre-service teachers' attitudes towards ICT-Integration in teaching and learning of Geometrical Constructions after the ICT-based intervention. A regression analysis model equation with cognitive, affective and conative domains being positively related to pre-service teachers' attitudes towards ICT-Integration. All the three predictors were significantly related to pre-service teachers' attitude towards ICT-Integration ($R^2 = 0.692$, $F= (3, 28) = 20.998$, $p < 0.001$). The observed standardized coefficients of the predictors were obtained as 0.017, 0.490 and 0.387 for cognitive, affective and conative domains of pre-service teachers' attitude after the ICT-based intervention respectively.

The regression model for the standardized coefficients were formulated as below:

Pre-service teachers attitude towards ICT-Integration = 0.017Cognitive + 0.490Affective + 0.387Conative

From the above model, affective appeared to be the best predictor of pre-service teachers' attitudes towards ICT-Integration while cognitive and conative appeared to be quite acceptable. It is therefore clear that there is a positive relationship between the dependent variable and all the three independent variables, (cognitive, affective and conative) with significant values of 0.907, 0.013 and 0.021 respectively. The regression analysis verified that the F-value was significant indicating that the independent variables have an impact on the dependent variable (see Table 7).

Table 7: Coefficients of Predictors (Cognitive, Affective and Conative of Pre-service teachers' attitude towards ICT-Integration after the intervention, N = 32)

	R	R-square	F (Sig.)	Standardized coefficients	t	sig
Impact of Cognitive2, Affective2 and Conative2 on Pre-service teachers' attitude towards ICT-Integration	0.832	0.692	20.998(0.000)	.017 .490 .387	0.117 2.658 2.448	.907 .013 .021
A. Dependent Variable: Attitude2 B. Predictors: (Constant), Conative2, Cognitive2, Affective2						

1.8. Paired Samples T-test Results

Research Question 3 sought to determine whether there was a statistically significant difference in the pre-service teachers' attitude towards the ICT-Integration before and after the interventional period, a paired samples t-test was used (see table 8).

Table 8: Descriptive table from the paired sample t-test (N = 33)

		Mean	Std. Deviation	t-value	Effect size (d)	Sig. (2-tailed)
Pair 1	Attitude1	2.51	.634	-3.506	0.28	0.001
	Attitude2	3.01	.455			

From the tables 8 above, there was a statistically significant differences in the pre-service teachers' attitude towards ICT-Integration before the intervention '**Attitude1'** (M = 2.51, SD = 0.634) and after the intervention '**Attitude2**' (M = 3.01, SD = 0.455); $t(32) = -3.506, p = 0.001, (p < 0.05)$. This result suggests that the use of the SMART Notebook application in teaching geometrical constructions had a positive influence or impact on the pre-service teachers' attitude. The magnitude of the impact (effect size) was calculated as $(d) = 0.28$ which is considered as a modest effect (Cohen et al., 2007).

V. DISCUSSIONS

This study examined the relationships and the impact that cognitive, affective and conative domains have on pre-service teachers' attitudes towards ICT-integration in teaching and learning of geometrical constructions, using the Tripartite Model of Attitude (TMA). Also, the study sought to find out whether there were statistically significant differences in pre-service teachers' attitudes before and after the ICT-based intervention. The results showed that cognitive, affective and conative correlated positively with the pre-service teachers' attitude before the ICT-based intervention, and this is supported by other studies (Abun, Magallanes & Incarnacion, 2019). The strongest and the least relationships were registered for cognitive and the affective domains respectively. Also, cognitive reported the best predictor of pre-service teachers' attitude (Altun, 2006; Huang, et al., 2015) while affective dimension was the least predictor of attitude before the ICT-based intervention. These results suggest that before the ICT-based intervention the pre-service teachers were thinking or doubtful as to how the Smart Notebook could be used in teaching and learning of geometrical constructions.

The results after the ICT-based intervention also showed strong positive relationships between cognitive, affective, conative domains and the pre-service teachers' attitude (Ahn & Back, 2018; Chowdhury & Salam, 2015) towards the ICT-integration. The affective domain reported the strongest relationship and the best predictor while cognitive reported the least relationship and influential to the pre-service teachers' attitude towards the ICT-integration. In this case, the results seem to suggest that the pre-service teachers were feeling relief after the use of the Smart Notebook application in teaching and learning of geometrical constructions. Based on the results discussed so far, there was a movement between the cognitive and affective domains of pre-service teachers' attitudes. That is affective moving from being the least predictor to be the best predictor before and after the ICT-based intervention respectively. The cognitive domain also moved from being the best predictor to be the least predictor of pre-service teachers' attitude. This also suggests that the predictability of the domains to attitude largely depends on the situational environment (the ICT-based intervention) as confirmed by Millar and Tesser (1990).

Furthermore, the result from the paired samples t-test suggests that there was much improvement in pre-service teachers' attitudes towards ICT-integration and that the ICT-intervention helped improved pre-service teachers' attitudes positively.

VI. IMPLICATIONS

Some educational implications on professional development and support can be deduced from this study. The results suggest that ICT-integration tends to influence the attitude of pre-service teachers at the colleges of education in Ghana. This study as well suggests that to influence pre-service teachers' attitudes positively, the affective (feelings) domain should be given more attention when designing ICT-integration lessons in the teaching and learning of geometrical constructions. It is therefore recommended that mathematics tutors in the colleges of education should identify such ICT-based interventions and use them in teaching and learning of mathematics to develop pre-service teachers' attitudes positively towards the subject. The pre-service teachers should also be supported to integrate ICT in their mathematics lessons during and after the Supported Teaching in Schools (STS) programme. It was also evident that pre-service teachers had hands-on experience in the use of computers and this boosted their confidence in using the computers in the classroom.

VII. LIMITATIONS

Some of the limitations of this study are outlined as First, the study concentrated on only the first-year mathematics major pre-service teachers and therefore its findings are limited to only first-year mathematics pre-service teachers. Second, this study again considered the integration of ICT in only teaching and learning of geometrical constructions and that its findings cannot be generalized to cover all first-year mathematics topics. Third, some of the respondents failed to provide sufficient information on the questionnaire which led to the exclusion of such questionnaires from the data analyses and that interned reduced the number of respondents for the study.

VIII. CONCLUSIONS

This study highlights the importance of ICT-integration in teaching and learning of mathematics at the colleges of education institutions in Ghana. The ICT-based intervention showed the great potential of causing positive attitudinal change towards teaching and learning of geometrical constructions among pre-service teachers. It is, therefore, necessary for all stakeholders concerned with mathematics education to find new ways of developing content delivery through ICT-integration in the educational institutions in Ghana.

REFERENCES

[1] Abun, D., Magallanes, T. & Incarnacion, M. J. (2019).College Students' Cognitive and Affective Attitude toward Higher Education and Their Academic Engagement. International Journal of English, Literature and Social Science (IJELS). Infogain Publication. Vol. 4(5). pp. (1494-1507).

[2] Agyei, D. D., & Voogt, J. (2014). Examining factors affecting beginning teachers' transfer of learning of ICT-enhanced learning activities in their teaching practice. Australasian Journal of Educational Technology, 30(1), 92-105.

[3] Agyei, D. D. & Voogt, J. M., (2010). Exploring the potential of the will, skill, tool model in Ghana: Predicting prospective..., Computers & Education.

[4] Ahn, J. & Back, K-J. (2018). Influence of brand relationship on customer attitude toward integrated resort brands: a cognitive, affective, and conative perspective. Journal of Travel & Tourism Marketing. Vol., 35(4), pp (449-460).

[5] Altuna, J. & Lareki, A. (2015). Analysis of the Digital Technologies in schools that implement Different learning theories. Journal of Education Computing Research, Vol. 53(2), pp (205-227). Sage.

[6] Altun, A., & Cakan, M. (2006). Undergraduate Students' Academic Achievement, Field Dependent/Independent Cognitive Styles and Attitude toward Computers. *Educational Technology & Society*. Vol., 9 (1), pp (289-297).

[7] Brouwer, N., Ekimova, L., Jasinska, M., Van Gastel, L. & Virgailaitė-Mecˇkauskaite, E. (2009) Enhancing mathematics by online assessments: Two cases of remedial education. Industry & Higher Education, Vol., 23(4), pp (277-283).

[8] Chowdhury, S. K. & Salam, M. (2015). Predicting Attitude Based on Cognitive, Affective and Conative Components: An Online Shopping Perspective. Stanford Journal of Business Studies. Vol., 6 (7).

[9] Cohen, L., Manion, L. & Morrison, K. (2007). Research Methods in Education. 6th Edition, Routledge, USA

[10] Huang, C-H., Beatson, A. & Lings, I. (2015). The role that cognitive plays in attitude formation: An alternative model for the determinants of attitude. Journal of Management Research. Macrothink Institute. Vol., 7(3).

[11] Hwa, S. P. (2018). Pedagogical change in mathematics learning: Harnessing the power of digital game-based learning. *Journal of Educational Technology & Society, 21*(4), 259–276.

[12] Maldague, X., Kuimova, M., Burleigh, D. & Skvortsova, S. (2016). Information and Communication Technologies in Engineering Education. MATEC Web of Conferences. IME&T.

[13] Millar, M. G. & Tesser, A. (1990). "Attitudes and Behavior: the Cognitive-Affective Mismatch Hypothesis", in NA - Advances in Consumer Research Volume 17, eds. Marvin E. Goldberg, Gerald Gorn, and Richard W. Pollay, Provo, UT: Association for Consumer Research. pp (86-90).

[14] Ngware, M. W., Ciera, J., Musyoka, P. K. & Oketch, M. (2015). Quality of teaching mathematics and learning achievement gains: evidence from primary schools in Kenya: Educational Studies in Mathematics. Springer.Vol. 89 (1), pp (111-131).

[15] The National Teacher Education Curriculum Framework (2017). The Essential Elements of Initial Teacher Education. Ministry of Education. Ghana.www.t-tel.org/hub.html

[16] National Teaching Council, (2017). National Teachers' Standards for Ghana. Guidelines. Education Close Street, Accra. Ghana. www.ntc.gov.gh

[17] Sauro, J. (2019). Why you should measure UX attitudes, measuring you.com

[18] Wilson, B. G. & Myers, K. M. (2000). Situated Cognition in Theoretical and Practical Context. In D. H. Jonassen, & S.M.Land (eds), Theoretical Foundations of Learning Environments. NJ: Lawrence Erlbaum.

AUTHORS

First Author – Daniel Ashong, MSc. Industrial Mathematics, University of Cape Coast, Department of Mathematics and ICT Education, Ghana. Berekum College of Education, Department of Mathematics and ICT, Ghana, daniel.ashong@stu.ucc.edu.gh
Second Author – Douglas Darko Agye, Professor, Department of Mathematics and ICT Education, University of Cape Coast, Ghana, ddagyei@ucc.edu.gh
Third Author – Helena Naa Korkor Tetteh, MEd. Mathematics Education, Berekum College of Education, Department of Mathematics and ICT, Ghana, helenash14@becoled.edu.gh

Correspondence Author – Helena Naa Korkor Tetteh, helenash14@becoled.edu.gh, +233 245267273