Science, Technology, Engineering and Mathematics (STEM) Teachers' Attitudes towards Technology use in teaching in Bangladesh

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Abstract - *Given the popularity gained by ICT in universal education in the past two decades, as new capabilities for technology integration emerged, its use in educational contexts has steadily increased. The use of technology for a broad range of teaching and learning purposes is now established at many universities. Studies were conducted about technology use attitude in education, but the majority has concentrated on how to replace traditional with blended methods of instructions. This study examines Science Technology Engineering and Mathematics (STEM) teachers' attitude towards technology use in teaching in Bangladesh. A descriptive research design was used. Research instrument employed was questionnaire which was administered on 120 STEM teachers from three sampled universities of Bangladesh. It was found that the respondents' affective, perceived usefulness, behavioral intentions, and overall attitude towards technology use were significant, though challenges that include domain (affective, cognitive, perceived control), conceptualization of technology use attitude, teacher-training, objectives and contents were obtained. In essence, the study findings revealed a positive attitude of the STEM teachers towards technology use in teaching in Bangladesh universities and challenges needed to be overcome for better teacher delivery. A technology acceptance model formulated by Venkatesh and others (UTAUT) which hypothesized on user acceptance of technology towards a unified view was used in this study. The theory wants to explain user intentions to use technology following behavioral intensions. The constructs of UTAUT (performance expectancy PE, effort expectancy EE, social influence SI and the facilitating condition FC) are found to have positive effect on behavioral intension and the attitude of technology use in teaching as well. Attitude is the most important detector of behavioral intension towards the use of technology by STEM teachers.*

Keywords *– Attitude, STEM, Teachers, Technology, UTAUT.*

1. Introduction

Science, Technology, Engineering and Mathematics (STEM) curriculum is a recent interdisciplinary area which has been discussed by various experts around the world as an important aspect of development. Given the growing interest in, and relevance of, integrated technology approaches to STEM education, there is an urgent need to understand the challenges and obstacles in developing/implementing the use of technology in STEM curricula and instruction. This is of critical importance due to the significant variation across individuals, institutions, and disciplines with respect to current understandings of STEM education and its core components (Shernoff et al., 2017).

With STEM education it is believed that by increasing mathematics and science requirements in schools, along with infusing technology and engineering concepts, it would allow students to perform better and be better prepared for advanced education and jobs opportunities (Brown et al., 2011), it could also lead to better real-world development, and better life for citizens (Henderson et al., 2011). However, teachers play critical role in training and developing STEM curriculum, in doing that their attitude is an important factor. Teaching STEM is mainly influenced by how teachers deliver the contents, thus their attitude toward the use of technology in teaching has got a great function to serve in enhancing better teaching and learning. Moreover, dissimilar aspects of context persuade instructional practices either directly or indirectly (Thibaut et al. 2018). In that regard, measuring teachers' attitudes toward teaching STEM has demonstrated to be a complex task (El-Deghaidy & Mansour, 2015; Goodpaster et al. 2012). Be that as it may, "the term 'attitude' is defined as the overall evaluation of an object on several dimensions good/bad,

pleasant/ unpleasant". According to Al Salami et al. (2017) instruments used for measuring teachers' attitudes toward STEM only appraise attitudes toward each of the different STEM disciplines individually. Although, Thibaut et.al (2018) proposed the measurement of STEM teachers' attitude toward technology use from the perspective of cognition, affective and perceived control domains.

The term technology used herein refers to any modern technological tool(s) used in teaching and learning process, which encompasses but not limited to desktop PC; Laptop; palmtop; tablets; iPod; E-reader; mobile phone/smart phones; smart board; multimedia presentation; using internet for enhancing teaching and learning practice. Gaining an appreciation of the teachers' attitudes towards technology use may provide useful insights into technology integration and acceptance, and usage of technology in teaching and learning. Thus, the explanation of why some teachers' welcome technology integration while others reject is yet a controversial issue. It therefore remains significant to research on STEM teachers' technology acceptance and use; for better understanding of teachers' attitude towards using technology and its relationship with respect to age, gender, experience and specialization. As such, the present study tries to investigate STEM teachers' attitudes towards the use of technology specifically in engineering education field. With rapid advancements in technologies, there is greater pressure on teachers to engage various types of tools in conceptualization, preparation, and delivering their lessons. The thought that teachers' instructional practices are related to their attitudes is not new and has been examined in various fields of study. In Bangladesh, the national policy on ICT has been one of the human resource development efforts through the provision of basic information and communication skills at all levels of higher education. STEM education could therefore help the next generation of Bangladeshi to solve real-world problems by applying concepts that cut across disciplines, critical thinking, collaboration, and creativity. Innovation in STEM subjects drives not only economic growth, but also quality of life. Personal characteristics such as educational level, age, gender, teaching experience, experience with the technology use for educational purpose and attitude towards using it could influence the adoption of technology. Teachers are implored to adopt and integrate technology into teaching and learning activities, but preparedness to integrate it determines their efficiency in the classroom (Jones, 2001). In fact, Russell & Bradley (1997) reported that anxiety, lack of confidence and fear often take a back seat to conventional learning methods.

Therefore, an understanding of personal characteristics that sway teachers' acceptance of technology into teaching is quite fundamental (Buabeng-Andoh, 2012), especially in STEM where most of the current global dynamics are dictated. In line with this, the present study aimed to achieve the following objectives:
i) Find out the attitude of teachers towards the use of technology in teaching STEM;

ii) Establish the relationship between age, gender, and subject domain experience of technology use; and
iii) Challenges in measuring STEM teachers' attitude toward technology use.

2. Theoretical Framework
A number of theories which include but not limited to Theory of Reasoned action (TRA), Theory of Planned Behavior (TPB), Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT) have been suggested and employed in investigating the attitude of teachers towards technology use. More closely related to the present study is the UTAUT by Venkatesh et al. (2003). It was therefore adopted to explain the users' acceptance and use of information technology in teaching and learning. The theory explains four major constructs (performance expectancy, effort expectancy, facilitating conditions, and social influence) that affect the behavioural intention and technology use behaviour (attitude in the present case) (Venkatesh et al., 2016). Performance expectancy and effort expectancy are technology attributes while facilitating condition and social influence are contextual factors. In this study, UTAUT uses demographic variables (age, gender, experience in teaching and use of technology, specialization) as moderators that persuade the four construct. Behavioural intention is a good measure of technology acceptance in a voluntary system and it was observed to be positively co-related with four constructs of UTAUT (Figure 1). On the other hand, gender, age, voluntariness to use the technology, and teaching experience (moderating variables) are found to have influence on the dependent variables.
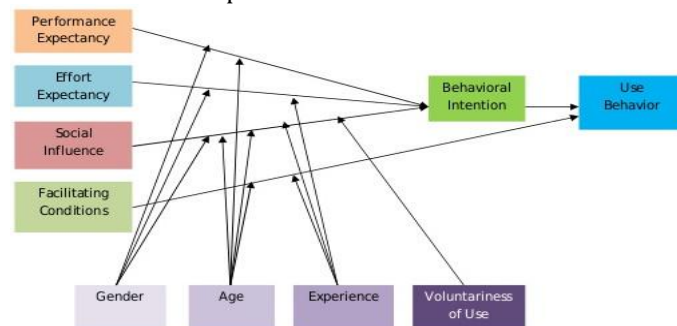

Figure 1. UTAUT: Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003)

The four constructs basically refer to:
a) **Performance expectancy**, "the degree to which an individual believes that using the system will help them attain gains in job performance"; In this particular research, performance expectation is viewed as the factors that make use of technology to improve teaching of STEM
b) **Effort expectancy**, "the degree of ease associated with the use of the system" Effort expectancy is hypothesized to moderate the influence on behavioural intention by gender and age, and

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experience. That is how much intention is required to use technology in teaching STEM, which includes the ease of use of the existing technology, availability of the technology and the cost of technology let alone learning to use the technology.

c) **Social influence**, the degree to which an individual perceived the importance, which others believe they should use the new system. It involves factors of environment in nature; this bounds culture, norms, and superstitions.

d) **Facilitating conditions**, the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system. It has influence on behavioral intention by age, and experience. It includes factors that drive the existing use of technology and may affect the social environment.

This study therefore examines the behavioural intention caused by the attitude of STEM teachers toward the use of technology; which in turn affects intention to use technology by learners of STEM. The UTAUT constructs seem to affect attitude in the sense that perception of teachers and their ability to use technology can be changed by changing their behavioural intention towards technology use in teaching and learning. It has been argued that social influence has impact on individual's behaviour through compliance and identification (Venkatesh and Davis, 2000; Warshaw, 1980). Based on these, it is possible that social influence may influence individual's attitude towards the use of technology. Facilitating conditions describes the perceived importance of organizational and technical infrastructure to support the use of technology in teaching of STEM in universities (Venkatesh et al., 2003; Dwivedi et al., 2016). Figure 2 presents the modified UTAUT with respect to teaching and learning STEM.
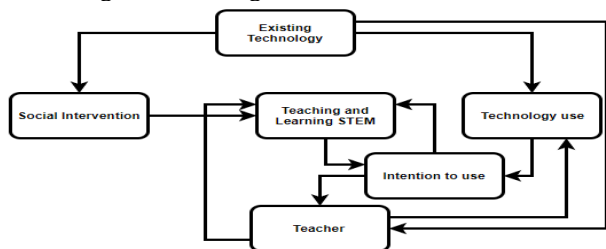

Figure 2. Modified Unified theory of acceptance and use of Technologies (Ventakesh et al., 2003)

Teachers with good perceptions about the usefulness (PE) of technology who finds them easier to use (EE) in teaching and learning STEM and those with positive view of facilitating conditions (existing technology) could have more attractions towards the use of technology.

3. Methodology

This study employed a descriptive research design. It was conducted on teachers with specialization in STEM within three Universities of Bangladesh, namely: Islamic University of Technology (IUT); Daffodil International University (DIU) and Bangladesh University of Engineering and Technology (BUET). Random and snowball sampling techniques were used to select a sample of 120 STEM teachers which comprises of male (93) and female (27). Random sampling was employed in the case of IUT and DIU. Besides the established scientific basis for random sampling, it was adopted due to the access to database of the relevant faculty members, and familiarity of the researcher with the universities. Conversely, snowballing method of sampling was used for Bangladesh University of Engineering and Technology (BUET) following lack of access to the database of the relevant faculty members and unfamiliarity of the researcher with the university. An Attitude scale was adopted from Teo (2010) which was developed in a questionnaire that was dispatched to the sampled STEM teachers for response. The scale basically elicits data that include demographic background, technology experience, and perceived confidence. Responses were collected after a period of 21 days. The scale contained items presented in a five-point Likert-type scale. Data analysis was performed using Statistical Package for Social Sciences software (IBM SPSS version 20). Statistical methods that were used for the analysis of data are descriptive (frequency count, mean, standard deviation, and percentiles) and analysis of variance (ANOVA).

4. Results

This section presents the findings of the research. The first part presents the demographic information of the respondents, while the second part presents results on attitude. The third part involves analysis of variance (ANOVA) results on whether there exists any difference(s) between the respondents in terms of their gender, age, specialization, teaching experience and confidence in the technology use.

4.1 Demographic information

Results in Table 1 indicate the following:

Gender: In this study the respondents 77.5% were males and the remaining 22.5% were females.

Specialization: four STEM specializations were used; science, technology, engineering and mathematics. A 17.5 % were science teachers, 12.5% technology teachers. Engineering teachers were 55%, while mathematics had 15% of the total respondents. Gutek and Bikson (1985) hypothesize that men are more technology-savvy than women On the contrary, there is also evidence in recent research that gender has not been significant in explaining attitude towards technology use in teaching (Rainer et al., 2003).

Technology use and teaching experience: this is classified into three; low experience (1-5 yrs) of teaching, medium (6-10 yrs), and high experience (11+ yrs) of teaching. Experience in teaching has also been a significant interpreter of technology use attitude. More experienced teachers are expected to be more technology-ready than their less experienced counterparts.

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Age: Age is expected to play an important role in technology use attitude in STEM teaching Meuter et al. (2003).

The respondents age were classified according to the following groups:-20-29 were 35.8%, age group 30-39 has 31.7%, 40-49 group were 20.0% and 50-59 group of age were 12.5% respectively. Detail of the respondent's demography is shown in table 1. According to Hertzog and Hultsch (2000) older people tend to have a reduction in their own cognitive capabilities to learn, which could be an obstacle for them to use new technological developments Rojas-Mendez et al (2017).

Table 1. Distribution of the respondents according to their demographic information

Gender	Age-group	Count	%	Teaching experience	Count	%	Specialization	Count	%
Male	20 – 29	33	27.5	Low (1-5)	21	17.5	Science	16	13.3
	30 – 39	29	24.2	Medium (6-10)	22	18.3	Technology	12	10.0
	40 – 49	19	15.8	High (11+)	50	41.7	Engineering	51	42.5
	50 – 59	12	10.0				Mathematics	14	11.7
Total Male		**93**	**77.5**		**93**	**77.5**		**93**	**77.5**
Female	20-29	10	8.3	Low (1-5)	6	5.0	Science	5	4.2
	30 – 39	9	7.5	Medium(6-10)	7	5.8	Technology	3	2.5
	40 – 49	5	4.2	High (11+)	14	11.7	Engineering	15	12.5
	50 - 59	3	2.5				Mathematics	4	3.3
Total female		**27**	**22.5**		**27**	**22.5**		**27**	**22.5**
	20 – 29	43	35.8	Low (0-5)	27	22.5	Science	21	17.5
	30 – 39	38	31.7	Medium (6-10)	29	24.2	Technology	15	12.5
	40 – 49	24	20.0	High(11+)	64	53.3	Engineering	66	55.0
	50 - 59	15	12.5				Mathematics	18	15.0
Total		**120**	**100**		**120**	**100**		**120**	**100**

Table 2. Distribution of the attitude components

Test parameter/components	Variables/Items	W.M	Std. Deviation
Affective	6	3.84	.724
Perceived usefulness	5	3.68	.673
Perceived control	7	3.42	.450
Behavioural intention	4	3.60	.637
Social influence	3	3.46	.726
Overall technology use attitude	**25**	**3.60**	**.756**

Table 3. Analysis for the respondent's attitude towards technology use with respect to gender, age, confidence in technology use, and specialization

		Sum Squares	df	Mean Square	F	Sig.
Gender	Between Group	.539	2	.270	1.547	.217
	Within Groups	20.386	117	.174		
Specialization	Between Groups	.910	2	.455	.515	.599
	Within Groups	103.415	117	.884		
Age Groups	Between Groups	49.884	2	24.942	38.343	.000
	Within Groups	76.108	117	.650		
How-confident teacher is	Between Groups	2.273	2	1.137	2.834	.063
	Within Groups	46.927	117	.401		

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Table 4. One-way ANOVA for Overall Technology use Attitude

		Sum of Squares	df	Mean Square	F	Sig.
Affective component	Between Groups	8.161	3	2.720	1.454	.116
	Within Groups	497.964	116	4.293		
	Total	**506.125**	**119**			
Perceived useful component	Between Groups	5.162	3	1.721	2.022	.012
	Within Groups	453.763	116	3.912		
	Total	**458.925**	**119**			
Perceived control component	Between Groups	15.106	3	5.035	3.268	.017
	Within Groups	1128.061	116	9.725		
	Total	**1143.167**	**119**			
Behavioural intention	Between Groups	26.285	3	8.762	3.109	.000
	Within Groups	540.082	116	4.656		
	Total	**566.367**	**119**			
Social influence	Between Groups	13.528	3	4.509	1.290	.204
	Within Groups	520.438	116	4.487		
	Total	**533.967**	**119**			

Table 5. Challenges in the scientific attitude measure

Challenges	Percentiles			Frequency					N
	75	50	25	1	2	3	4	5	
Domain	2	2	1	48	48	12	6	6	120
Conceptualization of STEM teachers	3	2	1	54	30	12	12	12	120
STEM Teacher-training	4	2	1	42	36	12	18	12	120
Objectives	3	2	1	36	30	30	12	12	120
Contents	3	2	1	48	42	18	6	6	120

4.2 Attitude of the respondents using weighted mean (W.M) and standard deviation (S.D).

The Table below shows five components; affective, perceived usefulness of technology use in teaching, perceived control, behavioral intention of the technology user, and social influences over the use of technology in teaching STEM which also comprises of variables or items under each component, the test components and their variables were categorized and rated based on five point scale (5-point Likert-type scale). The components were highlighted in the UTAUT (refer to theoretical frame work). Weighted mean and std. deviation were determined as shown in Table 2.

According to Teo (2008) "at global level the overall technology/computer attitude is well above midpoint of the scale (3.00) when using 5-point Likert-type scale" this indicated that the respondents in this study held a positive attitude towards the use of technology in STEM teaching. The respondents showed positive attitude towards technology use, as shown by the mean score for each subscale being 3.00 and above (on a 5-point Likert-type scale). The positive level of technology use attitude could be attributed to the availability and accessibility of technology in various universities of Bangladesh.

4.3 Analysis of Variance (ANOVA)

ANOVA is a statistical technique for testing if population means are equal. If it is found that there is a difference, then there is need to examine where the group differences occur. Using this technique, all data are treated together under a null hypothesis which assumes no difference(s) among the means of the various samples at 95% level of confidence and 5% significance level.

Based on the obtained results from Table 3 above, p value is greater than .05, for the following variables, gender [F (2,117) =1.547, p=.217], specialization [F (2,117) =.515, P =.599], confidence of a teacher [F (2,117) =2.834, P =.063]. These shows no statistically significant differences between the respondents' groups mean, thus, gender has no effect on the variables, confidence in use of technology, specialization and experience in teaching. As such, the null hypothesis may be accepted that teaching experiences of the respondents varies accordingly with their gender, specialization, and their confidence in the use of technology for teaching STEM. But, for the age groups [F (2,117) = 38.343, p =.000] which is lower than p =.05, then there is statistically significant differences between the means of these variables. Consequently, there is no enough proof to reject the null hypothesis. However, P-value differs in the case of teaching experience and the age groups, therefore null hypothesis is

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rejected and there is difference(s) in the mean of age group and the teaching experience.

4.4 One way ANOVA of overall technology attitude components

One way ANOVA performed on the five dependent variables (affective, perceived usefulness, perceived control, behavioral intention and social influence) for age group and gender. The results obtained for social influence [F (3,119) = 1.290, P =.204], and affective component [F (3.119) = 1.454, p = .116] p value is above .050 at 95% confidence level, this means the differences between the means is not statistically significant on age and gender, and no enough evidence to reject the null hypothesis since the means are all equal. This results suggest that both males and females STEM teachers at all ages were similar in their attitudes towards the technology use. For other three variables, behavioral intention [F (3,119), = 3.109, p =.000], percieved control component [F (20,119),=3.268, P= .017], and percieved useful components [F(20, 119), =2.022, P= .012] differences between some of their means is significant statistically, thus, null hypothesis rejected, meaning that not all the means of variables are equal.

This also indicates how much control they have over technology (perceived control), and their intentions in using the technology (behavioural intention). The results suggested that while most STEM teachers were similar in their attitudes towards the use of technology, they had different views regarding each component of the technology.

4.5 Challenges in measuring STEM teacher's attitude towards the use of technology in teaching

This study identified that teachers have high opinion on the use of technology as a mode of teaching and learning in universities in Bangladesh. However, challenges in the scientific attitude measure as mentioned by Dashpande (2004), the domain challenges (affective, cognitive and perceived control), challenges obtained in training STEM teachers on how to use technology in classroom teaching, conceptualization of STEM as a new emerging subject needed for the development, challenges towards strengthening the need for definite and specific STEM contents, and ensuring their objectives were all determined. These challenges were statistically measured, frequencies and percentiles were obtained. Each challenge was presented in five-point likert scale from 1 = very low challenge, to 5 = very high challenge, while 3= average/medium challenge. Percentiles were used to compare the challenges with respect to their occurrence, while frequency gave the number of challenges in the sample in accordance with the five point scale, which indicates how much or less a challenge was encountered. The results are presented in Table 5.

From the results in Table 5 above, 75 percentile or the third quartile ¾ of STEM teachers had less challenges in their domain, other teachers had neither good nor bad challenge with respect to the contents, objectives and

conceptualization of technology use attitude in teaching. It was observed that there was high challenge of training STEM teachers in the technology use in teaching, even though government and non-governmental agencies are doing their best to ensure that STEM teachers are kept up to date through workshops and seminars on how best to use the available software's and hardware's for STEM pedagogy. Median (50%) of the STEM teachers had less challenge in the domain, conceptualization, training, objectives and contents of technology use attitude in teaching, while ¼ of them had very less challenge in the entire technology use attitude in teaching. These tallies with the frequencies obtained indicates large number of STEM teachers with very low challenge having obtained scale of 1 on the five-point Likert-type scale, and more than 50% of the them had neither less nor high challenge as shown by the frequency values in scale of 3. And very few of them encountered very high challenge as seen from the less numbers obtained.

5. Discussion

Technology use attitude was measured in terms of the perceived control, perceived usefulness, social intervention, and behavioural intention and affective. From the results of descriptive statistics in table 2 above, the respondents showed positive attitude towards technology use in STEM teaching, as shown by the mean score for each sub-scale being 3.60 (on a 5-point scale) which was highlighted by Teo (2008) that computer or technology use attitude is good at or above midpoint when measured on 5-point Likert-type scale.

UTAUT help in the analysis of teacher's attitude towards the use of technology in teaching, benefits of using the model and its comfort ability, their perceptions affects their social beliefs which made most of them appreciate and likes to use the available technologies thus in turn shapes their attitude towards using them in classroom instructions.

The results of gender, specialization, age, and confidence are presented in Table 3 indicated no statistically significant effect of gender on the combined dependent variables (F (2, 117) = 1. 547, p= .217). Moreover, no statistically significant effect of confidence on the combined dependent variables (F (2, 117) = 2 .834, p= .63). On the other hand, no statistically significant effect of specialization on the combined dependent variables (F (2, 117) = .515, p= .599). Participants in different group of ages differ in their attitude towards technology use (F (2,117) =38.343, p<0.05), these goes in line with the stern and florin attitude measure.

Table 4, ANOVA one way, between groups multivariate analysis of variance was performed on the five dependent variables (affective, perceived usefulness, perceived control, behavioral intention and social influence) for age and gender. No significant differences were found: F (20, 119) = 1.454, p = .116.These results suggest that both male and females STEM teachers at all ages were similar in their attitudes towards the technology use. For other three

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variables, behavioral intervention [F (20,119), = 3.109, p =.000], perceived control component, [F (20,119), =3.268, P= .000] and perceived useful components, [F (20, 119), =2.022, P= .012] which shows a statistically significant, this emphasized the research of (Teo 2011) on the influence of teachers to use technology in teaching.

Results obtained from table 5 of percentiles and frequency measure of the five attitude measure challenges in technology use in teaching in Bangladesh, shows that majority of the STEM teachers had encountered less of these challenges as ¾ of the population sample were in the scale 1 of sale, while ¼ had very high of one or more of the attitude measure challenge in their domain, conceptualization, training, objectivity and contents of technology use in Teaching in Bangladesh, these tallies with the frequency showing large number of STEM teachers with less challenges in technology use attitude challenge measure obtaining in scale no 1,while few STEM teachers on scale no 5 shows very high challenge in one or all of the technology use attitude measure. This is in accordance with Deshpande (2004).

6. Conclusions

The overall findings indicates a positive technology use attitude of the STEM teachers in teaching in Bangladesh universities, this could be associated with level of commitment of the teachers and their positive believe in technology integration in education as well as digital Bangladesh and IR 4.0 initiative programmes by the government of the People's Republic of Bangladesh. The study was limited to few variables of scientific attitude measure; it was also limited to UTAUT model among other models like TRA (theory of reasoned action), TPB (theory of planned behavior) and TAM (technology acceptance model) to mention but a few. Technology use attitude in teaching has less effect on gender and age of the STEM teachers in Bangladesh. Extension of UTAUT to examine further attitude measure using other independents variables, in this study also few demographic factors were tested, others could be used to measure using UTAUT modified theory (Ambigai et.al 2017). From the statistics of challenges in the scientific attitude measure presented in table 5, it was seen that above 75% of the respondents in this study experienced less challenges in the domain, conceptualization, teacher

training, objectives and contents. The results compared with the high frequency obtained in scale of 1, and less in the scale of 5 of the 5- point likert scale.

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